



Australian Government

**Department of Agriculture,
Water and the Environment**

Waste Glass Industry Standards

Snapshot of MRA Consulting Group's Report

February 2021



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Glossary

Terminology	Definition
ACOR	Australian Council of Recycling
CDS	Container Deposit Scheme
COAG	Council of Australian Governments
CRT	Cathode Ray Tube
EU	European Union
ISRI	Institute of Scrap Recycling Industries
RCG	Recycled Crushed Glass
NSW	New South Wales
PPM	Parts Per Million
USD	United States Dollar

Introduction

Waste Export Ban

On 13 March 2020, the former Council of Australian Governments (COAG) agreed to ban the export of waste plastic, paper, glass and tyres. These discarded materials have the potential to cause harm to human health and the environment. The ban will be a phased process, starting with waste glass on 1 January 2021. The Department of Agriculture, Water and the Environment (The Department) will continue to engage with industry to guide implementation of the waste export ban.

From 1 January 2021, exporters will no longer be able to send unprocessed waste glass overseas. Companies operating in Australia will need to hold a licence to export processed waste glass. To be granted a licence, exporters will be required to demonstrate that they can source or process waste glass to an appropriate standard and that the waste glass will be reused or remanufactured overseas, in addition to several other requirements. There will be limited circumstances where these new rules do not apply, such as exports for personal use.

MRA Consulting Group's Report

Prior to the start of the export ban on waste glass, the Department commissioned Mike Ritchie and Associates (MRA) Consulting Group in August 2020 to produce a report that sets out:

- waste glass material flow and recycling, including likely reuses and remanufacture processes;
- the Australian waste glass market and export information, including prices and trading dynamics;
- standards, specifications and guiding principles used in the industry for furnace ready and non-furnace ready waste glass;
- an overview of operations required to process glass to the standards identified; and
- any overlap with the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*.

Following extensive research and consultation with industry, MRA Consulting Group completed the report in September 2020. The report will be an important reference for the Department, including when assessing waste glass licence applications as the waste export ban commences.

The Department consulted with businesses referenced in the report. Multiple organisations identified that the report contained commercial-in-confidence information. As such, the Department has decided to not publish the report in full.

The Australian Government has made commitments under the National Waste Policy Action Plan 2019 (and has a general preference) to publish data and reports to support better consumer, investment and policy decisions. Recognising this, the Department has produced this snapshot of the report to maximise public information while not breaching commercial-in-confidence and privacy obligations. As such, this snapshot focuses on general industry practices and material flows and does not detail specific information on market conditions for individual businesses nor their proprietary processes and technology.

Snapshot

Production and Consumption of Glass Packaging

Glass packaging, in the form of bottles and jars, is produced using virgin materials (mainly sand, limestone and soda ash) and recycled glass material (cullet). Total glass packaging consumption in 2017-18 was reported to be approximately 1.3 million tonnes.¹ 1.1 million tonnes of glass packaging were manufactured domestically and 158,000 tonnes were imported from overseas.

Waste Glass Recovery

Nearly half of glass packaging consumed in Australia per year is recycled.² Most recycled glass is collected through the kerbside recycling system as part of a comingled mix of recyclable products. Nearly all states and territories have container deposit schemes (CDS) to collect recycled glass. A small proportion is also collected by major glass users, such as pubs and clubs.

Following collection, glass is delivered to a Materials Recycling Facility (MRF) for sorting. There are an estimated 94 MRFs Australia-wide.³ Glass recycled through CDS and other separate collection methods is considered cleaner and may go to a MRF or straight to a beneficiation facility. The processes and equipment used to sort and process waste glass differs between facilities.

For material collected from kerbside comingled recycling bins, glass is typically sorted and separated from other comingled recycling material at an MRF. Depending on the processing equipment available at the facility, the separated glass may be colour sorted and crushed at the MRF or sent to a beneficiation plant to be processed.

