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# **Sustainable Packaging Specification Recommendations for Automotive Manufacturing Operations**

**Guidance Document**

**Version 3.0**  
February 2024

**Established Scope:** The Suppliers Partnership for the Environment (SP) provides a forum for global automotive manufacturers and their suppliers to work together toward a shared vision of an automotive industry with positive environmental impact.

SP's Sustainable Packaging Work Group was established as a platform for companies from across the automotive value chain to collaborate to identify opportunities to minimize automotive packaging waste and address barriers to packaging recyclability and/or reuse.

The purpose of this guidance document is to provide straightforward industry-supported guidance to help automakers and their suppliers identify potential opportunities to source sustainable packaging designs for use in automotive manufacturing operations. This guidance document was originally published in 2020, with this updated third edition published in 2024.

This document is designed to align with established [sustainable packaging guidelines for automotive expendable packaging](#).

**Acknowledgements:** This guidance document was produced through a collaborative process by the Suppliers Partnership for the Environment (SP) Sustainable Packaging Work Group, co-chaired by Bridget Grewal of Magna International and Matt Marshall of Toyota Motor North America. The document included input and review from work group members representing automakers, tiered suppliers, packaging suppliers and recyclers.

**Next Steps:** Going forward, the SP Sustainable Packaging Work Group intends to build on learnings from this process to promote advancement of sustainable packaging practices within the automotive industry and identify targeted opportunities to continually improve packaging sustainability in support of industry sustainability goals. This guidance document will continue to be reviewed on a regular basis.

**Contact:** Please submit any feedback on this guidance or suggestions for future improvements to [info@supplierspartnership.org](mailto:info@supplierspartnership.org).

**Disclaimer:** This document is intended solely to provide information for automakers, their suppliers and the general public on sourcing sustainable packaging designs. This document sets forth various findings based on information available to working group members at the time of issuance. These findings are not intended to set forth any industry rule, requirement or standard. Each company should independently determine its own processes and practices, including, without limitation, levels, measurements, vendors, materials, equipment, energy sources, energy use, emissions, and recyclability.


























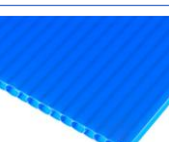
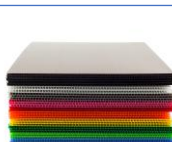






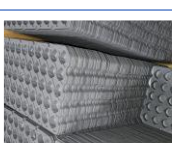

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## Executive Summary


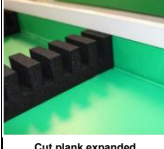

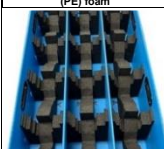

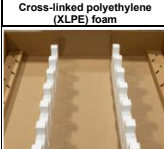
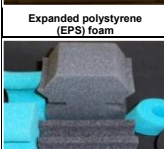
This guidance document focuses on voluntary best practice recommendations intended to help automotive original equipment manufacturers (OEMs) and their suppliers to identify potential opportunities to source sustainable packaging designs for use in automotive manufacturing operations.

1. When building business cases for packaging design and logistics, include and communicate to procurement / supply chain managers a total enterprise financial scope that considers all corporate goals and strategies including health, safety, and the environment.
2. Whenever possible, source parts, modules and other products using returnable packaging and base this decision on life cycle factors.
3. When choosing plastic films consider the use of standard natural (clear) to increase recycling value. When choosing returnable plastic containers and dunnage consider the use of standard black to increase recycling value.
4. Reduce the use of foams in packages that include spacers and dunnage as most foams are difficult to recycle.
5. Use of expanded polyurethane foam in packages should be avoided, especially when formed within plastic bags. This package material creates a significant challenge for recycling and reuse.
6. If a foam packaging formed container is sourced, expanded polypropylene (EPP) may be more recyclable than other foam options.
7. Combination packaging (specifically incorporating multiple materials) should be avoided whenever possible. When unavoidable, materials should be able to be segregated without requiring significant time or labor.
8. Pallet and container separation ease improves reuse and recycling potential. Avoid using screws, nails or staples to attach corrugated board / old corrugated container (OCC) boxes to wood pallets.
9. Avoid using metal clips on plastic banding. Plastic banding should be secured using plastic weld (sonic) technology.
10. The use of metal banding should be avoided where possible. The disassembly and separation of metal banded packaging can be a safety concern, and increases the time and labor required to prepare materials for recycling.
11. Avoid using metal brackets and wood to reinforce corrugated board / OCC boxes. Oftentimes corrugated brackets and spacers can reinforce boxes where needed.
12. Whenever possible, avoid one-time use packaging and assembly aids.
13. Plastic corrugate, multidirectional board and straight walled totes, which many times are made of polypropylene or polyethylene, should not be sourced with mixed plastics as dunnage or metal fasteners, except for the plastic pallets with seatbelts. This material, when clean and used without fasteners, can be processed for recycling as well.
14. HDPE polybags, LDPE polybags, bubble wrap and other plastic films should be baled and placed into a recyclable film program, wherever possible.
15. Polypropylene and polyester fabric bags that may be used to protect class A surface parts from mutilation such as lighting fixtures, fascias, chrome parts, etc. can be placed in the container and sent back to the supplier for reuse where feasible.
16. Use Lean manufacturing principles to move recyclables through the system in the most efficient manner possible to optimize transportation to the recycling center.
17. Natural solid wood with no adhesives should be specified for use in wood packaging applications, including pallets, crates, and dunnage, whenever possible.
18. Wood pallets sourced in the US should be 48" x 40", 48" x 42", or 48" x 45" whenever possible, with the auto industry using 48" x 45" for production and 48" x 42" for service. To enable efficient recycling and reuse of 48" x 45" stringer pallets, reference the SP design guidance. These sizes greatly improve the possibility for these pallets to be reused as compared to off-spec sizes.
19. Use of OSB (Oriented Strand Board) pallet planks and risers will likely limit recycling options and should only be used if local rules and international issues prohibit alternatives.
20. Wooden crates, even for small batch shipping use, should be designed with ease of disassembly for reuse and/or shredding for recyclability in mind. Often, wooden crates are assembled using plate steel and bolts that unnecessarily make recycling very laborious and costly.
21. Whenever possible, reduce use of continuous line of hook-and-loop fasteners, glue and double-sided tape in securing interior dunnage to a container.
22. Whenever possible, source VCI (vapor corrosion inhibitor) polybags and films that are recyclable by design and do not contain hazardous substances.
23. VCI paper and VCI corrugated products are typically repulpable and viably recyclable through existing paper recycling streams.
24. Reduce use of PVC (polyvinyl chloride) packaging where possible as PVC is challenging to recycle. Consider the use of an alternative viably recyclable material such as PET, PE, or PP where feasible.

