

Domestic / International Standards for Waste Tyres and Market Information

A Submission to the Department of Agriculture, Water and the Environment

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Glossary

Terminology	Definition
AAPA	Australian Asphalt Pavement Association
ACOR	Australian Council of Recycling
ATRA	Australian Tyre Recyclers
AV	Aviation tyres
BTA	Bus, Truck and Aviation tyres
COAG	Council of Australian Governments
CRM	Crumb Rubber Modified
DAWE	The Department of Agriculture, Water and the Environment
EOLT	End-of-life-tyres
FEM	Foreign End Markets program
GDT	Green Distilling Technologies
MRA	MRA Consulting
MRF	Materials Recycling Facility
NWRIC	National Waste and Recycling Industry Council
OTR	Off-the-road tyres
RAWR	Recycling and Waste Reduction Act 2020
RCA	Rubber crumb asphalt
SUV	Sports Utility Vehicle
TDF	Tyre Derived Fuel
TPA	Tonnes per annum
TSA	Tyre Stewardship Australia
WMRR	Waste Management and Resource Recovery Association

Executive Summary

MRA Consulting Group was engaged by the Department of Agriculture, Water and the Environment to identify domestic and international specifications that Australian exporters are likely to use to process waste tyres once the export of waste tyres becomes regulated.

From 1st December 2021, exporters will be prohibited from exporting waste tyres without a waste export licence and will be required to meet certain conditions set out in the licence and the legislation. This includes conditions requiring the waste be processed according to a specification prior to export. Following the introduction of the ban, the following waste tyre products will no longer be exported according to the Recycling and Waste Reduction Act 2020 (RAWR Act):

- Whole baled passenger tyres or tyres in pieces larger than 150mm

From 1st December 2021, a waste export licence is required to export the following waste tyres:

- Passenger, SUV, bus, truck and aviation (BTA) tyres for re-treading to a verified re-treading facility;
- Tyres that have been processed into crumbs, buffings, granules or shreds;
- Tyres that have been processed into shreds of not more than 150mm for use as tyre-derived fuel (TDF); and
- Tyres to an appropriate importer for re-use as a second-hand tyre.

The following information was reviewed and discussed with relevant stakeholders:

- Domestic and International standards and specifications used in the industry for waste tyres and TDF;
- Equipment and processing operations required to process waste tyres to these standards and specifications;
- The reuse and remanufacturing markets for waste tyres overseas and their quality requirements for recycled tyre material; and
- Market information regarding pricing and contracts between exporters and importers.

Most processors and exporters consulted expressed support for licencing the export of waste tyres, developing the tyre recycling sector in Australia and enforcing end-of-market verification to combat negative environmental outcomes overseas.

For waste tyres processed into TDF or granules, buffings and crumb rubber, no international standards or specifications were identified by stakeholders. It is likely that existing TDF exporters will meet the specification proposed by Tyre Stewardship Australia/Australian Tyre Recyclers Association (ATRA) or the 2" or 6" standards for TDF. The majority of stakeholders involved in the use of crumb into road products referred to the Austroads/Standards Australia rubber crumb standard that has been adopted by most state EPAs. Export of crumb rubber was reported as uncommon due to higher Australian prices compared to overseas.

Regarding tyres for re-treading, there were no set standards identified outlining the re-treading criteria or how tyres should be maintained prior to re-treading however, re-treading companies have internal standards (commercial in confidence). Stakeholders reported that BTA tyres are able to be re-tread one to six times depending on the type of tyre.

For whole tyres exported without compression (i.e. not baled), tyres are sold as second-hand tyres to be re-used as vehicle tyres. Stakeholders indicated the amount of tread required to be accepted was often 50%-60%, although this differed per customer and there is no relevant standard/specification. Some stakeholders raised concerns about the lack of transparency in import destinations.

Regulations and requirements for importers differ by country. Some countries have outright bans on whole baled tyres, processed tyres or both in response to rising local environmental concerns or to combat disposal fee arbitrage. In Australia, TSA administers the voluntary Foreign End Markets (FEM) program for whole baled tyres, processed tyres and tyres for re-tread.

Generally, retailers pay domestic processors and exporters for waste tyres. This price ranges from around \$1.50 per tyre for passenger tyres to more than \$5 per tyre for larger bus, truck and aviation tyres.

The market price of TDF was reported as comparable with international prices (\$0-21/t) however it was reported by domestic processors and exporters that the price of rubber crumb processed in Australia was \$400-600/t while the same product produced overseas was \$200-300/t. This is likely due to high domestic processing costs in addition to comparatively higher disposal levies being applied overseas to subsidise tyre recycling. While domestic retailers replacing tyres may charge customers a disposal fee of \$3 -4 per tyre, some stakeholders indicated that this is commonly not passed on to the processor/exporter to cover processing costs as intended.

It is estimated that currently 135,500 tonnes per annum (tpa) of whole waste tyres are exported from Australia, however there are no export figures available that distinguish between baled tyres, tyres for re-tread and tyres for re-use.

Multiple stakeholders indicated that unlike BTA tyres, passenger and SUV tyres are unlikely to be re-tread because a) most modern tyres are not designed to be and b) it is usually uneconomical to do so. Despite this, it was found that there are at least two businesses currently exporting passenger and SUV tyres for re-tread, most likely in small quantities. Spain, Portugal and Italy were re-tread destinations identified by stakeholders.

For tyres exported for re-use, there are three TSA-accredited businesses that export whole tyres to verified facilities and more than six non-accredited businesses that also claim to export whole tyres for re-use. A number of destinations for tyre re-use were identified including Trinidad and Tobago, USA, Spain and Singapore.

It is unlikely that processed waste tyre products for export would be considered 'hazardous waste' under the *Hazardous Waste Act 1989*.

1 Introduction

1.1 Waste export ban

In March 2020, the former Council of Australian Governments (COAG) announced a ban on the export of waste plastic, paper, glass and tyres. The purpose of the ban was to prevent the export of unprocessed waste which will likely have a negative environmental or health impact in the importing countries; to encourage Australian companies to take greater responsibility for the waste produced in Australia; and to develop Australia's capacity to recycle material and produce high value products with recycled content. The ban was legislated under the *Recycling and Waste Reduction Act 2020* (RAWR Act).

From 1 December 2021, all whole baled tyres or tyres in pieces larger than 150mm will be banned from export. From 1 December 2021, a waste export licence is required to export the following waste tyres:

- Passenger, SUV, bus, truck and aviation (BTA) for re-treading to a verified re-treading facility;
- Tyres that have been processed into crumbs, buffings, granules or shreds;
- Tyres to an appropriate importer for re-use as a second-hand tyre; and
- Tyres that have been processed into shreds of not more than 150mm for use as tyre-derived fuel (TDF).

The RAWR Act allows for supporting legislation to be made under it, referred to as the waste tyre 'rules'. The standards and specifications outlined in this report will help finalise those rules.

The ban of tyres for export presents an opportunity for the Australian market to increase its capacity to process and utilise end-of-life tyres (EOLT). The commodities which the tyre recycling industry in Australia currently produces are:

- Re-tread BTA tyres;
- Rubber crumb, granules and buffings;
- TDF; and
- High tensile steel.

Additionally, tyres are currently exported as:

- TDF;
- Casings (body of the tyre);
- Whole tyres (for re-use or re-tread); and
- Baled tyres not suitable for re-use.

1.2 Scope

In preparation for the waste tyre export ban, MRA Consulting Group (MRA) was engaged by the Department of Agriculture, Water and the Environment (DAWE) to identify domestic and international industry standards that Australian waste tyre exporters are likely to use when processing material to be exported. A desktop review and industry consultation were performed to gather information regarding:

- Standards, specifications and guiding principles used in the industry for processing waste tyres, maintaining waste tyres for re-treading and for re-use;
- Likelihood of Australian exporters processing to these standards/specifications;
- An overview of the equipment and operations required to process waste tyres and TDF to the standards identified;

- Likely reuses and remanufacture processes of waste tyres and TDF overseas; and
- Any assurance or verification methods used by importers to confirm processed waste tyres meet their requirements;
- Market information for the relevant material; including prices, margins and contractual arrangements;
- Potential for waste tyres to be considered 'hazardous waste' as defined in the Hazardous Waste (Regulation of Exports and Imports) Act 1989. If yes:
 - would processing requirements in the identified specifications/standards remove the hazardous characteristics; and
 - the likelihood that an overlap creates a situation where exporters cannot export hazardous waste under the Recycling and Waste Reduction Act 2020 but the facilities to safely dispose of said waste are not available in Australia;
- Data on passenger and off-the-road (OTR) tyres exported for re-tread and whole tyres exported for re-use including:
 - the number of exporters exporting these tyres;
 - tonnes exported; and
 - export destinations (country and specific re-tread facilities).