Beneficiation is the process of sorting, cleaning and crushing glass. At the beneficiation plant, contaminants are removed from the feedstock: ferrous metals are removed by large magnets and nonferrous metals are removed via an eddy current. Contaminants such as plastic and paper are removed using negative or positive air pressure systems. Optical sorting is performed to remove other contaminants such as ceramics and to sort the glass by colour. Subsequently the glass is crushed. Burning and washing to remove sugars may be performed.

¹ Sustainable Resource Use (2019), *Recycling market situation*, accessed on 13 October 2020, available at: <https://www.environment.gov.au/system/files/resources/12ab3fc8-7154-44e1-8691-cc05fd9d72bb/files/recycling-market-review-paper.pdf>

² Australian Packaging Covenant Organisation (2016), *National Recycling and Report Survey 2015-16*, accessed on 13 October 2020, available at: <https://www.packagingcovenant.org.au/documents/item/1196>

³ Department of the Environment and Energy (2018), *Analysis of Australia's municipal recycling industrial capacity*, accessed on 13 October 2020, available at: <https://www.environment.gov.au/system/files/resources/f0196d2e-9040-4547-8cb6-8b433923b53d/files/waste-stocktake-report.pdf>

Glass Packaging Recovery in Tonnes (2017-18) ⁴					
Type	Kerbside Recycling (tonnes)	Pubs & Clubs (tonnes)	CDS (tonnes)	Total (tonnes)	Total (%)
Amber	101,000	2,000	43,000	146,000	25%
Flint	115,000	2,000	46,000	163,000	28%
Green	100,000	2,000	36,000	138,000	24%
Mixed	134,000	0	0	134,000	23%
Total (tonnes)	450,000	6,000	125,000	581,000	-
Total (%)	77%	1%	22%	-	-

Source: Australian Packaging Covenant Organisation

Waste Glass Products

Waste glass is generally in two forms: furnace ready and non-furnace ready. Furnace ready glass is sorted glass feedstock resulting from the beneficiation process of mixed container glass, consisting of glass pieces generally larger than 8mm in size ('cullet'). Cullet cleaned of contaminants and sorted by colour (amber, flint, green) is considered furnace ready for further glass manufacturing.

Furnace ready glass can be reprocessed infinite times. Reprocessing involves melting the glass and mixing with virgin glass to manufacture new glass packaging products and glass fibre. The proportion of recycled glass used to manufacture new glass packaging is limited as it can introduce impurities⁵. Over 60 per cent of glass for manufacturing can be made up of high-quality recycled glass, however, the current recycled content is approximately 30 to 37 per cent.⁶

Non-furnace ready glass is generally made up of glass fines: unsorted material generally smaller than 8mm, left over following the sorting and beneficiation processes. Non-furnace ready glass can contain contamination such as small pieces of ceramics, plastics and metals and, due to their small size, are difficult to sort making the market value of this product low. The contaminants make this product non-furnace ready as they can damage the furnace equipment or reduce the quality of the recycled glass product. Glass fines are commonly stored in stockpiles awaiting further processing.

⁴ Australian Packaging Covenant Organisation (2019), *Australian Packaging Consumption Resource & Recovery Data*, accessed on 13 October 2020, available at:

<https://www.packagingcovenant.org.au/documents/item/3164>

⁵ Australian Packaging Covenant Organisation (2019), *Glass Working Group 2018*, accessed on 13 October 2020, available at: <https://www.packagingcovenant.org.au/documents/item/2177>.

⁶ Sustainable Resource Use (2019), *Assessment of Australian recycling infrastructure – Glass packaging update*, accessed on 13 October 2020, available at: <https://www.environment.gov.au/system/files/resources/367a8ec1-67e2-44fc-9dd0-3daa90c886e9/files/assessment-australian-recycling-infrastructure-glass-packaging.pdf>

Glass fines can be further processed into sand and aggregate substitutes for use in construction and other applications such as road base, pipe embedment and as a filter media for water quality projects. Fines used in these applications are non-recoverable and do not contribute to reducing demand for virgin glass in the manufacturing of glass packaging, however, this market has the ability to absorb large volumes of lower quality material.⁷

Domestic Demand for Glass Cullet and Glass Sand

The glass container industry is interested in high quality beneficiated cullet for remanufacture into glass containers. However, availability of recycled glass product that meets quality specifications at a competitive price is limited. The price for recycled glass cullet is driven by the cost of virgin materials, imported glass packaging and alternative packaging materials, and the cost of beneficiating the collected glass.⁸ The demand for glass sand is more limited and inconsistent due to the nature of secondary uses.

