TECHNICAL WHITEPAPER

Transport packaging for aerospace and space hardware

Engineering the container, support structure and handling process as one system

A technical guide for engineering, project and procurement teams specifying reusable transport containers and Mechanical Ground Support Equipment.



Reusable container with an internal barrier and support system.

AEROSPACE & SPACE / NOVEMBER 2026

Specify the complete transport system

A transport container has to work at every handover: when hardware leaves assembly, enters a test facility, travels between sites and arrives for integration. Its value depends on how well protection, access and handling work together.

The starting point is the hardware and its allowable exposure. Dimensions establish the space required, but mass distribution, mechanical interfaces, cleanliness limits and the planned handling sequence determine how the product should be supported and protected. A late change to any of these inputs can affect the base frame, isolation system, enclosure and transport method.

This whitepaper explains how to turn those inputs into a workable specification. It focuses on satellites, instruments, subsystems and other sensitive aerospace hardware transported on the ground. The level of engineering and verification should match the application; a small service unit and a complete spacecraft will require different solutions.

Three decisions to make early

Define what the hardware can tolerate. State mechanical and environmental limits at the relevant interface, together with the conditions and duration to which they apply.

Agree how people will handle it. Review loading, lifting, inspection, unloading and return transport with the teams who will use the system.

Decide how performance will be demonstrated. Link the requirements to agreed evidence before the design is released.

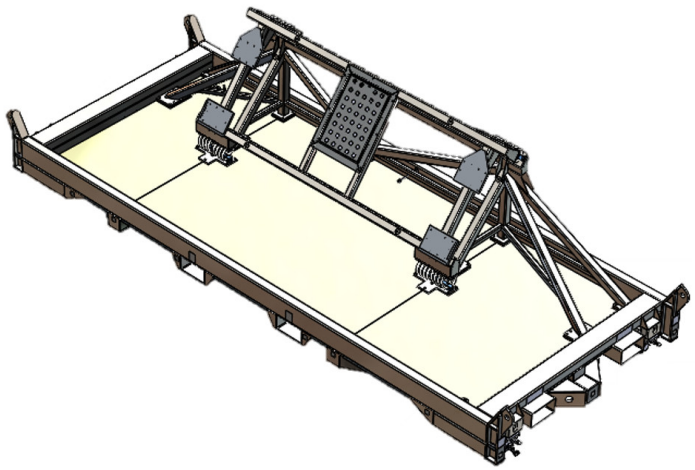
Fawic develops custom transport containers, support frames and MGSE, with engineering and production in-house. The following chapters translate that system approach into practical specification decisions. [1-5]

IN THIS WHITEPAPER

03 Requirements and interfaces
06 Environmental protection
09 Handling and logistics
13 Reuse and ownership cost
05 Mechanical protection
08 MGSE and access
11 Verification and delivery
15 Project checklist

Build the engineering brief

A useful specification connects each product requirement to a design decision. Record missing information explicitly, including who will confirm it and when it is needed.



Develop the support concept from the hardware definition and transport requirements.

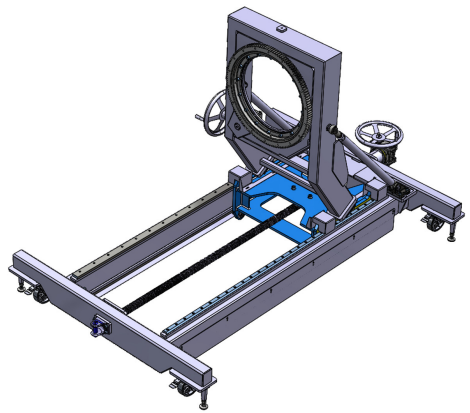
Input	What to establish	Design consequence
Hardware definition	Envelope, mass range, centre of gravity, transport orientation and exclusion zones	Internal clearance, support positions and stability
Mechanical interfaces	Mounting geometry, allowable interface loads, fastening and access	Fixture design, load paths and installation sequence
Transport exposure	Modes, handling events, storage periods and specified shock or vibration inputs	Structure, isolation and verification scope
Payload limits	Allowable response by axis, sensitive features and prohibited contact areas	Support concept, available travel and protection
Environment	Cleanliness, humidity, temperature, pressure and ESD requirements	Barrier, materials, monitoring and conditioning
Operations	Loading method, lifting equipment, access, return flow and expected reuse	Panel arrangement, handling interfaces and service access

Keep the interface definition under control

Define the transport configuration. Payload mass includes the equipment travelling on the internal support; shipping mass also includes the support, container and transport accessories. Use the appropriate mass and centre of gravity for each calculation. Describe the complete journey, including temporary storage, receiving doors and unloading equipment.

