Aftermarket Supplier Packaging Guidelines

Hyster-Yale Group

February 2024

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1 INTRODUCTION

1.1 SCOPE

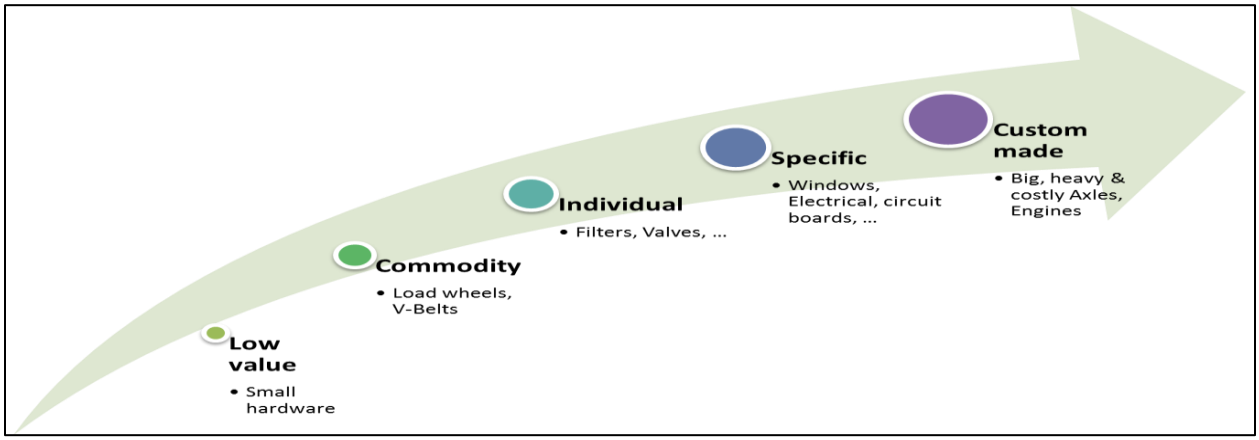
This document provides general guidelines on the minimum packaging requirements for parts and materials shipped to the Hyster-Yale Group (HYG) Distribution Centers located in Danville, IL/USA; Nijmegen, Netherlands; Sao Paulo, Brazil; Shanghai, China; note that this document applies to parts and materials intended for use as service parts, which by nature are sold individually to an authorized dealer or end user. In general, these parts must be packaged for individual sale, shipment, and storage. Parts and materials procured by Hyster-Yale Group for use by our manufacturing facilities must comply with the packaging requirements guidelines for HYG manufacturing, and not this document.

In many instances, it is likely that the supplier will be providing both materials for the manufacture of new units (manufacturing packaging standards apply) as well as service parts for the HYG aftermarket operation to which these standards apply. The supplier will be expected to follow the applicable standards for each on all product shipped.

1.2 PURPOSE

The purpose of this document is to provide suppliers with concise guidelines for packaging aftermarket materials for warehouse storage, handling and transport to internal customers and dealers while maintaining the highest product quality throughout the supply chain. This should be achieved by maintaining the lowest total cost by minimizing product damage, freight costs, ergonomic hazards, material handling labor, and environmental impact.

The aftermarket product packaging falls into 5 main categories:



Low **value (Small hardware)**
These products are normally packaged in a poly bag with a specific number of pieces in each bag. Country of Origin (Where part was made) must be printed on each bag. If the bag contains more than one piece, the part quantity (PQ or QTY) must also be printed on the bag.

Commodity Level Parts

- Oil Filters and Water separators
  - Individual pieces in shrink-foil or chipboard carton
  - Over-packed into corrugated carton in case quantity
  - Each part must be labelled (full label) or full print directly on the filter
- Air Filters
  - Individual pieces in shrink-foil or corrugated carton
  - Each part must be labelled (full label) or full print directly on the filter
- Spark Plugs
  - Commercial branding acceptable
  - Outer carton of chipboard in package quantity

  - Individual plugs in chipboard carton
- Fan and Drive belts
  - Folded and placed in chipboard sleeve –or-
  - Placed in corrugated box if too large for sleeve
  - Each part must be labelled (full label)
- Bearings
  - Individually packed in sealed poly bags below 4 kg/ 8.818 lb
  - Corrugated box must be used above 4 kg/8.818 lb
  - Each part must be labelled (full label)
- Load Rollers or Load Wheels weighing under 3.1 kg/7 lb
  - Individual pieces should be in shrink foil
  - Each part must be labelled (full label)
  - Label must not be applied directly to part (apply over foil)
- Load Rollers or Load Wheels weighing between 3.1 kg/7 lb and 13.6 kg/30 lb
  - Individually packaged in corrugated carton or shrink foil
  - Heavy paper dunnage used to prevent movement in carton if needed
  - Full part label should be applied to outside of corrugated carton
- Load Rollers or Load Wheels weighing between 13.6 kg/30 lb and 23 kg/50.7 lb
  - Crumpled paper must be used inside the carton to prevent movement of the part in transit
  - Full part label should be applied to outside of corrugated carton
- Load Rollers or Load Wheels weighing over 23 kg/50.7 lbs and below 30 kg/ 66.14 lbs including all packaging material crumpled paper filler preferred and over 30 kg/ 66.14 lbs and below 60 kg/132.3 lbs foam filler must be used
  - Individually packed in a box on a wooden skid
    - Skid must conform in size to the box (not be oversized)
    - Skid runners must be tall enough and spaced far enough apart to hand pallet truck to pick up the skid
    - Skid must be heat treated and show appropriate heat treat certification stamps
  - Part should be covered (both sides) by a corrugated sheet to protect from surface damage
  - Part should be banded to the skid using heavy duty poly strapping

- 2 straps must be used
- Edge protectors must be used at the point where each strap contacts the edge of the box to prevent damage

- Full product label should be applied to the side of the corrugated box

Individual (Filters, Valves, ...)
These products packed in a corrugated board box or shrink foil.

Specific (Windows, Electrical circuit boards, …)
The packages of these products are specific designed per item or group. The packaging design is based on their vulnerability or special demands.

Custom Made (Big, Heavy & costly, …)
Due to the size and weight of these parts, it is necessary to develop a custom-made solution.

Due to the wide range of parts supported by the aftermarket, some packages may not fit into the guidelines supplied below. For inquiries regarding packages outside of these guidelines, please contact your Buyer.

HYG Packaging is willing to partner with suppliers to establish sound, economical packaging designs that promote efficiency throughout the entire supply chain. However, suppliers retain the responsibility for providing damage free production materials shipped in the lowest total cost package.

2 IDENTIFICATION

Base label should be white & all printing on label should be in black.
Logo must be colorful, see special technical description for branding, see section 12.
Label material preference is Ribbon
Thermal is acceptable if meets following standard

- Label should be fade resistant to UV and temperature for a minimum of 3 years

Label should include:
HY Source Part Number Indication
Commodity Part Description
Country of Origin
BAR code + QR code of HY Source Number Indication
Package Quantity
“Scan me!” text
QR code of landing page
Package Location/Partner (See Appendix B for Chart)
See Appendix A for detailed dimensions, approved logo and package placement.

Product labels must be used on all packages shipped to the HYG facilities.

Please note the following items are not allowed on the label:

- Supplier Part Number
- Manufacturing Name/Logo

3 ACCEPTABLE PACKAGING

3.1 Vendor Box (chipboard and corrugated)

- Must be one solid color
- Must be made of material suitable to protect
- Must meet ISTA Standards
- No logos or ads identifying Supplier

3.2 Inner Pack

- Plain package
- No identifiable information unless necessary
    - Serial or Model number

  - Test Data Information is acceptable
- Secure – No rattle
- Survive ISTA drop test
- Styrofoam and popcorn should **not** be used as filler

3.3 Vendor Bag

- Must not have printed graphics.
- Must be solid in color or clear (acceptable to be clear on one side and solid on the other).
  - White is preferred color
  - 2 ml/0.0508mm thickness minimum
- Must be made of material suitable to protect and support part.
  - Small hardware less than 1lb or .45kg
- Closure must be rolled and stapled or heat-sealed (preferred).
  - Other closures must be agreed upon.
- Date code and country of origin are acceptable. Part number and brand are not required.
- Sustainable, environmentally friendly, recyclable material of minimum 30% recyclable content

3.4 Shrink Foil

- Items that must to flat
- Must be able to label over vendor label.
- Must not have printed graphics anywhere on corrugated board. The board must be stout enough to not warp or bow when heat shrink is applied.
- Example of commodities to be packed in shrink foil: load wheels, load rollers

3.5 Cold Seal/Security Seal

- Tamper evident package
- Used on electrical item with programming
  - Example – Eprom chips

3.6 Vendor Chipboard Sleeve

- Must be able to tape/label over vendor label
- Must be one solid color

4 CRATE

All wood used for parts packaging must be Certified Heat Treated (HT) or Kiln Dried Heat Treated (KD HT) and must carry a certification stamp on two sides of each crate, reddi-crate, shell carton, wooden box, crate or pallet to be able handle and manipulate with Hand pallet truck/pallet jack, etc... This requirement was enacted due to worldwide standards for wood acceptance into foreign countries and the United States.

5 CORROSION PREVENTION

Aftermarket parts that are required to be corrosion free must be adequately packaged to prevent corrosion for a minimum of 12 months.

5.1 OIL AND WAX BASED PRESERVATIVE OILS

Oil and wax based preservative oils should not be used without prior written approval.

5.2 VOLATILE CORROSION INHIBITORS (VCI)

Volatile corrosion inhibitors (VCI) are preferred over oil and wax based preservative oils in that they eliminate the need for cleaning Aftermarket parts prior to use.

VCI materials are available in many forms – poly films, Kraft papers, bags, sheets, tubes, additives, emitters, etc. VCI material selection will be based upon the minimum total cost application.

Select VCI films and papers that can be easily recycled with ordinary films and papers. Clear versus tinted films further aids the ease of recycling.

Depending upon the application, the best practice is typically to line the package with a VCI poly bag prior to loading Aftermarket parts to prevent direct contact between Aftermarket parts and the package. The VCI bag must be completely intact with no holes. Acceptable methods for sealing the bag after loading include zip lock, tape, twist tie, zip tie or heat seal. Staples must not be used.

