

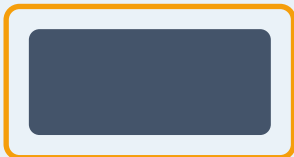
KINGSFORM METALWORKS

ENGINEERING TOOLKIT

PACKAGING STANDARD

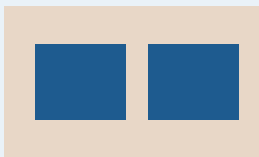
Protection, containment, palletization, validation and shipment release for metal parts

PROTECT THE PART



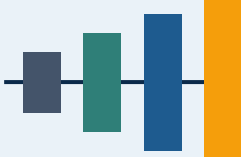
Control scratches, corrosion, deformation, threads, sharp edges and loose components.

BUILD THE LOAD



Select inner packs, cartons, crates, pallets, restraint and handling access as one system.

VALIDATE THE ROUTE



Match the test schedule to parcel, freight, sea, air, storage and customer acceptance risks.

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KFR-023	1.0	2026-07-18	English
FORMAT	OWNER	CONTACT	WEBSITE
A4 PDF reference	KingsForm Engineering	info@kingsformmetalworks.com	kingsformmetalworks.com

01 PURPOSE AND RELEASE WORKFLOW

Engineer the packaging system before the first shipment

This guide converts customer, product and route risks into a controlled packaging specification. It is intended for fabricated metal parts, welded frames, brackets, assemblies, coated components and equipment shipped by parcel, road, air or sea.

RELEASE FORMAT

Specify part condition + protection method + quantity/orientation + inner pack + outer pack + pallet/crate + restraint + labels + validation + inspection records.



Packaging is released as a system: product protection, container strength, restraint, marking, handling and validation must work together.

Minimum engineering inputs

Input	Required definition	Why it changes the package
Product	Mass, dimensions, center of gravity, finish, sharp edges, loose parts, fragility and approved contact points	Determines load paths, abrasion control, blocking, cushioning and handling
Route	Parcel/LTL/FTL/air/sea, transfers, storage, climate, stacking, clamp/fork handling and returnability	Determines hazard sequence, barrier level, pallet/crate type and test plan
Customer	Pack quantity, line-side presentation, labels, sustainability, opening method and disposal limits	Prevents repacking, receiving delays and nonconforming labels
Acceptance	Allowed cosmetic change, function, corrosion, torque, leakage, package damage and documentation	Makes testing and shipment release objective

PACKAGING IS A DESIGN OUTPUT

Do not leave the package to the shipping department after product release. Packaging loads can deform the product, damage coatings, contaminate surfaces or invalidate dimensional acceptance.

02 DISTRIBUTION RISK MODEL

Translate the actual route into controllable hazards

A packaging design should state the expected distribution system and the evidence used: customer data, carrier rules, field damage history, instrumented shipment data or a recognized test schedule.

Distribution hazards and the packaging controls they trigger

IMPACT

drops, fork contact

CONTROL: cushion / guard

VIBRATION

fretting, loosening

CONTROL: separate / restrain

COMPRESSION

stack / clamp

CONTROL: box + pallet

MOISTURE

condensation / rain

CONTROL: barrier + dry

CORROSION

salt / humidity

CONTROL: VCI / oil

HANDLING

tilt / mis-pick

CONTROL: mark + access

Use measured route data where available. A generic test schedule is a starting point, not proof that every field hazard has been represented.

Hazard	Metal-part failure examples	Packaging design response
Impact / rough handling	Bent flange, cracked weld, dent, broken knob, shifted assembly	Protect strong load paths, cushion fragile features, guard protrusions, prevent free movement
Vibration	Fretting marks, coating rub, fastener back-off, nesting lock, bag puncture	Separate surfaces, restrain parts, remove slack, protect edges, validate repeated exposure
Compression / stacking	Carton collapse, frame distortion, pallet deck failure, crushed top parts	Define stack height/duration, load-bearing zones, pallet support and container strength
Climate / water	Condensation, rust, wet cardboard, adhesive loss, label failure	Dry pack, barrier/VCI, desiccant where justified, water-resistant outer pack and storage controls
Handling equipment	Fork puncture, clamp crush, sling damage, tip-over	Fork pockets, lift points, clamp restrictions, center-of-gravity marks and anti-tip geometry

KNOWN ROUTE VS UNKNOWN ROUTE

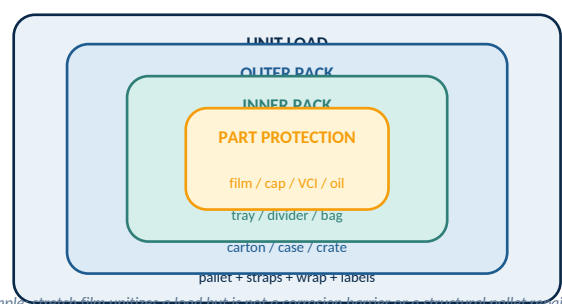
For a known route, reproduce measured hazards and operating conditions. For an unknown route, use a defensible general simulation and document assumptions, severity and exclusions.