Use a controlled drawing or Interface Control Document (ICD) to define connection geometry and limits. Record revisions and identify the configuration used for design reviews. A Verification Control Document (VCD) has a different purpose: it tracks requirements and verification evidence. [1,2,9]

At the concept stage, a range may be sufficient for an initial estimate. Before detailed design, confirm which inputs are fixed and which changes would require the concept, price or schedule to be reviewed.



Engineering model



Handling equipment

Interfaces, access and operating configurations are agreed for the application.

Control the loads at the hardware

The outer enclosure, transport base, isolation system and payload fixture form a mechanical chain. Evaluate that chain using the intended configuration and agreed transport conditions.

Choose isolation from the load case

Select shock mounts or wire rope isolators from the supported mass, centre of gravity, mounting orientation, input loading and permitted payload response. Available displacement and stability are part of the same decision. [1,10]

A maximum acceleration value alone is not a complete shock requirement. Define the pulse duration and shape, direction and measurement location, or the agreed shock spectrum where applicable. For vibration, identify the relevant frequency range and input profile. The design must address these conditions rather than promise a universal reduction in g-level.



Wire rope isolation

Selection depends on the complete load case. [10]

Allow the isolation system to move

Check clearance around the supported assembly throughout its expected movement. Covers, fasteners, cables and barrier supports should not create an unintended rigid connection across the isolation system. Review the distribution of load between mounts, including eccentric payloads and different transport orientations.

Wire rope isolators have non-linear behaviour. Use catalogue data and engineering analysis for selection, then verify the complete assembly against the agreed requirement. [10]

Measure where the requirement applies

A logger on the outer base records a different location from a sensor on the isolated support. Agree sensor positions, axes, measurement settings and acceptance limits in advance. After transport, a recorded event should be assessed against those limits and the receiving procedure, with responsibility for release clearly assigned.

Define the environment around the payload

Dust protection, humidity control and cleanliness are different requirements. Identify the volume that must be controlled and the barrier responsible for each function.

A demountable enclosure provides access and physical protection. A separate inner barrier may provide the controlled atmosphere. Specify each layer's function, including how it is opened, inspected and restored after use.



Detail of an internal barrier, connections and support.

Function	Design question	Evidence to agree
Dust and water	What exposure must the complete closed enclosure withstand?	Defined test method and acceptance criteria
Humidity	Which volume must stay within limits, for how long and under which conditions?	Barrier and seal assessment, desiccant or purge sizing, monitoring
Cleanliness	Which particles, surfaces and contamination sources matter to the hardware?	Cleaning procedure, material review and agreed sampling or inspection
Temperature	What are the allowable range, duration and external conditions?	Thermal assessment and, where required, a representative test
Pressure	How will altitude and temperature changes affect each enclosed volume?	Pressure limits and equalisation or relief concept

Maintain the agreed conditions



Internal barrier and support



Closed protective enclosure

Example configurations. Performance is specified for each project.

Treat cleanliness as a controlled process

ISO 14644-1 classifies airborne particle concentration. Cleanroom-compatible materials, or packing in an ISO Class 5 or 8 room, do not by themselves establish the cleanliness of a closed container. Define the condition to maintain and how it will be checked. [7]

Control materials, cleaning and handling against the project contamination requirements. Address particles and molecular contamination where relevant, and specify ESD protection separately. [8]

Coordinate sealing and pressure management

Specify desiccant, gaseous nitrogen (GN2) purge, monitoring, filtration or thermal control where needed. Fawic can integrate the required provisions. [1] For barrier bags, define seals, penetrations and pressure limits; identify which volume each breather serves. Passive insulation slows temperature change and does not hold a set temperature.

Connect transport with the handling process

Mechanical Ground Support Equipment supports the hardware during ground operations. Its interfaces and operating sequence should be reviewed together with the transport container.

Retaining an existing assembly or test fixture for transport can avoid an additional transfer. A dedicated transport fixture may be needed where support, orientation or isolation requirements differ. Review the options with integration and logistics teams.

Fawic can develop support structures and handling equipment or engineer the container around existing customer MGSE. This makes it possible to coordinate the enclosure, transport base and fixture at the design stage. [2]

Review each configuration separately

Transport, lifting and integration can impose different loads. Identify the locks, supports and accessories required in each state. For rotation or tilting, specify permitted positions, movement control and stability.

Review the sequence in its working position

Walk through installation, securing, closure, arrival inspection and removal. Check tools, sling clearance, access to fasteners, operator positions and panel storage. Include the barrier-opening procedure.

