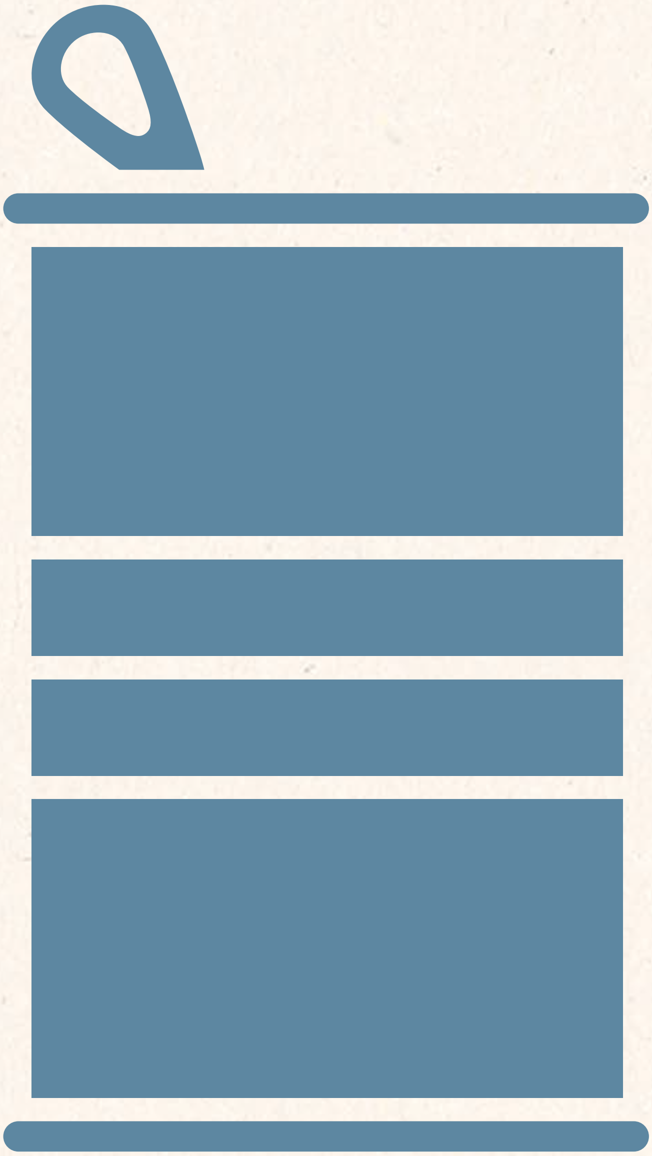
Design Smart Material Guide No.6

Australian Packaging Covenant

# Steel Packaging



Australian Packaging Covenant

# Contents



# Purpose of this Guide

## This Steel Packaging Design Guide is the sixth in a series of ten guides published by the Australian Packaging Covenant (APC).

Its purpose is to help you improve the environmental performance of your packaging system, without compromising on cost or functionality. It provides a 'checklist' of sustainability issues to keep in mind when designing and/or specifying your next steel-based package.

The guide will also support your packaging reviews against the Sustainable Packaging Guidelines (SPG), as required by the APC. To facilitate this, the design considerations are grouped under the four principles of the Guidelines.

The information contained in this guide is based on 'life cycle thinking', which considers the sustainability impacts of packaging throughout its supply chain, during use, and at end-of-life. It considers the impacts of whole packaging system, including primary, secondary and tertiary packaging[1], as well as its performance in delivering the product to the consumer.

You are probably designing your packaging to fulfil a particular function, rather than an intrinsic need to use steel as the primary packaging material. If this is the case, then we encourage you to read the first of the guides, which provides information on the comparative environmental and functional performance of the many different packaging material types that are available. Maybe there is another packaging format that will better fulfil your need to optimise cost, function, and environmental performance. Maybe now is the time to consider a bigger change?