Waste Glass Exports

In 2018-19, 4.4 million tonnes of waste were exported from Australia, including 1.4 million tonnes (32 per cent) of waste plastic, paper, glass and tyres. Waste glass is not exported on a large scale compared to other waste material, such as paper and plastics. Recovered glass packaging is predominantly used domestically with only 3 per cent being exported overseas in 2017-18.⁹ In 2019-20, approximately 26,000 tonnes of waste glass were exported, making up 0.7 per cent of total tonnes and 0.05 per cent of the total value of waste exported from Australia. This is an increase from 16,100 tonnes in 2018-19 and 23,200 tonnes in 2017-18.

Australia exported waste glass to a total of nine countries in 2018-19 and eight countries in 2019-20, with Malaysia importing the largest proportion (79 per cent in 2018-19 and 43 per cent in 2019-20) as of May 2020.

Waste Glass Exports (2019-20) – Top 5 Importing Countries		
Country	Tonnes Received	Tonnes Received (%)
Malaysia	11,039	42.7%
India	8,544	33.0%
Thailand	4,708	18.2%
Bangladesh	1,500	5.8%
New Zealand	58	0.2%
Other ¹⁰	22	0.08%
Total	25,871	100%

⁷ Sustainable Resource Use (2019), *Assessment of Australian recycling infrastructure – Glass packaging update*

⁸ Australian Packaging Covenant Organisation (2019), *Glass Working Group 2018*

⁹ Australian Packaging Covenant Organisation (2019), *Australian Packaging Consumption Resource & Recovery Data*

¹⁰ Other includes: Singapore, Philippines and South Africa.

Waste Glass Standards and Specifications

Parameters

The parameters outlined below are commonly used in waste glass standards.

Size

Size specifications are necessary for the recycling of glass cullet into container glass as the accuracy of sorting and processing equipment is reduced for smaller particles, impacting the quality of the cullet feedstock. Cullet must generally be greater than 8mm in size to accurately sort and remove colour and other contaminants. However, facilities with high resolution automatic sorting machines may be able to accurately sort and process smaller glass pieces. Glass particles smaller than 8mm are suitable for non-furnace applications.

Colour

There are three colour groups of container glass – flint (clear), amber and green. These colour groups are characterised by a different oxidation state and large colour changes in the cullet feedstock can affect the oxidation state of the glass melt in the furnace. Colour consistency helps maintain chemical consistency in the feedstock and optimises the glass melting stage of the re-manufacture process. Colour consistency is generally not required for non-furnace applications.

Contaminants

Contaminants in furnace ready glass material feedstock can impact the remanufacture process, including damage to the furnace, and impact the quality of the remanufactured glass product. Metal or ferrous contaminants sink in the furnace and can corrode the furnace floor. Organic contaminants affect the oxidation state of the glass melt. Ceramic contaminants do not melt in the furnace and can obstruct operational equipment. Minimisation of contaminants helps to optimise the glass melting stage of the remanufacture and minimise damage to the operational equipment. Limits for physical and chemical contaminants also exist for non-furnace ready glass depending on the application.

Moisture Content

A high moisture content can inhibit the capacity of optical sensors used to sort and process waste glass.

Purchase Agreement

A purchase agreement between the buyer and seller detailing specific requirements of the product and adherence to any specifications should be provided in writing.

Testing and Sampling

Testing and sampling requirements for the glass product are dependent on the specification used and should be outlined in the purchase agreement.

