Removable equipment modules in confined vessel spaces

An illustrative study of packaging, disconnect access and a continuous removal route

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A 900 × 800 mm equipment skid fits its operating bay but cannot be accommodated upright in the 700 mm exit corridor. We compare splitting the equipment with retaining a fixed docking frame and removing a smaller service cassette.

For the declared geometry, the preferred concept is a 760 × 540 mm cassette. Its full removal route fits after a 15 mm allowance is added to each local face. The tightest stage is the turn, where 12.9 mm remains beyond that expanded envelope.

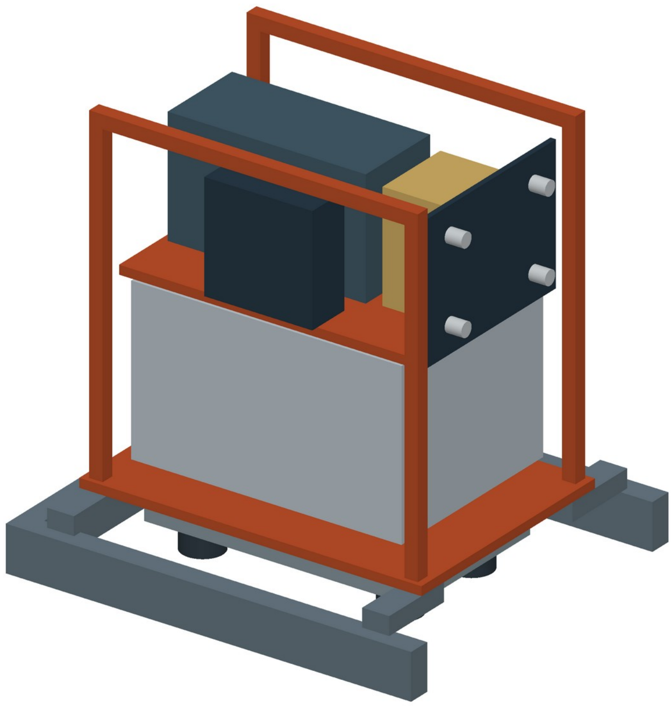

Figure 1 Original CAD envelope assembly. Orange is the removable cassette; grey is the fixed dock. Equipment, connectors and the lifting carrier are geometric reservations.

The engineering decision is to define the removable boundary and the space needed to service it before fixing the equipment layout. The narrower cassette preserves the grouped process equipment, while front-facing connections allow disconnection before withdrawal.

Illustrative concept study. All dimensions and equipment envelopes are hypothetical. This is not a client case study, tested product, fabrication package or vessel approval.

1 The declared vessel layout

The model represents a small auxiliary equipment bay opening into a turning pocket and a narrow exit corridor. The deck is level, the route is unobstructed and the cassette remains upright. The study covers access geometry; the spaces shown are not assessed for crew passage or escape.