[1]Primary packaging contains the sales unit product (e.g. a steel can containing baked beans), secondary packaging contains a number of the sales units (e.g. a cardboard box of twelve cans), and tertiary packaging is the freight/distribution-related

**Disclaimer**

This document is provided as a general guide only. Aspects relating to material extraction, material processing, transport systems and consumption patterns will impact the environmental, financial and functional performance of packaging systems. Appropriately detailed analyses of specific packaging systems are necessary to confirm the benefits of any of the design considerations outlined in this guide.

The development of this guide has largely relied on the sources listed in the Useful Further Reading section, as well as targeted consultation to confirm design aspects for the Australian context. The APC will endeavour to review the content of these guides on a regular basis to ensure currency and alignment to industry developments.

If you have any questions about these guides, would like to make comments regarding the guidance provided, or just like to better understand sustainable packaging assessments in general, please contact the APC at apc@packagingcovenant.org.au.

# The Life Cycle of Steel Packaging

While there are numerous steel alloys to suit different applications, there are two general classifications of steel: low carbon steel, also called mild steel, and high carbon steel. Low carbon steel is more ductile (deformable without cracking), which is a requirement for steel packaging formation, so low carbon steel is used for virtually all steel packaging.

The low carbon steel manufacturing process is limited to a maximum of about 30% recycled content, with the majority of the steel sourced from iron ore. So 30% is the maximum proportion of recycled content that is technically feasible in steel packaging at the current time. This is not a negative outcome, as end-of-life steel packaging is readily recycled into many other steel products for which ductility is not required. It is not possible, or necessary, to specify the use of steel packaging sheet containing a high level (>30%) of post-consumer steel packaging recyclate.

Steel production is relatively resource-intensive—see the Introductory Guide for a comparison of the greenhouse gas emissions and water inputs for steel production, versus other packaging material types.

**Food cans are by far the largest steel packaging application by weight, accounting for over 90% of all steel packaging for containers less than 20 litres.**

Aerosol cans account for the majority of non-food steel packaging. Other applications of steel packaging include: paint cans, drums, crown caps, and jar lids.

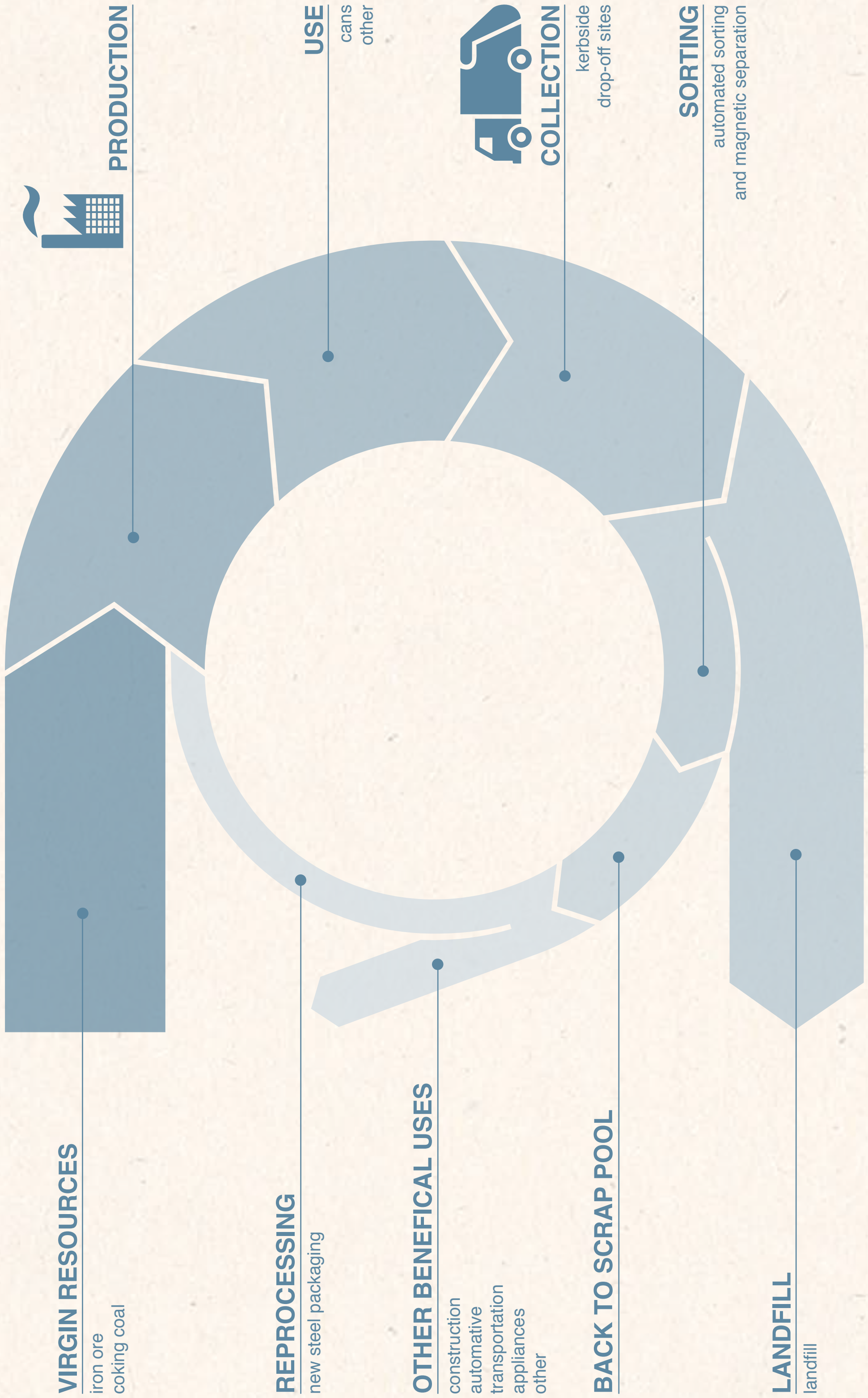
Over the last ten years steel packaging consumption has increased by 55%, from 82,300 tonnes in 2002 to 127,600 tonnes in 2011. At 34% (2011), the recycling rate of steel cans in Australia remains relatively low in comparison to other packaging formats. The majority of steel packaging, even though it is highly recoverable, often ends up in landfill, due in part to consumer behaviour.