The organisations involved in the industry consultation component are outlined in Table 1.

Table 1: Stakeholders consulted

Industry Section	Organisation
Industry body	Tyre Stewardship Australia
	Australian Tyre Recyclers Association
	Waste Recycling Industry Association Queensland
Waste tyre recyclers, re-treaders, aggregators and exporters.	TyreCycle
	Ecoflex International
	Ozcom Recycling
	Chip Tyre
	Pearl Global
	Michelin Australia
	Goodyear & Dunlop Tyres
	Bandag Manufacturing (Bridgestone)
Users of processed waste tyres	A1 Rubber
	Downer Group

2 Waste Tyres

Tyres are essential components of an economy and are used across almost all industries in Australia. Australia generates approximately 466,000 tonnes of EOLT annually, with around 259,000 tonnes recovered for export¹.

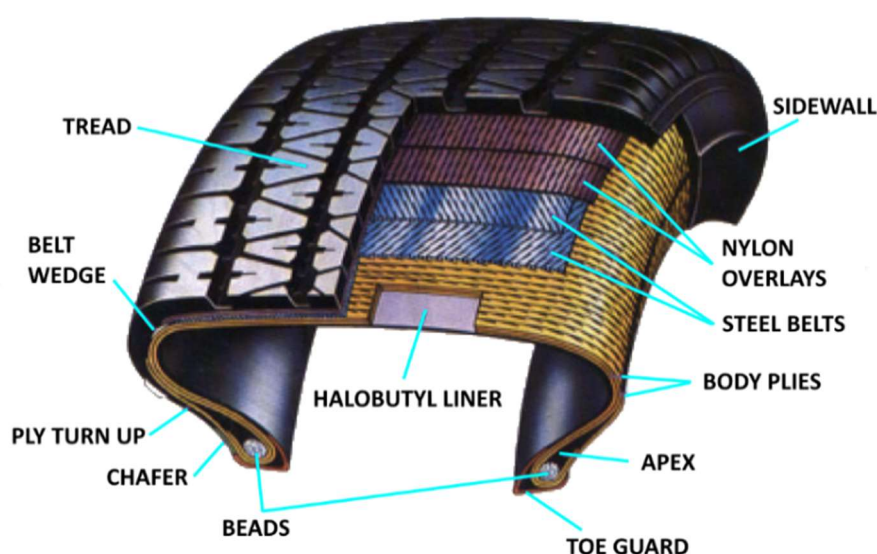
There are different types of tyres, but pneumatic (air filled) tyres, the major type of tyre in use, are generally made up of the following materials:

- natural and synthetic rubbers;
- steel;
- fibre (nylon and/or polyester);
- carbon black; and
- bonding agents.

The manufacture of tyres involves several components being assembled and moulded together in a curing process, which acts to bind components into a singular product.

Typical tyre components are shown Figure 1 and described in Table 2.

Figure 1 Tyre construction



Source: Adapted from WBCSD Tyre Industry Project 10 year progress report 2015 and 3M Group “Tyrewise 2.0” Report 2020

Table 2 Tyre structure

Component	Description
Bead	Rubber-coated steel cable which ensures the tyre remains attached to the wheel rim.
Belts	Rubber-coated layers of steel, fiberglass, rayon, and other materials located between the tread and plies, crisscrossing at angles, hold the plies in place.

¹ TSA 2019/20 Annual Report <https://crm.tyrestewardship.org.au/TSA0016%20AR2020-Web.pdf>

Component	Description
Body plies	This is the tyre itself, made up of several layers of plies. Plies include polyester and nylon and are coated with rubber to help bond with other plies and belts to seal in air.
Casing	The tyre casing is the body of the tyre and includes the Bead, Sidewall, Body and liner.
Liner	The innermost layer of a tubeless tyre that prevents air from exiting the tyre.
Rim	The outside of the inner metal wheel connecting the tyre to the wheel. Not considered a tyre component and not covered in this report.
Sidewall	The sidewall of the tyre protects the cord plies and features tyre markings and information such as tyre size and type.
Tread	The tread of a tyre or track refers to the rubber on the circumference that makes contact with the road.

Tyres are classified as being:

- Passenger tyres, including those used on passenger vehicles, motorcycles and, as well as trailers for domestic use;
- Bus, truck and aviation (BTA) tyres, including those used on buses, light and heavy commercial vehicles, aeroplanes, prime movers, trailers and semi-trailers, and fire fighting vehicles; and
- Off-the-road (OTR) tyres, including those used on machinery or equipment used in areas such as agricultural, mining and construction and demolition.

2.1 Waste tyre products

Most waste tyres are collected through Australian tyre retailers and industrial users. Tyres may be processed into several waste tyre products. The definition, source material and likely end uses of each waste tyre product is outlined in Table 3. Further details regarding crumb rubber sizes and end-use are provided in Appendix A.

Table 3 Waste tyre products

Waste tyre product	Definition	Source material	Likely end uses
TDF	TDF are shredded (generally to 50mm-150mm) waste tyres which serve as an alternative fuel source.	Primarily whole passenger tyres, but BTA and OTR tyres can also be processed with the appropriate equipment.	Alternative fuel source, likely to be used in industrial processes including as boiler fuel, paper mills and cement kilns.

Waste tyre product	Definition	Source material	Likely end uses
Rubber crumb/ powder, granules or buffings	Rubber granule: 2-15mm rubber. Fibre and steel has been removed from the rubber product.	Primarily bus and truck tyres due to a high natural rubber content compared with passenger tyres. There is limited domestic capacity to crumb OTR and AV tyres.	<ul style="list-style-type: none"> • Playground surfaces • Sporting mats • Sporting fields • Acoustic mats • Anti-slip mats • Equestrian surfaces
	Buffings: rubber component only cut to a <2mm size. Fibre and steel has been removed from the rubber product.	Derived from BTA tyres during the re-tread process.	<ul style="list-style-type: none"> • Matting • Moulded products
	Crumb rubber or powder: Very small pieces of rubber with no contaminants <.7mm	Primarily BTA tyres due to a high natural rubber content.	Used in industrial processes including spray on bitumen roads and additive to asphalt mix. <ul style="list-style-type: none"> • Adhesive tile glue • Bitumen and asphalt aggregates (road surfaces)
Whole tyres for re-tread	A whole tyre that has good structural quality where the tyre casing remains intact but the tyre tread requires renewed tread and sidewall rubber.	BTA and OTR tyres. Passenger tyres are not designed to be re-tread.	Re-used as a BTA tyre. Re-tread process can be repeated more than 3 times depending on the quality of the casing ²
Whole tyres for re-use	Whole tyres that have been discarded but still capable of being used.	Primarily passenger and OTR tyres.	Exported to countries with lax regulations for re-use as passenger, OTR or BTA tyres.

² Bridgestone Australia, Why retread Tyres <https://www.bridgestone.com.au/tyres/bandag/why-retread>

3 Standards and specifications

3.1 Processed tyres standards and specifications

There are some international standards and specifications for waste tyres processed into shred, crumb, granules and buffings, however none of these are widely used by industry in Australia. Rather, it was reported that material for export is processed to an agreed size depending on individual customer requirements.

While international specifications for processed waste tyres exist, these were not mentioned by stakeholders and therefore not identified as specifications that would likely be used by Australian exporters. Some international specifications and voluntary standards include:

- ISRI Scrap Specifications Circular Guidelines for Tire Scrap
- ATSM D6270 Standard Practice for Use of Scrap Tires in Civil Engineering Applications
- ATSM D6114/D6114M Standard Specification for Asphalt-Rubber Binder
- ATSM D6700-19 Standard Guide for Use of Scrap Tires as Tire-derived Fuel.

Nationally, a number of national standards or specifications widely used in Australia were identified by stakeholders, Table 4. The details of the international and national specifications are provided in Appendix B.

In view of the forthcoming export ban, Tyre Stewardship Australia (TSA) and Australian Tyre Recyclers Association (ATRA) have recently proposed a processing standard which must be met for export. According to TSA/ATRA, requiring processors to export to this standard would help prevent the formation of a secondary / illegitimate market that would funnel Australian waste materials to unsustainable offshore applications³.