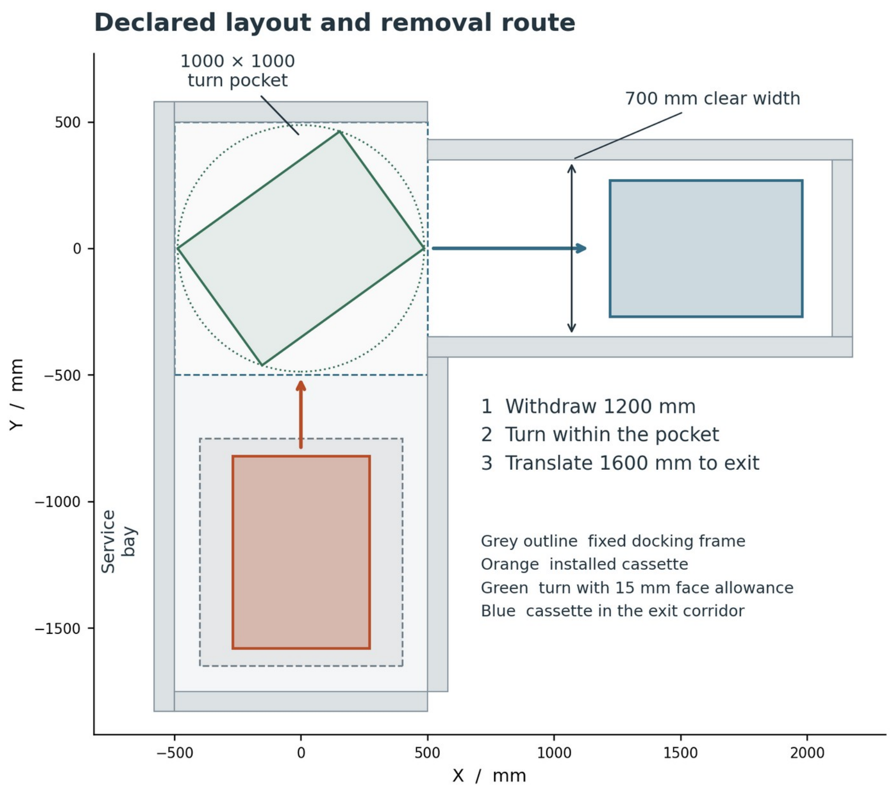

Figure 2 Plan in global coordinates. The cassette centre starts at X = 0, Y = −1200 mm with its length along Y. It turns at the origin and finishes at X = 1600, Y = 0 mm.

Assumed input	Dimension or location
Service bay clear plan	1000 wide × 1250 long mm
Reserved turning pocket	1000 × 1000 mm
Exit corridor and overhead clearance	700 wide × 1600 high mm
Fixed dock and removable cassette	900 × 800 mm / 760 × 540 × 760 mm
Cassette in docked and transport states	Bottom 140 / 180 mm; top 900 / 940 mm
External envelope allowance per face	15 mm = 5 survey + 3 build + 7 positioning

The 15 mm allocation is an explicit study assumption, not a standard tolerance or measured site accuracy. It expands the moving outline to 790 × 570 mm. Docking fits, human reach and handling stability require separate checks.

2 Comparing removal architectures

Architecture or trial	Nominal footprint	Turn span[1]	Route result[1]
Original complete skid	900 × 800	1246.5	Corridor and turn fail
A Split reservoir module	640 × 480	842.0	Fits
A Split power module	640 × 400	796.1	Fits
B Longer cassette trial	840 × 540	1040.1	Turn fails
B Selected cassette	760 × 540	974.2	Fits

[1] Millimetres. Turn span includes 15 mm per face and is compared with 1000 mm. "Fits" concerns the prescribed geometric route. Split modules are footprint concepts; their detailed assemblies are not developed here.

Option A gives more turning clearance and separates the reservoir from the pump, valve and electrical group. It also introduces separable fluid interfaces between those groups. At least suction and return connections would need definition; the final circuit could require more. Both submodules still need a qualified handling arrangement.

Option B keeps the grouped equipment in one removable cassette. We select it for this brief because it meets the route allowance while keeping those interconnections within the removable boundary. Mass, service frequency or later dimensional growth could reverse that choice.

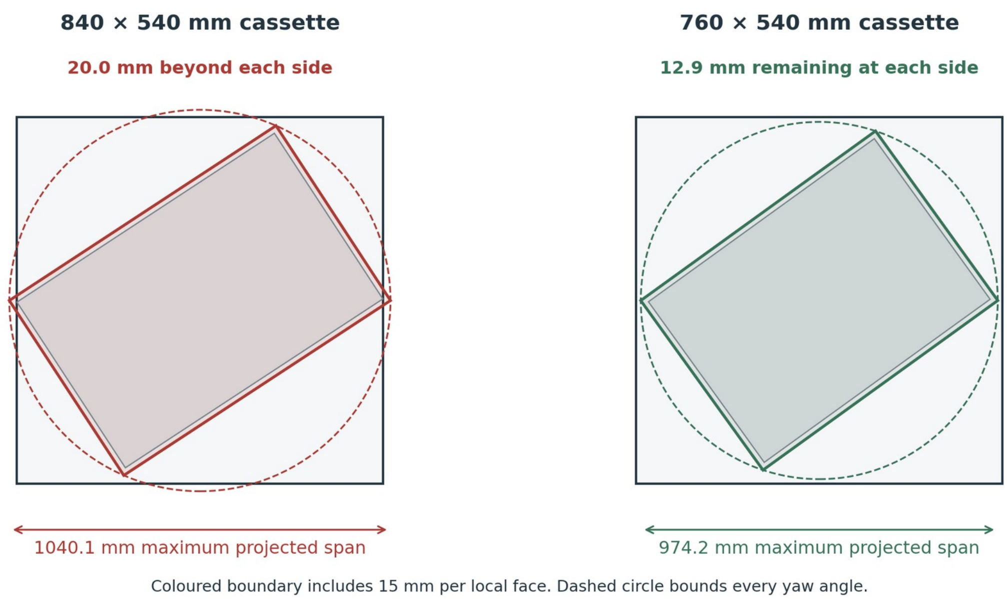

Figure 3 Critical projected width during a centred turn. The 840 mm trial fits an ideal 1000 mm square by only 0.7 mm per side before allowance; the expanded outline exceeds the square.