Furnace Ready Glass Standards

Furnace ready glass is generally made up of pieces of cullet greater than 8mm in size that has been sorted at a MRF, contaminants removed, glass pieces crushed and cleaned at a glass beneficiation plant.

Best practice specifications exist for processing furnace ready cullet for recycling into glass container packaging in Australia and overseas. The Australian Council of Recycling (ACOR) has published standards for beneficiated glass in Australia designed to achieve best practice in beneficiated glass cullet recycling. Compliance is not compulsory.

The Institute of Scrap Recycling Industries (ISRI) is a trading association in the United States providing education and advocacy for responsible recycling and working with governments and manufacturers to increase procurement of recycled products. ISRI published the Scrap Specifications Circular (2020) as a guideline for buyers and sellers of scrap commodities, including beneficiated cullet.¹¹

The European Union (EU) developed the Commission Regulation No 1179/2012 (2012) outlining the criteria when glass cullet ceases to be waste and is furnace ready.¹² The regulation was developed to ensure recovered cullet meets the technical requirements of glass production and complies with existing legislation and standards related to products. The criteria were based on a technical study performed which included an analysis of the economic, environmental and legal impacts when glass cullet ceases to be waste.¹³ No specifications are required for size and colour of cullet as these parameters do not have any associated environmental impact and do not seem to affect the existence of a market for the cullet.

¹¹ Institute of Scrap Recycling Industries (2020), *ISRI Scrap Specifications Circular*, accessed on 14 October 2020 at: <http://www.scrap2.org/specs/>.

¹² European Union (2012), *Commission Regulation No 1179/2012*, Official Journal of the European Union, available at 14 October 2020 at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R1179>.

¹³ Vieitez et al (2011), *End-of-Waste Criteria for Glass Cullet: Technical Proposals*, JRC Scientific and Technical Reports, accessed on 14 October 2020 at: <https://publications.jrc.ec.europa.eu/repository/bitstream/JRC68281/jrc68281.pdf>

Furnace Ready Glass Standards

Parameter	Beneficiated Cullet Specifications	Scrap Specifications Circular 2020	Commission Regulation (EU) No 1179/2012
<i>Organisation</i>	ACOR	ISRI	European Commission
<i>Jurisdiction</i>	Australia	United States of America	European Union
<i>Sizing</i>	<ul style="list-style-type: none"> All pieces must be <50mm <10% of pieces to be <8mm 	<ul style="list-style-type: none"> Ideally between 9.5mm and 19mm 	<ul style="list-style-type: none"> No size specified As specified in customer/industry specification.
<i>Colour</i>	<p><i>Flint:</i></p> <ul style="list-style-type: none"> Flint glass: min. 98% Other colours: max. 2% (<0.3% may be dark green/blue) <p><i>Amber:</i></p> <ul style="list-style-type: none"> Amber glass: min. 90% Other colours: max. 10% (<5% may be dark green, <5% may be dark blue) <p><i>Green:</i></p> <ul style="list-style-type: none"> Green glass: min. 90% Other colours: max. 10% (<1% may be dark blue) 	<p><i>Flint:</i></p> <ul style="list-style-type: none"> Flint glass: min. 95% Other colours: max. 5% (<5% amber, <1% green, <0.5% other) <p><i>Amber:</i></p> <ul style="list-style-type: none"> Amber glass: min. 90% Other colours: max. 10% (<10% flint, <10% green, <5% other) <p><i>Green:</i></p> <ul style="list-style-type: none"> Green glass: min. 70% Other colours: max. 30% (<15% flint, <15% amber, <10% others) 	<ul style="list-style-type: none"> As specified in customer/industry specification.
<i>Contaminants</i>	<ul style="list-style-type: none"> Organic matter: <3kg per tonne of cullet Ferrous material: <3g per tonne of cullet Non-ferrous metals: <15g per tonne of cullet 	<ul style="list-style-type: none"> Organic matter: limits to be set in buyer and seller agreement <p><i>Prohibited Material:</i></p> <ul style="list-style-type: none"> Ferrous materials Non-ferrous metals Ceramics 	<ul style="list-style-type: none"> Ferrous materials: <50ppm Non-ferrous metals: <60ppm Non-metal non-glass inorganics (e.g. ceramics, stones, porcelain, pyroceramics): <100ppm for glass cullet size >1mm