**Table A: Directional Guidance on Ease of Viably Recycling Common Automotive Packaging Designs in U.S. Region**

 <p>Expanding PU foam formed within plastic bags</p> <p>Very challenging to viably recycle</p>	 <p>Air-filled paper</p> <p>Can be viably recycled</p>	 <p>One-sided synthetic flash spun high density polyethylene fiber coating</p> <p>Can be viably recycled</p>	 <p>Two-sided synthetic flash spun high density polyethylene fiber coating</p> <p>Very challenging to viably recycle</p>	 <p>Brushed nylon</p> <p>Very challenging to viably recycle</p>
 <p>Corrugated attached to wood pallets with screws, nails or staples</p> <p>Detrimental to recycling</p>	 <p>Corrugated attached to wood pallets with plastic banding</p> <p>Can be viably recycled</p>	 <p>Metal clips on plastic banding</p> <p>Detrimental to recycling</p>	 <p>Friction sealed polyester banding</p> <p>Can be viably recycled</p>	 <p>Metal banding</p> <p>Generally not allowed by industry specifications</p>
 <p>PP / PE Zip Ties (segregated)</p> <p>Can be viably recycled</p>	 <p>Corrugated reinforced with metal brackets and/or wood</p> <p>Detrimental to recycling</p>	 <p>Corrugated reinforced with cardboard brackets</p> <p>Can be viably recycled</p>	 <p>Single-use tape (plastic with adhesive)</p> <p>Very challenging to viably recycle</p>	 <p>Dunnage with laminates, labels, PVC, glues, foam, and/or wire</p> <p>Detrimental to recycling</p>
 <p>LDPE / LLDPE</p> <p>Can be viably recycled</p>	 <p>Polypropylene and polyester fabric bags</p> <p>Very challenging to viably recycle</p>	 <p>Wood pallets</p> <p>Can be viably recycled</p>	 <p>Oriented strand board (OSB)</p> <p>Very challenging to viably recycle</p>	 <p>Polypropylene and polyethylene sleeve packs</p> <p>Can be viably recycled</p>
 <p>Triple wall corrugated board sleeve packs</p> <p>Can be viably recycled</p>	 <p>Wooden crates assembled with large steel bolts / plates</p> <p>Detrimental to recycling</p>	 <p>Wooden crates assembled with removable clips</p> <p>Can be viably recycled</p>	 <p>Dunnage secured with hook-and-loop fasteners, glue and/or tape</p> <p>Detrimental to recycling</p>	 <p>High Density Polyethylene (HDPE) Totes</p> <p>Can be viably recycled</p>
 <p>Polypropylene (PP) corrugated plastic sheet</p> <p>Can be viably recycled</p>	 <p>HDPE corrugated plastic sheet</p> <p>Can be viably recycled</p>	 <p>Corrugated plastic with PU Foam attached</p> <p>Very challenging to viably recycle</p>	 <p>Corrugated plastic insert with fabric</p> <p>Very challenging to viably recycle</p>	 <p>Corrugated plastic covered with fabric</p> <p>Very challenging to viably recycle</p>
 <p>VCI Film</p> <p>Can be viably recycled</p>	 <p>VCI Paper</p> <p>Can be viably recycled</p>	 <p>PVC Trays</p> <p>Very challenging to viably recycle</p>	 <p>PP / PE Trays (segregated)</p> <p>Can be viably recycled</p>	 <p>PET Trays</p> <p>Can be viably recycled</p>