The use of VCI film or paper to separate parts or layers of parts is preferred over individually wrapping or bagging Aftermarket parts.

VCI products provide the best protection when the Aftermarket parts are free of all contaminants – dust, dirt, residue, etc.

Aftermarket parts must be completely dry after washing operations, etc. prior to packing with VCI products.

Wear clean and dry rubber gloves when handling clean Aftermarket parts during the VCI packaging process.

VCI products prevent corrosion, but cannot reverse corrosion that has already begun. Make sure that all Aftermarket parts are corrosion free prior to packing.

5.3 DESICCANT

Depending upon the transit and storage requirements, desiccant may be required to keep Aftermarket parts corrosion free. Calculate the proper amount of desiccant required for the application and enclose the desiccant within the VCI poly bag, or other water vapor barrier material, to absorb excess moisture.

6 CLEANLINESS

Production materials with cleanliness specifications must be protected from degradation by the use of proper packaging materials. The packaging materials must not release contaminants when in direct contact with the production materials. The use of individual part wraps or bags should be avoided unless absolutely necessary to maintain cleanliness.

6.1 HYDRAULIC CLEANLINESS

Aftermarket parts that come in contact with hydraulic fluid, brake fluid, or fuel must be protected from corrosion and contamination.

All open points on these materials must be sealed with a securely fitting plug. Use of threaded plugs is preferred to seal open threaded holes. The cleanliness of all sealing plugs must be consistent with the cleanliness expectations of the Aftermarket group.

Depending on the Aftermarket part design, sealed bags or other protective packaging may also be required.

Please see addendum for more detailed Cleanliness Requirements

7 PACKAGING AND WEIGHT

Supplier is responsible for correct packaging and labeling of all hazardous material.

8 PALLET REQUIREMENTS

Wood pallets adhering to recycling standards are preferred.

Wood pallets should be fabricated in general accordance with current Good Manufacturing Practices outlined in the latest version of the Uniform Standard for Wood Pallets published by the National Wooden Pallet and Container Association (www.palletcentral.com).

Wood pallets that will be shipped internationally must comply with the latest version of the International Standards for Phytosanitary Measures, ISPM No. 15, Regulation of Wood Packaging Material in International Trade (www.ispm15.com).

Approved pallet size is 80 x 120 cm and 120 x 120 cm unless the part requires a larger pallet be used to avoid overhang. It is not acceptable for cartons, cases, or parts to overhang the edges of the pallet base.

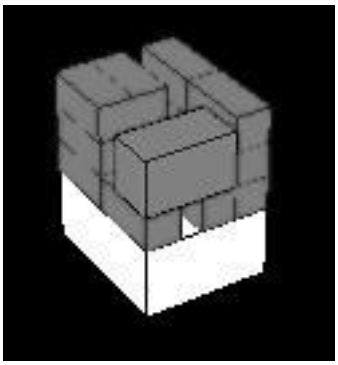
The maximum height of a pallet plus contents shall not exceed 1200 mm/48 in for pallets with cartons.

Clear height underneath the pallet (height of the legs) must be 100 mm/0.328 in for manipulation with HPT (hand pallet truck).

8.1 CARTON STACKING

Cartons should be secured on pallets via shrink wrap or poly banding
Edge protectors should be in place including knee boards

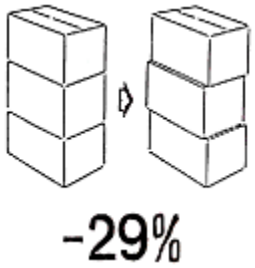
Interlocking stacking method is preferred for Aftermarket when shipping pallets with mixed part.



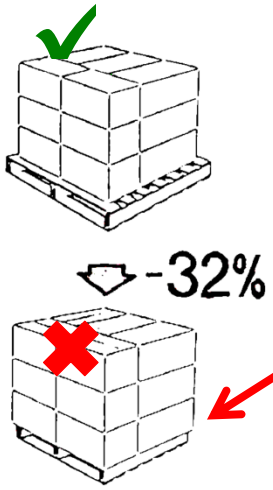
Refrain from carton overhang off the pallet. Carton overhang can reduce stacking strength by up 32%.

- Containers must be aligned for full pallet part shipments

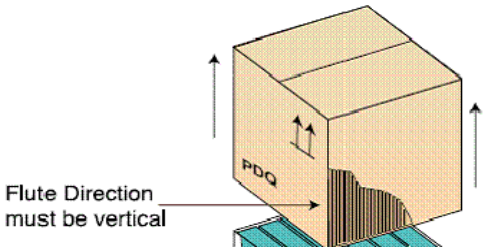
- Boxes are strongest when stacked aligned.
- Non-alignment by just 1” (25 mm) results in a 29% compression strength loss.



- Containers must not overhang the pallet
- Shipping units must fully utilize the length and width of the pallet, but they must not be larger in length or width than the pallet.
- Overhang on a pallet by 1” (25mm) results in a 32% compression strength lost.



- Flute direction must be vertical
- Corrugated pattern in wall of carton must have visible spaces in the vertical direction to optimize compression strength of the carton.

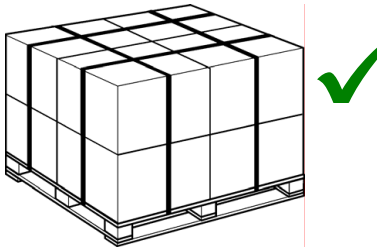


- A minimum 44 Edge Crush Test (ECT) / 275 psi / 7.7 kN/m is required.
- All containers must have a box maker's certificate visible on the assembled container displaying ECT or bursting strength.

- Parts plus dunnage should completely fill the container to prevent collapsing because of excessive empty space.

The following are acceptable methods for securing cartons to a pallet:

- Plastic (Non-Metallic) Strapping –
  - Metal strapping is prohibited. Metal clips or buckles are prohibited
    - Metal strapping may be used as an exception for heavy parts not shipped in cartons
    - A minimum of two vertical bands lengthwise and two vertical bands widthwise must be used.



- Loose banding is prohibited. Bands must be secure and tight
- Horizontal banding of corrugated boxes is prohibited.

- Stretch film is acceptable
  - Stretch wrap must encompass the entire shipping unit including the pallet.

UNACEPTABLE DESIGN CHARACTERISTICS

- Pyramid stacking of containers disallowing load stacking.
- Misalignment of containers causing crushing.
- Overweight containers.
- Insufficient container strength to protect components.
- Multiple footprints disallowing standard loading patterns.
- Not enough dunnage
- Improper closure
- Too much airspace

9 PACKAGING CHANGES

All changes to packaging material, labeling or design should be communicated to HYG for review and approval.

10 SPECIAL MARKINGS

Hazmat material markings
California requirements
Country of Origin Documents

11 BOX AND FOAM VS. CRATE - PACKAGING STANDARD

Special category of packaging is covered by box and foam packaging vs. crates, which needs to be followed based on below described packaging standards.

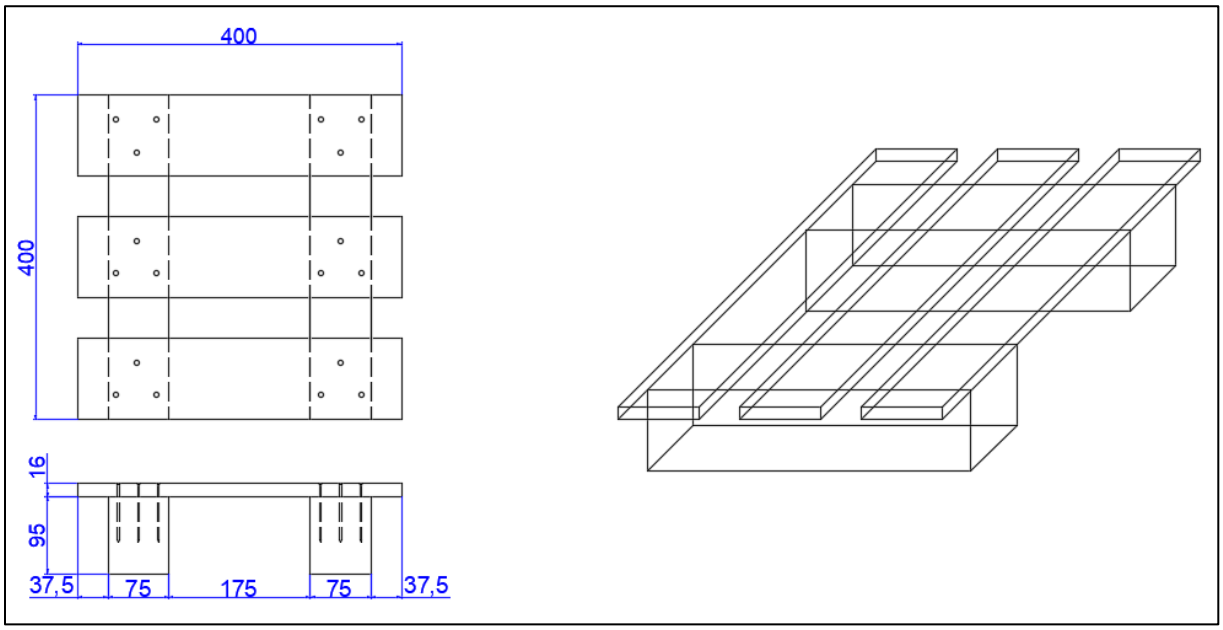
Packaging for commodities between 23 – 60 kg (51 – 110 lb.) has to be standardized following these requests:

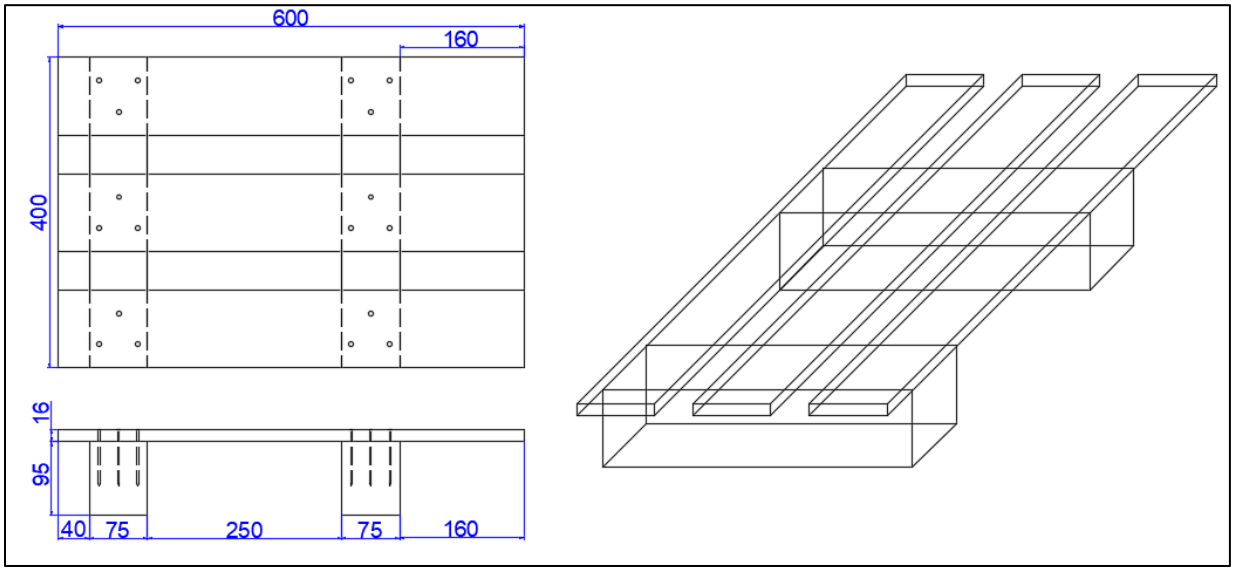
1. Skid – wooden material HT (Heat treated), minimum dimensions see drawing
2. H-taping – paper tape only for top of the packaging, if skid applied. If skid under 23 kg / 51 lb. not used, bottom and top has to be H-taped.
3. Strap Edge Protectors/plastic strap guard/corner protector or edge protector- 4x
4. Banding – plastic 2x

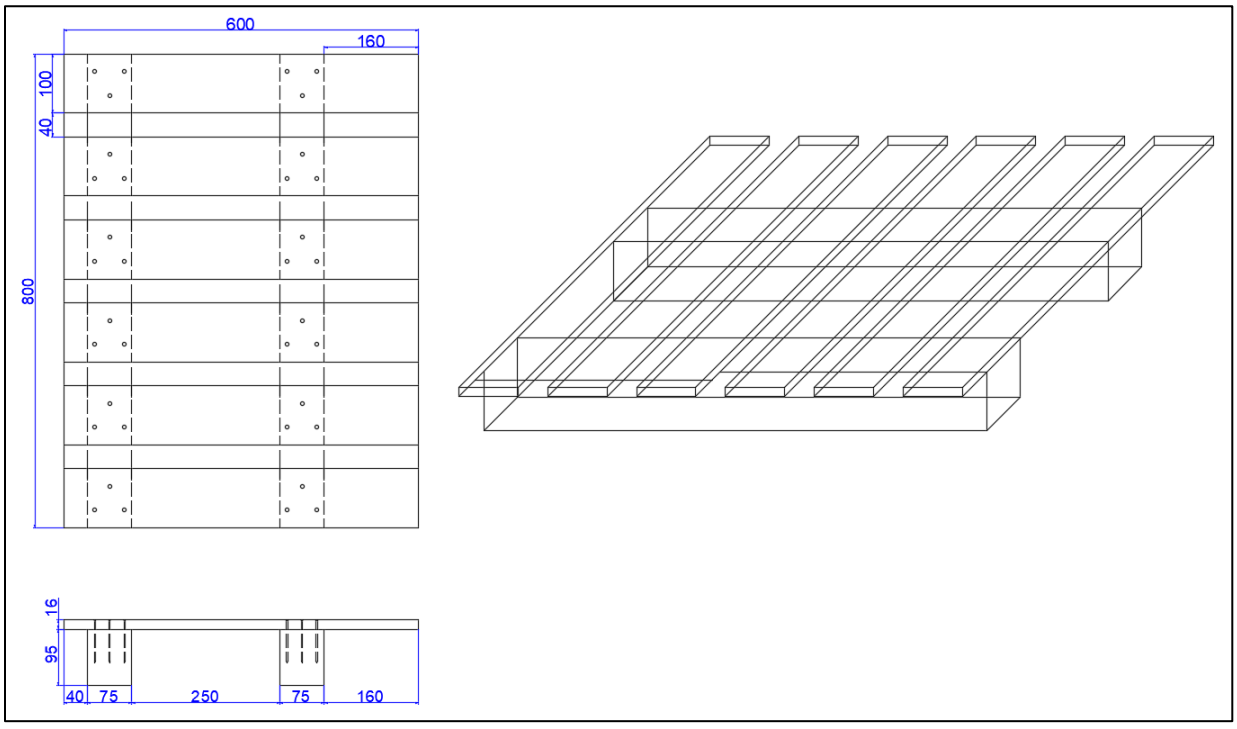
Every packaging must fit to EU pallet size dimensions by multiple packaging and for US market present packaging with imperial dimension is valid. With development of new packaging applies rule with standard height of the pallets and skids, see drawing below. Eco friendly packaging materials are requested.

3 main dimensions on skid applies:

1. 400 x 400 mm or 15 ¾ x 15 ¾ in
2. 600 x 400 mm or 23 5/8 x 15 3⁄4 in
3. 800 x 600 mm or 31 ½ x 23 5/8 in

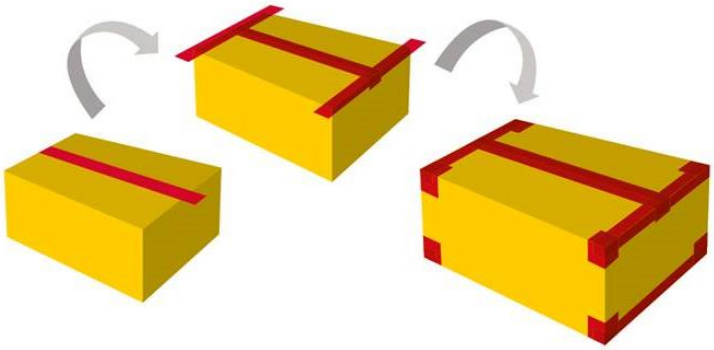






NOTE: Nails must be always in “triangle” position! Not aligned in one line, but in triangle shape due to better robustness holding the wooden parts together.

H-taping:



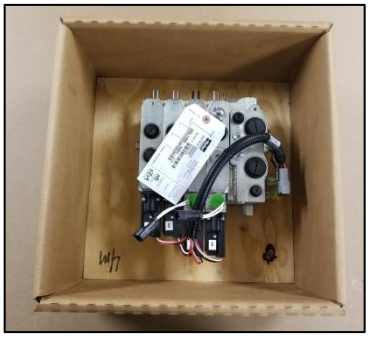
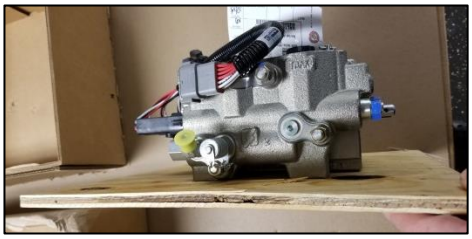
Banding:



Plywood fixation:

- screws and washers need to be implemented for valves. No inserts needed. Offset 6 cm / 2 23⁄64 in from each side including top of the packaging

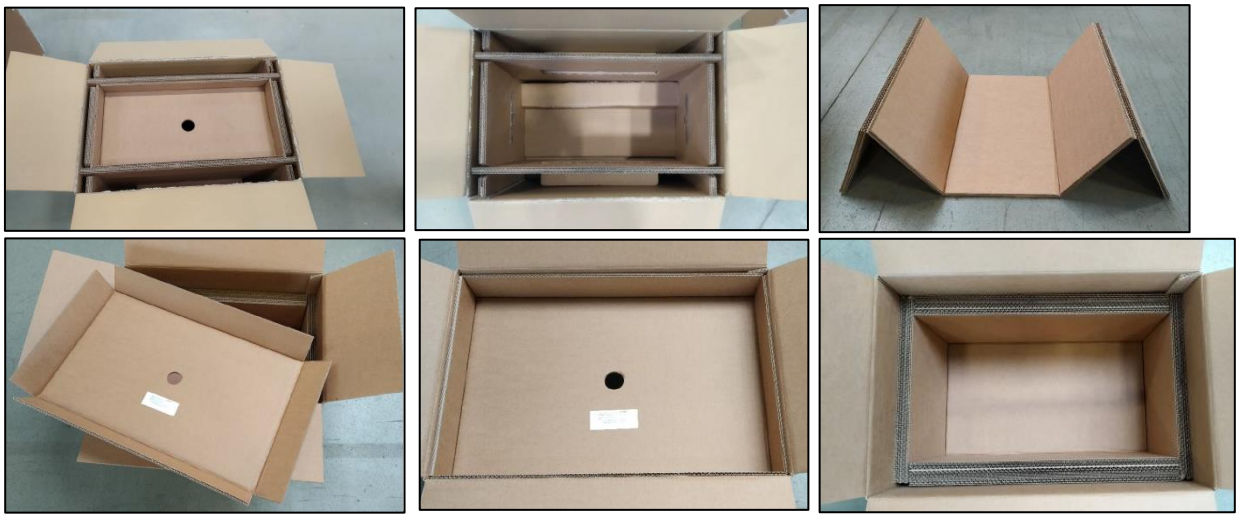


Crumpled paper:

- Fillers are suitable for max. 30 kg/66 lb. heavy weight commodities

- Fillers are suitable for heavy weight commodities (custom made inlayers)



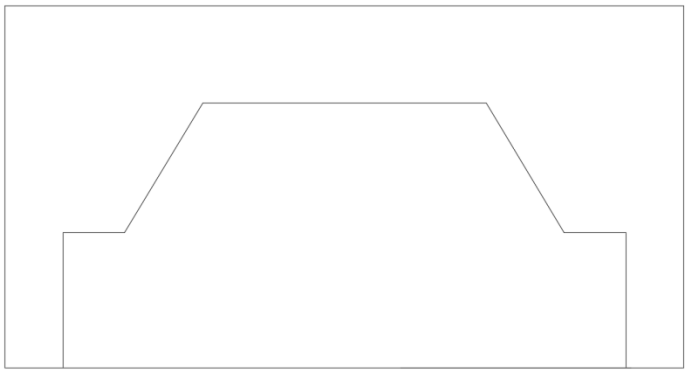
Foaming fillers from 30-60 kg/66 – 132 lb.:

- have to cover bottom, sides and top complete filling in the box. Pump, motors, drives, engines with shaft 6 cm / 2 23⁄64 in offset from outside ring. Recommended foam type is Instapack 50W

Round items:

- Must be in lying flat position to avoid movement of the items in the packaging

Front view



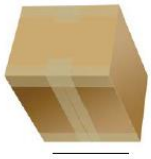
All the commodities over 60 kg/ 132 lb. are not able to survive with acceptable quality and damage conditions drops with tested packaging materials. Crates packaging as a Eco-friendly solution is the way, how the commodities should be delivered.




