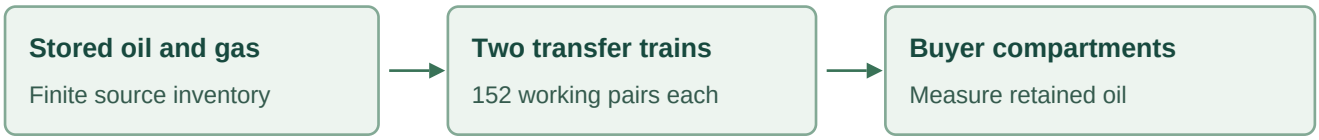
Buyer isolation during emergency transfer

The Haven Protocol aims to keep crude moving to a buyer that can retain it, and to stop feeding a buyer that fails. Two trains each have eight piston pairs unavailable. The required genuine delivery is 400 m³/h for 72 hours in recoverable cases.



Test at the original inlet	Oil crossing	Interpretation
False weights alone, original shutoff	1,442.857 L	Paired crossing after loss at second 80. The original interlock continued to admit oil.
False weights, working liquid witness	11.676 L	Paired crossing. A prefilled float pocket and a calibrated liquid-volume linkage tripped in 39.75 ms. Closure and moving oil added to the crossing.
Only one buyer fails	5.838 L	Crossing into that one failed buyer with the liquid witness working. The surviving port can continue receiving.
One failed buyer, standby receives remaining flow	6.042 L	Forward crossing into the single failed buyer, including its small supplementary line. The modeled 3 s transfer to standby maintained 400.030 m³/h with a separately stocked, powered and intact receiving path.
Both weights and physical indications mimic receipt	1,437.143 L	Paired crossing over the modeled 10.1 s fault episode. Genuine receipt at the failed buyers was zero. A longer hidden fault has no demonstrated bound here.
Controlled separation with both seats closed	0 L	Both seats physically close before the receiving connection is released. This result requires the intended mechanical release sequence.

Decision

Use the local retained-volume comparison to stop the sustained transfer under false weights. The independent coupling addresses physical separation. A silent internal loss that leaves all physical indications unchanged can defeat both protections. None of the 20 complete installation missions has passed. All quantities in this proposal are simulations.

Measurement boundary

Count all forward oil crossing the original wet inlet after loss. Track genuine retained sale and exterior release separately. The 1 L environmental limit applies outside the installation over 72 hours.

Isolation at the wet connection

The mechanical arrangement addresses physical separation and retains the oil trapped in a closed connection. A live jet and a release inside the buyer require their own capture path.

A coupling that closes before it releases

A separate mechanical link holds two independently sprung seats open at the original inlet. Loss of alignment releases them. A latch permits planned separation after both seats have closed and the trapped oil has been recovered. A separate linkage compares incoming oil with liquid accumulating in the receiving compartment. TODO describes closure before disconnection in its commercial TODO-MATIC range. The proposed geometry, flow response and quarantine system require independent tests. Manufacturer source: todocouplings.com/en/products/todo-matic/.

Failure condition	Paired forward crossing or disposition
Controlled separation or 140 ms mechanical warning	0 L after loss in either specific trial. A seated valve before separation is a physically different condition from a sudden failure in a connected buyer.
Loss and independent frame trip at the same instant	6.392 L. The positive inlet flow and finite valve travel persist after the local trigger. A 46.67 ms advance warning still allowed 1.072 L to cross.
False weights and delayed liquid trip with twin seats	12.070 L. In this trial the twin-seat train passed slightly more oil during closure than the compact single-seat trial.
Both seats jam, drive unloads	14.821 L forward and 27.772 L reverse over 0.45 s. Each direction is counted separately. With a blocked joint drain, the latch must hold the connection closed to departure.
Pressure and stocked oil	The healthy component screen gives 400.065 m³/h in the rolling-minute calculation, 88.383 Pa residual reversal head and only 0.894 reference L residual source stock per buyer. Assembly tolerances and a qualifying receiver are still required.
Trapped joint charge per buyer	0.5505 hot L per jointly closed cycle. The model returns 0.544995 hot L to the seller and stores 0.005505 hot L in a separate quarantine cylinder. After 1,016 cycles that cylinder holds 5.593 hot L against 8 L working volume.