Several stakeholders cited the #30 mesh rubber crumb standard (AGPT/T190) as specified by Austroads. This standard has been adopted by most state EPAs as the required standard for rubber crumb suitable for bitumen spray roads.

The likelihood of Australian exporters or waste tyre processors using these standards depends largely on the intended end-use and not on specific importer requirements or industry standards.

It is likely that existing TDF (shred) exporters will meet either the TSA/ATRA or industry processor 6" or 2" standards as most TDF currently exported are shred to 50-80mm⁴. The 6" and 2" standards have been developed by an industry leader to meet their established customer demands in Asia and therefore are likely to remain in use.

Due to the upcoming ban, some businesses that currently bale and export tyres (mainly for pyrolysis) have invested or plan to invest in shredding infrastructure to continue operating.

³ TSA/ATRA, Draft tyre export specifications 2021

⁴ TSA website

Table 4 Standards and specifications for processed tyres used by Australian processors

Specification/ standard title:	TSA/ATRA recommended minimum standard ⁵	6" (150mm) Tyre Derived Fuel ⁶	2" (50mm) Tyre Derived Fuel ⁷	AGPT/T190 - Size #16 ⁸	AGPT/T190 - Size #30 ⁹	CRM OGA - Pilot Specification ¹⁰
Publisher	TSA/ATRA	Industry processor (internal standard)	Industry processor (internal standard)	Austrroads/ Standards Australia	Austrroads/ Standards Australia	Australian Asphalt Pavement Association
Material type and size	TDF shred <150mm, rubber crumb	TDF shred <150mm	TDF shred <50mm	Rubber crumb 0.6- 1.18mm	Rubber crumb (powder) 0.3-0.6mm	Rubber crumb (granule) 10-14mm
Likely end uses	TDF for industrial processes	TDF for industrial processes	TDF for industrial processes	Bitumen road spray	Bitumen road spray and tile adhesive glue	Asphalt mix
Operation s/ machiner y required to meet specification	Primary shredders	Primary shredders	Primary and secondary shredders	Primary shredders, secondary shredders, grinding mill	Primary shredders, secondary shredders, grinding mill	Primary shredders, secondary shredders, grinding mill

3.2 Tyres for re-tread standards and specifications

Re-treading is the process of replacing the outer tread of a tyre. Re-treading is considered suitable for BTA tyres however it is rarely suitable for passenger tyres due to them being composed of thinner materials. Unlike passenger car or OTR tyres, BTA tyres are specifically designed to be re-tread and extract maximum value from the casing. There is no standard or specification that outlines the maximum number of times a tyre casing can be re-tread.

⁵ TSA and ATRA 2021, Draft tyre export specifications 2021.

⁶ Industry processor internal standard.

⁷ Industry processor internal standard

⁸ Australian bitumen specification AS 2008, Specification Framework for Polymer Modified Binders – test Method AGPT/T190. <https://austrroads.com.au/publications/pavement/agpt-t190-19>

⁹ Australian bitumen specification AS 2008, Specification Framework for Polymer Modified Binders – test Method AGPT/T190. <https://austrroads.com.au/publications/pavement/agpt-t190-19>

¹⁰ Australian Asphalt Pavement Association, 2018, Crumb Rubber Modified Open Graded and Gap Graded Asphalt - Pilot Specification. <https://www.afpa.asn.au/wp-content/uploads/2018/06/CRM-OGAGGA-Model-Specification-v1-12-June-2018.pdf>

Aviation (AV) tyres are highly specifically designed to be re-tread multiple times. Some AV tyres are designed to be re-tread more than 7 times¹¹, although industry stakeholders advised most are only re-tread 2-3 times. The process for inspecting casings for re-tread is highly technical and can only be undertaken at an approved AV re-treading facility.

It was reported by stakeholders that bus and truck tyres are able to be re-tread as long as the casing of the tyre remains undamaged. One stakeholder reported that most bus and truck tyres in Australia are only re-tread once or twice, while others suggested it wasn't uncommon for tyres to be re-tread up to 6 times.

All tyres submitted for re-treading are tested and inspected to reject any that have suffered abuse including: underinflation, overloading, incorrect repairs or with significant damage.¹² Tyres are inspected visually and using sophisticated equipment such as a shearography machine to determine the condition of the casing. There are no set standards outlining how tyres need to be maintained before re-treading or the exact criteria for re-treading however re-treaders reported that they have their own judgement criteria which include aspects such as:

- The brand of the casing;
- The age of the casing; and
- Whether the casing is a “clean skin” or a re-tread.

During visual inspection, details to look for to determine if a casing is appropriate for re-tread include:

- nail hole injuring;
- liner splits; and
- bumps and separations.

It was reported that almost all tyre casings can be re-tread to meet the Australian standard for re-tread tyres however it is often not economical to do so.

There is one main company in Australia that re-treads tyres domestically. It operates one site which manufactures the pre-treated tread (Wacol, QLD) and 19 company owned and franchised sites which apply the tread to the tyre casings (see Appendix C for locations).

All tyres re-tread in Australia by this company are manufactured to meet the Australian Standard AS1973-1993¹³ for truck and bus tyres as well as to more stringent internal standards (commercial in confidence). However, various stakeholders mentioned that the AS 1973-1993 standard is relatively lenient.

All tyres that are re-tread in Australia or imported into Australia must meet the AS1973-1993 standard. A list of standards and specifications that re-tread tyres must meet before use is included in Section 4.2 which covers the re-treading process and in Appendix A.

3.3 Tyres for reuse standards and specifications

Tyres which are replaced but not fully worn are often sold on by a tyre collector though a seconds or re-use market. Stakeholders claimed there was small domestic demand for re-used tyres but that genuine markets existed overseas.

Exporters mentioned that generally only tyres with >50% tread remaining were accepted in export markets for re-use. However, there is no relevant standard/specification dictating tread wear or other minimum requirements for tyre re-use and therefore acceptability is dictated by individual customers/importers.

¹¹ Dunlop Aircraft Tyres <https://www.dunlopaircrafttyres.co.uk/technical/retreading-process>

¹² TSA 2019, TSA re-treading fact sheet 2019.

¹³ Bridgestone Australia consultation

Although there may be genuine export markets for re-use tyres there is no way of guaranteeing they will be re-used as intended.

4 Equipment and Processing Operations

4.1 Tyre processing

Recycling of waste tyres into shreds or crumbs involves a mechanical process. A high-level overview is presented in Figure 2 and a more detailed description is provided below (the numbered points below do not correlate to those in Figure 2):

1. **Shredding:** a shredder, such as a rotary shear shredder, is first used to reduce the waste tyres to smaller pieces generally less than 150mm in size. A wire drawing machine is an optional piece of equipment that may be used prior to shredding to draw the tyre wires out of the tyre to protect the blades of the shredder.
2. **Contamination removal:** steel, nylon and fibre contaminants are removed from the shredded tyres via a drum magnet and air separation (blower). After passing through the shredder or a series of shredders and removal of the steel, the <150mm output can be traded as TDF or further processed into rubber granules or crumb.
3. **Size reduction:** a secondary shredder, also known as a grater or rasping machine, may be used for further size reduction (10-44mm) to create “rubber mulch”.
4. **Granulation:** the shredded rubber is put through a granulator to form rubber granules (2-15mm).
5. **Crumbing:** the rubber may be further processed into a powder-like crumb less than 0.7mm in size via a grinding mill or “miller”. This may first involve a dust removal system and further fibre removal via a zig-zig screen.
6. **Buffings** are an output of the re-treading process as opposed to an output of the crumb/granule processing operations. Buffings are similar to granules however they are less than 2mm and are the pure tyre rubber that is shaved off the tyre casing before the new tread is applied.