# The Life Cycle of Steel Packaging

Figure 1

## Life cycle of steel packaging

Adapted from diagrams developed by GreenBlue (2011)



# The Life Cycle of Steel Packaging

## In favour

**Life Cycle Related Considerations in Favour of Steel Packaging**

- Highly suitable for recycling, and is virtually 100% recyclable (the steel component only).
- Strong demand for recycled steel – although steel packaging is a relatively low value form of recovered steel.
- Easily separable from other packaging materials at the Materials Recovery Facility (MRF) as steel is magnetic.
- Established and large-scale reprocessing facilities.
- Excellent product protection – strong and durable, so steel packaging needs less secondary packaging than other packaging types.
- Product is sterilised and shelf-stable, lowering wastage and refrigeration requirements.
- A recycled content of up to 30% in steel packaging is possible, limited only by the availability of steel scrap and the many other uses for post-consumer steel.

## Against

**Life Cycle Related Considerations Against Steel Packaging**

- Low diversion of steel packaging into recycling at end-of-life in Australia.
- Steel production is relatively resource- and energy-intensive when considered on a unit basis. Steel is heavier per unit volume of packaged goods than most other packaging materials.
- Steel production is relatively emissions-intensive, including greenhouse gases, when considering the weight of material required for a packaging unit.
- Iron ore is a non-renewable (if abundant) resource, and the environmental impacts associated with mining are significant.
- There are some scientific and consumer concerns about Bisphenol A (BPA) migrating from internal can lacquers into the product, although Food Standards Australia New Zealand (FSANZ) reports no health or safety issues at typical exposure levels, including those for small children.
- Steel packaging is relatively heavy and therefore can have more impact in transport than lighter materials. It may however require less secondary and tertiary packaging to transport.
- The metallic tin coating is a (manageable) contaminate in steel production.
- From a consumer perspective, packaging can be difficult to open, and packaging can generally not be resealed after opening.

# Design Considerations for Steel Packaging

Packaging design should be guided by the resource efficiency design hierarchy[1].