Why a hidden failure still admits oil

At second 80 one open inlet carries 75 hot L/s. If an internal diversion leaves upstream pressure and indications unchanged for 1 ms, 0.07143 reference L crosses that failed inlet before a causal controller can distinguish the event. Catching that oil can protect the environment. It cannot erase its passage across the inlet.

Emergency service with one buyer available

The target after a receiving failure depends on having sufficient capacity at a genuinely intact endpoint. An available upstream train alone cannot supply a buyer through a closed connection.

Healthy receiving capacity	Modeled value	Implication
One installed nozzle, always open	257.143 m³/h	Absolute upper bound. The emergency target exceeds it by 142.857 m³/h.
One installed nozzle, native cycle	203.641 m³/h gross	The other port must accept real oil at the surviving buyer. Four selectable compartments share one nozzle.
Second port, switch at second 80	214.286 L over 3 s	Working oil necessary to replace this missing pulse exactly. A 5 s switch displaces 357.143 L. Funding is separate from the 0.894 L residual stock of the twin-seat option.
Spare buyer capacity over the mission	14,395.6 m³ extra	Additional volume to be retained or safely conveyed onward if the healthy receiver takes the failed buyer’s equal share for the remainder of 72 hours.

72-hour operating cases

The base custody replay covered all 20 schedules, 160 train traces and 27,152 modeled sale lots. Eight pairs were unavailable on each train. The six recoverable cases delivered for 72 hours on their registered schedules. The five delayed cases shut at hour 60 and the nine immediate cases shut at onset. The minimum aligned sale rate was 400.151 m³/h.

Installation acceptance

A second port must terminate at an intact buyer that can retain the additional saleable crude. The measured quantities would have to include the added stock, differential pressure, inlet crossing on each arm, physical receipt, quality and exterior oil. A shutdown succeeds on the total-loss schedule only when the final boundary retains the released oil.

A standby receiving port

With one original buyer lost, an independently primed spare and a continuous 0.20 m³/h net oil feed into the healthy buyer clear the 400 m³/h rolling-minute target in the 72-hour model. The delayed original inlet still admits oil to the failed buyer.

Standby trial	Outcome
Timely 3 s takeover	214.286 L from a separately charged 250 L chamber
39.75 ms witness, no margin feed	399.894 m³/h lower bound
39.75 ms witness, 30 ms opening and healthy margin feed	400.030 m³/h lower bound
Half-rate healthy margin feed	399.930 m³/h lower bound
Five-second switch	393.665 m³/h lower bound
Empty three-second bridge	394.425 m³/h gross ceiling

Scope

The trial assumes an additional intact receiver with 15,000 m³ free, a charged 250 L supply chamber, an empty 250 L recovery chamber and 14.4 m³ of additional on-spec oil per buyer. It charges the spare line with 476.19 reference L. The separate 30 kPa drive requires about 197.3 kWh over 72 hours at the assumed efficiency. A 15 kPa source misses the modeled 22.20 kPa opening requirement. Receiver integrity, power availability, product quality and final containment remain unverified.

The 20-case operating register

The added buyer failure occurs in the second minute, at second 80. Eleven cases were transferring oil. Their initial inlet states matched, so the compact hydraulic closure calculation applies to each of those cases. Nine were already isolated.