At a fixed 540 mm width, this turn permits a maximum nominal length of 791.6 mm with the declared allowance. Selecting 760 mm leaves 31.6 mm of length headroom. It is a packaging allocation, not evidence that an actual pump package has been sized for duty.

3 Verifying the complete route

A few clear CAD screenshots cannot establish clearance between positions. For this simple route, we can bound every intermediate position analytically, then cross-check the result with a separate collision calculation.

A bound covering every turn angle

Let L and W be the cassette length and width, b the per-face allowance and S the square pocket width. At yaw angle θ between 0° and 90°, the expanded rectangle projects onto the X axis as follows; the Y projection swaps sine and cosine.

$$P_x = (L + 2b)\cos\theta + (W + 2b)\sin\theta$$

The maximum of either projection is the diagonal D of the expanded rectangle. A disk of radius D/2 therefore contains the rectangle throughout the centred rotation.

$$D = [(L + 2b)^2 + (W + 2b)^2]^{1/2} = 974.166\ mm$$

$$c = \frac{S - D}{2} = \frac{1000 - 974.166}{2} = 12.917\ mm$$

The 12.9 mm result is the remaining gap outside the expanded envelope. It is not the total nominal gap between the bare cassette and the wall.

Translations and the turn

Stage	Continuous bound	Remaining room
Withdraw along +Y	X −285 to 285; Y −1595 to 395	215 mm to bay side walls
Turn 90° to 0° at the origin	Disk radius 487.083 mm	12.917 mm to pocket sides
Translate along +X	X −395 to 1995; Y −285 to 285	65 mm to corridor sides
Vertical transport envelope	Top 940 + 15 = 955 mm	645 mm below 1600 mm head

The stage envelopes fit the stated walls and join at common end positions. The model therefore establishes a continuous clear route under its assumptions. Reversing it gives the same geometric installation route; reconnection, alignment and load transfer remain engineering tasks.

A separate separating-axis check examined 921 poses at 5 mm translation and 0.25° rotation increments with zero wall intersections. Eight CAD Boolean checks also found zero interference. These are diagnostic cross-checks; the continuous bound carries the route conclusion.

The proof is sufficient for the prescribed upright route. It is not a search for every possible path, a dynamic simulation or proof that a larger module could never use a different manoeuvre.

4 Making the cassette accessible

Removal starts at the interfaces. A 220 mm tool and connector withdrawal reservation behind the cassette extends 50 mm into the aft wall. The same reservation at the front is clear, so the service panel faces the withdrawal direction.