## The hierarchy of preferred packaging design changes is: avoid, minimise, reuse, recycle, recover (energy) and dispose.

The robustness of this general hierarchy is backed by a very significant body of evidence, based on packaging life cycle assessments (LCAs).

Embedded across the resource efficiency design hierarchy are the requirements to maintain or improve the packaging system functionality (fitness for purpose), and to minimise product losses.

As with all other packaging materials, steel packaging systems have specific design constraints, which may limit the application of the resource efficiency design hierarchy. With this in mind, we have outlined the general design considerations for steel packaging in Figure 2. During material selection and packaging system design all of the aspects in Figure 2 should be considered.

Each of these design considerations is then discussed in more detail in Table 1.

[1]The resource efficiency design hierarchy is also often referred to as the waste hierarchy.

# Design Considerations for Steel Packaging

Figure 2

## Summary of design considerations for steel packaging

| Design to be fit-for-purpose<br>SPG principle 1 | Design for resource efficiency<br>SPG principle 2 | Design with low-impact materials<br>SPG principle 3 | Design for resource recovery<br>SPG principle 4 |
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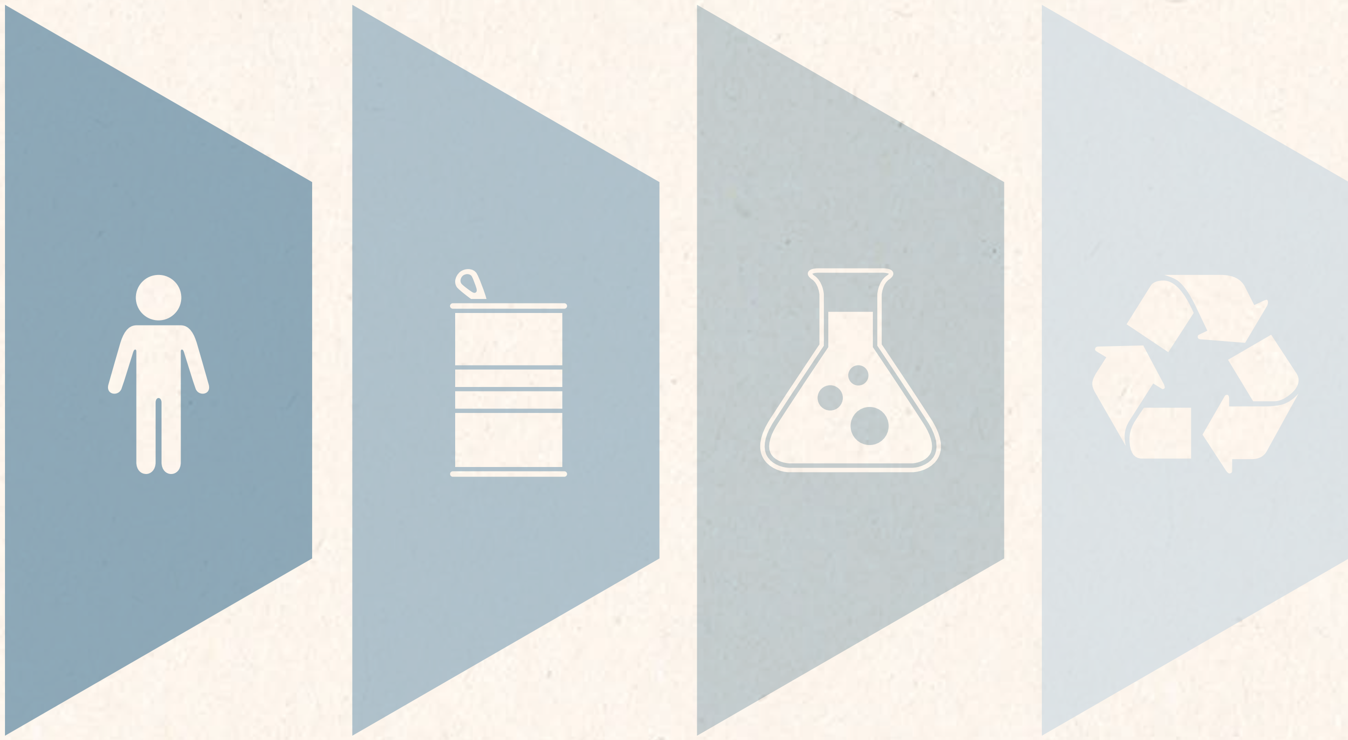