Case	Registered duty	Added fault	Both failed inlets	Full mission
1	Immediate stop	Closed control	0 L, closed	Unverified
2	Immediate stop	Closed control	0 L, closed	Unverified
3	Immediate stop	Closed control	0 L, closed	Unverified
4	Immediate stop	Closed control	0 L, closed	Unverified
5	Immediate stop	Closed control	0 L, closed	Unverified
6	Immediate stop	Closed control	0 L, closed	Unverified
7	Immediate stop	Closed control	0 L, closed	Unverified
8	Immediate stop	Closed control	0 L, closed	Unverified
9	72 h service	Live failure	11.676 L	Unverified
10	72 h service	Live failure	11.676 L	Unverified
11	Immediate stop	Closed control	0 L, closed	Unverified
12	Stop at 60 h	Live failure	11.676 L	Unverified
13	72 h service	Live failure	11.676 L	Unverified
14	72 h service	Live failure	11.676 L	Unverified
15	Stop at 60 h	Live failure	11.676 L	Unverified
16	72 h service	Live failure	11.676 L	Unverified
17	Stop at 60 h	Live failure	11.676 L	Unverified
18	Stop at 60 h	Live failure	11.676 L	Unverified
19	Stop at 60 h	Live failure	11.676 L	Unverified
20	72 h service	Live failure	11.676 L	Unverified

Test interpretation

An early shutdown receives no 72-hour service credit. An isolated inlet with zero crossing still requires verified site containment. The evidence download identifies the applicable gates in every case.

Emergency transfer after loss of normal service

The Haven Protocol is a proposed system for transferring crude to a buyer that can still receive it, while isolating damaged equipment and retaining the oil already on site.

How the system operates

Two trains use stored gas and piston pairs to move oil. Each buyer receives oil through a short rotary inlet into one of four compartments. A mechanical linkage compares the inlet movement with the rise of the actual liquid. A local valve closes on a detected mismatch. A seller-side bellows accepts some moving oil during closure. Secondary containment collects releases from the receiving yard.

Operating requirement	Evidence
40% delivery for 72 hours	The six recoverable cases sustained their modeled duties for 72 hours. The minimum across all due, clock-aligned minutes was approximately 400.151 reference m³/h. The design requires 400 m³/h over every 60-second interval.
Reduced gas and equipment	Each train had 152 working piston pairs and eight unavailable. Both gas assignments were tested: A at 73% with B at 100%, then A at 100% with B at 73%.
Pressure and earthworks	The hot-water calculation includes the heat stored in the bearing steel and shims. The selected nominal excavation is 72,186,722 m³ against a 72,200,000 m³ cap.
Safe containment	The inlet closed at the registered stops. Site-wide exterior oil retention and installed support performance remain unverified. Zero of the 20 complete missions are verified.

What counts as delivery

A sale requires genuine retained oil at the original buyer inlet, with the specified water, chloride and solids limits. Oil directed into a damaged buyer, a seller-side catch or secondary containment does not earn delivery credit. All results in this proposal are simulations. No plant or hardware test is represented.

What the flow records establish

A registered minute begins on the controller clock. A rolling minute can begin at any instant during required service. Both are measured at the original buyer inlet.

Test	Result	Scope
Aligned delivery	400.151 m³/h	Minimum over 175,680 paired due-minute replays. Four settings repeat 43,920 scheduled case minutes. Six incidents require 72 hours, five require service to hour 60.
Sales quality	27,152 lots	All modeled sale lots met the specified grade. With the proposed pockets the peaks were 0.5702% water by volume, 3.828 mg/kg organic chloride and 0.02025% solids by mass.
Shifted 60 s interval	393.792 m³/h	A possible assignment consistent with the aligned net-volume certificates puts deductions from adjacent minutes into one interval beginning at second 35. This establishes a limit on the certificate alone.
Instantaneous inlet flow	0 during exchange	The model needs 12.384 seconds with both inlets dry. Ideal continuous downstream demand would need at least 1.385 m³ of usable paired buffer capacity for the gross periodic waveform.