03 PACKAGING HIERARCHY

Assign protection, containment and unitization to the correct layer

A reliable package uses several layers. The layer touching the part should protect the finish and geometry; the outer container should resist handling and stacking; the unit load should survive mechanical handling and transport.

Packaging hierarchy: each layer has a different engineering job



Do not ask one layer to perform every function. Example: stretch film unitizes a load but is not a corrosion barrier or a structural pallet repair.

Layer	Primary functions	Typical materials	Release checks
Part protection	Scratch, corrosion, thread, edge and port protection	PE film, VCI, oil, caps, plugs, sleeves, peelable coating	Compatibility, cleanliness, residue, removal and coverage
Inner pack	Separate, orient, count, locate and cushion parts	Dividers, trays, foam, honeycomb, molded pulp, bags	Contact pressure, abrasion, nesting, pack count and operator repeatability
Outer pack	Containment, compression, puncture and handling protection	Corrugated box, plywood case, wood crate, returnable tote	Strength, closure, hand/fork access, gross mass and labels
Unit load	Pallet support, restraint, stacking and mechanical handling	Pallet/skid, straps, stretch wrap, edge protectors, anti-slip sheet	Footprint, load path, restraint, stability, overhang and route compatibility

CONTACT MATERIAL APPROVAL

Paper dust, recycled fibers, sulfur compounds, plasticizer migration, adhesive residue and moisture can affect plated, painted, polished or precision surfaces. Validate every material that contacts the product.

04 PART AND SURFACE PROTECTION

Prevent damage before selecting the outer box

Start with the product drawing and finish specification. Identify surfaces that may contact packaging, features that cannot carry load and components that must be immobilized or separately bagged.

Product risk	Preferred controls	Common mistakes
Painted / powder-coated Class-A surface	Non-abrasive film or sleeve, clean separators, controlled contact pressure, no part-to-part rubbing	Bare cardboard contact, foam grit, stretch film directly on fresh coating, insufficient cure
Polished stainless / anodized aluminum	Protective film qualified for dwell and removal, soft interleaf, clean gloves and isolated tools	Adhesive staining, trapped chips, paper abrasion, PVC contact or moisture entrapment
Threads / shafts / ports	Caps, plugs, sleeves, rigid guards, corrosion inhibitor and count verification	Tape over threads, plugs that shed, caps used as load points, missing removal instruction
Sharp edges / burr-sensitive parts	Edge guards, formed separators, deburr verification, puncture-resistant bag or liner	Relying on thin film, edges facing box walls, loose parts cutting the barrier
Welded frames / long tubes	Support at structural nodes, spacers between members, no point load on thin wall or cosmetic faces	Straps over unsupported spans, fork contact with tubes, stacking on protrusions
Assemblies with loose components	Positive retention, separate accessory pack, torque/position marks and visual inventory	Hardware moving inside frame, cables carrying load, accessories hidden under cushioning

Compatibility review	Questions to record
Chemical	Can oil, VCI, adhesive, plastic or ink stain, soften, embrittle or contaminate the finish?
Mechanical	Does contact pressure create witness marks, distortion, fretting or print-through during stacking?
Removal	Can the customer remove caps, film, oil and labels without tools, residue or surface damage?
Cleanliness	Are chips, dust, moisture and fingerprints controlled before the barrier is sealed?

DO NOT PACKAGE UNCURED FINISHES

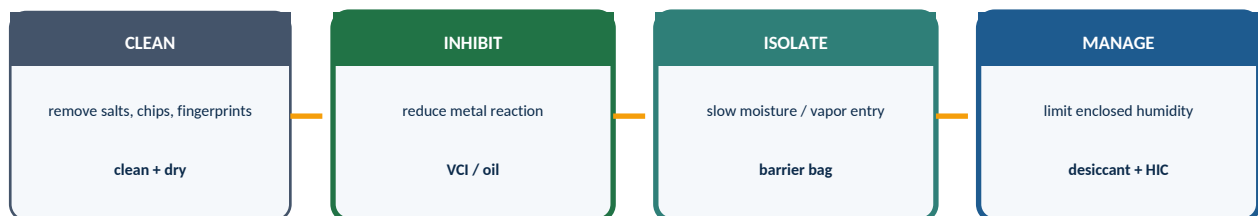
Confirm coating cure, adhesive cure, plating rinse/dry and part temperature before closing the package. Warm or wet parts can create condensation, blocking, imprinting and corrosion.