**Design to:**

- Improve accessibility
- Withstand loads from stacking
- Minimise product waste by consumers
- Manage the trade-offs between primary, secondary and teriary packaging

**Design to:**

- Minimise the steel in the can walls and ends, without compromising can strength
- Minimise other elements of the primary packaging
- Minimise the thickness of can coatings (particularly tin)
- Recover filling line packaging losses
- Maximise product to packaging weight/ volume ratios
- Maximise transport efficiences
- Enable packaging reuse

**Design to:**

- Maximise recycled content in primary packaging
- Maximise recycled content in secondary packaging
- Minimise the use of problematic chemicals in coatings and lacquers
- Print directly onto can bodies

**Design to/for:**

- Maximise the recovery of usable recyclate
- Provide clear consumer information
- Ensure compatibility of minor components with recycling systems
- Maximise the value of recovered recyclate

# Design Considerations for Steel Packaging

Table 1

| SPG Principle | Design to | Design Considerations | Life Cycle Importance |
|---|---|---|---|
| 1 - Design to be Fit-for-Purpose | Improve accessibility | Consider using down-gauged easy open ends (EOE) with full width apertures. Alternatively, peelable aluminium foil ends can assist in improving accessibility depending on the application. For an example see the Case Study provided at the end of this guide. Ensure that the force required to pull the seal does not exceed 22 newtons, and avoid seals that require a tool to puncture.<br><br>If using a traditional ring pull, make it easier for the consumer to access, either by raising the ring or providing a depression under the ring. Ensure there are no sharp edges on the lid or ring pull.<br><br>Stipulate a grip span of no more than 71 mm for products required to be gripped in one hand.<br><br>Minimise the rotational force requirements for breaking the initial seal on screw top containers. Rotational forces greater than 1.1 Nm (newton metre) often exceed the functional capabilities of the frail, elderly and those living with arthritis.<br><br>Check Arthritis Australia's Food Packaging Design Accessibility Guidelines (see Useful further reading list) for more suggestions to improve the accessibility of your packaging. | HIGH |
| | Withstand loads from stacking | If specifying lower gauge steel sheet, confirm with suppliers that the finished steel package will be sufficiently robust to tolerate the required stacking loads for your product. | HIGH |
| | Minimise product waste by consumers | Investigate the use of non-stick additives to reduce the cling of contents to the internal walls of the steel can, to reduce any product losses.<br><br>Where product wastage is likely, consider providing a reusable (and recyclable) plastic lid with the steel can packaging. | MEDIUM |
| | Manage the trade-offs between primary, secondary and tertiary packaging | Consider primary, secondary and tertiary packaging as a total system. In particular avoid functional overlap between the primary and secondary packaging levels. For example, steel packaging is weight-bearing, so secondary packaging is required to provide little, if any, load-bearing functionality.<br><br>Consider possibilities for minimising the tertiary packaging components that are required to secure loaded pallets, which include the use of: strapping, down-gauged and perforated stretch films, sleeves, 'lock-'n-pop' low-residue adhesives, returnable plastic crates that lock into place on pallets with minimal strapping, or pallet boxes. | MEDIUM |