**Table B: Directional Guidance on Recycling Opportunities for Common Automotive Foam Packaging Designs in U.S. Region**

Packaging Material	Material Type	Class A Protection	Reusable	Potential Recycling Pathways			Common Recycling Outputs	Automotive Packaging Circularity
Base packaging material type	General category of plastic	Is this material generally suitable for Class A surfaces, where required?	Is this material generally suitable for direct reuse in closed-loop returnable packaging systems?	What pathways MAY exist for recycling this material? Practical viability dependent on various factors including volumes, location, transportation, densification, attachments, markets, etc.			When successfully recovered, what are common outputs of recycling this material today?	What potential exists for properly recovered and segregated end-of-life material to be circulated back into automotive packaging applications at similar quality via currently available recycling technology?
				Closed-loop mechanical recycling	Open-loop mechanical recycling	Chemical recycling		
 Molded expanded polypropylene (EPP) foam	Thermoplastic (melt reprocessable)	✓	✓	✓	✓	✓	Mechanically recycled back to original form (PP resin) for use in new packaging and/or a wide range of equivalent quality product applications	<b>Higher Likelihood for Circularity</b>  (via existing closed-loop mechanical recycling processes)
 Cut plank expanded polypropylene (EPP) foam	Thermoplastic (melt reprocessable)	✗	✓	✓	✓	✓	Mechanically recycled back to original form (PP resin) for use in new packaging and/or a wide range of equivalent quality product applications	<b>Higher Likelihood for Circularity</b>  (via existing closed-loop mechanical recycling processes)
 Extruded polyethylene (PE) foam	Thermoplastic (melt reprocessable)	✗	✓	✓	✓	✓	Mechanically recycled back to original form (PE resin) for use in new packaging and/or a wide range of equivalent quality product applications	<b>Higher Likelihood for Circularity</b>  (via existing closed-loop mechanical recycling processes)
 Expanded polyethylene (EPE) foam	Thermoplastic (melt reprocessable)	✓	✓	✓	✓	✓	Mechanically recycled back to original form (PE resin) for use in new packaging and/or a wide range of new product applications	<b>Higher Likelihood for Circularity</b>  (via existing closed-loop mechanical recycling processes)
 Cross-linked polyethylene (XLPE) foam	Thermoset	✓	✓	✗	✓	✓	Mechanically recycled for use in other industries / applications such as sports pads, playground underlayment, artificial turf	<b>Lower Likelihood for Circularity</b>  (future opportunities may exist via emerging chemical recycling processes)
 Expanded polystyrene (EPS) foam	Thermoplastic (melt reprocessable)	✗	✗	✓	✓	✓	Mechanically recycled back to original form (PS resin) for use in new packaging or in other applications such as picture frames, interior molding, surfboards, coat hangers	<b>Lower Likelihood for Circularity</b>  (future opportunities may exist via development of localized closed-loop recycling processes)
 Polyurethane foam (PU) foam	Thermoset	✗	✓	✗	✓	✓	Mechanically recycled for use in other industries / applications such as carpet underlay, sports mats, cushioning, fillers	<b>Lower Likelihood for Circularity</b>  (future opportunities may exist via emerging chemical recycling processes)

*Note: All foams by their nature tend to be both very lightweight and bulky. These properties can provide a challenge in practically and economically collecting, storing, transporting, and processing the materials for recycling at scale. Availability of curbside collection systems for foams is very limited in the U.S., and foams are most often collected and recycled in dedicated, source selected industrial systems. For clarity, the above chart focuses on potential recycling pathways for those automotive packaging foams which may be collected through such industrial systems*



**Table C: Summary of Referenced Packaging Materials / Design Types**

Packaging Material / Design Type	Viable Recyclability	Class A Protection	Reference
Base packaging material type and/or design feature.	Under normal conditions, is this material generally viably recyclable in the U.S.?	Is this material suitable for Class A surfaces, where required?	Reference to SP Sustainable Packaging guidance document for more information.
Extruded polyethylene (PE)	Higher Likelihood for Circularity		<a href="#">Learn More</a>
Expanded polyethylene (EPE)	Higher Likelihood for Circularity	✓	<a href="#">Learn More</a>
Molded expanded polypropylene (EPP)	Higher Likelihood for Circularity	✓	<a href="#">Learn More</a>
Cut plank expanded polypropylene (EPP)	Higher Likelihood for Circularity		<a href="#">Learn More</a>
Cross-linked polyethylene (XLPE)	Lower Likelihood for Circularity	✓	<a href="#">Learn More</a>
Expanded polystyrene (EPS)	Lower Likelihood for Circularity		<a href="#">Learn More</a>
Polyurethane foam (PU)	Lower Likelihood for Circularity		<a href="#">Learn More</a>
Expanding polyurethane foam formed within plastic bags	Very challenging to viably recycle		<a href="#">Learn More</a>
Air-filled paper	Can be viably recycled		<a href="#">Learn More</a>
One-sided synthetic flash spun high density polyethylene fiber coating	Can be viably recycled	✓	<a href="#">Learn More</a>
Two-sided synthetic flash spun high density polyethylene fiber coating	Very challenging to viably recycle	✓	<a href="#">Learn More</a>
Brushed nylon	Very challenging to viably recycle	✓	<a href="#">Learn More</a>
Corrugated board /old corrugated container (OCC) boxes attached to wood pallets with screw fasteners, nails or staples	Detrimental to recycling		<a href="#">Learn More</a>
Corrugated board /old corrugated container (OCC) boxes attached to wood pallets with plastic banding	Can be viably recycled		<a href="#">Learn More</a>
Metal clips on plastic banding	Detrimental to recycling		<a href="#">Learn More</a>
Friction sealed polyester banding	Can be viably recycled		<a href="#">Learn More</a>
Metal bandings	Generally not allowed by industry specifications		<a href="#">Learn More</a>
PE / PP Zip Ties (segregated)	Can be viably recycled		<a href="#">Learn More</a>
Corrugated reinforced with metal brackets and/or wood	Detrimental to recycling		<a href="#">Learn More</a>
Corrugated reinforced with cardboard brackets and / or spacers	Can be viably recycled		<a href="#">Learn More</a>
Single-use tape (plastic with adhesive)	Very challenging to viably recycle		<a href="#">Learn More</a>
Dunnage with laminates, vinyl labels, PVC components, glues, foam, and/or wire	Detrimental to recycling		<a href="#">Learn More</a>
Low density polyethylene (LDPE) / Linear low-density polyethylene (LLDPE)	Can be viably recycled		<a href="#">Learn More</a>
HDPE polybags	Can be viably recycled		<a href="#">Learn More</a>
Polypropylene and polyester fabric bags	Very challenging to viably recycle	✓	<a href="#">Learn More</a>
Wood pallets	Can be viably recycled		<a href="#">Learn More</a>
Oriented strand board (OSB)	Very challenging to viably recycle		<a href="#">Learn More</a>
Polypropylene and polyethylene sleeve packs	Can be viably recycled		<a href="#">Learn More</a>
Triple wall corrugated board sleeve packs	Can be viably recycled		<a href="#">Learn More</a>
Wooden crates assembled with large steel bolts / plates	Detrimental to recycling		<a href="#">Learn More</a>
Wooden crates assembled with removable clips	Can be viably recycled		<a href="#">Learn More</a>
Dunnage secured with hook-and-loop fasteners, glue and/or double-sided tape	Detrimental to recycling		<a href="#">Learn More</a>
High Density Polyethylene (HDPE) Totes	Can be viably recycled		<a href="#">Learn More</a>
Polypropylene corrugated plastic sheet	Can be viably recycled		<a href="#">Learn More</a>
HDPE corrugated plastic sheet	Can be viably recycled		<a href="#">Learn More</a>
Corrugated plastic with PU Foam attached	Very challenging to viably recycle		<a href="#">Learn More</a>
Corrugated plastic insert with Fabric	Very challenging to viably recycle		<a href="#">Learn More</a>
Corrugated plastic covered with fabric	Very challenging to viably recycle		<a href="#">Learn More</a>
Vapor corrosion inhibitor (VCI) films	Can be viably recycled		<a href="#">Learn More</a>
Vapor corrosion inhibitor (VCI) paper	Can be viably recycled		<a href="#">Learn More</a>
Poly vinyl chloride (PVC) trays	Very challenging to viably recycle		<a href="#">Learn More</a>
PP / PE / PET Trays	Can be viably recycled		<a href="#">Learn More</a>