Removable panels can provide side access while the payload remains on its support. Fawic's FB20 system can be configured with individually removable panels and tool-free assembly of the enclosure. The appropriate opening sequence depends on the hardware and the available working area. [3]



The photographs show examples of Fawic configurations. They illustrate access and support arrangements; dimensions, capacities and performance are project-specific.

Make the design work along the route

Transportability is determined by the complete loaded system and every transfer on the route. Confirm the interfaces at the receiving site as carefully as those at the shipping site.

Separate the handling functions

Specify forklift pockets, lifting points, castors and lashing points for their intended operation, considering total mass, centre of gravity, load direction and handling equipment. Lifting and lashing points are not automatically interchangeable.

Mark identification, gross mass, centre of gravity, handling locations, orientation and restrictions. Distinguish the loaded configuration from the empty return. [1,6]

Freeze the shipping envelope with logistics

Include permanent projections and shipment accessories in the external dimensions. For a large assembly, vehicle height and loading arrangements also affect route clearance. Have the logistics provider confirm feasibility before freezing the shipping envelope.



A large assembly: handling interfaces and the full shipping envelope must be reviewed together.

Check every transfer on the route

Stage	Check before design release
Inside the facility	Doors, turning space, floor loading, lift capacity, working height and panel removal space
Loading and unloading	Fork length and spacing, crane access, sling geometry, ramp limits and loading height
Road or multimodal transport	External shipping envelope, gross mass, restraint arrangement and route restrictions
Air transport	Aircraft and cargo-door compatibility, loading equipment and agreed pressure exposure
Arrival and return	Unpacking area, inspection responsibility, empty configuration and return equipment

If route constraints change the transport orientation or structure, recheck support loads, isolation clearances, restraints and unloading with engineering.

Agree the shipment records and receiving checks, including who reviews condition data and authorises the next step. [6]



Transport envelope, loading height and restraint arrangement form part of the route review.

Agree the evidence before manufacturing

A requirement is useful when both parties understand what would demonstrate compliance. Define the verification method, configuration and acceptance criteria while the design is being developed.

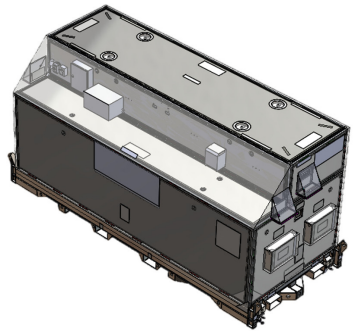
Agree inspection, analysis, testing or review of design for each requirement. A structural calculation covers the loads and assumptions in its scope; dynamic isolation, environmental protection and usability need their own evidence. [9]



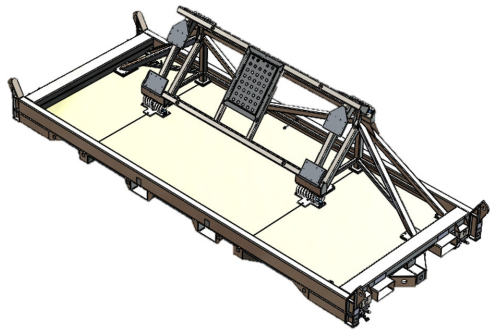
Controlled interfaces connect design to verification.

Requirement area	Possible evidence	Define in advance
Fit and interfaces	Drawing review, dimensional inspection or fit check	Controlled interface revision, tolerances and reference points
Structural behaviour	Engineering calculation or FEM analysis; load test where specified	Load cases, restraints, margins and acceptance limits
Shock and vibration	Dynamic assessment and agreed representative testing	Input, payload configuration, sensor locations and response limits
Environment	Inspection, leakage or exposure test, monitoring as applicable	Protected volume, duration, conditions and acceptance criteria
Handling and access	Functional demonstration or operating trial	Sequence, equipment, personnel access and pass criteria

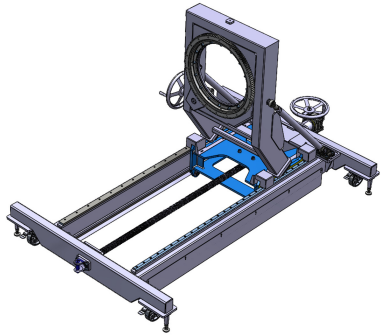
Make the handover package usable



Requirements & interfaces



Engineering & design



Manufacturing & integration



Verification & acceptance

Distinguish design qualification from delivery checks

Qualification establishes that the design satisfies the agreed requirements. Acceptance checks a delivered item against its specification and approved configuration. Define first-unit activities and the checks repeated for subsequent units.

If testing uses a dummy payload, agree the required mounting geometry, mass, centre of gravity and dynamic representation. Record any limitations.

