



Document Number: SC PROC-10014 / Rev 02
Part Packaging and Handling Requirements

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Revision History

Revision	Date	Change
L1-755I001	9/14/2018	Initial document creation 6.25 Raw Metals, Storage, and revised formatting and structure Revised layout, added explosives and ESD sections
01	04/18/19	Initial release of SC document Added packaging types
02	06/30/20	Changed document title to "Part Packaging and Handling Requirements" Removed materials/inventory requirements (covered by SC PROC-10017 and SC WI-20040) Added requirements for supplier packaging of parts Added in-process packaging for internal parts Removed approver names

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1 Introduction

1.1 Scope

This procedure defines packaging types and outlines the requirements for effective preservation and packaging of products and hardware during supplier operations, VO internal transport between work centers, and VO internal final packaging for Inventory storage. For supplier shipping requirements, refer to SC PROC-10019. This procedure is applicable to all flight and qualification products and hardware at suppliers and within Virgin Orbit in Long Beach.

2 Definitions

2.1 Terms

Table 1 - Terms

Term	Definition
Flight Hardware	No test-dedicated development or qualification article exists and all production hardware is intended for flight.
Qualification Hardware	Intended for development and testing of designs that may then be used for production flight hardware.
Machined Components	Components with machined surfaces such as holes, interlocks, specific finish types, set screws, exposed threads, or sealing surfaces for compression fits. Components that are manufactured or altered using conventional/ CNC machining methods.
ESD Components	Any component (primarily electrical) which can be damaged by common static charges which build up on people, tools, and other non-conductors or semiconductors.
Cured Composite Components	Hardened polymer material, primarily used in the Structures department.
Tubing	Includes all hardware that has an internal diameter, such as weldments and raw material.
LOX Hardware	Hardware that comes in contact with liquid oxygen or has the potential of coming into contact with LOX or GOX.
LOX Compatible Tape	Particle free tape, suitable for ISO Class 3 to ISO Class 6 cleanrooms. Examples include Kapton and Polyimide tape.
Solumina	Software used to create process plans and WO's that manage the production of a given component or assembly. Has capability to generate and link non-conformances (WTF's) to a WO.
Work Order	Contains all work instructions for hardware.
Work Center	Location where work is being done on hardware, this location should be specified in each Solumina WO operation or WTF.
Hardware Coordinator	Technician, production coordinator, or inspector who is tasked with packaging and hardware movement between work centers.

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In-Process Packaging	Packaging used to prevent hardware damage during transit between work centers. This packaging type should be specified in the WO instructions.
Final Packaging	Packaging used to prevent hardware damage during storage in Inventory and should be completed at the final operation of a WO. This packaging type shall be specified in the part drawing notes.
Supplier	An organization that provides products to VO and is approved by the legal team. There must be an active NDA associated with them, unless purchasing COTS parts.

2.2 Acronyms

Acronym	Definition
ESD	Electrostatic Discharge
GOX	Gaseous Oxygen
LOX	Liquid Oxygen
ME	Manufacturing Engineer
NDA	Non-Disclosure Agreement
OSP	Outside Processing
PM	Production Manager
QA	Quality Assurance
QE	Quality Engineer
RE	Responsible Engineer
RI	Receiving Inspection
RTS	Return to Stock
VO	Virgin Orbit
WIP	Work in Progress
WO	Work Order
WTF	What to Fix

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3 Packaging Requirements

3.1 General Requirements

All Parts shall be packaged per Virgin Orbit Drawing or Purchase Order requirements. If a packaging type is not specified, package products per ASTM D3951 or default to Type 1. General packaging requirements are summarized in Table 2 below.

Table 2 – General Packaging Requirements

Packaging Characteristics	Description
Durable	Packaging adequately protects the product for shipment and storage at the VO facility for a minimum of one (1) year from the time of receipt.
Easy to Handle	Packaged product can be handled using standard equipment and meets common carrier minimum packaging and handling requirements.
Appropriate Size	Packages are of a uniform consistent size.
Easy to Remove	Packaging can be removed/disassembled using common hand tools with no risk to damage the fit, form or function of the part
Maintain Cleanliness	Packaging adequately protects the product from decontamination when appropriate.

If the ASTM standard may not adequately protect the product, the supplier or VO internal Hardware Coordinator shall supplement the packaging using additional materials, or more substantial containers. For labeling and shipping requirements, reference SC PROC-10019.

3.2 Packaging Types

Part Packaging types are outlined in Table 3 below. Parts are to be packaged per the type specified on the Drawing or better.

Table 3 – Packaging Types

Type	Sub-Type	Description
1 - Bag	1.A - Machined Components	Individual packaging using polyethylene bag or equivalent.
	1.B - ESD Components (PCBA's, Harnesses, Controllers)	Individual packaging using ESD compliant bag. Refer to Section 3.4.
	1.C - Cured Composite Components	Individual packaging using polyethylene bag or equivalent.