## I. Introduction

Following are voluntary recommendations that are intended to help automotive original equipment manufacturers (OEMs) and their suppliers to identify potential opportunities to source sustainable packaging designs for use in automotive manufacturing operations.

These recommendations focus on opportunities to minimize automotive packaging waste and address barriers to recyclability in the design phase. Detailed guidance on sustainable management of packaging waste streams at the site level is outside the scope of this document.

Please note, additional recommendations and design variations can vary, based on business goal alignment, package material availability, and reuse as well as recycling infrastructure issues based on geographic location. Companies should be aware of national and local regulations that may dictate packaging selections in certain instances, such as hazardous materials regulations which are outside the scope of this document.

It is recommended that these specifications are entered into sourcing packages and other product sourcing documents as needed, typically described as Statement of Requirements (SORs) or Terms and Conditions to influence conformance.

In order to assure conformance to a sustainable packaging system, an internal monitoring program should be in place to track, measure and formally approve package design conformance by environmental or sustainability team personnel.

## Key Definitions

- **Viably Recycled.** For the purposes of this guidance, a material is considered to be viably recycled where established systems are in place with capability to technically, and economically, recycle the material in major automotive operating regions in the United States. To be considered economically sustainable, the material must have a market value that typically meets or exceeds the cost to collect, transport and process the material for recycling. Consideration of materials that can be processed into resin for use back into the same or similar application is typically preferred where possible, however materials that are downcycled for use in other industries may be suitable where economically sustainable recycling systems exist.
- **Detrimental to Recycling.** For the purposes of this guidance, packaging materials or designs that require separation or other pre-processing in order to be acceptable into established recycling systems are considered to be detrimental. While the challenges presented by these materials can often technically be overcome, the additional time, labor and other costs required to do so may outweigh the recycling value thereby increasing the likelihood that the material may be sent to landfill.

## II. Sustainable Packaging Specification Recommendations

1. **When building business cases for packaging design and logistics, include and communicate to procurement / supply chain managers a total enterprise financial scope that considers all corporate goals and strategies including health, safety, and the environment.**
  - a. In order to continually improve the life cycle management of containers and packages entering manufacturing operations, enlist the participation of environmental / sustainability professionals located at the first point of package use and at the destination point after first use during the packaging design phase so local considerations can be incorporated into package designs.
  - b. A packaging bill of materials (BOM) including information on all materials used within the finished pack should be defined during the packaging design process. This information may be used by packaging engineers and environmental professionals to evaluate the recyclability and sustainability of the materials incorporated in the package.
  - c. The cost to dispose of non-recyclable packaging materials, including labor, handling and transportation, should be included in the total business case for packaging design.
  - d. It is recommended that each of the following functions be included throughout the packaging design and decision-making process.
    1. Packaging Engineer
    2. Plant Manager
    3. Health & Safety
    4. Design Engineering
    5. Sustainability
    6. Material Handling
  - e. It is recommended that the packaging engineer, or the individual responsible for the final sign off on the packaging design, review the following recommendations to assess conformance with industry best practice for sustainable packaging design.



**2. Whenever possible, source parts, modules and other products using returnable packaging and base this decision on life cycle factors.**

- a. Returnable packaging should be designed to withstand the full life cycle of the product to minimize returnable packaging waste.
- b. It is recommended to focus on large, high-volume parts which will max trailer cubing on return route.
- c. The expected financial value of returnable packaging compared to expendable packaging may be estimated based on expected production and logistics factors. For example:
  1.  $\text{Returnable Cost} = (\text{Daily Prod Volume} / \text{Pack Qty}) \times \text{Days in System}^* \times \text{Pack Cost} + \text{Transportation Cost Per Container}$ 
    - a. This calculation assumes the pack will last entire life cycle of product.
    - b. \*Days in System is the sum of days the packaging will take to move all the way through the supply chain during normal conditions.
  2.  $\text{Expendable Cost} = (\text{Daily Prod Volume} / \text{Box Qty}) \times \text{Annual Prod Days} \times \text{Life cycle in Years}$
- d. The expected environmental value of a reduction in packaging waste can be calculated using established models, such as the [US EPA's Waste Reduction Model \(WARM\)](#).
- e. Other factors to be considered may include: Return Route cost, non-recyclable material in expendable needed for part quality, Repack Cost, Ease of removal, Damage Reductions, trailer cubing, warehouse stacking, and production fluctuations.