Make the handover package usable

Agree drawings, calculations, test reports, operating instructions, inspection points and maintenance information at quotation stage. Keep revisions aligned with the delivered configuration.

ECSS-Q-ST-20-08C addresses storage, handling and transportation of spacecraft hardware; ECSS-E-ST-10-02C Rev.1 provides a verification framework. If applicable, identify relevant requirements and project tailoring. A standard reference alone does not establish compliance. [6,9]

Design for the next shipment

A reusable container needs a repeatable return-to-service process. Assess inspection, cleaning, repair and return logistics together with the purchase price.

Make service access part of the design

Identify inspection and replacement needs for seals, fasteners, castors, restraints and isolation elements. Provide access without unnecessary disturbance of the payload interface. Set inspection intervals and limits from operating conditions and component guidance.

Fawic uses modular constructions that can support repair and replacement of individual components. Demountable panels can also reduce empty storage and return volume where the geometry and return process allow it. The achievable benefit depends on the selected configuration. [1,3]

Control changes over the service life

A different payload, revised fixture or altered centre of gravity can change structural loads and isolation behaviour. Treat a new use as a configuration review: confirm the interface, permitted payload range, transport conditions and validity of the existing verification evidence.

Record inspections, repairs and significant transport events. Use that history to determine whether the container can return to service or needs engineering review.



Demountable construction can support an efficient return flow.

Compare cost over the expected number of uses

Compare engineering and purchase, outbound and return freight, labour, cleaning, inspections, consumables, repairs and storage. Apply the same service requirement to each option. Test the result against lower reuse or more expensive returns.

A lower purchase price can be outweighed by repeated labour or return costs. Equally, a reusable design may be difficult to justify if the programme involves few shipments or there is no reliable return flow. Calculate the break-even point from the actual programme rather than using a generic saving percentage.

A cost comparison does not establish an environmental saving. Environmental claims require their own scope, data and assessment of manufacture, transport, maintenance and end of life.

COST PER USE

Engineering + purchase
+ lifetime operating costs

Number of uses



Include the empty return and storage configuration in the cost comparison.

Prepare a useful request for quotation

Provide enough information to select a credible concept and make remaining decisions visible. The following checklist supports an initial technical discussion and a comparable quotation.

01 Hardware and interfaces

Drawings or CAD, envelope, mass range, centre of gravity, orientation, mounting points and any contact or access restrictions.

02 Mechanical protection

Expected transport and handling loads, allowable payload response, axis definitions and any existing qualification data.

03 Environment

Temperature and humidity limits, duration, cleanliness and ESD requirements, storage conditions and pressure exposure.

04 Loading and handling

Existing MGSE, preferred loading sequence, available lifting equipment, forklift interfaces and unloading arrangements.

05 Transport and return

Shipping and receiving locations, transport modes, external size restrictions, anticipated use frequency and empty return process.

06 Verification and documents

Applicable specifications and revisions, required analyses or tests, acceptance criteria and the expected handover package.

07 Commercial scope

Quantity, required delivery date, programme milestones and budget range where available.

Identify confirmed and provisional inputs.

Use the checklist to start the technical discussion.

Sources and technical references

Company capabilities and technical context for the specification decisions in this guide.

[1] **Fawic** · Satellite Transport Containers

[2] **Fawic** · Mechanical Ground Support Equipment

[3] **Fawic** · FB20 Transport Containers

[4] **Fawic** · Custom Base Frames

[5] **Fawic** · About Fawic

[6] **ECSS** · ECSS-Q-ST-20-08C Storage, handling and transportation of spacecraft hardware 1 October 2014

[7] **ISO** · ISO 14644-1:2015 Classification of air cleanliness by particle concentration

[8] **ECSS** · ECSS-Q-ST-70-01C Rev.1 Cleanliness and contamination control 15 October 2025

[9] **ECSS** · ECSS-E-ST-10-02C Rev.1 Verification 1 February 2018

[10] **ITT Enidine** · Wire Rope Isolator Technologies Technical catalogue

Use the applicable editions and project tailoring when defining contractual requirements. Photography and product visuals: Fawic.

Share your packaging challenge with us

Move from an initial concept to an agreed scope

Identify confirmed and provisional inputs. The proposal should describe the concept, engineering, documentation and remaining decisions, including their effect on price or delivery. Resolve critical interfaces before detailed design.

Fawic has developed and produced custom industrial packaging in Almelo since 2001. An aerospace project can combine a reusable enclosure, internal support, handling provisions and MGSE integration, with the configuration and verification agreed with the customer. [2,4,5]



Engineering and production in Almelo, the Netherlands.

Fawic Packaging Systems

www.fawic.com

info@fawic.nl

+31 546 767 250