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	1.D - Tubing	Individual packaging using polyethylene bag or equivalent. Plugs installed in all threaded ports, and caps installed over all unthreaded ports.
2 - Bag and Bubble Wrap	2.A - Machined Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Ensure corners are well protected.
	2.B - ESD Components (PCBA's, Harnesses, Controllers)	Individual packaging using ESD compliant bag layered in pink poly bubble wrap. Apply ESD electrical connector caps or plugs if required. Kapton tape is an acceptable alternative. Refer to Section 3.4.
	2.C - Cured Composite Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Ensure corners are well protected.
3 - Bag, Bubble Wrap, and Container	3.A - Machined Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Then placed in a container that is divided to ensure no contact is made between parts. Ensure that parts do not move freely within the container.
	3.B - ESD Components (PCBA's, Harnesses, Controllers)	Individual packaging using ESD compliant bag layered in pink poly bubble wrap. Then placed in an ESD container/tote with ESD warning labels. Ensure that parts do not move freely within the container. Apply ESD electrical connector caps or plugs if required. Kapton tape is an acceptable alternative. Refer to Section 3.4.
	3.C - Cured Composite Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Then placed in a container that is divided to ensure no contact is made between parts. Ensure that parts do not move freely within the container.
4 - Bag, Bubble Wrap, and Foam Container	4.A - Machined Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Then placed in a container that is divided to ensure no contact is made between parts. Ensure that parts do not move freely within the container. Apply foam around bubble wrap for additional protection, a pelican case would suffice for this.

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	4.B - ESD Components (PCBA's, Harnesses, Controllers)	Individual packaging using ESD compliant bag layered in pink poly bubble wrap. Then placed in an ESD container/tote with ESD warning labels. Ensure that parts do not move freely within the container. Apply anti-static PE foam for additional protection. Apply ESD electrical connector caps or plugs if required. Kapton tape is an acceptable alternative. Refer to Section 3.4.
	4.C - Cured Composite Components	Individual packaging using polyethylene bags or equivalent, layered in bubble wrap. Then placed in a container that is divided to ensure no contact is made between parts. Ensure that parts do not move freely within the container. Apply foam around bubble wrap for additional protection.

3.3 Prohibited Packaging Materials

Packaging materials that may not be used are outlined in Table 4. Refer to SC PROC-10019, *Supplier Shipping Requirements* for additional requirements.

Table 4 – Prohibited Packaging Materials

Packaging Material	Description
Metal Staples	Metal staples when used to secure polyethylene wrapped or bagged items
Loose Objects	Newsprint, polystyrene “chips”, “peanuts,” “popcorn” or shredded paper for wrapping or cushioning.
Contaminants	Any materials that may risk damage to the product by corrosion, static electricity, tape residue, and other contamination.
Preservatives	Any preservative which, when removed using a standard technique, may damage the product

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3.4 ESD Components

Electrostatic discharge (ESD) protection shall be provided by a static shielding bag that meets or exceeds ANSI/ESD S20.20 and ANSI/ESD S541 requirements. The bag must be sealed with a label that has ESD warning per MIL-STD-129 5.10.20, and shown in Figure 1. Please note that if the seal is broken a new ESD label must be placed.



Figure 1 – ESD warning label

3.5 External Fasteners

External threaded fasteners shall be wrapped in webbed meshes, as shown in Figure 2.



Figure 2 – Webbed mesh

3.6 LOX Hardware

LOX hardware must be sealed in airtight packaging, as shown in Figure 3. If hardware size precludes storage in sealed packaging and outside surfaces of hardware will not contact LOX, then at a minimum all ports in the hardware shall be covered at all times. Ports shall be covered with LOX compatible caps, plugs or bagging material sealed with LOX-compatible tape. In addition, a label shall be applied to an easily visible surface of the packaging, identifying the part(s) as OX CLEAN. Example of label shown in Figure 4.



Figure 3 – Airtight Packaging



Figure 4 – LOX Label

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4 Packaging Multiple Parts

4.1 Multiple Unique Part Numbers

A supplier may consolidate multiple unique items, or part numbers, in a container if the following requirements are met:

- 1) The container is marked "Multiple items in this container."
- 2) A packing list is attached to the container, and has a list of each individual item, including quantity.
- 3) Each item is individually packaged per drawing requirements.
- 4) Each individual package has a label meeting requirements per SC PROC-10019.
- 5) All items in the package have the same purchase order number.

4.2 Multiple Batch / Lot Numbers

If a supplier makes a shipment of individual items with the same part number that come from multiple batches/lots, the supplier shall meet the following requirements:

- 1) Pack each batch/lot in individual containers.
- 2) Mark the batch/lot number on each box label.

5 Waterproof Packaging

For product that requires a waterproof barrier, the supplier shall use a suitable cover. The supplier shall position the cover(s) to prevent formation of water pockets and to allow air circulation. In addition, the supplier shall cushion sharp points of contact between the product and the cover to prevent tearing.

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6 Internal VO Packaging Requirements

6.1 Responsibilities

6.1.1 Hardware Coordinator

The Hardware Coordinator shall preserve and package hardware to prevent deterioration or damage during transport between work centers, and for final packaging before Inventory storage. This should occur before and after work has taken place at a specific work center, and at the final operation of a WO.

6.2 Hardware Transit Requirements

Hardware should be issued from Inventory in a bin per Figure 5, and shall be identified by a WIP card or transport ticket. During transit between work centers, the Hardware Coordinator should keep parts in this original container with the WIP identification card and should package parts per the Packaging Type specified in Section 3 or the drawing requirements if the part is complete. Hardware should be placed on the appropriate work station rack. The intent is to prevent damage from occurring during transit on the shop floor. Additionally, packaging shall not be opened at a work center unless the surrounding environment allows the cleanliness level of the part to be maintained per MFG PS-00025.



Figure 5 – Plastic bin for transporting hardware

7 Reference Documents

- MFG PS-00025, *Hardware Cleaning Specification*
- SC PROC-10019, *Supplier Shipping Requirements*
- ASTM D3951, *Standard Practice for Commercial Packaging*
- ASTM D5118, *Standard Practice for Fabrication of Fiberboard Shipping Boxes*
- ASTM D6880, *Standard Specification for Wood Boxes*
- ASTM D6039, *Standard Specification for Open and Covered Wood Crates*