**3. When choosing plastic films consider the use of standard natural (clear) to increase recycling value. When choosing returnable plastic containers and dunnage consider the use of standard black to increase recycling value.**

- a. Generally, natural (clear) plastic material has the highest value as a recycled stream since it has the widest variety of end-use applications. Markets exist for mixed colored plastics as well, however end-use applications are more limited and therefore values tend to be lower.
- b. For durable returnable plastic packaging materials, the use of standard black provides opportunities to further increase incorporation of post-consumer recycled content in the manufacture of new products as compared to other colors. Colored returnable packaging materials are generally more likely to be manufactured from virgin materials.

**4. Reduce the use of foams in packages that include spacers and dunnage as most foams are difficult to recycle.**

- a. Foams by their nature tend to be both very lightweight and bulky. These properties provide a challenge in practically and economically collecting, storing, transporting, and processing the materials for recycling at scale. Therefore, it is recommended to minimize the use of foams in packages where possible when seeking to optimize for recyclability.

- b. When evaluating the recyclability of a foam material, it may be useful to consider the properties of two broad categories of plastics: thermosets and thermoplastics.
- c. A thermoset is a material that strengthens when heated but cannot be remolded or heated after the initial forming. While they offer many benefits, thermosets generally are more difficult to recycle back to their original form via mechanical recycling due to their cross-linked molecular structure. Cross-linking is a chemical or irradiation process that ties the polymer molecules together with a strong chemical bond. Due to their properties, cross-linked materials generally cannot be recycled back into the same or equivalent application via typical mechanical recycling processes.
  - i. A typical recycling process for thermosets involves grinding the material into smaller pieces, which are then used as filler materials for other products. For example, cross-linked foam scrap may be reprocessed for use in other industries such as in sports pads or playground underlayment.
  - ii. There is ongoing work in the development of new advanced recycling technologies, such as pyrolysis, which aim to break down cross-linked materials to their base molecules. If scaled, these technologies may allow thermoset materials to be recycled back to their original form more easily in the future. However, the majority of recycled materials marketed in the United States today are the product of mechanical recycling.
- d. Thermoplastics can be reheated, remolded, and cooled as necessary without causing any chemical changes. As thermoplastics can be melted down and reshaped multiple times without losing their properties, they are generally easier to recycle back to their original form than thermosets. If properly recovered, thermoplastics can generally be recycled back into the same or equivalent application via typical mechanical recycling processes.
- e. Existing governmental regulations and environmental NGO plastic standards may discourage or disallow the use of certain single-use foam packaging materials, such as expanded polystyrene (EPS), in certain regions. As the volume of such materials in use continues to decrease, the economics of viably recycling the materials can be expected to become increasingly challenging.
  - i. Single-use dunnage is sometimes used inside returnable containers in automotive manufacturing operations, such as in container pooling models.
  - ii. Emerging governmental regulations and environmental NGO initiatives focused on packaging circularity may seek to further prioritize materials which can be a) sorted into defined waste streams without affecting the recyclability of other waste streams and b) can be recycled so that the resulting secondary raw materials are of sufficient quality to substitute the primary raw materials, among various other sustainability criteria.
- f. Where Class A product protection is required and added protection is necessary in the form of inserts, foams that are recyclable by design should be considered. This may prevent the use of additional plastic bags and other secondary coverings used to prevent scratching and damage during transport.
  - i. Consideration should be given to the durability and longevity of the foam for use in returnable containers.
  - ii. It is recommended that manufacturers provide contact information for suppliers and end users of foam packaging products at program launch to support recovery of foams at the end of the program. Foam manufacturers may have the ability and desire to reclaim their products for recycling but often do not have visibility to the end user.

- g. To maximize the total recyclability of a returnable container and dunnage, use of like-to-like materials is preferred whenever possible. For example, extruded PE or EPE dunnage adhered to an HDPE container may be able to be recycled without separation. The disassembly and separation of different material types within a single container increases the time and labor required to prepare materials for recycling. It is recommended to source all foams with recycled content where possible.

**5. Use of expanding polyurethane foam in packages should be avoided, especially when formed within plastic bags. This package material creates a significant challenge for recycling and reuse.**



- a. Consideration should be given to using foams that are recyclable by design if a local reuse or recycle solution is available. Although many reuse options exist, expanding polyurethane foams are typically a challenge to recycle.
- b. Consider the use of viably recyclable alternatives, such as air-filled paper products.

**6. If a foam packaging formed container is sourced, expanded polypropylene (EPP) may be more recyclable than other foam options.**



- a. EPP foam containers are commonly used for products in need of surface protection and nesting within the container and are used as a returnable container option over a product's entire life cycle.
- b. Reuse options for EPP foam formed containers are limited outside of the original packaging application. EPP foam second use options can include densification and resin creation for new products.
- c. The Recyclability of EPP is a matter of supply and demand. Usually purchased as spot buys rather than contracts. Specifications to recycle include melt flow and ethylene content.
- d. It is recommended to source EPP foams with recycled content where possible.
- e. It is recommended that manufacturers provide contact information for suppliers and end users of EPP foams at program launch to support recycling of foams at end of the program. EPP manufacturers may have the ability and desire to reclaim their products for recycling but often do not have visibility to the end user.
- f. The addition of a flame retardant should be considered when sourcing EPP to address potential fire safety requirements. Flame retardants generally do not adversely affect the recyclability of EPP for use in packaging products.

**7. Combination packaging (specifically incorporating multiple materials) should be avoided whenever possible. When unavoidable, materials should be able to be segregated without requiring significant time or force.**

- a. Up to 5% contamination of non-conformance materials may be allowable for recycling, assuming those contaminants do not create risk of damage for the recycler.
- b. Consider opportunities to reduce the use of two-sided synthetic flash spun high density polyethylene fiber, and brushed nylon, or use alternate coatings to improve recyclability.