All new packaging has to be tested by supplier following drop test procedure. Drop test has to be provided as a full shipping unit including skid, banding, H-taping, corner posts.

Package Weight	Drop Height	Drop per Sequence
Equal to or less than 75 lbs. / 34 kg	30"/ 76 cm	10
Greater than 75 lbs. / 45 kg but equal to or less than 100 lbs. / 45 kg	24" / 61 cm	10
Greater than 100 lbs. / 45 kg but equal to or less than 150 lbs. / 68 kg	18" / 46 cm	10

1. Most fragile corner.



3. Medium edge radiating from the drop corner.

5. Flat on one of the smallest faces.

7. Flat on one of the medium faces.

2. Shortest edge radiating from the drop corner.

4. Longest edge radiating from the drop corner.

6. Flat on the opposite small face.

8. Flat on the opposite medium face.

9. Flat on one of the largest faces.

10. Flat on the opposite large face.

Summarization of packaging standard

Overall overview through all weight categories

Overall overview:

weight range [kg/lb.]	Type of packaging	Primary packaging material used	Alternative
23-30 kg/ 51-66 lb.	Box on Skid	Filler with crumpled paper/fixation to bottom plate / carboard custom made inlayers	supplier's alternative which passes drop test
30-60 kg/ 66-132 lb.	Box on Skid	Foam Instapack 50W/fixation to bottom plate/custom made cardboard inserts	supplier's alternative which passes drop test
>60 kg/ 132 lb.	On skid (banding) or Crate	Wood/Crate	supplier's alternative which passes drop test

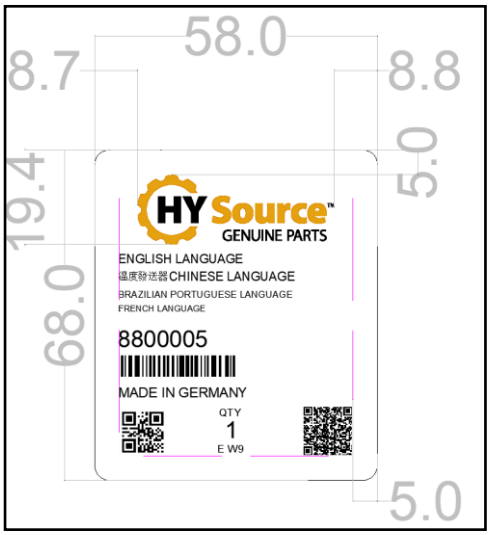
12 PRODUCT LABEL

- Description: HY Source label – colorful branding/text black
- Dimensions: Metric: inside/outside 58x68 mm. Imperial: inside/outside 2 1/4x2 5/8''
- Tech properties label: 75 grs/m2 thermo (paper), Opaque thermo top, Extra permanent glue – black, white surface – brightness of label surface minimum 89
- Backing paper: Yell glass BG40
- Winding orientation: B or 3 - See below section winding

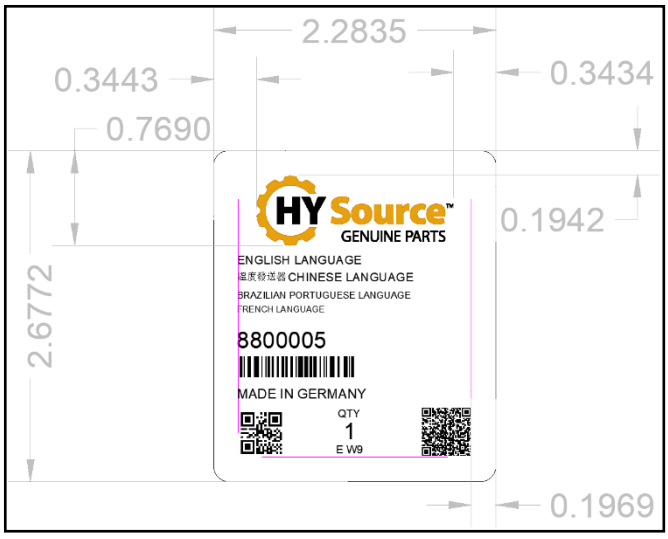
All measures are in metrical system [mm], for imperial norm [in] use conversion ratio as follow: **1 millimeter [mm]= 0.03937 in**
Acceptable tolerance +/- 1 mm

1. Branding logo position and offset from edge of the printing area on the label:

Metrical:



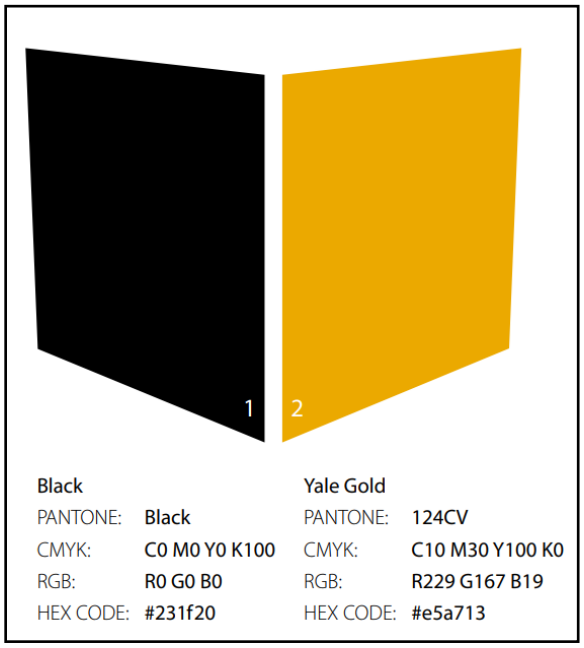
Imperial:



Technical description of branding:

- Color definition:

  Black PANTONE: Black CMYK: C0 M0 Y0 K100 RGB: R0 G0 B0 HEX CODE: #231f20
  Yale Gold PANTONE: 124CV CMYK: C10 M30 Y100 K0 RGB: R229 G167 B19 HEX CODE: #e5a713



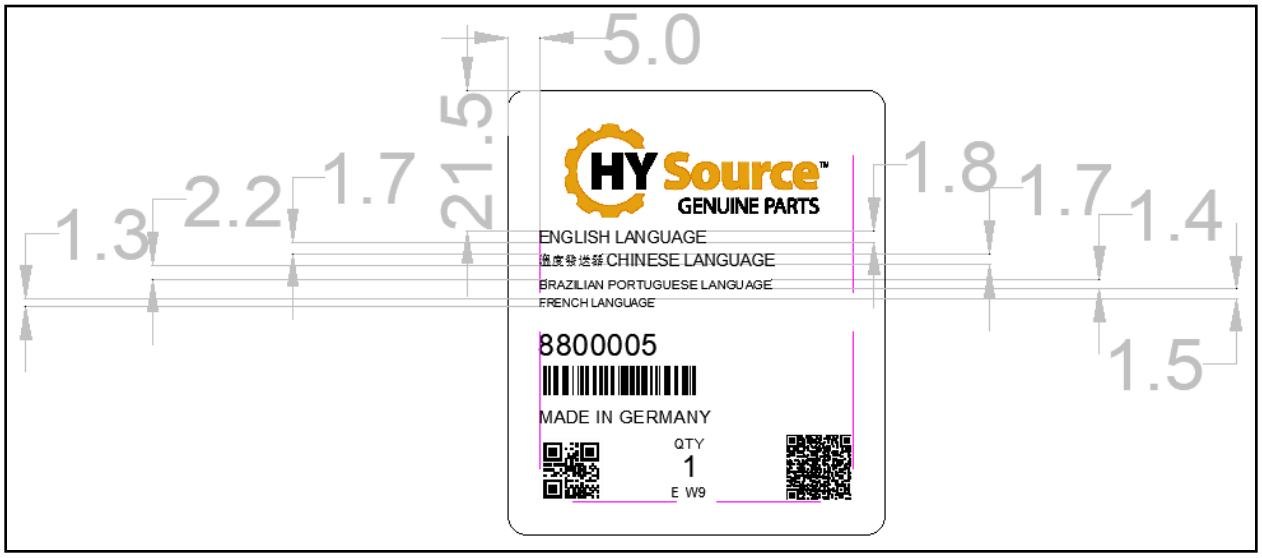
- Printing process: Uv Flexo (150 lines)

- Branding will be provided by HYG as separate file with *.ai extension:

HY Source™
GENUINE PARTS

2. Commodity descriptions/heights/gaps + font type:
    - Font type: Arial/Regular
    - Line 1 English language 8 points
    - Line 2 Simplified Chinese language 7 points
    - Line 3 Brazilian Portuguese language 6 points
    - Line 4 French language 6 points

Metrical:



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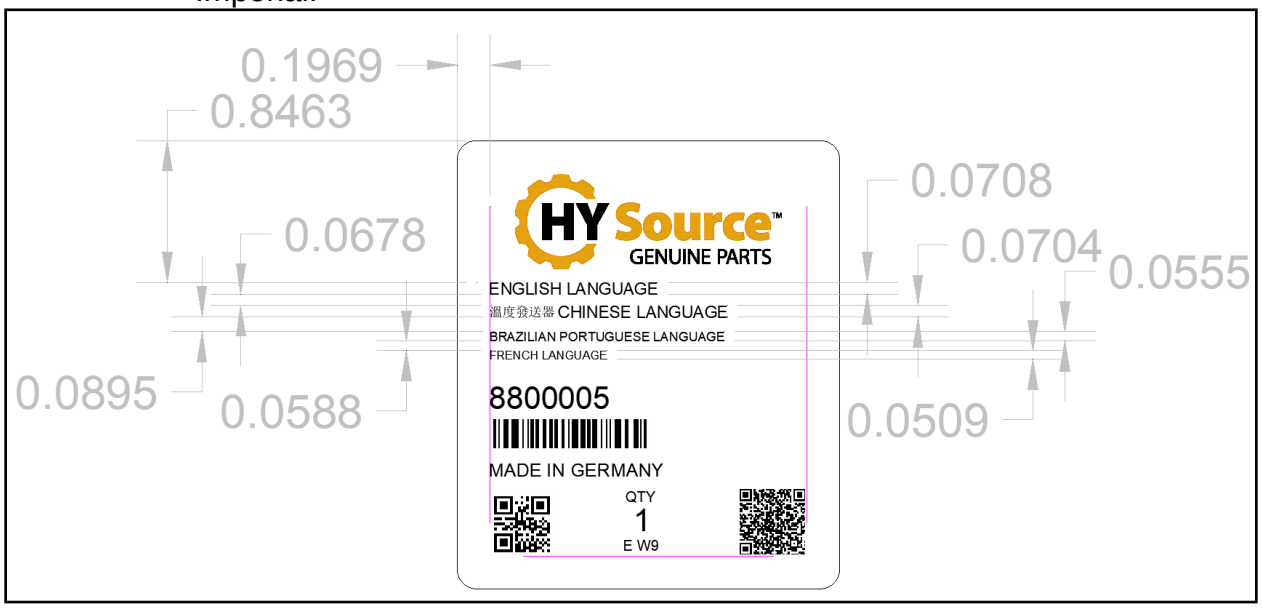
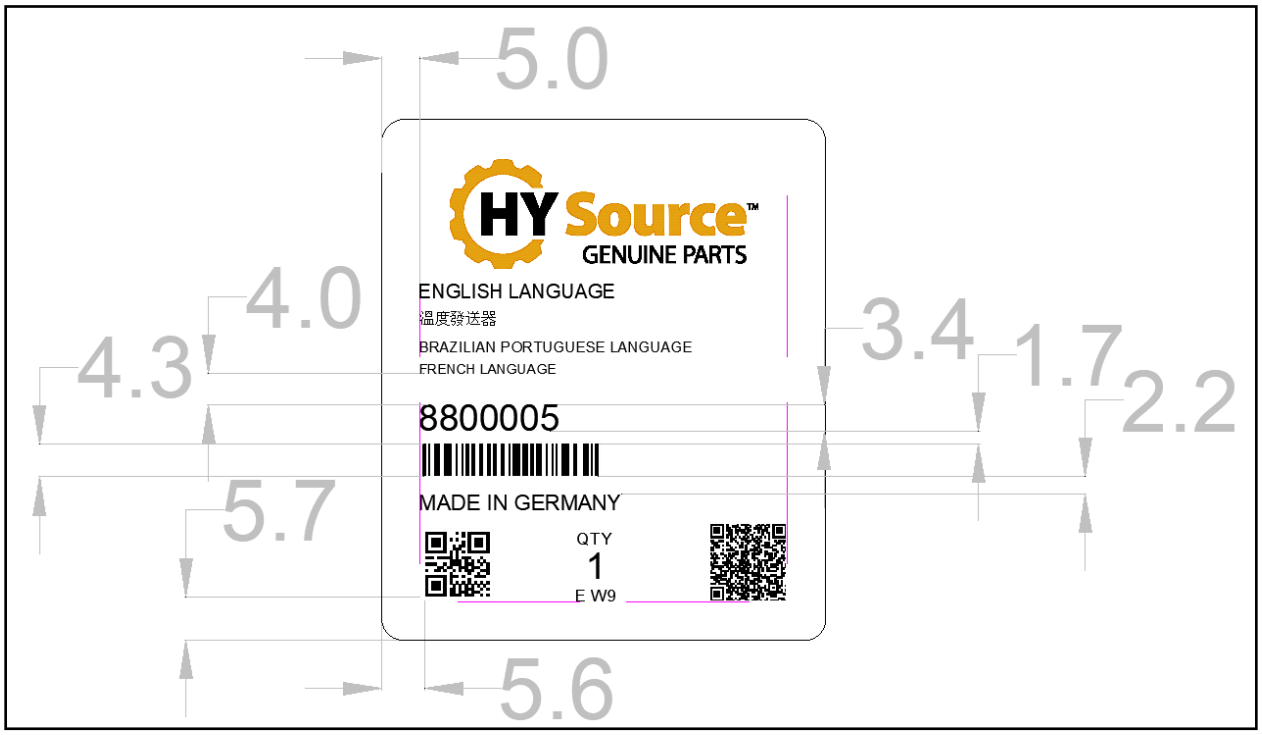


3. Fields of HY Source number, BAR code, QR code and gaps:
   a. BAR code -> type Code-128 is showing HY Source number
   b. 2D code -> type QR code
      - code in the left bottom corner is showing HY Source number

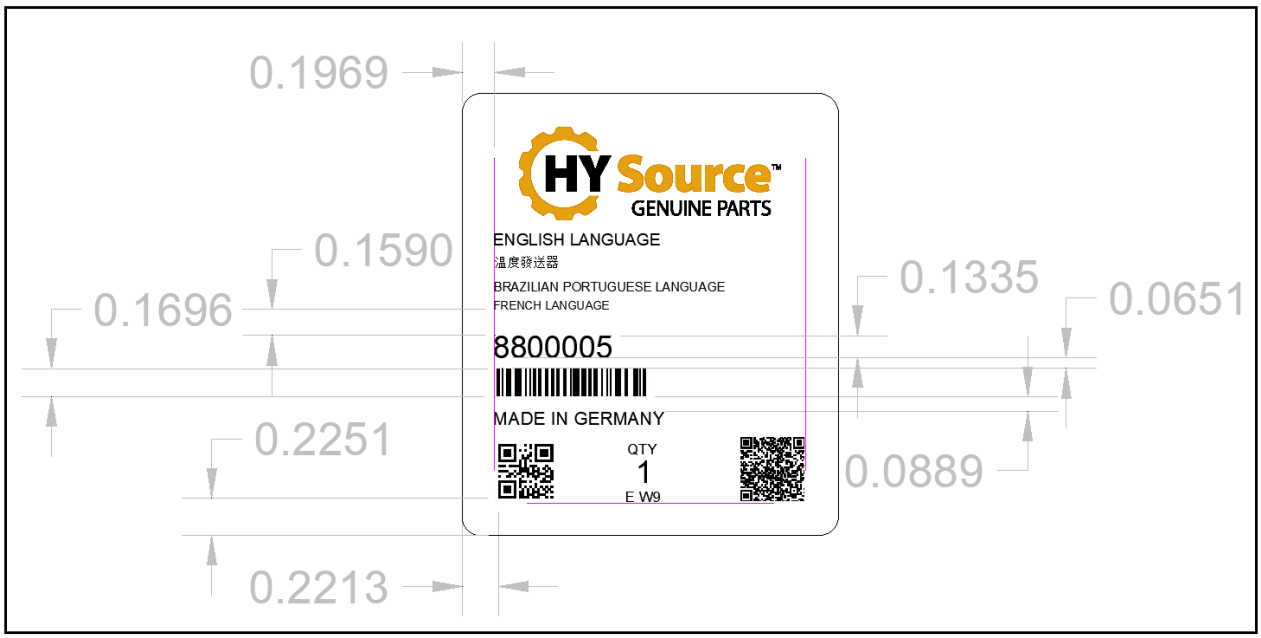
Item number:

- Font type: Arial/Regular
- Item number 16 points

Metrical:



Imperial:



4. Fields of country of origin, quantity field text, quantity volume and location + gaps:
    - Font type: Arial/Regular

Country of origin:

- Country of origin 8 points

QTY field:

- QTY text 8 points
- QTY value 16 points

Date and location field:

- Date and location 8 points

The HYG Date Code consists of three fields: the first being a letter designation for the company/location performing the packaging process:

A	Bolzoni
B	Brazil
C	SC2
D	Danville (PDC)
E	Nijmegen (EPO)
F	FAPCO
G	Geodis
P	Still Waters
S	Shanghai (PDC)
V	Vendor