Evidence needed at the inlet

The two adjacent minutes in the counterexample meet their scheduled requirements. Time-resolved measurements must establish where genuine oil, returned oil and measurement allowances fall within each pulse. A buffer downstream of the sale plane can smooth demand. It cannot establish how much crossed the original inlet.

A stronger physical calculation

With finite line inventory, ingress and film charged once per window, a stable composition of 0.50% water and 0.02% solids gives 400.139425 m³/h. Charging a further 0.020% scale error and 3 ms at each edge leaves 400.007968 m³/h. Moving 5 L of existing water to each side of a minute boundary, while preserving the two minute totals and the 44 m³ composite, lowers the once-only bound to 399.925976 m³/h. These are modeled lower bounds. Neither the timing of that water nor uniform composition has been measured.

Acceptance test

Record the two original inlet displacements, protected retained-volume measurements, grade, diverted flow and independent time references. Evaluate every 60-second window during service, including startup and the last full window before a scheduled isolation. Test hidden diversion and a falsely healthy mechanical indication with the same recording arrangement.

A finite mixing chamber for the rolling-flow requirement

A proposed chamber mixes oil before it crosses the original buyer inlet. The test shifts existing water between adjacent parts of the flow. Genuine oil still has to reach and remain in a healthy buyer.

Same test, different equipment condition	Rolling 60-second lower bound
350 L working mixer per buyer and specified lighter drive shaft	400.066785 m³/h, including 0.020% volume-scale error and 3 ms at both window edges. The repeated water shifts, their two directions and startup are included.
Mixer completely bypassed	399.978994 m³/h. The lighter shaft alone cannot remove the composition shift.
Only 10% of the chamber volume mixes	399.987808 m³/h. Oil can pass through the chamber while most of its volume is inactive.
Hot shaft shear modulus falls to 20 GPa	399.825138 m³/h. The reduced stiffness consumes the timing and displacement margin.

What was purchased in the model

Each buyer uses 350 L of startup stock in the working chamber and 13.333 L in its necks, expressed at reference conditions. The conservative startup-pocket budget then leaves only 16.050 L per buyer. The drive calculation assumes a solid 70 mm member over 315 m, hot density of 2,100 kg/m³ and hot shear modulus of 26 GPa. Its one-sided displacement allowance is 18.401 L.

Where the design still fails

Forty millimetres of effective wet length at the assumed resistance costs 146.939 Pa out of 181.765 Pa available. Sixty millimetres costs 198.367 Pa and fails. The effective length must include the real chamber flow path. Mixing power, initial composition, the additional stored oil, pressure containment, seals and hot shaft couplings need independent evidence. The conditional rolling-flow pass adds no whole-installation passes.

Pressure margin and excavation

The selected support uses an 8 mm steel sheet and a 3 mm dry shim under the process piping. The model charges 0.5 mm of wear, a maximum 20 mm unsupported strip and finite heat stored in the new materials.

Condition	Modeled outcome
Nominal thermal and pressure calculation	Minimum hot-water pressure above saturation was 2.411 kPa against 1.33 kPa. The 12 mm steel and 6 mm liner gave 2.287 kPa under the same heat and displacement calculation. Each gas assignment and pressure rule used its source history. The maximum source-gas temperature was 111.940 °C.
Lower ambient pressure	A 2 kPa reduction in atmospheric pressure lowered the minimum water margin to 0.411 kPa on the frozen gas histories. Cases 12, 18 and 19 missed 1.33 kPa.
Nominal civil scope	72,186,722 m³ paired excavation. The change to the process-floor support saves 5,069 m³ relative to the measured-model baseline.
Wider yard construction	With a 1.5 m work strip, 25 m anchors and 12% overbreak, the combined excavation was 72,196,191 m³. This leaves 3,809 m³ under the cap.
Further work on the process floor	The same yard condition plus 9 mm additional average floor truing required 72,202,708 m³. This exceeds the cap by 2,708 m³.