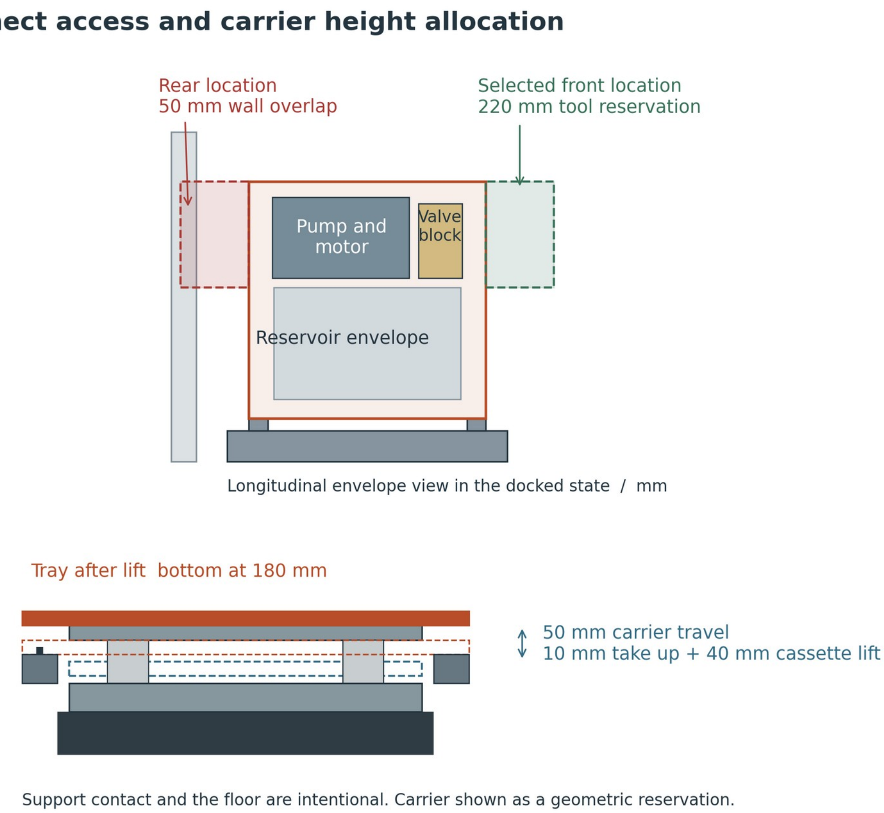

Figure 4 Longitudinal envelope view of connector access and the carrier lift allocation. Dashed outlines show reserved access or an earlier position. The lower diagram separates the two lift stages.

The proposed panel groups two fluid and two electrical connector envelopes. These are illustrative locations, not selected connector products or a completed circuit. All external connections must be detached and secured clear before the geometric transport envelope applies.

A 600 × 360 mm carrier reservation enters between docking pads whose inner faces are 400 mm apart, leaving 20 mm nominally on each side. Its lowered support plate is at 130 mm, 10 mm below the cassette tray. A 50 mm carrier stroke takes up that gap and lifts the cassette 40 mm.

After lifting, the tray underside is at 180 mm and clears the 150 mm locator tops by 30 mm. The model includes a round hole and a longitudinal slot as an illustrative location strategy. Operating hold-downs, fits and load paths are not sized. The carrier must provide controlled support during withdrawal and turning; no load capacity is inferred from its outline.

5 What the evidence supports

Check	Result	Meaning
Continuous exterior route	Analytical bounds fit	Valid for the declared dimensions and motion
Independent plan collision check	921 poses; zero intersections	Cross-check of wall geometry and route
CAD route checks	8 poses; zero interference	Second geometric representation
Carrier insertion and cassette withdrawal	Swept boxes clear the dock	Support contact excluded intentionally
Connector access reservation	Rear overlaps 50 mm; front clear	Supports the front service-panel choice
STEP export and reimport	30 module / 37 layout solids; valid	Checks geometry interchange integrity

The boundary of the study

The CAD contains original equipment and support envelopes. It does not establish reservoir capacity, pump duty, cooling, pressure containment, electrical performance, component mounting or access to individual internal parts. Piping, cable bend radii, guards and operating hold-downs must fit within the final allocated envelope or the route must be recalculated.

The main unresolved handling inputs are the cassette mass and centre of gravity. Carrier capacity, stability, wheel steering, deck loading, local structure, vessel motions and the means of controlling the load are not verified. Tool volumes demonstrate geometric reservation only; they do not establish human reach, working posture or safe access.

Turning the concept into a project scope

The dock is also divided geometrically into two 900 × 200 mm side frames and a 700 × 50 mm cross member. Both footprints meet the same turn and corridor allowance. A sectional joint design and accessible deck fixings are needed to make future dock replacement practical; those joints are not detailed here.

A project-specific study would begin with an as-built survey and actual supplier dimensions, mass and connection requirements. The survey must capture coatings, door hardware, thresholds, overhead services and temporary obstructions.

The next design package would combine an interface drawing, a dimensioned installation and removal sequence, a qualified handling concept and the required structural checks. A physical access trial would test the assumptions that geometry alone cannot resolve. This example claims no measured downtime reduction, cost saving or completed vessel installation.

Reproducibility and intended use

The companion package contains three STEP assemblies, the component register, exact figures, a route animation, calculation results and Python source. The equations and geometry are original to this hypothetical study; no external design standard is invoked as its acceptance basis.

For an equipment integration problem, the useful starting information is the available route, the equipment envelope and the maintenance operation that must remain possible. MareForge can use that basis to define a focused technical assessment and the next equipment development scope.

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