05 CORROSION PREVENTION

Design the preservation system from exposure, time and metal condition

Corrosion prevention is not one material. It combines clean/dry product condition, an inhibitor where appropriate, a barrier against the environment and humidity control inside the enclosed volume.

Corrosion control: separate three different mechanisms

**WARNING**

Desiccant is effective only inside a sufficiently sealed barrier with known internal volume, moisture load, storage time and climate.

Method	Best use	Critical controls	Limitations
VCI paper / film	Ferrous or multi-metal parts where approved chemistry is available	Metal compatibility, enclosure, distance, clean surface, seal quality and exposure time	Not a universal barrier; openings, high airflow, incompatible metals and wash requirements matter
Rust preventive oil / wax	Machined steel, long storage, robust cleaning process at destination	Coverage, film consistency, drainage, residue, bag compatibility and removal instruction	Can contaminate painting, welding, bonding or customer assembly
Barrier bag + desiccant	Long sea storage, sensitive assemblies or difficult climates	Water-vapor barrier rating, seal integrity, internal volume, moisture load, desiccant amount and HIC	A puncture or poor seal can defeat the system; desiccant can saturate
Dry air / nitrogen purge	Selected high-value equipment and controlled sealed systems	Leak rate, purge verification, seal design and safe opening	Requires validated process and may not be economical for routine parts

CONDENSATION RISK

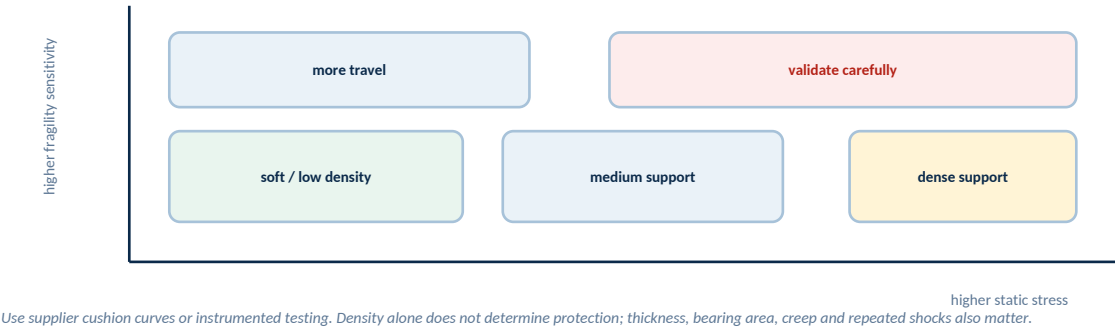
A sealed package can still contain enough moisture to corrode the part. Account for wet wood, paper, foam, cleaning fluid, ambient humidity, temperature cycling and residual water in tubes or cavities.

06 CUSHIONING AND SEPARATION

Control motion, contact stress and repeated impact

Cushioning is needed when the product cannot tolerate the acceleration, shock or localized contact expected in the route. Separation may be sufficient for robust metal parts, but it must prevent fretting, edge contact and nesting lock.

Cushioning is selected from product fragility, static load and impact environment



Material / form	Advantages	Design checks
PE / EPE foam	Clean, resilient, broad density range, easy conversion	Cushion curve, thickness, creep, surface imprint, static stress and recyclability
EVA / PU foam	Wide damping range and custom shapes	Compression set, chemical compatibility, outgassing, odor and abrasion
Corrugated / honeycomb	Low cost, recyclable, good for blocking and edge protection	Humidity sensitivity, compression direction, dust, moisture and repeated-use durability
Molded pulp	Repeatable nests and recyclable fiber content	Moisture, surface abrasion, dimensional tolerance and tooling economics
Plastic tray / tote	Repeatable orientation, returnable, automation-friendly	Tooling, cleanliness, drainage, ESD if relevant and reverse-logistics control
Paper / film interleaf	Thin, economical surface separation	Slip, tearing, sulfur/chloride content, moisture and migration

AVOID OVER-PACKING BY GUESSWORK

More foam is not always safer. Too much or too stiff cushioning can transmit higher shock, overload a fragile feature, increase compression or make the pack unstable. Use calculations, supplier data and testing.

07 INNER PACKS AND CORRUGATED CARTONS

Control count, orientation, closure and compression performance

The carton specification should be based on the finished pack mass, dimensions, stacking duration, climate, pallet pattern and handling method. Grade names alone do not define performance.