Installation assumptions

The selected sheet depends on the installed flatness, the maximum unsupported gap, at least 75% contact and the assumed substrate stiffness. The conditional water ingress is 0.698480 L/h against 0.699. If 1 microgram of additional water per square metre of counted bearing surfaces reached the buyer in one hour, ingress would rise to 0.701472 L/h. Actual moisture transport is unmeasured.

How the civil totals were combined

The buyer-yard vault and the process-train underfloor are separate excavation items. The applicable result subtracts the revised underfloor volume once and adds the buyer-yard construction allowance once. The calculation is conditional on both geometries being buildable at the site.

Detecting receipt from an empty compartment

The receiving cart has four compartments arranged around a fixed inlet. An initially dry compartment presents a specific problem for a level float. Oil can already be entering while the float is still resting on the floor.

Receiver test	Observed result
Dry start with a free float	With an assumed 20 mm draft, 117.34 hot L must enter one selected compartment before the float lifts. The healthy-flow trial tripped after 2.40 hot L entered that buyer.
Prefilled recessed pocket	A 90 mm diameter, 70 mm deep pocket starts the float at the floor datum. The healthy local trial continued. Each pocket holds 0.389 hot L. All 2,048 pockets contain 0.796 m³ hot oil across the installation.
Buyer fails at second 20	Both weights stayed falsely healthy. A compartment area calculation that ignored the central hub allowed 27.53 reference L across the two inlets. Correcting the height-to-volume relation for the hub reduced crossing to 11.68 L. Neither failed buyer retained saleable oil.
Failure controls	Losing the pocket charge, a stuck float, a 40 ms tracking lag, or a 0.1% low volume calibration each shut down a healthy receiver in its own trial. Replayed physical follower movement remains capable of defeating detection.

Finite resources

After charging all the pocket liquid, 0.435 reference m³ of reserved oil remained per buyer. The modeled 72-hour yard energy was 87.246 kWh per buyer against 89.6 kWh available. The added cups must clear the moving dock and remain sealed under load. Their 0.796 m³ of installed oil is included as inventory at risk.

Measurement limit

The model corrects for the known central hub. It still assumes a 15 ms maximum tracking lag, bounded signed error and a calibrated volume curve throughout the usable depth. The installed curve must account for braces, deformation, liquid properties and draft. OIML R 71 describes the role of a calibration table in fixed storage tanks. It is a metrology reference for this proposal.

Containment and the incident register

The exterior limit is 1 litre across both trains over 72 hours. Internal oil held on the aisle, in a damaged cart or in the catch must be traced to an intact final boundary.

Conditional exterior test	Result
Trace oil with the charged pockets	0.999798439 L before any bulk oil escapes. Only 201.6 microlitres remain for all additional escape.
Sparse direct leakage paths	0.999818 L in the pre-pocket compact layout with one selected sector path per buyer, charged rotor paths and the applicable loaded-loss paths.
Distributed direct leakage paths	1.002587 L with a path at every wetted sector. Eleven selling cases exceed the allowance in the upper screen. The maximum modeled lower sum during normal exposure alone is 1.718 mL.

Leakage assumptions

The comparison uses an equivalent 2 µm diameter, 1 mm long through-pore and 2 mPa·s viscosity. These are specified trial conditions. Neither the number of actual through-paths nor the integrity of the external collection boundary has been measured. The pocket inventory is a separate potential bulk release.

Incident numbers	Registered duty	Full installation
9, 10, 13, 14, 16, 20	72 hours of delivery	Unverified
12, 15, 17, 18, 19	60 hours, then isolate	Unverified
1, 2, 3, 4, 5, 6, 7, 8, 11	Isolate immediately	Unverified

Evidence that would change the verdict

The three loaded-yard cases are 12, 18 and 19. Their containment result depends on the supports and on the exterior boundary after oil reaches secondary containment. The remaining cases also require installed support and exterior integrity. The private case register lists the applicable requirements for every incident.