# Design Considerations for Steel Packaging

| | | | |
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| 2 - Design for Resource Efficiency | Minimise the steel in the can walls and ends, without compromising can strength | If you are using the same steel can as you were five years ago, then it is probably heavier than current lightest gauge that is available for your functional requirement.<br><br>Consider also reducing the thickness of the can ends. For example a reduction of easy open ends (EOE) for steel cans from 0.20 mm to 0.17 mm will save 15% of can end material, and allow ~15% more to be transported by truck movement.<br><br>Consider shifting from rigid can ends to peelable aluminium foil ends, as these foil closures can generate significant weight savings (and accessibility improvements). Steel can ends, if separated from the can body, are also less likely to be recovered at Material Recovery Facilities (MRFs).<br><br>For all lightweighting options, assess the potential for any negative impacts on functionality, such as food safety or stacking integrity. | HIGH |
| | Minimise other elements of the primary packaging | Composite steel packaging includes cardboard tubes with steel ends, and bi-metal beverage cans which have steel bodies with aluminium ends (which are currently rare in Australia). Electro-magnets at Materials Recovery Facilities (MRFs) will generally divert these types of composite steel packaging into the steel can stream early in the sorting process and the wood fibre or aluminium components will be lost during steel smelting.<br><br>This would seem to suggest that composite steel packaging is generally to be avoided, however, from a life cycle perspective, this isn't the full story. Consumer steel packaging in Australia has a relatively low recycling rate (34% in 2010-11). So the significant weight reduction achieved by moving to a composite cardboard/steel can, and the substitution of steel with cardboard (with its much lower embodied energy), will reduce the embodied energy of the can significantly. So from a life cycle perspective, substituting steel for cardboard is possibly a good outcome. This is even more likely to be the case if the product is consumed away from home, where facilities for steel packaging recovery are more limited.<br><br>Steel/aluminium composite packaging (e.g. bi-metal beverage cans) should generally be avoided as aluminium has a high embodied energy and will definitely be lost at end-of-life, either to landfill or during steel smelting. | HIGH |
| | Minimise the thickness of can coatings (particularly tin) | Specify steel packaging sheet that has the thinnest possible layers of tin and/or chromium plating that will met the required packaging function, in terms of corrosion resistance, packaging surface durability, and product protection. The tin, but not the chromium, is a contaminant in steel smelting. | MEDIUM |
| | Recover filling line packaging losses | While steel packaging losses are typically low on the filling line (<0.5%), confirm with operators that they have steel recycling systems in place. | LOW |
| | Maximise product to packaging weight/volume ratios | Products packaged in steel cans typically already have close to ideal product-to-packaging weight and volumetric ratios. However, consider doing some 'back of the envelope' calculations on these ratios as part of your steel can packaging system design process. | LOW |
| | Maximise transport efficiencies | Have a look at your palletisation (volumetric) efficiencies; improving these can significantly reduce the costs associated with product storage and distribution. | LOW |

# Design Considerations for Steel Packaging

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| 2 - Design for Resource Efficiency | Enable packaging reuse | Reusing a package increases the material's useful life, and gives a greater return from the energy, materials and water used to manufacture the package in the first place. It also reduces the need to recover or dispose of single-use packaging at end-of-life.<br><br>Consider providing reusable plastic lids (e.g. clear polyethylene) with dry products such as ground coffee. Perhaps you can promote the reuse of your branded steel can, with customers subsequently purchasing satchel refills.<br><br>However, the reuse of steel packaging is mainly limited to large industrial steel drums, and as steel production processes require steel scrap, recycling represents a more beneficial end-of-life option for steel packaging. | LOW |

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| 3 - Design with Low-Impact Materials | Maximise recycled content in secondary packaging | Specify the highest possible level of post-consumer content in cardboard or polyethylene over-wraps and shelf-ready packaging, while maintaining the required functional and strength performance of the secondary packaging. | MEDIUM |
| | Minimise the use of problematic chemicals in coatings and lacquers | Coatings are thin layers used on the inside and outside of steel packaging to provide corrosion or scuffing resistance. These layers consist of other metals (tin and/or chromium), and sometimes plastics, such as epoxies.<br><br>Steel cans for food almost always have a thin layer of protective plastic lacquered onto the inside of the can, which are usually epoxy-based, and contain Bisphenol A (BPA). BPA is a weak endocrine disruptor that appears to interfere with normal hormone function at sufficiently high concentrations, and does measurably migrate into the food contained by the steel can, particularly those high in fat. Food Safety Australia and New Zealand (FSANZ) advises that BPA is not a health or safety risk at the levels to which most people are exposed. This is a developing (and contested) area, so it would be worthwhile undertaking a risk assessment of potential BPA migration into your product, particularly if it is intended for consumption by small children.<br><br>Tin-plated and chromium-plated (also called tin-free) packaging sheet usually has a hexavalent chromium-based 'chromate conversion' layer applied, over the top of the metallic tin or chromium layers. There are no known health issues associated with the use of this layer. | MEDIUM |
| | Maximise recycled content in primary packaging | Consider speaking to your suppliers about the availability of steel packaging sheet that has the highest possible proportion of recycled content. Specify the highest possible level of post-consumer content in labels and any other primary packaging components. | LOW |
| | Print directly onto can bodies | Consider avoiding the use of paper or plastic labels, as neither will be recovered at end-of-life. Keep in mind that while this eliminates additional label materials there may be negative costs and environmental impacts such as higher inventory and more redundant stock sent to landfill. | LOW |