Design item	Engineering requirement	Verification
Pack quantity	Fixed quantity, orientation and separator pattern; prevent part migration or count ambiguity	Pack photo, count check, line-side trial and drop/vibration review
Board / box construction	Flute/board construction selected for compression, puncture, humidity and print needs	Supplier certificate, box compression or validated equivalent
Dimensions	Allow for product, separators, closure and manufacturing tolerance without excessive void	Internal fit check and external logistics dimensions
Closure	Tape, staples, adhesive or strap pattern documented; compatible with climate and board	Closure strength, opening method and tamper/receiving needs
Hand holes / access	Only where structure, gross mass and handling practice support them	Rough-handling test and operator trial
Stacking	Load carried through box walls or internal supports; no crushing of product	Compression/stacking test after conditioning
Moisture	Storage limits, coated board or liner where justified; avoid wet wood/paper inside barrier	Conditioning, water resistance and warehouse trial

Carton warning sign	Likely cause	Corrective action
Bulged side walls	Excess void, poor divider support, loose heavy parts	Reduce void, increase internal support, restrain contents
Bottom opening	Closure pattern or board/tape mismatch	Redesign closure, verify tape/application and gross mass
Top crush	Product or filler not sharing load, humidity, pallet overhang	Create load path, increase performance, correct pallet pattern
Abrasion dust	Relative motion or incompatible separator	Immobilize, change contact material, clean before pack

SPECIFY PERFORMANCE, NOT ONLY ECT/BURST

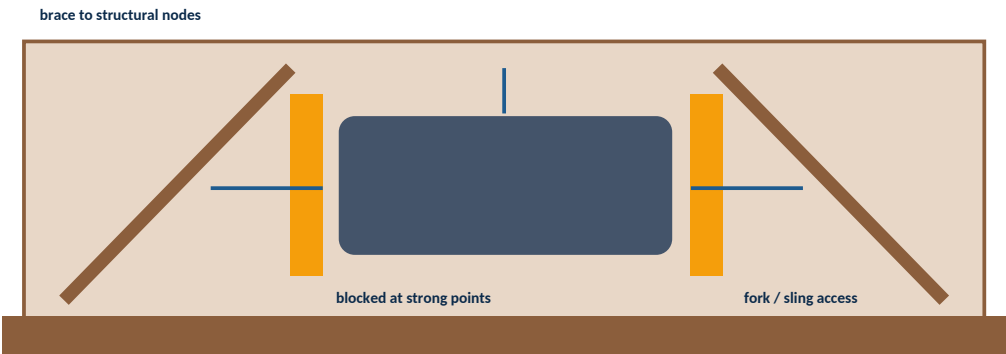
Corrugated performance depends on board construction, box style, dimensions, converting quality, humidity, storage time and pallet pattern. Confirm the method and acceptance criterion with the packaging supplier.

08 CASES AND CRATES

Design bases, blocking, bracing and lifting for heavy or oversized parts

A case encloses and protects the product; a crate primarily provides structural containment and handling. The base carries the load and must transfer it into skids, fork pockets, lifting points and transport restraints.

Heavy equipment crate: transfer loads into the base and restrain every direction



Do not restrain through cosmetic skins, thin covers, unsupported tubes or precision shafts. Document center of gravity, lifting points and tie-down forces.

Design factor	Required decision	Release evidence
Base / skid	Floor load, skid spacing, forklift direction, jack access, container interface and drainage	Drawing, load calculation and handling trial
Blocking	Contact only at approved structural points; resist longitudinal, lateral and vertical movement	Block material, fasteners, bearing area and installation photo
Bracing	Transfer forces into the base/frame without overloading skins, covers or precision features	Brace layout, force path and fastener inspection
Lifting	Fork, sling, hoist or crane method; center of gravity and minimum fork length	Lift plan, marked points and trial where risk warrants
Weather barrier	Shroud, wrap, roof, drain and ventilation appropriate to storage and route	Seal/overlap details and water-exposure review
Service opening	Safe opening sequence, retained fasteners, inspection/access and repacking	Work instruction and customer unpack trial

NO UNMARKED CENTER OF GRAVITY

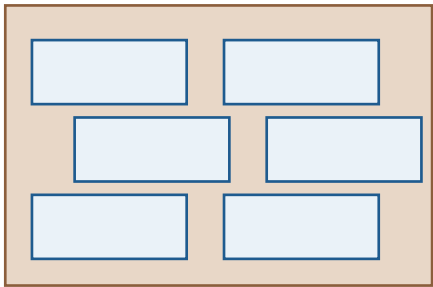
For asymmetric or high-center-of-gravity equipment, mark the actual center of gravity and lifting points. A balanced-looking crate can still tip when lifted or braked.

09 PALLETIZATION AND UNIT LOADS

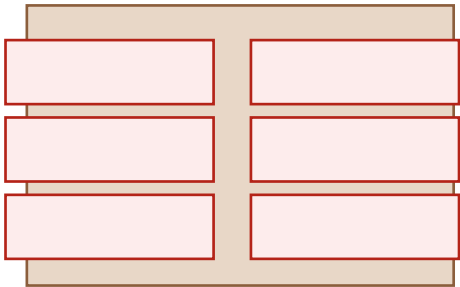
Build a stable load without carton overhang or hidden pallet failure

The pallet, packages and restraint system act together. Select a pallet for the actual load case - static storage, rack storage, stacking, forklift handling and transport - and state whether reuse is allowed.