Furnace Ready Glass Standards

Parameter	Beneficiated Cullet Specifications	Scrap Specifications Circular 2020	Commission Regulation (EU) No 1179/2012
	<ul style="list-style-type: none"> • Ceramics, refractory, glass-ceramic, etc: <15g per tonne of cullet <p><i>Prohibited Material:</i></p> <ul style="list-style-type: none"> • Cullet should be free from non-glass containers, including aluminium cans, plastic bottles and containers, and steel containers • Cullet should be free from any Pyroceramic material 	<ul style="list-style-type: none"> • Other glass • Other material such as bricks, rocks, etc 	<ul style="list-style-type: none"> • Organic matter: <2000ppm <p><i>Prohibited Material:</i></p> <ul style="list-style-type: none"> • Hazardous material listed in Annex III to Directive 2008/98/EC. e.g. Aldrin, Endrin, DDT, Mirex.
<i>Moisture Content</i>	Less than 3 per cent	Not specified	Not specified
<i>Purchase Agreement</i>	<p>The following should be specified in the Purchase Agreement:</p> <ul style="list-style-type: none"> • Cullet grade: outline accordance with these specifications • Quantity: tonnes • Packaging: in boxes or in bulk • Price: agreed price (\$AUD/tonne or relevant overseas currency and exchange rate payment terms) • Rejection terms 	<p>The following should be agreed in writing:</p> <ul style="list-style-type: none"> • Cullet grade: outline accordance with these specifications • Quantity: tonnes or car/truckloads • Packaging: in boxes or in bulk • Price: \$USD/2,000 pounds or \$USD/hundred weight • Terms: terms shall be “net cash 30 days after date of shipment” unless otherwise agreed upon 	<p>The producer must provide a statement of conformity with end-of waste criteria:</p> <ul style="list-style-type: none"> • Name and technical provisions of an industry specification or standard • Cullet grade: outline accordance with the specifications and criteria in this regulation • Quantity: kilograms • Management system verified by an accredited conformity assessment body or verifier
<i>Testing and Sampling</i>	Representative 100kg sample testing: <i>Ceramics and Metals</i>	Not specified	Qualified staff shall carry out visual inspection of each consignment to verify compliance with the appropriate specification. Further sampling and

Furnace Ready Glass Standards

Parameter	Beneficiated Cullet Specifications	Scrap Specifications Circular 2020	Commission Regulation (EU) No 1179/2012
	<ul style="list-style-type: none"> 100kg to be hand sorted and contaminants removed and weighed <p><i>Colour</i></p> <ul style="list-style-type: none"> 5kg to be passed over screen with square holes between 6 and 7mm in size Flint: 1kg of cullet retained on screen to be removed and hand sorted to determine level of non-flint glass Amber: 500g of cullet retained on screen to be removed and hand sorted to determine level of amber glass Green: 500g of cullet retained on screen to be removed and hand sorted to determine level of green glass Mixed: 500g of cullet retained on screen should be removed and hand sorted to determine the amounts of each glass 		<p>testing shall be taken due to suspicion of possible hazardous properties. Appropriate frequencies of monitoring shall be established for:</p> <ul style="list-style-type: none"> Analysing representative samples of glass cullet gravimetrically to measure the total non-glass components

Non-Furnace Ready Glass Standards

Fines are unsorted glass material typically in the size range 1 to 8mm. Fines can be processed further to produce glass sand (<2mm). Glass sand is suitable for use as a sand replacement in a variety of infrastructure projects including as pipe embedment and other bedding material, water filtration, as aggregate in asphalt and concrete, road base and sub-base, select fill, drainage medium and sand blasting. In Australia, there is no common legislation or regulation outlining specifications for chemicals and contaminants in recycled crushed glass (RCG). Specifications and guidance are inconsistent from project to project and state to state.