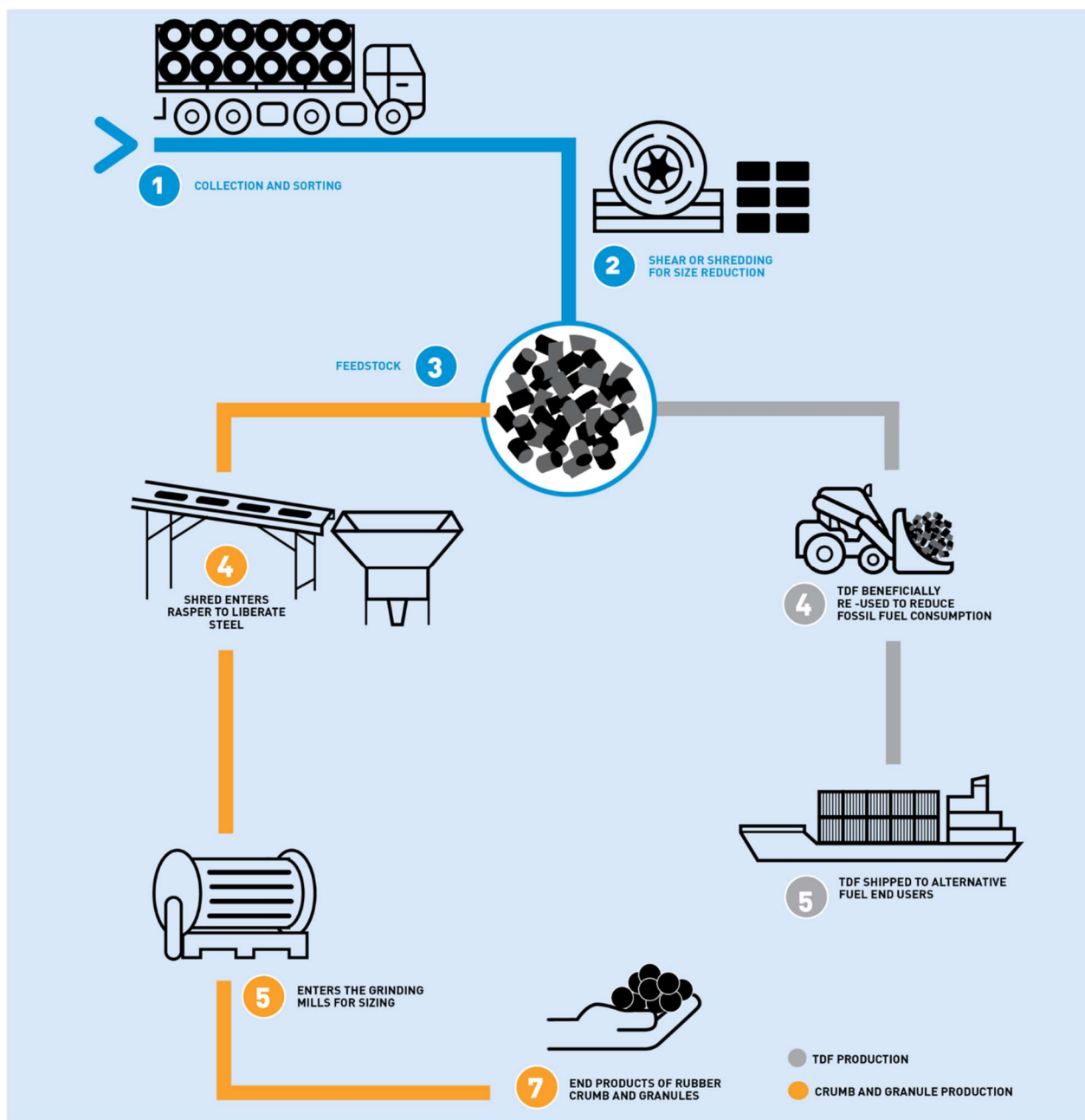
Throughout the recycling process, conveyors are used to transport material to each subsequent piece of equipment. Additional screens, such as a disc classifier, vibratory conveyor or taper slot conveyor, may be employed throughout the process to classify material by size. Oversized pieces may be removed or re-fed through the shredder or granulator to ensure appropriate size reduction is achieved.

The cost and size of a shredding operation can vary widely with plants ranging from \$1 million to \$13 million. Some operations may involve multiple shredders, granulators and blowers to process high quantities of material and ensure removal of contaminants. Well-known brands of tyre recycling equipment include Tana, Barclay, Eldan and Columbus McKinnon. Descriptions of equipment are provided in Appendix D along with example equipment that may be utilised by processors. This list is not exhaustive and is provided as a guide only.

For a facility processing approximately 20,000 tonnes per year, it is estimated that the following staff would be required:

- 1 plant manager;
- 6 operators per shift; and
- 2 maintenance technicians per shift.

Figure 2 Tyre shredding and crumbing recycling process flow



Source: Tyrecycle

4.2 Re-treading tyres

The process of re-treading truck and bus tyres is presented in Figure 3 and involves the following steps:

1. **Inspection:** tyres are inspected visually and using sophisticated equipment to ensure they meet the relevant acceptance criteria.
2. **Buffing:** removal of the tyre's old tread is performed using high-speed buffers. Computerised machinery allows exact dimension requirements to be met. High-powered fans are used to collect buffings for recycling.
3. **Repairing:** the casing is inspected and any surface injury is repaired.
4. **Building:** new tread material (rubber) is applied to the casing via a building machine to the exact dimensions required.
5. **Curing:** the built tyre is put through a hot curing process to ensure the new rubber is vulcanised to the original casing.

Upon re-treading, the re-treaded tyre must meet the relevant specifications or standards before use. Some key specifications and standards are listed in Table 5.

For AV tyres, the industry is tightly regulated with few manufacturers and a limited customer base. The international specification for re-treaded AV tyres is SAE ARP4834B. It was reported by a stakeholder that re-treaders use this specification, and the AC145-4A specification, as guidance and develop a re-tread specification capturing their own unique process. These specifications are then approved by a recognised airworthiness authority, such as the US Federal Aviation Administration (FAA), and access to these specifications is governed by intellectual property (IP) restrictions. Australia accepts FAA certification for re-tread. Facilities are also independently audited by national airworthiness authorities.

For truck and bus tyre casings exported for re-tread, there are no industry wide standards or specifications used. Rather, truck and bus tyres are visually inspected before export and again upon arrival. Industry sources indicated that, even with pre-export inspection, the average rejection rate re-treaded casings are around 10%. This is because some casing damage can only be identified during the re-tread process.¹⁴

Table 5 Specifications and standards for re-tread tyres

Specification/standard title	Publisher	Location	Material Type
SAE ARP4834B Aircraft Tire Retreading Practice - Bias and Radial ¹⁵	SAE International	International	Re-tread aviation (AV) tyres
AC145-4A : AC Inspection, Retread, Repair, and Alterations of Aircraft Tires ¹⁶	Federal Aviation Administration	United States of America	Re-tread aviation (AV) tyres
AS1973-1993 Pneumatic Tyres - Passenger Car, Light Truck and Truck / Bus -	Standards Australia	Australia	Re-tread truck waste tyres

¹⁴ Stakeholder consultation

¹⁵ <https://www.isri.org/recycling-commodities/scrap-specifications-circular>

¹⁶ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_145-4A_CHG_1.pdf

Specification/standard title	Publisher	Location	Material Type
Retreading and Repair Processes ¹⁷			
AS4457.2-2008 Earth-moving machinery - Off-the-road wheels, rims and tyres - Maintenance and repair Tyres ¹⁸	Standards Australia	Australia	Re-tread waste tyres
NZS 5423:1996 Specification for repairing and retreading car, truck and bus tyres ¹⁹	Standards New Zealand	New Zealand	Re-treading waste tyres
ISO 83.160.10 Road vehicle tyres Including cycle tyres, and tyre retreading and repair processes ²⁰	International Organization for Standardization	International	Re-treading waste tyres