Unit load design: footprint, interlock, restraint and pallet support



BETTER: no overhang, stable pattern



POOR: overhang + column instability

Stretch wrap, straps, edge protectors and anti-slip layers must be designed for the load and verified after vibration, impact and handling - not selected by wrap count alone.

Unit-load item	Design rule	Verification point
Footprint	Avoid carton/product overhang; match destination pallet and warehouse system	Plan view, max dimensions and receiving compatibility
Load distribution	Place heavy mass low and over supported deck areas; avoid concentrated point loads	Deck bearing, bottom-package compression and fork deflection
Stack pattern	Use column/interlock pattern based on box strength, stability and route	Compression, vibration and handling test as unit load
Straps	Choose material, count, tension, edge protection and anchor path without product damage	Tension setting, creep, cut risk and post-test retention
Stretch wrap	Define film, pre-stretch/application, containment requirement and top/bottom coverage	Load displacement and containment after route simulation
Pallet condition	No broken boards, protruding nails, contamination or unauthorized repair	Incoming pallet inspection and lot traceability

PALLET CAPACITY IS CONFIGURATION-SPECIFIC

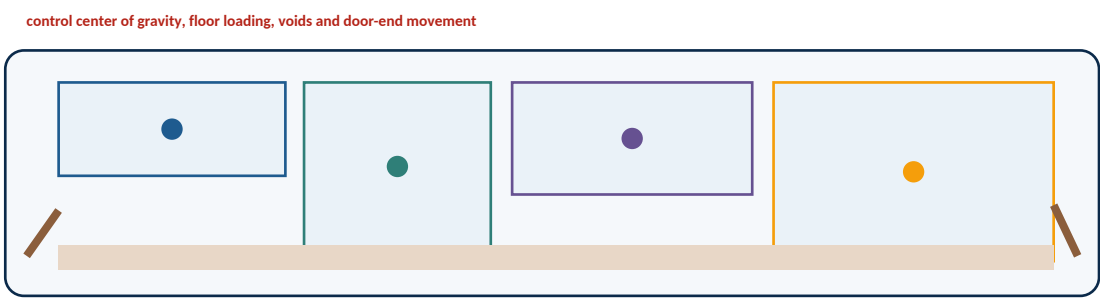
A pallet does not have one universal safe load. Capacity depends on support mode, load distribution, duration, environment, handling and damage. Use ISO 8611 or an equivalent validated pallet specification.

10 CONTAINER AND VEHICLE LOADING

Control floor loads, voids, movement and unloading access

The package can pass a laboratory test and still fail in a container if the loading plan creates unsupported spans, excessive floor pressure, movement space or unsafe unloading.

Container and truck loading: protect the cargo from empty space and concentrated loads



Carrier equipment limits, cargo securing regulations and local loading practices govern. Record actual gross mass, dimensions, center of gravity and securing plan.

Loading question	Control to document
Does the floor support the load?	Gross mass, contact area, skid layout, point loads and carrier/container floor limits
Can the load move?	Blocking, lashing, friction, void fill and door-end restraint in every relevant direction
Can it tip?	Center of gravity, base width, restraint height, braking/turning forces and lift geometry
Can it be unloaded safely?	Sequence, access to straps/bolts, fork entry, crane points and removal of adjacent packages
Will climate damage it?	Container condensation, roof leakage, ventilation, desiccant/barrier strategy and wet-floor separation
Are mixed loads compatible?	Odor, chemicals, moisture, crushing, abrasion, contamination and dangerous-goods segregation

CARGO SECURING IS REGULATED

Use the carrier, transport mode and destination rules for lashing, blocking, weight distribution and dangerous goods. This guide does not replace a certified cargo-securing plan.

Handling mark	Use when	Do not rely on mark alone
Fork here / no forks	Fork entry is limited or product can be punctured	Provide physical fork pockets, guards or blocked access
Sling here	Approved lifting points are known	Verify sling angle, load rating and balance
Center of gravity	Mass is asymmetric or high	Design stable base and lifting method
Do not stack / stack limit	Top load is limited	Provide structural prevention or receiving control where consequence is high

11 LABELS, MARKS AND TRACEABILITY

Make the package identifiable, receivable and safely handled

Marking should be legible after the expected exposure and placed where it remains visible during storage and handling. Symbols should be used only when needed and should not conflict with regulatory marks.