For asphalt, concrete and road infrastructure projects, road authorities in each state in Australia may have their own specifications and guidance documents for the supply of aggregates, such as RCG.¹⁴ For use in roads, glass fines must generally be less than 5mm in size, odourless, washed and free of physical contaminants.¹⁵

In NSW, there are guidelines for the use of RCG in asphalt, requiring RCG to comply with the Transport for NSW Granulated Glass Aggregate 3154 Specification and the Recovered Glass Sand Resource Recovery Order.¹⁶ In Victoria, glass fines used in construction projects must meet the specification for its intended use, such as consistent quality and size; have less than 2 per cent physical contamination and are below the chemical contamination thresholds set out in the EPA Victoria guidelines for solid industrial waste hazard categorisation and management¹⁷

Road infrastructure specifications published by Main Roads Western Australia and the Department of Transport and Main Roads in Queensland require RCG crushing operations to include a shape crushing plant, such as a Barmac impactor or equivalent, to achieve the required size and shape (a maximum dimension to minimum dimension ratio of 5:1).¹⁸

For use in other projects, such as filtration and sand blasting, consultation with industry stakeholders revealed there are no standard specifications used in Australia or overseas. Specifications are project specific and are agreed upon with the customer depending on the application of the product and are outlined in the purchase agreement between the buyer and seller. General physical properties of glass sand for both applications include odourless, ground and graded glass. For pool filtration applications, glass sand sits in a vessel with cracks underneath allowing water to pass through and be filtered. The size of the cracks varies depending on producers of the pool filtration equipment and therefore so do the customer-driven size specifications.

¹⁴ Cement Concrete & Aggregates Australia (2009), *Technical Note 71; Coarse asphalt aggregate – the requirements of AS2758.5*, accessed on 22 October 2020 at: https://www.ccaa.com.au/imis_prod/documents/Library%20Documents/Tech%20Note%2071%20Course%20Asphalt%20LR.pdf.

¹⁵ NSW EPA (2019), *Waste Markets – Post National Sword and Moving Towards a Circular Economy*, Presentation for the National Committee for Clinical Engineering Meeting, accessed on 22 October 2020 at: <https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/community/nccce/nccce-presentation-waste-markets-and-glass.pdf?la=en&hash=617E600A5AE3D39279D2354D87AFAF8C00AA9185>.

¹⁶ RMS NSW (2020), *Recycled Crush Glass in Asphalt*, accessed on 22 October 2020 at: <https://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/approved-products-materials/recycled-crushed-glass-rcg-in-asphalt.pdf>.

¹⁷ EPA Victoria (2019), *Fact Sheet – Use of Glass Fines*, accessed on 22 October 2020 at: <https://ref.epa.vic.gov.au/-/media/Publications/1748.pdf>.

¹⁸ Mainroads WA (2019), *Earthworks – Specification 302*, accessed on 22 October 2020 at: <https://www.mainroads.wa.gov.au/globalassets/technical-commercial/technical-library/specifications/300-series-earthworks/specification-302-earthworks.pdf>.

Machinery and Facilities

The plant and machinery utilised depends on the source of the recycled glass, the type of facility, the scale of operation and the reuse and remanufacturing purposes (i.e. customer specifications). Some MRFs perform glass processing operations or have adjacent facilities. Most MRFs simply separate glass from other recyclable material and send cullet for further processing.

Glass sourced from kerbside recycling is the most contaminated and requires the most cleaning to be furnace ready. Therefore, facilities are likely to maximise quantities (e.g. upwards of 20 tonnes of glass per hour) to achieve economies of scale.

Processing at MRFs generally involves breaking glass and sorting for size. Equipment may include loaders, conveyor lines, a glass breaker unit and screening trommels for cullet (>8mm) and fines (<8mm). Beneficiation to produce furnace ready glass involves removing contamination and sorting by colour and equipment may consist of conveyor lines, de-labelling/washing rotary drums, over-band or drum magnets, air separators or wind shifters, vibratory screens, eddy current separators, sizing trommels and optical sorters.