**8. Pallet and container separation ease improves reuse and recycling potential. Avoid using screw fasteners, nails or staples to attach corrugated board / old corrugated container (OCC) boxes to wood pallets.**

- a. Alternatively, secure the box to the pallet using recyclable polyethylene plastic banding that wraps around the box and secures to the pallet through the fork spaces or polyethylene-based stretch film. Putting banding through the bottom side of the corrugated box to the pallet before it is loaded may be another alternative.
- b. Also, consider sourcing OCC pallets that are fastened to the boxes or manufactured as part of the container. These designs improve the recyclability of the entire package. Please note, some OCC pallets have limitations based on moisture compromise, weight capacity and stacking limits.

**9. Avoid using metal clips on plastic banding. Plastic banding should be secured using plastic weld (sonic) technology.**

- a. The use of polyethylene banding is preferred where possible to improve recyclability.



*PE Banding*

**10. The use of metal banding should be avoided where possible. The disassembly and separation of metal banded packaging can be a safety concern, and increases the time and labor required to prepare materials for recycling.**

**11. Avoid using metal brackets and wood to reinforce cardboard/OCC boxes. Oftentimes cardboard brackets and spacers can reinforce boxes where needed.**

- a. Use glued joints and avoid metal staples whenever possible to improve recyclability.
- b. When using a corner support system, any water-based glue is generally acceptable to secure to the package. Metal or Velcro attachments should be avoided where possible. There are designs now in place where slits are made in the sleeve in order to slide in a corner support where no other attachments are needed.
- c. When securing a sleeve to a wood pallet, avoid nailing or stapling to the pallet. Consider the use of recyclable plastic stretch film or recyclable plastic banding instead where possible. Designs with internal corrugated pallets may also be considered to eliminate the need for stapling.
- d. Material must be dry for recycling. Baled is the preferred method of handling and shipping to achieve the best volume for shipping. Printed and unprinted materials are both acceptable for recycling. Note: It is recommended to consult your waste service provider for the current regional market index pricing for OCC.
- e. Cardboard /OCC boxes sourced for use in automotive industry packaging should be sustainably sourced with documentation of Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC) or an equivalent certification.
- f. For additional recommendations to optimize sustainable design of corrugated containers, reference the SP guidance document: [“Sustainable Packaging Specification Recommendations for Automotive Expendable Packaging”](#).



*Sleeve designed  
with removable  
wood support*



*Double wall  
corrugated  
container with  
internal corrugated  
pallet*

**12. Whenever possible, avoid one-time use packaging and assembly aids.**

- a. These packaging aids, commonly called caps and plugs, can be cleaned, inspected and reused to protect fittings, threaded fasteners and ports.
- b. Whenever possible source in neutral colored polyethylene packaging aids. Please note that sometimes colors are used as visual aids, where possible consider the use of alternative options to achieve the same goal.
- c. Single-use tape (plastic with adhesive) is also to be avoided.

**13. Plastic corrugate, multidirectional board and straight walled totes, which many times are made of polypropylene or polyethylene, should not be sourced with mixed plastics as dunnage or metal fasteners, except for the plastic pallets with seatbelts. This material, when clean and used without fasteners, can be processed for recycling as well.**

- a. In addition to rivets, recyclability challenges can include dunnage that also has laminates, vinyl labels, PVC components, glues, foam, and/or wire. While many of these challenges can be addressed, doing so takes time and labor that may negate the cost advantage of recycling the material.

**14. HDPE polybags, LDPE polybags, bubble wrap and other plastic films should be baled and placed into a recyclable film program, wherever possible.**

- a. Consideration should be given to the use of paper bags and cushioning materials as an alternative to plastic films where feasible. Paper bags and cushioning materials can generally be viably recycled together with existing paper recycling streams at a site.
- b. It is recommended to separate HDPE and LDPE material streams to improve recyclability.
- c. When preparing materials for recycling, baled material is preferred for storage and transportation whenever possible. Material may also be collected and sent offsite to a central baling location where available.
- d. Clean films tend to have higher value for recycling and higher potential for recycled materials to go back into similar packaging applications.
- e. Dirty films (e.g., those with oily residues from parts) are typically acceptable for recycling into other industries. Dirty materials should be segregated where possible to avoid contaminating an otherwise clean bale.
- f. Both printed and unprinted polybags are generally viably recyclable. It is recommended to bale printed vs. unprinted materials separately to improve recycling value.
- g. Other non-conforming materials (e.g. plastic banding, labels, adhesives, etc.) should be separated from the film recycling stream to extent possible and should represent no more than 5% of the bale.
- h. Consideration should be given to sourcing LDPE bags / films using post-consumer recycled content where possible to improve overall sustainability of materials.
- i. These materials can also be reused internally, or sent to non-profits, small local businesses as well as sent back to the supplier for reuse if clean and in good condition.



**15. Polypropylene and polyester fabric bags that may be used to protect class A surface parts from mutilation such as lighting fixtures, fascias, chrome parts, etc. can be placed in the container and sent back to the supplier for reuse where feasible.**

- a) EPP and/or multi-directional dunnage materials may be considered as an alternative to fabric bags for protecting Class A parts to improve recyclability where feasible.

**16. Use Lean manufacturing principles to move recyclables through the system in the most efficient manner possible to optimize transportation to the recycling center.**

- a. If a Logistics Optimization Center (LOC) is used to service nearby manufacturing operation(s), then efforts to concentrate and manage expendables for reuse and recycling at this location may be considered. Aftermarket parts locations can also help consolidate materials for this purpose. These strategies may create consolidation points for improved material management.