Label layer	Minimum information	Control method
Part / inner pack	Part number, revision, quantity, lot/batch, date and orientation where required	Barcode/2D data verified against human-readable text
Outer carton / case	Customer PO, ship-to, package count, gross/net mass, dimensions, handling and preservation marks	Approved label template and scan verification
Pallet / unit load	SSCC or customer unit ID, pallet count, gross mass, center of gravity or stacking limits where applicable	Labels on accessible faces; duplicate where route needs
Wood packaging	ISPM 15 mark only when applied by an authorized system to compliant raw-wood packaging	Supplier authorization and mark inspection
Dangerous goods	Mode-specific regulatory marks, labels and documents	Trained specialist; do not substitute ISO 780 symbols

Symbol / instruction	Engineering meaning	Physical design still required
This way up	Package orientation matters	Internal restraint must tolerate expected accidental orientations
Keep dry	Water exposure should be limited	Use suitable barrier/outer pack and storage controls
Fragile	Special care is requested	Packaging must survive the selected distribution test without careful handling assumptions
Temperature limits	Product/package performance depends on temperature	Validate dwell time, thermal packaging and monitoring where needed
Stacking limit	Maximum superimposed load or stack is defined	Container and pallet must carry the stated load with safety margin

AVOID AMBIGUOUS LABELS

Do not print “waterproof,” “rustproof,” “fragile,” “export packing” or “seaworthy” without a defined design, test and acceptance basis. Replace marketing words with measurable requirements.

12 WOOD PACKAGING AND ISPM 15

Separate structural design from phytosanitary compliance

Raw-wood pallets, crates, boxes and dunnage used in international trade may be regulated by ISPM 15. Processed wood such as plywood is generally excluded when manufactured in a way that renders it free from pests, but destination-country rules still apply.

Requirement	Engineering control
Scope	Identify every raw-wood pallet, skid, crate component, brace and loose dunnage in the shipment
Approved treatment	Use an authorized supplier applying a treatment recognized by the governing phytosanitary system
Debarked wood	Verify the wood packaging system meets the debarking and treatment requirements
Official mark	Inspect legibility, permanence, location, country/producer/treatment codes and absence of unauthorized imitation
Repair	Control replacement components and marking; repaired packaging may require re-treatment/re-marking under the applicable system
Remanufacture	Old marks may need permanent removal; remanufactured units may require re-treatment and a new compliant mark
Destination	Check importing-country implementation, carrier rules and any additional declarations before shipment

IPPC SYMBOL	COUNTRY - PRODUCER	TREATMENT CODE
Use only through an authorized compliance system.	Trace the registered producer/treatment provider.	Example codes depend on approved treatment.

PLYWOOD DOES NOT SOLVE STRUCTURAL DESIGN

Processed wood may be outside ISPM 15 scope, but the case still needs adequate fasteners, cleats, base support, weather protection, lifting and test validation.

MARK CONTROL

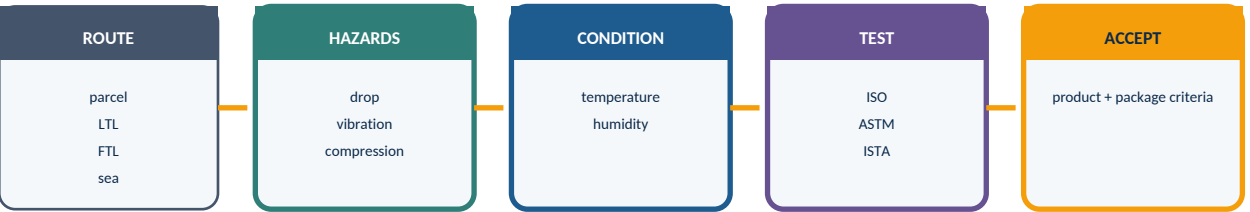
Never add, copy, repair or obscure an ISPM 15 mark outside the authorized system. Noncompliant wood packaging may be treated, destroyed, refused or reshipped at the border.

13 PERFORMANCE VALIDATION

Choose a test schedule that represents the intended distribution system

ISO 4180, ASTM D4169 and ISTA procedures provide frameworks or test sequences. The packaging engineer must still select the correct route, hazard intensities, conditioning, sample count and acceptance criteria.

Validation plan: select hazards, sequence, intensity and acceptance before testing



DO NOT TEST WITHOUT ACCEPTANCE CRITERIA Define allowable cosmetic change, functional performance, leakage, fastener torque, corrosion, package damage and retest rules.

Shipment profile	Possible framework	Selection notes
Individual parcel package	ISTA 3A or ASTM D7386	Confirm mass/size category, orientation, carrier environment and special product risks
General shipping container/system	ASTM D4169 or ISO 4180-based schedule	Select distribution cycle, assurance/severity and sequence from route evidence
Unitized full truckload	ISTA 3E or route-specific unit-load plan	Focus on compression, vibration, mechanical handling and load containment
Large crate / skid	ASTM D6179 plus route-specific vibration/impact/stacking	Mechanical handling and base/brace performance often dominate
Pallet qualification	ISO 8611 series or ASTM D1185	Select tests and support modes matching actual use and load distribution

TEST THE FINAL CONFIGURATION

Use production-intent parts, packaging materials, closures, labels, pallet pattern, strap/wrap settings and packout method. A hand-built laboratory pack may not represent production.