Processing into glass sand also requires size separation, metals separation and crushing equipment such as a glass pulveriser, crusher, such as hammer mills and impact crushers. Washing and drying may also be performed.

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 Organisation for Economic Co-operation and Development (OECD) Regulations. Glass waste from cathode ray tube (CRT) is considered hazardous due to the presence of lead at high concentrations. CRT glass is the glass video display component of an electronic device such as an old television.

In 2014-15, crushed, mixed CRT glass made up 3 per cent (approximately 1,700 tonnes) of hazardous waste exported out of Australia.¹⁹ Leaded glass was most likely exported to a Korean lead smelter. In 2017-18, CRT glass was not included on the list of exported hazardous wastes and was included as an import (under waste electrical and electronic equipment).

Lead waste, including CRT glass, management is dominated by domestic recycling with approximately 85 per cent of all D22 (lead) waste being recycled and the presence of significant lead recyclers in NSW and Queensland. CRT glass waste most commonly comes from e-waste recyclers, or from intermediate storage facilities. As waste glass for export is sourced from MRFs and CDS programs, hazardous glass waste is unlikely to be received by Australian exporters. Testing lead is recommended under some industry standards.

¹⁹ Blue Environment (2017), *Hazardous Waste in Australia*, available at 22 October 2020 at: <https://www.environment.gov.au/system/files/resources/291b8289-29d8-4fc1-90ce-1f44e09913f7/files/hazardous-waste-australia-2017.pdf>.

Typical Waste Glass Processing Equipment			
Process	Equipment	Purpose	Examples
General	Feed Hopper	Evenly disperses material onto conveyor lines.	<u>Andela Metering Surge Hopper Model AMSH86-18FS55:</u> Capacity: 162-189 cubic ft Length: 125" Width: 101" Height: 111" Discharge opening: 18" wide Motor size: 3hp Motor voltage: 230/460 VAC, 60Hz, 3 phase (customer specifications)
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 customer. <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
Glass Breaking	Glass Breaker Screen	Steel discs break and separate glass from mixed recyclables at a MRF. The broken glass falls through the screen while other material passes on top.	<u>Glass Breaker Screen (general):</u> Screen width: 1220mm Screen length: 3725mm Capacity: 30t/h Approx. cost: \$250,000 <u>Andela Glass Breaker AGB-3HD:</u> Capacity: 30t/hr Length: 92" Width: 66" Motor size: 25 hp No. of hammers: 32

Typical Waste Glass Processing Equipment			
Process	Equipment	Purpose	Examples
Size Screening	Trommel Screen	Cylindrical drum screen operates at an angle to separate material by size. Undersized material passes through the screen while oversized material exits at the end of the drum.	<u>Andela Trommel Separator, Model ATROM-104:</u> Length: approx. 16ft Width: approx. 6ft Barrel diameter and length: 48" x 11ft Motor size: 5hp Motor Voltage: 230/460 VAC, 60Hz, 3 Phase.
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. Multi-deck screens can separate the pieces into specified particle sizes.	<u>Vibratory Screen (general):</u> Approx. cost: \$65,000-220,000 Screen width: 850-1300mm Screen length: 1500-5000mm IFE waste screen single deck SM FUW3057: Width: 2000 Length: 7000m Motor: 22kW Output power: 100-290m3/h
De-labelling, washing and drying	Rotary drum washer/dryer	For de-labelling bottles, washing and drying glass	<u>Drying plant including rotary drum dryer (general):</u> Approx. cost: \$1,200,000 (of whole drying plant including external hot gas generator, dryer dust collection system, spark detection and extinguishing unit, etc.) <u>Allgaier Rotary drum for label removing:</u> Capacity: 10t/h Diameter rotary drum: 1590mm Length rotary drum: 6000mm