**17. Natural solid wood with no adhesives should be specified for use in wood packaging applications, including pallets, crates, and dunnage, whenever possible.**

- a. Natural solid wood is generally viably recyclable. The addition of formaldehyde, adhesives, and/or other additives in wood products can create a challenge in recycling or composting the materials and should be avoided where possible. ISPM 15 heat treatment does not affect recyclability.

**18. Wood pallets sourced in the US should be 48" x 40", 48" x 42", or 48" x 45" whenever possible, with the auto industry primarily using 48" x 45" for production and 48" x 42" for service. These sizes greatly improve the possibility for these pallets to be reused as compared to off-spec sizes.**

- a. To enable efficient recycling and reuse of 48 x 45 wood stringer pallets, reference the SP design guidance: "[Automotive NA 48 x 45 Wood Stringer Pallet Specification Recommendations](#)".
- b. Wood pallets sourced for use in automotive industry packaging should be sustainably sourced with documentation of Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC) or an equivalent certification, and be compliant with the Lacey Act.

**19. Use of OSB (Oriented Strand Board) pallet planks and risers will likely limit recycling options and should only be used if local rules and international issues prohibit alternatives.**

- a. Consider the use of viably recyclable alternatives, such as triple wall corrugated board sleeve packs, corrugated plastic sleeve packs, or sustainably sourced wood.

**20. Wooden crates, even for small batch shipping use, should be designed with ease of disassembly for reuse and/or shredding for recyclability in mind. Often, wooden crates are assembled using plate steel and bolts that unnecessarily make recycling very laborious and costly.**



- a. Wood crates sourced for use in automotive industry packaging should be sustainably sourced with documentation of Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC) or an equivalent certification, and be compliant with the Lacey Act.
- b. It is recommended that manufacturers provide contact information for suppliers and end users of wooden crates at program launch to support responsible management at end of life. Wooden crate manufacturers may have the ability and desire to reclaim their products for refurbishment or recycling but may not have visibility to the end user.

**21. Whenever possible, reduce use of continuous line of hook-and-loop fasteners, glue and double-sided tape in securing interior dunnage to a container.**



PP zip tie

- a. Spot applications (for example, one inch of fastening material for every 10 inches of container length) of these materials can allow the dunnage to be separated with ease. Continuous line materials can create a challenge for recycling. Use of friction in securing dunnage is preferred where feasible. Polypropylene or polyethylene-based fasteners (e.g. zip ties), or sonic welding, can be used to secure interior dunnage to a container as an alternative.
- b. Many zip ties are composed of nylon which is a recyclable material on its own. However, a nylon zip tie comingled with a PP or PE container can impact the recyclability of the full container and require additional time and labor to separate the materials for recycling. Use of like-to-like materials in securing interior dunnage (e.g., PE-based fasteners together with PE-based containers) is preferred whenever possible to improve recyclability.
- c. It is not recommended to use metal fasteners or metal reinforcement on containers, if possible, to improve recyclability.

**22. Whenever possible, source VCI (vapor corrosion inhibitor) polybags and films that are recyclable by design and do not contain hazardous substances.**

- a. It is recommended to source VCI products containing non-hazardous and non-regulated additives where possible. Companies should review Safety Data Sheet (SDS) information with the packaging manufacturer in the design and sourcing stage to evaluate material content.
- b. In the packaging design and sourcing stage it is recommended to engage the VCI packaging supplier, as well as the end recycler at the product's point of use if known, to identify viable recycling pathways and any sortation or other pre-processing steps that may be needed to optimize the value and sustainability impact of the materials at end of life.
  - i. VCI polybags and other VCI plastic films should be baled and placed into a recyclable film program, wherever possible. In order to maximize a truck/trailer, the bags or films must be baled or compacted in some manner in order to maximize weight for economical transportation.
  - ii. Recovered end of life VCI film materials can be recycled back into new VCI films for use in the automotive industry through closed loop recycling processes where available. Certain companies may offer incentives to reclaim their materials at end of life. It is recommended that VCI products be labeled to indicate the manufacturer and/or that the packaging manufacturers' contact information be provided to end users to support recycling at end of life.
  - iii. Where closed loop recycling processes are not available, VCI film materials may be recycled into other applications and industries via open loop recycling processes. Clean VCI films are typically accepted by LDPE recyclers. VCI additives should represent less than 5% of the total bale of LDPE film.
  - iv. Dirty materials must be separated from clean materials for recycling. Oils, residues, tapes, labels and other materials can contaminate an otherwise clean bale and cause the materials to be rejected by a recycler.
  - v. Clear films should be separated from colored films to maximize value for recycling. Colored VCI films may be mixed together for recycling.
- c. Consider sourcing VCI materials containing post-consumer recycled content where possible.



*VCI Film Products*

**23. VCI paper and VCI corrugated products are typically repulpable and viably recyclable through existing paper recycling streams.**

- a. Dirty materials must be separated from clean materials for recycling. Oils, residues, tapes, labels, and other materials can contaminate an otherwise clean bale and cause the materials to be rejected by a recycler.
- b. Please note that certain products shipped with VCI paper may require additional plastic wrapping to create a sealed environment in some circumstances. It is recommended that companies evaluate the requirements of each specific VCI use case with the aim of minimizing material usage while maximizing recyclability, where possible.



*VCI Paper Products*

**24. Reduce use of PVC (polyvinyl chloride) packaging where possible as PVC is typically challenging to recycle. Consider the use of an alternative viably recyclable material such as PET, PE, or PP where feasible.**

- a. For example, consider the use of viably recyclable mono-material alternatives such as PET, PE or PP in the design of automotive dunnage trays.
- b. At this time, PVC collection systems are limited in the United States. In consideration of the relatively lower volumes of PVC collected and the unique properties of the material, the [Association of Plastic Recyclers \(APR\) Design Guide](#) considers PVC to be a contaminant if included with mixed bales of other recyclable plastics.