# Design Considerations for Steel Packaging

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| 4 - Design for Resource Recovery | Maximise the recovery of usable recyclate | Steel packaging has a relatively high level of embodied energy, and steel is a non-renewable resource, so optimising steel packaging for recovery and recycling makes sense. The steel in steel packaging is virtually 100% recyclable, and easily separated from other recyclables due to its magnetic properties. However, other components, such as labels, aluminium, plastic coatings on the inside of cans, and the tin or chromium metal plating are either destroyed when the packaging is smelted, or are contaminates to the steel making processes (e.g. the tin). To maximise material recovery, eliminate or minimise any non-steel components, e.g. specify steel packaging sheet that has the thinnest possible layers of tin and/or chromium plating that will meet the required packaging function.<br><br>Steel can lids, if completely separated from the can body, are less likely to be recovered at MRFs, and more likely to end up in landfill.<br><br>Consider making paper labels easy to remove so they can be separated by householders and potentially recovered separately at the MRF for recycling. Another option is to eliminate paper (or plastic) labels, and instead print the label directly onto the can, with an appropriate pre-printing layer. | HIGH |
| | Provide clear consumer information | End-of-life steel packaging has had persistently low recycling rates for many years, so ensure recycling messages are clear and visible. The Mobius loop recycling symbol is recommended, plus the words ‘rinse and recycle’ where relevant. Provide a clear anti-littering message for products that are more likely to be consumed away from home.<br><br>See the Introductory Guide for more on labelling in general. | HIGH |
| | Ensure compatibility of minor components with recycling systems | Consider using a ‘skeletal’ carton-board wrap for multi-packs, rather than polyethylene film. Residential collection of plastic film for recycling is currently very low, and is unlikely to improve markedly for at least 3–5 years.<br><br>If a reusable plastic lid is supplied with steel packaging to reduce product wastage, ensure it is made from a commonly recyclable plastic such as polyethylene, and preferably un-pigmented (clear). | MEDIUM |
| | Maximise the value of recovered recyclate | Due to the metallic tin layer that is plated onto most steel cans, steel packaging recyclate is of low value. By specifying steel packaging sheet with the minimum thickness of tin, you may assist in improving the value of steel packaging recyclate. | LOW |

# Design Example

This design example illustrates some of the sustainability design aspects that could be considered during a packaging development or review. The brief is for a single serve metal can for seafood. The industry standard is steel cans with a 'ring pull' opener.

## Sustainable design considerations

### Design for efficiency

Lightweight as much as possible by choosing a low gauge steel (the starting gauge is around 0.18mm – check the minimum that can be achieved for this application)

Design the bowl with a wider opening so they can 'nest' in transport to the factory

### Low impact materials

Undertake a risk assessment of all materials and constituents, e.g. evaluate the latest research on potential migration into food and any health concerns.

### Accessibility

Conventional steel cans with a ring pull opener are difficult for many people to open. Options to improve openability could be:

- A depression under the ring pull that improves the consumer's ability to grasp it[1]
- An aluminium peel-off lid (although check the pinch force required to hold it)[2]
- A large, prominent tab for consumers to grab onto[3]

### Design for recycling

Many consumers don't know that steel cans are recyclable. There is also a common misconception that if the can contains any food residue, it is not recyclable. Provide recycling information on the can in a prominent location, including the Mobius loop recycling symbol and the message 'Rinse and recycle'.