14 TEST METHODS AND ACCEPTANCE

Define what passes before the package enters the laboratory

A complete test plan states specimen condition, sequence, test method, intensity, orientation, sample count, instrumentation and acceptance. Record both product and package observations after each stage.

Hazard / method	Typical reference	What to inspect
Conditioning	ISO 2233 / ASTM D4332	Package moisture, adhesive/tape behavior, dimensional change and product corrosion
Drop / vertical impact	ISO 2248 / ASTM D5276 / ISTA sequence	Product shift, dents, cracked welds, cushion bottoming, closure and leaks
Random vibration	ISO 13355 / ASTM D4728	Fretting, fastener loosening, nesting, abrasion, restraint loss and pallet movement
Compression / stacking	ISO 12048 / ISO 2234 / ASTM D642	Container deformation, product load path, pallet deck, creep and stability
Rough handling unit load	ASTM D6179 or selected ISTA sequence	Fork/skid damage, load shift, strap/wrap retention, tipping and base integrity
Water / climate	Route-specific spray, humidity or condensation protocol	Barrier/seal, wet strength, label legibility, corrosion and dry-out

Acceptance category	Example measurable criteria
Product function	All functions pass; no leakage; torque and electrical/mechanical performance within released limits
Geometry	No permanent deformation outside drawing tolerance; no cracked weld or loosened joint
Surface	No corrosion; no visible scratch/dent beyond Zone A/B/C acceptance sample or defect limits
Completeness	All parts, accessories, caps, labels and documents present and correctly oriented
Package	Remains safely handleable and contained; defined damage is acceptable only if product protection remains proven
Traceability	Test specimen, materials, lot, packout settings, photos and deviations fully recorded

LAB PASS DOES NOT EQUAL ZERO FIELD RISK

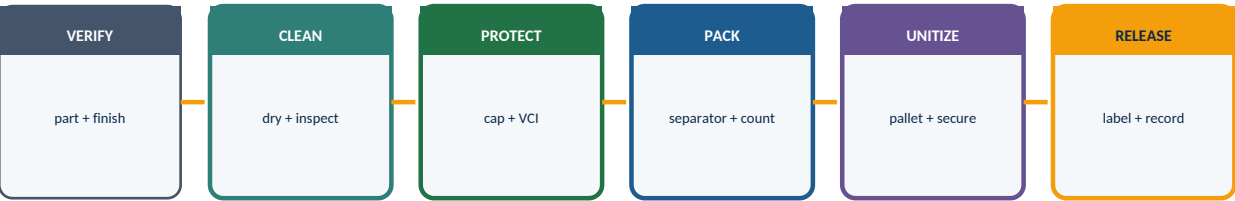
Use field feedback, damage claims, warehouse observations and carrier data to revise the package. Revalidate after material, supplier, part, quantity, pallet or route changes.

15 PACKOUT WORK INSTRUCTION

Make the approved package repeatable at production speed

The work instruction should be visual, version-controlled and linked to the product/packaging BOM. Include the order of operations and the checkpoints that cannot be recovered after sealing.

Packout workstation: convert the approved design into a repeatable operation



Control: material code, quantity per pack, orientation photo, seal method, strap/wrap settings, label template, inspection points and operator sign-off.

Step	Operator instruction	Quality record
1. Verify	Confirm part number/revision, finish cure, quantity, accessories and packaging material codes	Traveler / scan / lot
2. Inspect / clean	Remove chips, water, fingerprints and unauthorized labels; inspect cosmetic and functional condition	Visual checkpoint
3. Preserve	Apply caps, sleeves, film, VCI, oil or desiccant exactly as specified; avoid bare-hand recontamination	Material lot and quantity
4. Orient / separate	Use approved tray/divider orientation and fixed pack count; no free movement or unsupported stacking	Pack photo / first-piece approval
5. Close / unitize	Apply closure, straps and wrap with released pattern/settings; install edge guards and labels	Settings and operator sign-off
6. Release	Verify gross mass, dimensions, label data, pallet condition, ISPM mark where applicable and shipment checklist	Final inspection record

CHANGE CONTROL TRIGGERS

Re-review packaging after changes to part geometry, finish, supplier, packaging material, quantity per pack, route, carrier, pallet, storage duration, customer label or damage history.

16 FAILURE DIAGNOSIS AND RELEASE CHECKLIST

Use field evidence to find the missing control

Damage patterns often identify the failed layer. Preserve photos, package orientation, route, environmental data and material lots before discarding the packaging.