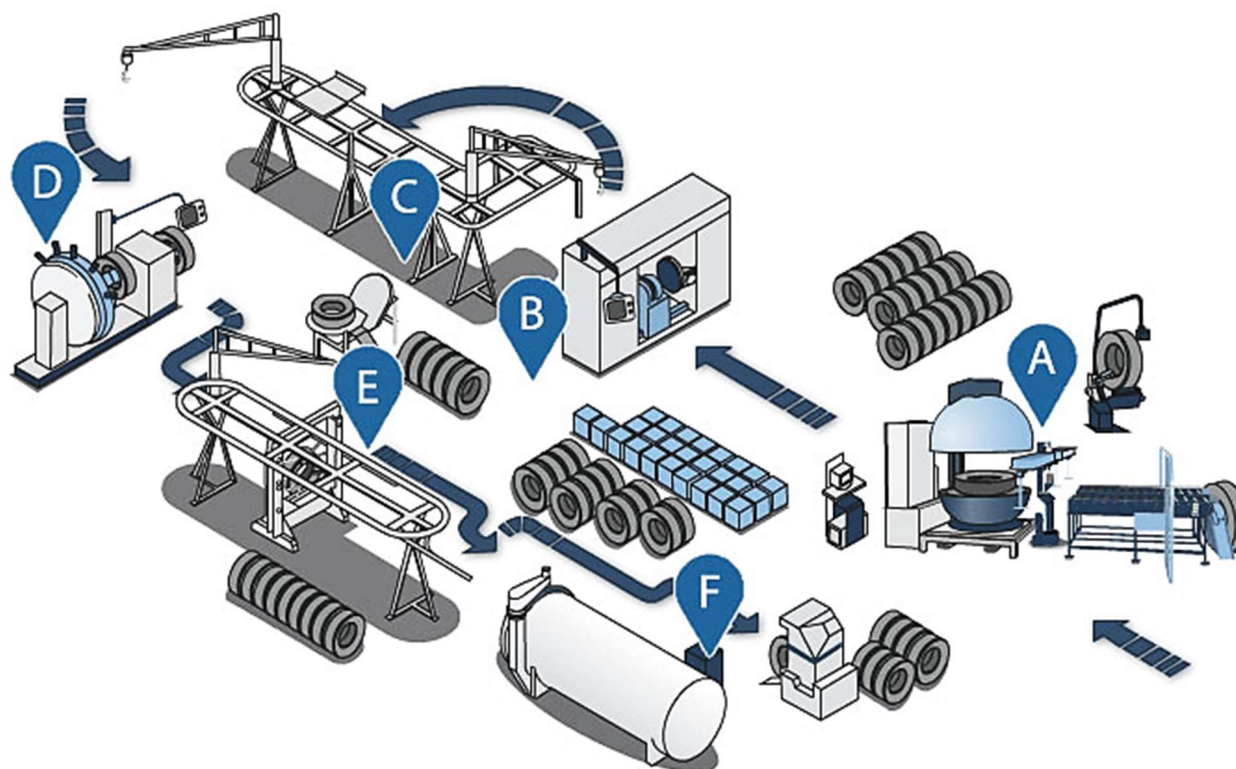
¹⁷ <https://ablis.business.gov.au/service/wa/australian-standard-as-1973-1993-pneumatic-tyres-passenger-car-light-truck-and-truck-bus-retreading-and-repair-processes/17544>

¹⁸ https://infostore.saiglobal.com/en-us/standards/as-4457-2-2008-130476_saig_as_as_276323/

¹⁹ <https://www.standards.govt.nz/shop/nzs-54231996/>

²⁰ <https://www.iso.org/ics/83.160.10/x/>

Figure 3 Truck tyre re-treading process flow



Key:

- A) Inspection
- B) Buffing
- C) Repair damage

- D) Building tread rubber
- E) Rim mounting & enveloping
- F) Curing

Source: Marangoni Re-treading Systems

5 Import Markets and Requirements

5.1 Reuse and re-manufacturing markets

5.1.1 Processed tyres

Around 90% of exported product are in the form of a <150mm shred used as a tyre-derived fuel (TDF)²¹. As outlined previously, TDF is used as fuel in industrial processes including cement kilns, boiler fuels and paper mills. Stakeholders indicated the primary markets for TDF are Korea, India, Malaysia and Thailand.

Stakeholders indicated it was rare for other processed tyres (rubber crumb, granule or buffings) to be exported for re-manufacture due to sufficient domestic demand and high sea freight costs. Stakeholders indicated any exported rubber granule or crumb would most likely be used in rubber matting or bitumen spray.

5.1.2 Tyres for re-use

For whole tyres exported without compression (i.e. not baled), tyres are sold as second-hand tyres to be re-used as vehicle tyres. The price and demand of re-use tyres is dictated by the condition (usually tread level) of the waste tyre. Stakeholders indicated the amount of tread required to be accepted was often >50%-60%, although this differed per customer. Some stakeholders raised concerns about the lack of transparency in import destinations, even if importers had been verified via TSA's Foreign End Market (FEM) process (see 5.3). Concerns were raised by some stakeholders about the occurrence of approved importers accepting large volumes of tyres for re-use but subsequently on-shipping containers to lower regulated countries for disposal.

The most common export destination for Australian tyres for re-use are The United States, India, Malaysia, Singapore, Spain and El Salvador.

Stakeholders mentioned the market for re-use tyres in Australia is small (approximately 20,000tpa) compared with demand from export markets. It was indicated that Australian consumers are unlikely to purchase second-hand tyres due to the penetration of low cost tyres on the retail market.

5.1.3 Tyres for re-tread

Passenger, SUV, truck, bus and AV tyres are exported from Australia for re-tread.

Re-tread tyres are imported to Australia by large multi-national tyre manufacturers. All re-tread stakeholders interviewed export tyres for re-tread and re-import back into Australia. Some manufacturers own their overseas re-treading facilities while others have long standing contracts with reputable re-treaders. Some re-tread tyres belong to the customer for the life of the tyre (AV tyres are usually leased) while other manufacturers distribute re-tread tyres across their retail networks to meet specific demand. In this case Australian casings exported for re-tread will not be re-imported for sale and will most likely be sold in South-East Asia.

Truck tyres that are re-tread in Australia are likely to be exported within the Asia Pacific area, including to:

- New Zealand
- South Korea
- Fiji
- Thailand
- Other South-East Asian countries

²¹ TSA and ATRA 2021, Draft tyre export specifications 2021.

All AV tyres exported for re-tread are re-imported into Australia. For AV tyres, there are only four companies that operate facilities globally that re-tread tyres. Due to the highly technical nature of AV tyres compared with bus or truck tyres, it is only possible to review the casing for re-tread appropriateness with specialist equipment located at one of these facilities²².

There is no international verification or standard that re-reading facilities must meet. The most common domestic verification of overseas re-tread tyre facilities is TSA's Foreign End Markets (FEM) verification process (see Section 5.3). This is an optional verification process used by TSA's members and non-members and involves an onsite inspection from global auditing company Intertek²³.

All other verification of re-tread facilities will be dependent on the relevant domestic legislation.

For example, in Malaysia re-tread facilities must apply for a license to import casings and sign a K1 declaration form²⁴ upon receiving imported casings.

5.1.4 Whole baled tyres

Most whole baled tyres are currently exported for use in pyrolysis plants.

The pyrolysis process thermally decomposes the waste tyre materials into various oil components, low grade steel, water and residual waste. Some domestic pyrolysis capacity in Australia exists but pyrolysis is still an emerging and untested technology in the Australian context²⁵

Some baled tyres are imported into Asia and Africa and can be de-compressed and used on vehicles, however stakeholders agreed the tyre casing may be damaged by this.

In cases where baled tyres are exported most of the EOLT issue to neighbouring countries which opens the possibility of unregulated pyrolysis emissions elsewhere in the world.

5.2 Importer requirements

In general, regulations largely consist of whether countries accept waste tyre products or not. Many countries have outright bans on whole baled tyres, processed tyres or both. This is mainly in response to rising local environmental concerns. Many respondents also noted that countries are beginning to place greater scrutiny on the use of TDF both in terms of the quality of shred that is accepted and in ensuring that it is used in approved applications.

Overall, less developed countries are more likely to ban the importation of whole baled tyres to combat disposal fee arbitrage (i.e. exporting to countries with low or no disposal costs) in order to avoid high disposal costs which exist in high income countries. As most advanced economies have high waste disposal fees, it is not uncommon for unscrupulous operators to try to export unusable waste tyres under the guise of reuse in order to avoid relatively high domestic disposal costs.

Respondents did raise the possibility of containers being re-routed through a number of ports to avoid such bans.

Some developed countries do require importers to have a license to import waste tyre products, in particular for the importation of casing for re-tread. Industry has advised this is to confirm companies are not importing new tyres marked as casings in an effort to avoid duties and taxes.

²² Industry consultation

²³ TSA Foreign End Market Verification <https://www.tyrestewardship.org.au/accreditation/foreign-end-market-verification/>

²⁴ Royal Malaysian Customs Department 2014, Import Procedure.

²⁵ Arup/Rawtec 2018, Tyre Pyrolysis and Gasification technologies <https://www.tyrestewardship.org.au/wp-content/uploads/2020/04/tyre-pyrolysis-and-gasification.pdf>

5.3 Verification processes

TSA administers the primary verification processes for Australian retailers, , recyclers and collectors.²⁶ TSA was formed to implement the Tyre Product Stewardship Scheme, an Australian Government Accredited Product Stewardship Scheme²⁷.

Domestically, TSA administers a TSA Accreditation scheme whereby EOLT collectors and recyclers may apply for accreditation based on TSA's Sustainable Outcomes Indicator (SOI) framework.²⁸

For exporters of waste tyres, TSA administers the Foreign End Markets (FEM) Program, which is linked to TSA's SOI framework.²⁹ Currently, the only industry wide certification system for verifying the export of waste tyres from Australia is TSA's FEM Program.