## Appendix: Introduction to Circular Economy

### What is a Circular Economy

As defined by the [Ellen MacArthur Foundation \(EMF\)](#), a circular economy is a “system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources.”<sup>1</sup>

The Foundation outlines three key principles for a circular economy, each driven by design:

1. [Eliminate waste and pollution](#). In a circular economy, EMF suggests a specification for any design is that the materials re-enter the economy at the end of their use.
2. [Circulate products and materials \(at their highest value\)](#). According to EMF, this means keeping materials in use, either as a product or, when that can no longer be used, as components or raw materials. When done properly, nothing becomes waste and the intrinsic value of products and materials are retained.
3. [Regenerate nature](#). EMF suggests that moving from a take-make-waste linear economy to a circular economy shifts the focus from extraction of finite natural resources to regeneration.

### The Role of Design in a Circular Economy

The EMF suggests that in order for products to successfully become circular, it is critical that those products are designed with their eventual circulation in mind<sup>2</sup>. For example, packaging products destined for what EMF refers to as [technical cycles](#) (relevant for products that are used rather than consumed) would benefit from being easy to repair and maintain, easy to take apart, and made of modular components that can be easily replaced. Those products could also be durable enough to withstand the wear and tear of many uses and, they could be made from materials that are easily recycled.

The most effective way of retaining the value of products is to maintain and reuse them. Reusable packaging is widely used in the automotive industry and it is recommended that, whenever possible, companies seek opportunities to source parts, modules and other products using returnable packaging and base this decision on life cycle factors.

Eventually, when a durable packaging product can no longer be used, it may be able to be remanufactured. Products that cannot be remanufactured may then be broken down into their constituent materials and recycled. While EMF notes that recycling is the option of last resort because it means the embedded value (i.e. the time and energy invested in making it) in products and components are lost, it is extremely important as the final step that allows materials to stay in the economy and not end up as waste. Therefore, this guidance document focuses on opportunities to improve the recyclability of automotive packaging *in the design phase*.

Designing for recycling is an important consideration for all products in the technical cycle, but especially for those items that are not suitable for the other steps in the cycle (i.e. reuse, repair and/or remanufacture). These items include single-use packaging, which should be carefully considered in instances where it cannot be designed out and reusable alternatives are not possible.

<sup>1</sup> The Ellen MacArthur Foundation, Circular Economy Introduction, Retrieved January 2024, from <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

<sup>2</sup> The Ellen MacArthur Foundation, The technical cycle of the butterfly diagram, Retrieved January 2024, from <https://www.ellenmacarthurfoundation.org/articles/the-technical-cycle-of-the-butterfly-diagram>

## The Role of Recycling in a Circular Economy

A key principle of a circular economy is that products and materials are circulated at their highest value at all times. In the technical cycle, EMF notes this implies that packaging is reused when possible (circulating the packaging product), then recycled (circulating the packaging materials).

A high quality of recycling and of recycled materials is essential in a circular economy. This maximizes the value retained in the economy, the range of possible applications for which the material can be used, and the number of possible future life cycles. It therefore minimizes material losses and the need for virgin material input.

Within recycling, this principle results in the following general order of preference as recommended in the [Ellen MacArthur Foundation's New Plastics Economy](#) study<sup>3</sup>:

**“1. Mechanical recycling in closed loops.** This is the most value-preserving loop. Mechanical recycling keeps polymers intact and hence preserves more value than chemical recycling, where polymers are broken down. Closed-loop mechanical recycling keeps the quality of the materials at a similar level by cycling materials into the same application (e.g. from PET bottle to PET bottle) or into applications requiring materials of similar quality. As such, mechanical closed-loop recycling not only preserves the value of the material, it also maintains the range of possible applications in future, additional loops.

**2. Mechanical recycling in open loops ('cascading').** Given the inherent quality loss during mechanical recycling, closed-loop mechanical recycling cannot continue indefinitely. Open-loop recycling plays an important role as well. In open-loop mechanical recycling, polymers are also kept intact, but the degraded quality and/or material properties require applications with lower demands. Cascading to the highest-value applications each cycle could help maximize value preservation and the number of possible loops.

**3. Chemical recycling.** Chemical recycling breaks down polymers into individual monomers or other hydrocarbon products that can then serve as building blocks or feedstock to produce polymers again. As such, it is less value preserving than mechanical recycling. Chemical recycling technologies are not yet widespread and/or not yet economically viable for most common packaging plastics. However, as they could enable after-use plastics to be upcycled into virgin-quality polymers again, they could become an option for materials for which mechanical recycling is not possible.”

EMF notes that the rank order above offers a general order of preference and target state to innovate towards, but, should not be seen as a strict hierarchy for determining the best option for every single piece of packaging today. It should be understood though that for a piece of packaging to be considered truly circular in alignment with EMF principles, such products and the systems they sit within would be designed to ensure no materials are lost, no toxins are leaked, and the maximum use is achieved from every process, material, and component.

This sustainable packaging guidance document was developed in support of the vision of moving the automotive industry toward a circular materials economy, with the intention to provide information on opportunities to minimize automotive packaging waste and address barriers to packaging recyclability and/or reuse in the *design phase*. We recognize that the journey toward a circular economy is challenging and that much work remains to be done, but that there are practical opportunities that may be considered today to promote new innovation and continually strive to move materials further up the hierarchy to maximize their value.

<sup>3</sup> World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, The New Plastics Economy: Rethinking the future of plastics (2016).



### III. Acknowledgements

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SP work group members contributing to the development and review of this guidance document included:

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| • Absortech                        | • JSP                             |
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**Contact:** Please submit any feedback on this guidance or suggestions for future improvements to [info@supplierspartnership.org](mailto:info@supplierspartnership.org).

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