Observed failure	Likely root causes	Actions to investigate
Scratches / polish marks	Relative motion, dirty separator, high contact pressure, incompatible paper/foam	Restraint, cleanliness, contact material, vibration and pack pressure
Rust inside sealed bag	Wet part, puncture/poor seal, insufficient inhibitor, saturated desiccant, trapped moisture	Drying, bag barrier/seal, volume/moisture calculation, VCI compatibility and HIC
Bent flange / frame	Strap or stack load through weak feature, unsupported span, free movement	Load path, blocking points, strap path, pallet support and compression
Carton collapse	Humidity, pallet overhang, excessive stack, weak board/closure or no internal support	Conditioning, box performance, stack plan, closure and unit-load pattern
Load shifted on pallet	Low containment, smooth interfaces, poor pattern, broken pallet or voids	Wrap/strap design, anti-slip, load geometry, pallet and route handling
Fork damage / tip-over	Unclear access, wrong fork length, high CG, no guard or asymmetric load	Fork pockets/marks, base design, CG, handling instruction and lift trial
Label unreadable / wrong	Surface/moisture incompatibility, template error, poor placement or scan failure	Label material, data control, placement, duplicate labels and scan verification

- | | |
|--|--|
| 1. Product mass/dimensions/CG confirmed | 13. Base/pallet support mode defined |
| 2. Approved support and contact points defined | 14. No carton/product overhang |
| 3. Surface/finish compatibility validated | 15. Strap/wrap settings and edge protection defined |
| 4. Threads, edges and protrusions protected | 16. Fork/lift/sling access and CG marked |
| 5. Clean and dry condition specified | 17. Container/loading restraint planned |
| 6. Corrosion method and duration justified | 18. Labels and barcodes verified |
| 7. Barrier/seal/desiccant calculation recorded | 19. ISPM 15 scope and supplier controlled |
| 8. Pack quantity and orientation fixed | 20. Test schedule matches distribution route |
| 9. Separators prevent motion and abrasion | 21. Acceptance criteria approved before test |
| 10. Cushioning validated for fragility/load | 22. Production-intent pack passed validation |
| 11. Outer container performance specified | 23. Packout WI and inspection records released |
| 12. Closure method and pattern released | 24. Change-control and field feedback process active |

17 STANDARDS AND OFFICIAL REFERENCES

Confirm current editions, contract requirements and destination rules

The references below define terminology, dimensions, handling symbols, test frameworks, package tests, pallet tests or phytosanitary requirements. Purchase and apply the complete standard where it governs the product.

Reference	Use in packaging specification	Official page
ISO 780:2015	Graphical symbols for handling and storage of packages	https://www.iso.org/standard/59933.html
ISO 3394:2012	Dimensions of rigid rectangular transport packages and unit loads	https://www.iso.org/standard/50990.html
ISO 4180:2019	General rules for compiling performance test schedules	https://www.iso.org/standard/69054.html
ISO 2233:2000	Conditioning of complete, filled transport packages for testing	https://www.iso.org/standard/32409.html
ISO 2234:2000	Stacking tests using static load	https://www.iso.org/standard/32410.html
ISO 2248:1985	Vertical impact test by dropping	https://www.iso.org/standard/7062.html
ISO 12048:1994	Compression and stacking tests using a compression tester	https://www.iso.org/standard/20810.html
ISO 13355:2016	Vertical random vibration test	https://www.iso.org/standard/62098.html
ISO 8611-1:2025	Flat pallets - test methods	https://www.iso.org/standard/87543.html
ASTM D4169-23e1	Performance testing of shipping containers and systems	https://store.astm.org/standards/d4169
ASTM D7386-25	Performance testing for single parcel delivery systems	https://store.astm.org/d7386-25.html
ASTM D6198-18(2024)	Guide for transport packaging design	https://store.astm.org/d6198-18r24.html
ASTM D3951-18(2023)	Commercial preservation, packaging, unitization and marking	https://store.astm.org/d3951-18.html
ISTA Procedure 3A	General simulation for parcel shipments up to 150 lb / 70 kg	https://ista.org/test_procedures.php
ISPM 15	Regulation of raw-wood packaging material in international trade	https://www.ippc.int/en/publications/regulation-wood-packaging-material-international-trade-0

STANDARD STATUS NOTE

As of 2026-07-18, ISO 4180:2019 is the published general test-schedule framework; ISO 8611-1 was updated in 2025; ASTM lists D4169-23e1 and D7386-25 as current. Confirm status at every release.

KINGSFORM ENGINEERING TOOLKIT

Use KFR-006 Packaging Requirement Workbook to compare packaging concepts, define packout, calculate pallet loads, plan validation and record shipment release.

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Disclaimer: This guide is an engineering reference and does not replace customer specifications, dangerous-goods regulations, carrier rules, cargo-securing law, phytosanitary requirements, packaging supplier data or a qualified packaging engineer.