DATE CODE SYSTEM

ODD NUMBERED YEARS

B = January
L = February
A = March
C = April
K = May

O = June
R = July

W = August
H = September
I = October
T = November
E = December

EVEN NUMBERED YEARS

W = January
H = February
I = March
T = April
E = May

O = June
R = July

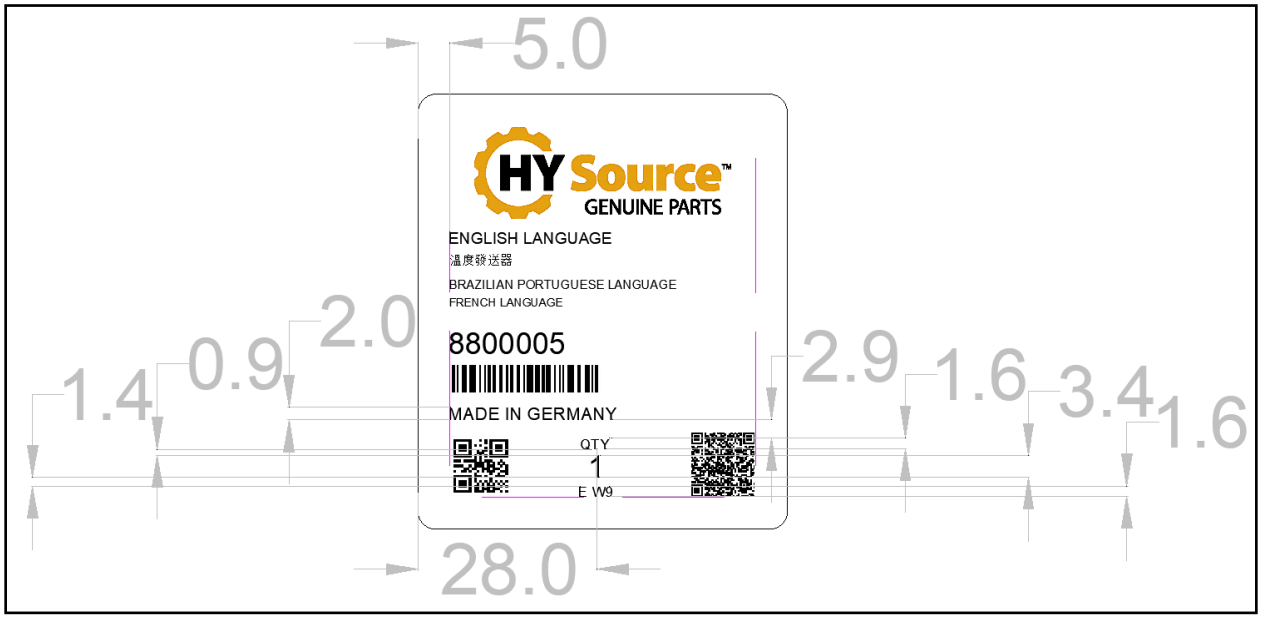
B = August
L = September
A = October
C = November
K = December

The third field is a numerical designation for the current year the packaging process took place, simply consisting of the last digit of that year (Ex: 4 = 2024). The number will be even or odd, which determines which column the month code is taken from.

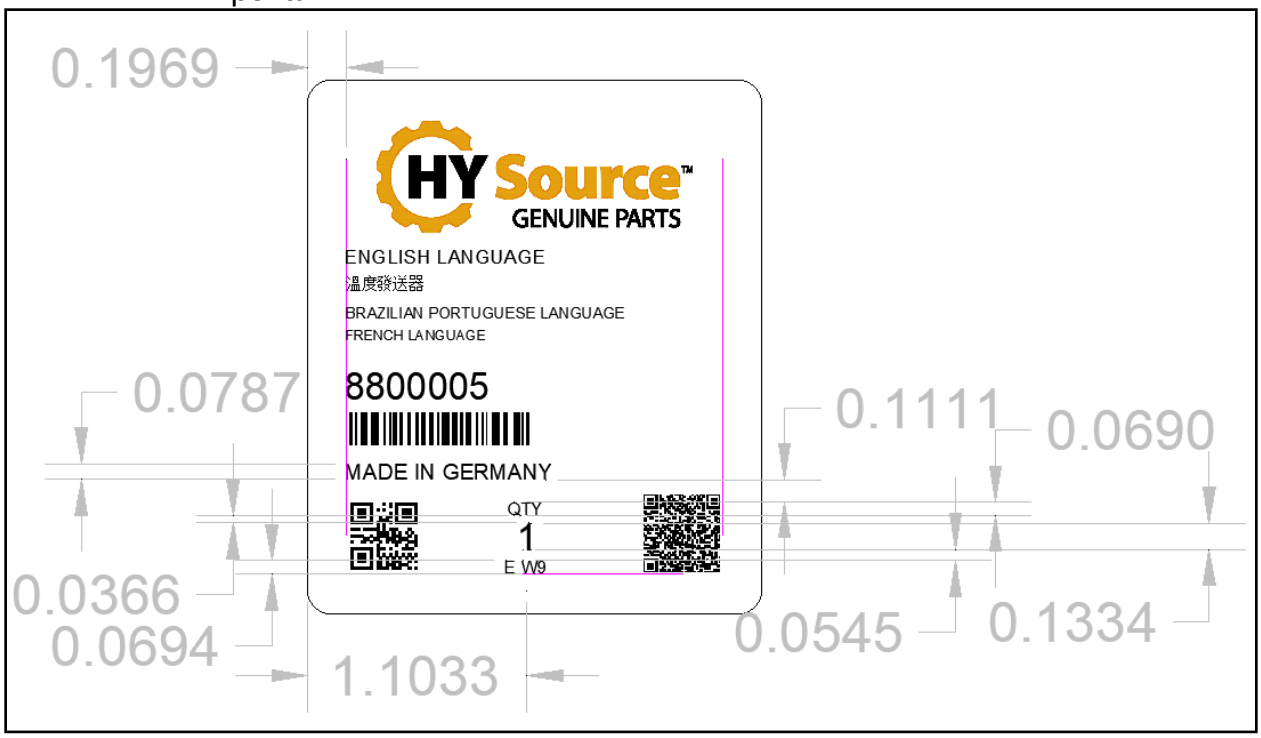
Example: The HYG Date Code on a label or a package, which was packaged by Vendor in April 2024, would appear as follows. **VT4**

Note: At HY Source label is used packaging date and not manufacturing date of item.

Metrical:



Imperial:

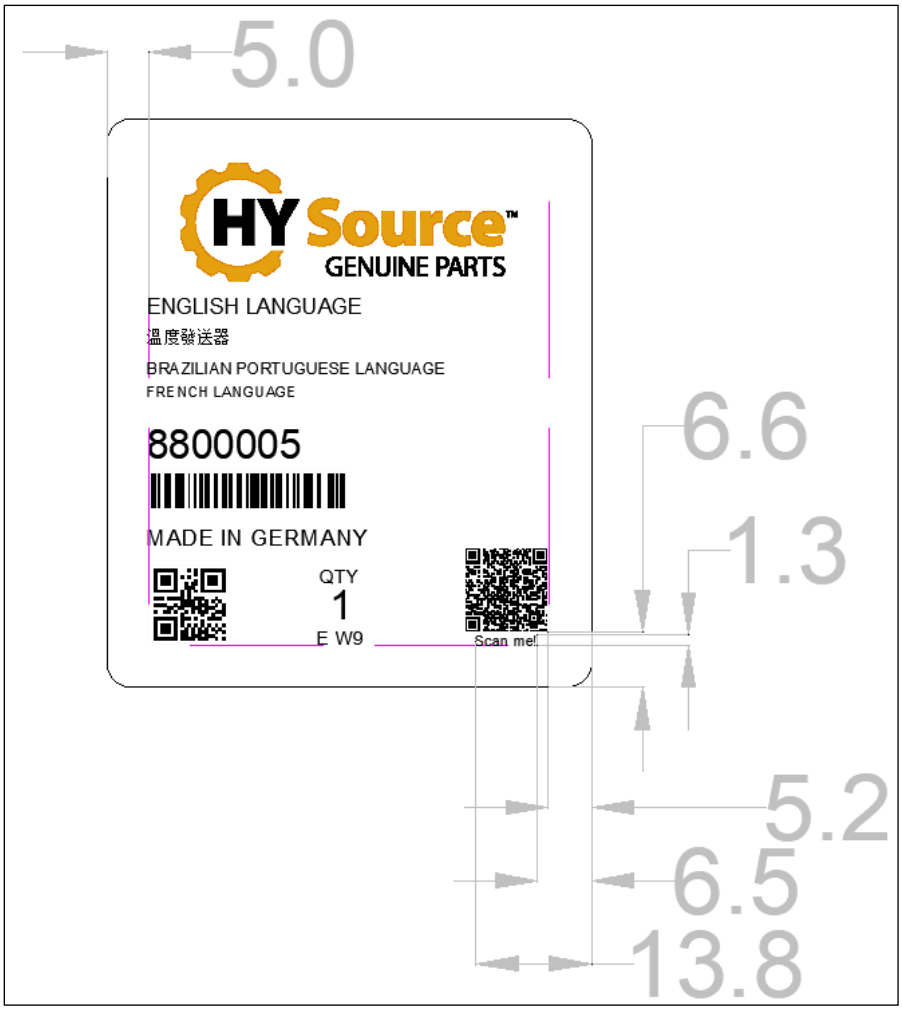


5. Customer QR codes detail + dimensions:
    - 2D code -> type QR code in the right bottom corner shows URL page/link –> landing page:
    - Example: https://HYGqr.com/?s=S01677190040
    - Break down for part number: S01677190040

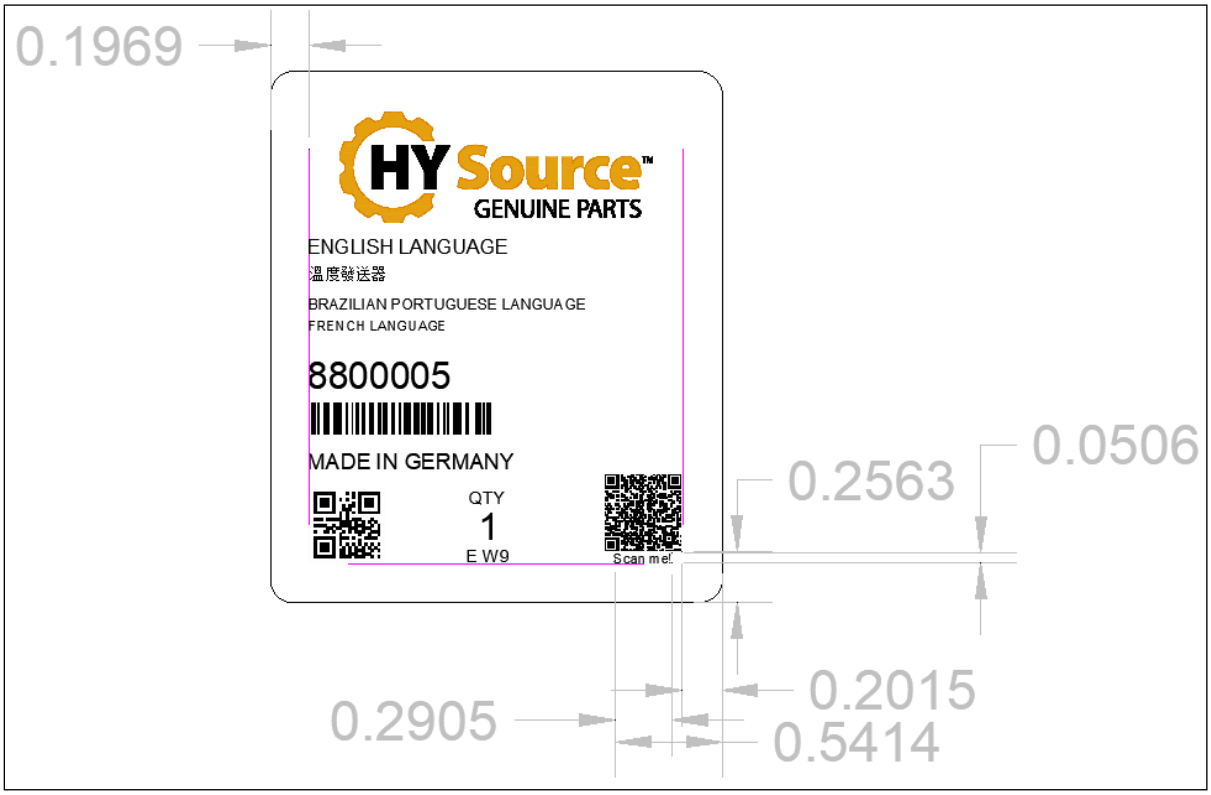
Scan me text field:

- Font type: Arial/Regular
- Scan me! 6 Points

Metrical:



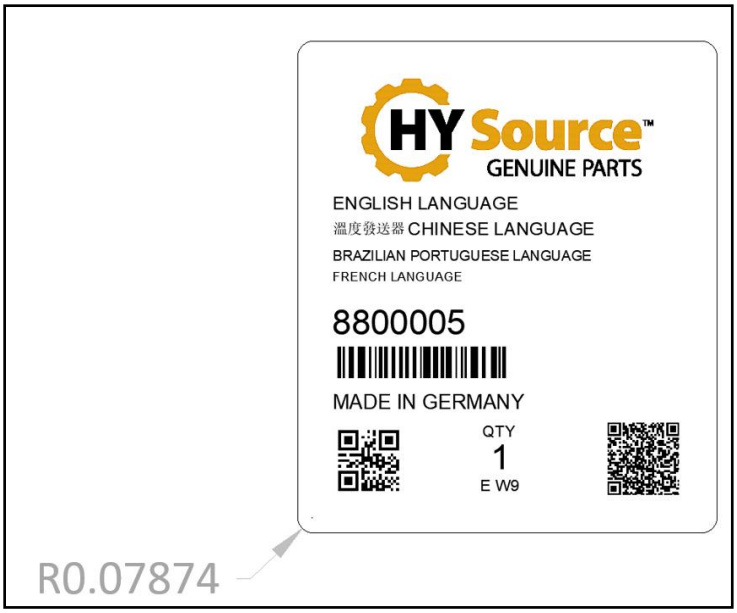
Imperial:



6. Radius of the label:

Metrical:

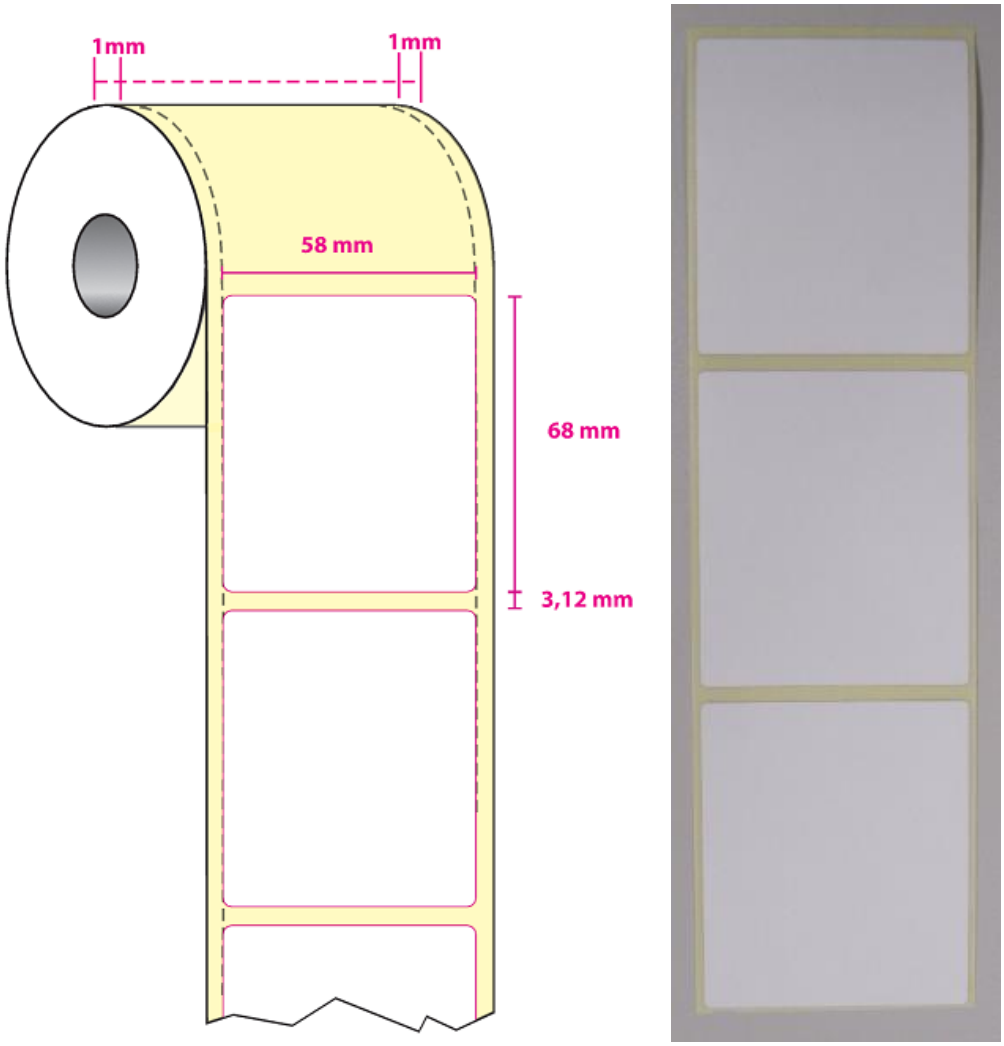
Imperial:



Pictures

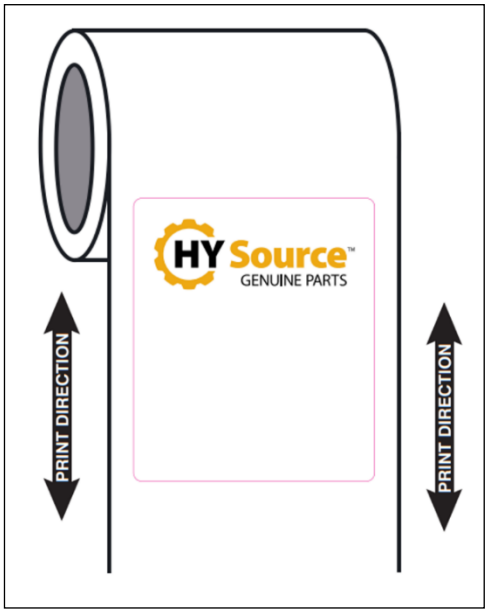
1. Printing of electronic form:

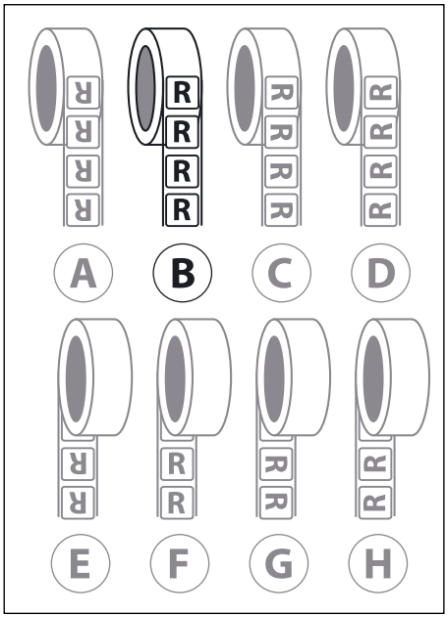
2. Picture of real labels on the backing paper:



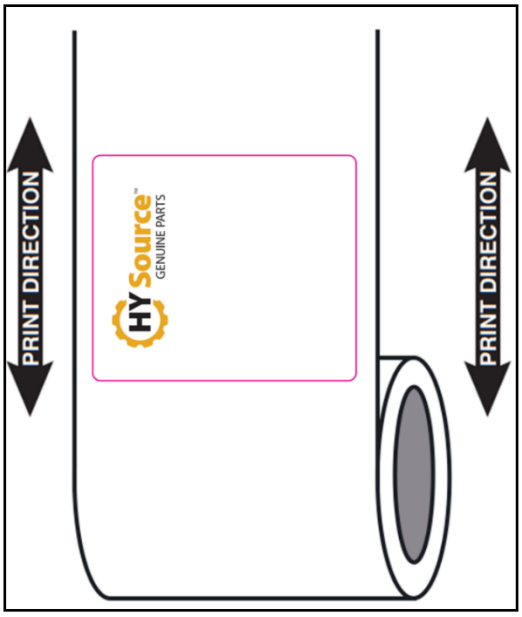
Winding on portrait printing:

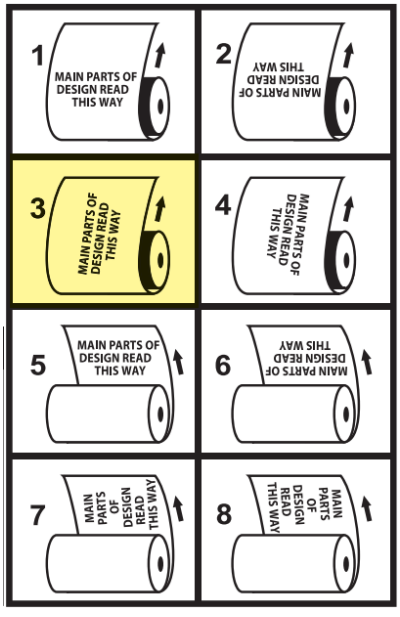
1. Winding PORTRAIT printing: B (Valid for Europe, Brazil, China)





2. Winding LANDSCAPE printing: 3 (Valid for US)





Label positioning and placement on outer packaging:

13 SUSTAINABLE ENVIRONMENTALY FRIENDLY PACKAGING MATERIALS

13.1 Recyclable requirements for plastic materials

Plastic packaging materials must fulfill request of minimum 30% recyclable content when applicable.