Typical Waste Glass Processing Equipment			
Process	Equipment	Purpose	Examples
			<u>Allgaier Cleaning-Drum-Dryer:</u> Capacity: 35t/h Diameter drum dryer: 1590mm / 2600mm Length drum dryer: 12000mm Annual capacity: approx.150,000 tonnes/yr
Metals Separation	Magnetic Separator	Over-band or drum magnets to remove ferrous material.	<u>Cross belt magnet separator (general):</u> Approx. cost: \$50,000 <u>IFE Electromagnetic Overband Separator MEQL 1401:</u> Width: 1400mm Length: 3150mm Magnet power: 6.06 kW Magnet voltage: 115 V DC
Metals Separation	Eddy current separator	A short conveyor belt with a magnetic drum in the head creates a powerful eddy current to push out and remove non-ferrous metal contaminants from the material flow.	<u>Eddy Current Separator (general):</u> Approx. cost: \$240,000 <u>IFE Eddy Current Separator INP Centric 400x500:</u> Width: 1200mm Length: 3180mm Rotor drive: 3kW Belt drive: 1.5kW
Light-weight contamination separation	Air separator or wind shifter	Light-weight contaminants are blown by an air stream. A vacuum drum may be used to capture the contaminants.	<u>Wind Shifter (general):</u> Approx. cost: \$100,000 (x3) <u>Doppstadt Airflex 1500 Windshifter:</u> Width: 2600mm Length: 8310mm Height: 2360-3690mm Power: 15kW Suction volume: 13,000m ³ /h Power of fan unit: 30kW

Typical Waste Glass Processing Equipment			
Process	Equipment	Purpose	Examples
			<u>JOST Zig Zag Air Separator SepK 6/250x2000:</u> Air volume: 12,000-24,000m ³ /h Mass flow: 12-24t/h Installed output: ~50kW
Crushing	Glass crusher or pulverisers	Reduces large glass shards to smaller glass shards or to a fines or sand product.	<u>McLanahan Double Roll Crusher:</u> Capacity: 82 mtp/h Size: 610mm x 610mm Motor: 56kW, 1800rpm <u>Barmac® B7150SE™ vertical shaft impact crusher:</u> Capacity: 125-545 mtp/h Motor: 160-320kW, 1100-2100rpm <u>Andela glass pulverisers GP1-HD:</u> Capacity: 5-10t/hr Width: 1727mm Length: 2082mm Hammers: 40 Motor: 7.5kW
Sorting	Optical sorter	Laser beams shine on the material and camera lenses record the light waves that bounce off to identify the colour and type of material. A jet of compressed air is used to remove contaminants such as CSP and sort cullet by colour.	<i>Mogensen Optical Sorters</i> <u>MSort AF/AK (smallest machine):</u> sorts material size 4-30mm, 2-5 t/h. <u>MSort AS/AT:</u> sorts material size 1580mm, 90t/h. <u>MSort AG/AH (biggest machine):</u> sorts material size 80-250mm, 200-250t/h.

Conclusion

In terms of the scale of waste exports, glass export is relatively minor compared to other waste materials, such as paper and plastics, and is not expected to grow to represent a significant percentage of collected glass. Domestic glass manufacturers have indicated their desire to increase the recycled glass content of their products and MRA estimates that the resulting increase in glass cullet demand is higher than quantities of glass cullet that has historically been exported from Australia.

The general feedback from stakeholders is the export of glass should be allowed where there is a viable overseas market and beneficial reuse. Requirement of export should be that the material be 'clean', or decontaminated. Based on the stakeholder consultation process, MRA understands that exports of glass from Australia have predominantly been for glass container remanufacture, with smaller quantities exported for water filtration media and abrasives.

While industry standards exist for glass cullet, feedback from the stakeholders, particularly from those that currently export glass, indicates that the specifications used are those set by individual customers. Feedback from stakeholders indicated that industry specifications for other uses of glass exports, such as water filtration and sand blasting, do not currently exist and product quality is specified by customers. Generally, stakeholders advised that there were limited requirements from their overseas customers to assure the product specifications.

However, as industry standards do not currently exist for some waste glass products that are being exported, customer specific specifications would likely be nominated by some exporters during the licencing process.

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