Figure 4 Foreign End Market Verification process



Source: Tyre Stewardship Australia

The FEM process currently covers whole baled tyres, processed tyres (shred, crumb, granule) and tyres for re-tread.

Under the Waste Tyres Rules, tyres for retread must nominate an appropriate retreading facility..

Licence holders will be required to have their chosen foreign end market locations verified, where the verification process involves the following steps:

- Education;
- Self Assessment Questionnaire (SAQ);
- Verification (by independent third party); and
- Site inspection (by independent third party, where requirements of SAQ are not met).

An online SAQ is to be completed by the identified foreign end market location (receiving permissible exports), this process includes key focus areas:

- Modern Slavery: labour rights, incl wages, underage workers;

²⁶ TSA Overview <https://www.tyrestewardship.org.au/about-tsa/overview/>

²⁷ TSA Overview <https://www.tyrestewardship.org.au/about-tsa/overview/>

²⁸ TSA Accredited Entities <https://www.tyrestewardship.org.au/accreditation/find-accredited-recyclers-collectors/>

²⁹ TSA Foreign End Market Verification <https://www.tyrestewardship.org.au/accreditation/foreign-end-market-verification/>

- Health and Safety: personal protective equipment, machinery condition/guarding, workplace conditions (appropriate facilities, including first aid), training (emergency response) and standard operating procedures;
- Environment: permitting, emissions to air/land/water and controls in place); and
- Distribution: safe transport, product delivered to site remains on site for processing and is not sent offsite for use that may cause harm.

Foreign end market locations whose SAQs receive a low score will be audited by a third party auditor, including via a site visit and an audit of the key focus areas identified above.³⁰

³⁰ TSA Foreign End Market (FEM) Verification <https://www.tyrestewardship.org.au/accreditation/foreign-end-market-verification/>

6 Market information

6.1 Pricing and margins

In general, waste tyres are seen domestically and internationally as having negative value. That is, processors and exporters of waste tyres are usually paid to receive tyres by retailers. In Australia, the value of waste tyres ranges from around \$1.50/tyre for passenger tyres to more than \$5 /tyre for larger bus, truck and aviation (BTA) tyres, see Table 6.

Table 6 Price to collect tyres

Tyre type	Market price to collect (i.e. retail disposal cost)
Passenger and SUV	\$1.50-\$3 per tyre
BTA tyres	\$3-\$5 per tyre (variations depend on size and ability to be re-tread)

Like most waste streams, waste tyres tend to be sold to the cheapest disposal/management option. For passenger and SUV tyres, this is currently:

- a) Bale as whole tyres and export (generally for pyrolysis); or
- b) Shred and export as tyre-derived fuel (TDF).

For BTA tyres, the cheapest management option depends on whether they can be re-tread. The disposal/management options for BTA tyres are:

- a) Re-tread domestically;
- b) Re-tread internationally; or
- c) Shred into rubber crumb (generally used domestically).

Over 400,000 truck tyres are re-tread in Australia at one of the remaining 19 re-tread facilities³¹. At an average weight of 50kg per tyre, this equates to more than 20,000tpa of tyres re-tread in Australia. Approximately 200,000 truck tyres are re-tread outside of Australia with approximately 20,000 tyres re-imported for Australian use³².

Prices for the processed waste tyre products (TDF and rubber crumb) conforming to the standards and specifications identified in Section 3 and tyres for re-tread, are shown in Table 7. The domestic price is the market price that Australian processors/exporters can sell their product for, whether that is to an Australian or international customer. The international price is the market price that overseas processors/exporters can sell their product for, whether that is to an Australian or international customer. The discrepancy between the domestic and international price is due to the low cost of processing or heavy subsidisation of processing overseas, discussed below. Most stakeholders declined to reveal their processing costs and profit margins as these were deemed commercial in confidence.

All prices are ex-works (excluding shipping) to remove the impact of volatile shipping costs.

³¹ Stakeholder consultation

³² Confidential source

Table 7 Waste tyre products market prices

Standard/ Specification	Product type and size	Processing costs (\$/tyre)	Domestic price (\$/tonne)	International price (\$/tonne)
TSA/ATRA 150mm specification	TDF (shred) <150mm	1.00-1.50 ³³	0-21	0-21
	Rubber crumb <4mm	Not reported	500-650	200-300
	Rubber crumb (granule) 10- 12mm	Not reported	400-600	200-300
2-inch and 6-inch standards	TDF <150mm and <50mm	1.00-1.50 ³⁴	0-21	0-21
AGPT/T190 - Size #16 (bitumen road spray)	Rubber crumb 0.6-1.18mm	Not reported	400-600	200
AGPT/T190 - Size #30 (bitumen road spray)	Rubber crumb (powder) 0.3- 0.6mm	Not reported	400-600	200
CRM OGA - Pilot Specification (asphalt m ix)	Rubber crumb (granule) 10- 14mm	Not reported	400-600	200
N/A	Baled passenger tyres	Not reported	Not reported	Not reported
N/A	Passenger tyres for re-tread	N/A	Not reported	Not reported
N/A	Truck tyres suitable for re- tread (casing)	Not reported	20-45 (per tyre)	35-45 (per tyre)
AS1973-1993 Pneumatic Tyres - Passenger Car, Light Truck and Truck / Bus - Retreading and Repair Processes	Re-treaded truck tyres	Not reported	150-250 (per tyre)	Not reported

³³ Reported by one stakeholder with economies of scale. Likely to be higher for smaller scale shredders.

³⁴ Reported by one stakeholder with economies of scale. Likely to be higher for smaller scale shredders.

The prices listed above were provided by stakeholders. Stakeholders indicated that the market price for TDF is highly volatile and aggressively traded amongst international processors.

The concentration of low-cost export options (i.e. TDF and whole baled tyres) has limited the creation of domestic secondary processing markets. One reprocessing stakeholder indicated that rubber crumb could be imported at approximately \$200/t while domestic prices range between \$400-600/t. This is likely due to high domestic processing costs in addition to comparatively higher disposal levies being applied overseas to subsidise tyre recycling. For example, the European Union Landfill Directive³⁵, has resulted in tyre recycling levies of more than \$3.00AUD/tyre^{36,37}. The equivalent disposal schemes in Australia (TSA) only charge 25c per tyre³⁸. While domestic retailers replacing tyres may charge customers a disposal fee of \$3.00-4.00 per tyre, some stakeholders indicated that this is commonly not passed on to the processor/exporter to cover processing costs as intended. Instead, retailers pay \$1.50-3.00 per tyre to processors/exporters and pocket the difference, representing an arbitrage opportunity for retailers.

When discussing prices, almost all stakeholders interviewed mentioned the recent increased cost of containerised transport for exports. Shipping costs are covered by the exporter and the COVID-19 pandemic has seen freight costs rise to between \$8000 - \$13,000 for a container of tyres. As a result of high shipping costs, the export of waste tyres and waste tyre products has become a marginal or in some cases loss-making business. The cost of freight almost always outweighs the value of the processed tyres. Some stakeholders reported that the higher shipping costs have increased the level of domestic stockpiling and landfill (where it is legal to do so).

All stakeholders believed that the increase in freight costs (coupled with the export ban) would eventually flow through to higher retail disposal costs.

6.2 Contract information

Exporters of whole baled tyres, TDF, tyres for re-tread and tyres for re-use all employed a combination of contract and spot price arrangements.

Almost all export stakeholders indicated they exported to multiple customers. One major TDF exporter advised they had employed a local sales team based in South-East Asia to manage relationships and secure new offtake arrangements. All exporters advised that the market for processed waste tyres was dynamic and the number of import customers changed frequently according to demand and changes in domestic regulations.

For TDF, which makes up approximately 90% of tyre exports, it was reported that Australian exporters were price-takers and were more likely to be subject to spot pricing arrangements due to the volatile market prices for TDF. Longer term contracts also exist but are less common. The re-tread and re-use markets are comparably smaller and much more dependent on individual importer arrangements. All stakeholders agreed that variations in shipping costs greatly outweighed any change in export prices for all forms of waste tyres.

All relevant stakeholders interviewed indicated that rubber crumb is unlikely to be exported due to Australia's relatively high processing costs in addition to freight costs. One stakeholder reported that there is currently not enough domestic finer crumb for end use applications and that a 40/60 split of domestic/imported rubber crumb was used in Australia. Domestic end market applications as described in Table 3.