## More innovative ideas that could be explored

Lightweight alternatives, such as an aluminium bowl. These can be nested to improve the efficiency of transport, prior to filling[4].

[1]Ardagh Group's Optilift® EZO can lid has a depression in the lid to improve a consumer's ability to grasp and lift the tap – see http://www.ardaghgroup.com/metal

[2]Amcor's has launched an easy-peel can lid that uses a BPA-free lacquer system – see www.amcor.com/products_services/ALUFIX_RETORT.html

[3]Saupiquet's Albacore tuna slices are packed in a steel can with a peelable lid and a tab for easy lifting – see www.crowncork.com/products_services/food_packaging_news.php?id=1069

[4]Amcor's 'Canny' bowl saves up to 90% on space during transport and storage and is 30% lighter than a conventional aluminium bowl – see www.amcor.com/about_us/media_centre/news/121048219.html

# Useful Further Reading

| Reference | What is it? |
|---|---|
| **ACOR, 2012. Recycling Guide for Fillers Marketing in Steel Cans, Australian Council of Recycling. 16 pages.** | This ACOR document provides an overview of steel packaging use and recycling in Australia, along with details steel packaging labelling. Free download from: www.acor.org.au |
| **APC, 2010. Sustainable Packaging Guidelines, Australian Packaging Covenant. 30 pages.** | The SPG is the key document for APC signatories and others to use in undertaking APC-compliant packaging reviews. The objectives of these reviews are to optimise resources and reduce environmental impact, without compromising product quality and safety. Free download from: www.packagingcovenant.org.au |
| **Arthritis Australia, 2012. Food packaging design accessibility guidelines. 31 pages.** | This document provides more detailed guidance on accessibility principles and strategies to improve accessibility of food packaging; prepared in conjunction with NSW Health. For a complimentary copy of the Food Packaging Accessibility Guidelines and several other packaging design reports contact Arthritis Australia at: design@arthritisaustralia.com.au |
| **GreenBlue, 2011. Design for Recovery Guidelines: Steel Packaging, California: GreenBlue. 25 pages.** | Lots of great information discussing the different packaging applications of steel, the manufacturing processes, and the possible end-of-life outcomes for the packaging. Free download from: www.greenblue.org/publications |
| **ILSI Europe, 2007. Packaging Materials 7: Metal Packaging for Foodstuffs, Brussels: International Life Sciences Institute (ILSI). 44 pages.** | This is a fairly technical report that provides an excellent overview of the numerous chemicals used in steel and aluminium packaging, and provides detail on the food safety and toxicology aspects that relate to the use of these chemicals. Free download from: www.ilsi.org |

# Useful Further Reading

**PRAG, 2009. An introduction to Packaging and Recyclability, United Kingdom: Packaging Resources Action Group. 23 pages.**

A comprehensive overview of packaging design aspects, particularly with respect to the impact upon end-of-life recyclability. Some information specifically on steel packaging. Free download from: www.wrap.org.uk

**Sustainable Packaging Coalition, 2009. Environmental Technical Briefs of Common Packaging Materials: Metals and Glass in Packaging, Virginia: Green Blue Institute. 32 pages.**

This SPC report provides life cycle-based information and data intended to assist packaging designers with understanding the environmental and human health impacts of using steel and aluminium in packaging. Lots of great information. Order from: www.sustainablepackaging.org

**Verghese, K., Lewis, H. & Fitzpatrick, L., 2012. Packaging for Sustainability. 1st ed. Boston: Springer. 384 pages.**

This life cycle thinking-based reference book provides extensive detail on just about every aspect of sustainable packaging design. Beyond design, it also contains detailed information on marketing, regulatory and labelling aspects. Order from: www.springer.com/engineering/production+engineering/book/978-0-85729-987-1

Developed by SRU Sustainable Resource Use, Helen Lewis Research

Designed by BOXER & CO.