Plastic tape must be replaced by paper tape, if applicable.

13.2 Timing

Required lead time with sustainable conditions of plastic packaging materials must be fulfilled January 2023.

COMPONENT / ASSEMBLY CLEANLINESS

General Requirements

A. All surfaces that come in contact with hydraulic fluid, transmission fluid, brake fluid or fuel must be free of foreign material including but not limited to:
- Machining chips, sand, rubber, plastic, visible water
- Corrosion and corrosion products
- Weld slag and spatter, cleaning shot
- Laser cutting oxidation layer

B. All surfaces that come in contact with hydraulic fluid, brake fluid or fuel must be protected (with caps, plugs, bags, etc.) against corrosion and recontamination until the component or assembly is installed into the next higher level at the consuming manufacturing plant (i.e., the component is installed into the lift truck, drive axle assembly, transmission assembly, etc.). Corrosion inhibitors must meet the cleanliness requirements and must be compatible with the system fluid that will be used in the component.

C. The specified cleanliness level must be met at the time of assembly into the next higher level at the consuming manufacturing plant (i.e., the component is installed into the lift truck, drive axle assembly, transmission assembly, etc.).

Specific Additional Requirements

A. Hoses and Tubes:
- Male ends of hose and tube assemblies shall use a threaded cap that protects the male threads as well as prevents contamination.
- Female Swivel ends shall use a threaded plug that prevents the part from contamination.
- Heat-shrink seals such as Ultra Clean “Clean Seals are allowed for hose and tube assemblies.
- Cut to length hose shall have both ends protected with the correct size Internal taper plug with pull tab to allow for easy removal
- Caps or plugs must stay in-place during handling and shipment and must not leave debris on the threads when removed at the point of use

B. Fittings:
- Individual hydraulic fittings (e.g., HCE-00250, HCE-00255) shall meet K144, Class 6.0 (111 mg/m2 max.), and maximum particle size of 500 microns for the surface wetted by hydraulic fluid. Fittings must be free of internal foreign material.
- All ports must be capped or plugged to prevent contamination and damage to threads and sealing surfaces.
- Caps or plugs must stay in-place during handling and shipment and must not leave debris on the fitting when removed at the point of use.
- Bagging of individual fittings is not allowed.

Note: Exceptions are allowed if a signed deviation is approved by the consuming Plant.

C. Tanks/Reservoirs
- All tanks shall have all openings and ports sealed from external contamination. The sealing material must remain intact from point of manufacture until installation at the consuming plant.

D. Bulk Hose and Tubing
- Bulk hose and tubing shall have both ends protected with internal tapered plugs with pull tabs to allow easy removal.
- Plugs must stay in-place during handling and shipment until removed at the consuming plant.

E. Formed Hoses
- Hoses, shall have both ends capped with a thick wide flanged plug (similar to MOCAP TWF series plugs) to prevent caps from being pushed inside the hose when installed.

F. Filters & Suction Screens
- Filters and suction screens shall be individually bagged to prevent contamination until the point of use at the consuming plant.

CLEANLINESS ASSESSMENT OF COMPONENTS / HOSES / TUBES

Gravimetric Method

The gravimetric method involves measuring the mass (mg) of contaminant per surface area (m^2) of the component being evaluated. The maximum allowable contaminant is specified using the Gravimetric Cleanliness Classes shown in Table 1.

Engineering Procedure K146, Method For Gravimetric Determination of Part Cleanliness, defines the method used to evaluate component, hose and tube gravimetric cleanliness.

Table 1, Gravimetric Cleanliness Classes

(Based on K146 Method for Gravimetric Determination of Component Cleanliness)

K144 Class	Mass of Contamination, mg/m^2 <=
8.2	17,700
8.0	11,100
7.8	7,030
7.6	4,440
7.4	2,800
7.2	1,770
7.0	1,110
6.8	703
6.6	444
6.4	280
6.2	177
6.0	111
5.8	70
5.6	44
5.4	28
5.2	17
5.0	11

Absolute Maximum Particle Size

Maximum particle size evaluations are based on flushing the specified area with solvent, filtering on to a membrane filter, and measuring the particle dimensions with a microscope as specified in Engineering Procedure K146.

Particle types to be measured for size are metal, sand, abrasive dust, mill scale, cleaning shot, weld slag and spatter, rust (either free or loosely attached), or other hard/abrasive particles, rubber, plastic, or other materials which could be considered detrimental to system reliability. If particles are fragile and break up when gently probed (gentle probing will not tear membrane filter patch), only the remaining solid pieces are to be measured.

Individual strands of fibers such as hair, lint (defined as having a thickness and width of 20 microns or less) such as cotton or plastic shall not be counted unless they are in a woven mass such as a piece of filter media, shop towel, etc.

The “Absolute Maximum Particle Size” is the largest dimension for a particle. For a long, narrow particle, the length is used as the Absolute Maximum Particle Size.

Hydraulic System Requirements

Table 1

Hydraulic System Component and Assembly Cleanliness Specifications

Grouping	Quality Assessment and Validation	Fluid Cleanliness Codes	Gravimetric Cleanliness Class	C_A Allowable Contaminant mg/m^2	Absolute Max. Particle Size (microns)
Hydraulic Tanks – Steel - Non-integral & Integral w/ frame structure - Requires 100 mesh inlet screen	Internal cleanliness		6.0	111	3000 No more than 1 particle/m^2 of wetted surface >500 microns
Hydraulic Tanks – Steel - Non-integral & Integral w/ frame structure - w/o inlet screen	Internal cleanliness				500
Hydraulic Tanks - Plastic - Non-integral w/ frame structure - Requires 100 mesh inlet screen	Internal cleanliness		5.2	17	3000 No more than 1 particle/m^2 of wetted surface >500 microns
Hydraulic Tanks - Plastic - Non-integral w/ frame structure - w/o inlet screen	Internal cleanliness				500
Plumbing: - Hose and Tube Assemblies, and Fittings	Internal cleanliness - Filtered Return Lines, i.e., between control valve and return line hydraulic filter		6.6	444	
	Internal cleanliness - Suction and supply lines		6.0	111	

	Fittings				
Misc Hyd Component Parts - Steel or Iron	- Valve Bodies- internal cleanliness - Spools, Springs, etc.- surface cleanliness		5.6	44	
- Aluminum	- Valve Bodies- internal cleanliness		5.2	17	

Grouping	**Quality Assessment and Validation**	**Fluid Cleanliness Codes**	**Gravimetric Cleanliness Class**	**CA Allowable Contaminant mg/m2**	**Absolute Max. Particle Size (microns)**
Cylinder Seals	Entire surface		5.2	17	500
Coolers - <u>Aluminum</u> In-tank Oil-to-Water Coolers	Internal cleanliness		5.0	11	
Coolers - <u>Aluminum</u> bar/plate CAC & Oil-to-Air Coolers for Hydraulic Systems	Internal cleanliness				1600 No more than 1 particle/m^2 of wetted surface >1000 microns
Coolers - <u>Steel</u> In-tank Oil-to-Water Coolers	Internal cleanliness		5.6	44	500
Coolers - <u>Steel</u> bar/plate CAC & Oil-to-Air Coolers for Hydraulic Systems	Internal cleanliness				1600 No more than 1 particle/m^2 of wetted surface >1000 microns
ASSEMBLIES - Pump Assembly - Control Valve Assembly - Steering Control Unit Assembly - Hyd. Cylinders & Accumulators - Drive Axle Wet Brake Cooling Oil Chamber (cooling oil shared with hydraulic system)	Lower level components and Final Assembly	20/17/14	6.0	111	500

Grouping	Quality Assessment and Validation	Fluid Cleanliness Codes	Gravimetric Cleanliness Class CA Allowable Contaminant mg/m2	Absolute Particle Size (microns)
Oil Cleanliness	Initial fill hydraulic oil	18/15/12		Max.
	Assembly on Test Stand (Final pass criteria - Test per K158)	20/17/14		
	System Start-Up oil cleanliness (Oil cleanliness at end of flushing process)			
	System cleanliness at time of shipment from the factory			
	System cleanliness for the product in service			

PS Transmission Assembly Requirements

Table 2

PS Transmission Component and Assembly Cleanliness Specifications

Grouping	Quality Assessment / Validation	Fluid Cleanliness Codes	Gravimetric Cleanliness Class	C_A Allowable Contaminant mg/m^2	Absolute Max. Particle Size (microns)
Drive Axle and PS Transmission Components (Does not include control valve)	Lower level component part cleanliness - TC housing, Front Cover Transmission housing, Axle housing, shafts, gears, etc.		6.0	111	1000 No more than 1 particle/m^2 of wetted surface >500 microns
Transmission Control Valve Component Parts	Aluminum valve body		5.6	44	500
	Steel and iron components		6.0	111	
SUB-ASSEMBLIES **Clutch Pack Assembly** **Converter Assembly**	Lower level component part cleanliness		6.4	280	
- Charge Pump Assembly	- Assembly on Test Stand (Final pass criteria - Test per K158)	20/17/14	6.0	111	
- Transmission Control Valves	- Assembly on Test Stand (Final pass criteria - Test per K158)	20/17/14	5.6	44	
Oil Cleanliness **- Transmission Sub – Assemblies** **- Drive Axle Wet Brake Cooling Oil Chamber**	Test stand reservoir oil and Initial factory fill oil	18/16/13			
	- Assembly on Test Stand (Final pass criteria - Test per K158) - System cleanliness for the product in service	20/18/15			
- Transmission Assembly (@ pressure port between filter and control valve)	Assembly on Test Stand (Final pass criteria - Test per K158)	21/19/16			
	System Start-Up oil cleanliness				

	System cleanliness at time of shipment from the factory		
	System cleanliness for the product in service	20/18/15	