³⁵ European Union Law <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31999L0031>

³⁶ Italia EPR scheme <https://www.ecopneus.it/en/who-we-are/system-and-management/eco-fees/>

³⁷ Spanish EPR scheme <https://www.signus.es/tarifa-ecovalor/>

³⁸ TSA levy per equivalent passenger unit (EPU) <https://www.tyrestewardship.org.au/about-tsa/scheme/>

7 Tyres exported for re-tread and re-use

7.1 Number of exporters

Multiple stakeholders indicated that unlike BTA tyres, passenger and SUV tyres are unlikely to be re-tread as most modern tyres are not designed to be. Stakeholders also advised that it is usually uneconomical to retread passenger and SUV tyres. However, it was found that there are at least two businesses currently exporting passenger and SUV tyres for re-tread. Industry stakeholders advised that most exporters of re-tread and re-use tyres are small family-run businesses which export small tonnages at times when shipping rates are low.

The exact number of exporters is unknown as there is currently no requirement for exporters to obtain a license for export or be registered with an industry body such as TSA.

For tyres exported for re-use, there are three TSA-accredited businesses that export whole tyres to verified facilities and more than six non-accredited businesses that also claim to export whole tyres for re-use. However, the exact number of businesses exporting tyres for re-use is unknown for the same reasons listed above for re-tread tyres.

7.2 Volume of exports

Currently 135,500 tpa³⁹ of whole waste tyres are exported from Australia (Table 8), however there are no export figures available that distinguish between baled tyres, tyres for re-tread and tyres for re-use.

The exact volume of passenger and SUV tyres exported for re-tread is unknown. Multiple stakeholders suggested that due to the current high cost of shipping it was likely to be under 10,000tpa.

Table 8 Recovery of EOLT in Australia (tonnes)

Domestic	Export (processed)	Export (whole)	Total
69,000	127,500	135,500	332,000

Source: Material flow analysis, TSA 2020

7.3 Export destinations

For passenger and SUV tyres exported for re-tread, the following destinations were identified by stakeholders:

- Spain
- Portugal
- Italy

Stakeholders advised that information about specific re-tread facilities and businesses was commercial-in-confidence.

For whole tyres exported for re-use, the following destinations were identified by stakeholders:

- Trinidad and Tobago
- Italy
- Liberia
- South Africa
- USA
- Sierra Leone
- Spain
- Singapore
- Japan
- Portugal
- Nigeria

³⁹ TSA, Tyre Consumption and Recovery in Australia 2021

8 Relevance to the Hazardous Waste Act 1989

The *Hazardous Waste Act 1989* controls the export of hazardous waste, requiring permits be obtained before hazardous waste is exported or imported. A waste is considered hazardous if it is listed in the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* or in the *OECD Regulations*. Waste tyres contain various substances listed as hazardous under the Basel convention (Table 9). However, it is unlikely that any of the processed waste tyres would be considered 'hazardous waste' under the Basel Convention unless they exhibited "hazardous characteristics" as listed in Annex 3 of the Convention⁴⁰.

Table 9 Basel Convention hazardous waste constituents found in waste tyres

Chemical name	Content (% by weight)
Copper Compounds	Approx 0.02%
Zinc Compounds	Approx 1%
Cadmium	Max 0.001%
Lead; Lead Compounds	Max 0.005%
Acidic solutions or acids in solid form	Approx 0.3%
Organohalogen compounds other than substances in Annex 3	Content of halogens max 0.10%

Source: <http://www.basel.int/Portals/4/Basel%20Convention/docs/meetings/sbc/workdoc/old%20docs/tech-usedtyres.pdf>

According to the Revised Basel Technical Guidelines, tyre components have no hazardous properties and are therefore not intrinsically hazardous⁴¹. If, however, they are improperly managed and disposed of, they may pose risks to public health and the environment.

The key hazardous risks outlined in the Basel Convention relate to the transport and storage of whole tyres, as these can provide ideal breeding grounds for disease carrying mosquitos/larva. In addition, stockpiled tyres are a significant fire risk⁴².

Stakeholders indicated however that all tyres for re-tread, re-use and processed tyres are exported in waterproof shipping containers and that it was a condition of import customers/facilities that tyres be free of water, dirt and soil.

Therefore, processed waste tyres are unlikely to be classified as 'hazardous waste' under the *Hazardous Waste Act 1989*.

⁴⁰ Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal, <http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf#page=81>

⁴¹ Basel technical guidelines <http://www.brsmeas.org/Resources/Shared/scripts/appPubKit/docs/04a-BaselConvention-TechnicalGuidelinesTyres.English.pdf>

⁴² Basel technical guidelines <http://www.brsmeas.org/Resources/Shared/scripts/appPubKit/docs/04a-BaselConvention-TechnicalGuidelinesTyres.English.pdf>

9 Conclusion

Most processors and exporters consulted expressed support for licencing the export of waste tyres, developing the tyre recycling sector in Australia and enforcing end-of-market verification to combat negative environmental outcomes overseas. Some stakeholders also expressed concern about the current lack of demand for waste tyre products and the potential for increased stockpiling following the ban. This is assumed to be due to whole baled tyres currently being exported for pyrolysis, an end-market that is not well developed in Australia.

International standards and specifications for processed waste tyres were not identified by stakeholders. The majority of stakeholders referred to the Austroads/Standards Australia rubber crumb standard that has been adopted by most state EPAs. It is likely that existing TDF exporters will meet the TSA/ATRA or industry processor standards for TDF. There are no set standards outlining the criteria for inspecting tyres for re-tread or how tyres should be maintained prior to re-treading, however re-treaders reported that they have their own judgement criteria. No relevant standards or specifications were identified for re-use of tyres.

Appendix A Rubber crumb sizes and end-use

Table 10 Rubber crumb sizes and end-use

Size	End-use
<0.7mm	<ul style="list-style-type: none"> • Tile adhesive glue • Spray for bitumen roads
<1mm	<ul style="list-style-type: none"> • Acoustic mats • Anti-slip mats • Gym matting
1-2mm	<ul style="list-style-type: none"> • Infill in synthetic grass
2mm	<ul style="list-style-type: none"> • Gymnasium flooring • Impact attenuating flooring • Sports and acoustics underlays
<4mm	<ul style="list-style-type: none"> • Sporting/hockey fields • Sporting mats • Playground matting.
10-25mm	<ul style="list-style-type: none"> • Equestrian matting

Source: Stakeholder consultation. These sizes should be used as a guide only and do not represent industry standards/specifications.

Appendix B Specifications details

Table 11 International waste tyre specifications and standards

Standard/Specification	Waste tyres	Publisher
ISRI Scrap Specifications Circular Guidelines for Tire Scrap	Rubber crumb, rubber shred, rubber granules.	Institute of Scrap Recycling Industries, Inc.
ATSM D6270 Standard Practice for Use of Scrap Tires in Civil Engineering Applications	Whole tyres for use in civil construction.	ASTM International (formerly American Society for Testing and Materials)
ATSM D6114/D6114M Standard Specification for Asphalt-Rubber Binder	Rubber crumb for use in asphalt.	ASTM International (formerly American Society for Testing and Materials)
ATSM D6700-19 Standard Guide for Use of Scrap Tires as Tire-derived Fuel	Tyre shred for use as TDF.	ASTM International (formerly American Society for Testing and Materials)

Table 12 Processed tyres specifications and standards used by domestic processors

Specification/ standard title	TSA/ATRA recommended minimum standard	6" (150mm) Tyre Derived Fuel ⁴³	2" (50mm) Tyre Derived Fuel ⁴⁴	AGPT/T190 - Size #16 ⁴⁵	AGPT/T190 - Size #30 ⁴⁶	CRM OGA - Pilot Specification ⁴⁷
Publisher	TSA/ATRA	Industry processor	Industry processor	Austrroads/ Standards Australia	Austrroads/ Standards Australia	Australian Asphalt Pavement Association
Country/continent	Australia	Australia	Australia	Australia	Australia	Australia
Material type and size	TDF shred <150mm, rubber crumb	Tyre Derived Fuel (TDF) shred <150mm	Tyre Derived Fuel (TDF) shred <50mm	Rubber crumb 0.6-1.18mm	Rubber crumb (powder) 0.3- 0.6mm	Rubber crumb (granule) 10- 14mm
Likely end uses	TDF for industrial processes.	TDF for industrial processes.	TDF for industrial processes.	Bitumen road spray	Bitumen road spray and tile adhesive glue.	Asphalt mix
Size (maximum)	150mm (and lower) in any dimension and free from attachment	6" x 6"	2" x 2"	<3mm	<3mm	<3mm

⁴³ Industry processor internal standard.

⁴⁴ Industry processor internal standard.

⁴⁵ Australian bitumen specification AS 2008, Specification Framework for Polymer Modified Binders – test Method AGPT/T190.

<https://austrroads.com.au/publications/pavement/agpt-t190-19>

⁴⁶ Australian bitumen specification AS 2008, Specification Framework for Polymer Modified Binders – test Method AGPT/T190.

<https://austrroads.com.au/publications/pavement/agpt-t190-19>

⁴⁷ Australian Asphalt Pavement Association, 2018, Crumb Rubber Modified Open Graded and Gap Graded Asphalt - Pilot Specification.

https://www.afpa.asn.au/wp-content/uploads/2018/06/CRM-OGAGGA-Model_Specification-v1-12-June-2018.pdf

Department of Agriculture, Water and the Environment / Standards for Waste Tyres & Market Information

Specification/ standard title	TSA/ATRA recommended minimum standard	6" (150mm) Tyre Derived Fuel ⁴³	2" (50mm) Tyre Derived Fuel ⁴⁴	AGPT/T190 - Size #16 ⁴⁵	AGPT/T190 - Size #30 ⁴⁶	CRM OGA - Pilot Specification ⁴⁷
Grading/passing size (%)	N/A	N/A	N/A	Passing 2.36mm – 100% Passing 1.18 mm – >80% Passing 600 µm – <10%	Passing 2.36mm – 100% Passing 1.18 mm – 100% Passing 600 µm – >60% Passing 300 µm – <20%	Passing 2.36 mm – 100%
Ash content	N/A	Approx. 20%	Approx. 12%	N/A	N/A	N/A
Gross Calorific Value (GCV) -dry basis (db)	N/A	Approx. 7,200 kCal/kg	Approx. 8,600 kCal/kg	N/A	N/A	N/A
Oversize in both dimensions	A maximum of ≤10% of exported product is >150 mm in any direction	10" X 10": <0.1% of container product	3.4" X 3.4": <0.1% of container product	N/A	N/A	N/A
Any one dimension greater than:	>300m: A maximum of ≤10% of exported product is >150 mm in any direction	>12": <2.5% of container product	>4": <2.5% of container product	N/A	N/A	N/A
Moisture level/water content	N/A	≤2%	≤2%	1%	1%	1%

Specification/ standard title	TSA/ATRA recommended minimum standard	6" (150mm) Tyre Derived Fuel ⁴³	2" (50mm) Tyre Derived Fuel ⁴⁴	AGPT/T190 - Size #16 ⁴⁵	AGPT/T190 - Size #30 ⁴⁶	CRM OGA - Pilot Specification ⁴⁷
Foreign materials other than iron (%) max	N/A	N/A	N/A	0.1%	0.1%	0.1%
Foreign materials – metallic iron (%) max	N/A	N/A	N/A	0.1%	0.1%	0.1%
Total Sulphur	N/A	≤2.5%	≤2.5%	N/A	N/A	N/A
Total Chloride	N/A	≤0.2%	≤0.2%	N/A	N/A	N/A
Contamination	<2% per exported container	≤2%	≤2%	N/A	N/A	N/A

Table 13 Specifications and standards for re-tread tyres

Specification/standard title	Publisher	Location	Material Type
SAE ARP4834B Aircraft Tire Retreading Practice - Bias and Radial	SAE International	International	Re-tread aviation (AV) tyres
AC145-4A : AC Inspection, Retread, Repair, and Alterations of Aircraft Tires	Federal Aviation Administration	United States of America	Re-tread aviation (AV) tyres
AS1973-1993 Pneumatic Tyres - Passenger Car, Light Truck and Truck / Bus - Retreading and Repair Processes	Standards Australia	Australia	Re-tread truck waste tyres
AS4457.2-2008 Earth-moving machinery - Off-the-road wheels, rims and tyres - Maintenance and repair Tyres	Standards Australia	Australia	Re-tread waste tyres
NZS 5423:1996 Specification for repairing and retreading car, truck and bus tyres	Standards New Zealand	New Zealand	Re-treading waste tyres
ISO 83.160.10 Road vehicle tyres Including cycle tyres, and tyre retreading and repair processes	International Organization for Standardization	International	Re-treading waste tyres

Appendix C Australian re-treading facilities

Table 14 Australian re-treading facilities

State	Area
Queensland	Wacol
	Toowoomba
New South Wales	Wetherill Park
	Coffs Harbour
	Nowra
	Wagga Wagga
	Albury
	Eden
Victoria	Laverton
	Altona
	Bendigo
	Morwell
	Geelong
	Portland
	Laverton
South Australia	Wingfield x2
Western Australia	Kewdale x2
Tasmania	Hobart

Appendix D Processing equipment

Table 15 Typical tyre processing equipment

Process	Equipment	Description/Purpose	Example equipment
Shredding	Shredder	Shreds waste tyres into even particle sizes ranging from 50 to 500mm. Can be used for creating shred for TDF or further secondary crumbing.	<u>Tana Shark 440DT:</u> Capacity: 162-189 cubic ft Power: 399 kW (535 bhp) @2100rpm Rotor length: 3000mm Number of rotor knives: 33/44 Screen area: 2.75m ² Dimensions: 125" x 101" x 111" Motor size: 3hp Motor voltage: 230/460 VAC, 60Hz, 3 phase (VAC and HZ provided to customer specifications) <u>Eldan SC1412 FD75 Super Chopper-Frequency Drive:</u> Capacity: up to 6000kg/hour (not specific to tyres) Rotor length: 1400mm Rotor speed: 5-30rpm Electrical motor: 75kW Dimensions: 73" x 191" x 148"
Metal removal	Tyre Wire Separators	Draws the tyre wires out of the tyres before shredding.	<u>Colombus McKinnon CM4R Liberator:</u> Motor: 315kW Dimensions: 208" x 86" x 176" Capacity: 3-9t/hour <u>Wuxi Dura-Shred Tyre debader/wire drawing machine</u>
Metals separation	Magnetic separator	Over-band or drum magnets to remove ferrous material.	<u>IFE Electromagnetic Overband Separator MEQL 1401:</u> Width: 1400mm Length: 3150mm Magnet power: 6.06 kW Magnet voltage: 115 V DC
Secondary shredding	Shredder/Grater	Crumb rubber secondary processing	<u>Barclay Roto-Shred Secondary Tyre Shredder Model 1.4S:</u> Output: 35mm tyre shreds.
Granulating	Granulator	Granulates shredded rubber to form rubber granules.	<u>Eldan FG1504 Granulator:</u> Rotor length: 1425mm Rotor speed: 460rpm Capacity: up to 4500kg/hr Motor: 110kW Motor speed: 1480rpm Dimensions: 84" x 100" x 116"

Process	Equipment	Description/Purpose	Example equipment
Crumbing	Miller	Grinds rubber to create rubber crumb/powder.	<u>Dura-Shred Grinder Mill TSD1663:</u> Capacity: 15-20t/hr Motor: 37kW <u>Colombus McKinnon CM Dual Drive™ Crackermill</u>
Material separation	Air screen cleaner and dust collector	Separates textiles from the rubber granules, classifies granules into different sizes and collects dust.	<u>Eldan UP1500 Aspirator</u> Capacity: 2000kg/hour Weight: approx. 4600kg Air volume: approx.. 11000m ³ /hour
General	Conveyor lines	Conveys material around the facility for sorting and processing.	Conveyor line systems can be engineered to meet the width and length requirements of the facility and equipment. <u>Andela System Conveyors:</u> Width options: 18", 24", 30", 36" Belt options: smooth, chevron, cleated AMPS: ~46 KW: ~25 Drive system: 3-phase motor and gear reducer, direct drive Head pulley: 10" head pulley Tail pulley: 10" self cleaning tail pulley
General	Tyre feeder	Feeds tyres evenly onto the conveyor lines.	<u>Eldan TTF10 truck tyre feeder:</u> Capacity: 5-6 t/hr
Size screening	Vibratory screen	Vibratory motion stratifies material and separates based on size. Larger sized material rise to the top of the bed while smaller particles fall through the screen	<u>IFE waste screen single deck SM F-UW30:</u> Width: 2000 Length: 7000m Motor: 22kW Output power: 100-290m ³ /h

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