THE WATER FAMILY

CS-310

THE SURVEY-AND-CARRIER HULL

A ring-framed polymer hull rated to 100 m that runs the long leg, carries one neutral 20 kg cartridge and brings its data home.

113.12 kg
WET, WITH A NEUTRAL 20 KG CARTRIDGE

100 m
DESIGN DEPTH, SAFETY FACTOR 2.71

20 kg / 20 L
WET-BAY CARTRIDGE

139 km
BEST RANGE AT 0.91 M/S, STILL WATER

2.60 m
OVERALL, OVER A Ø345 MM FAIRING

5
CROSSINGS OF THE PRESSURE BOUNDARY

AT A GLANCE

IT GOES OUT AND WORKS THE LINE. IT BRINGS THE DATA HOME.

A survey hull that doubles as a carrier bus: range and payload sit at this end of the Water family, and the quiet close work goes to the creeper it carries.

ONE DRY PART

ONLY THE CORE ANSWERS TO DEPTH

A ring-framed Ø240 mm polymer cylinder is the only volume at one atmosphere. Everything the water touches first is a free-flooded moulded shell, so the hard engineering sits in one simple part that is proof-tested before its first wet use.

THE LONG LEG

SIZED FOR RANGE, NOT SPRINT

A shrouded low-RPM screw and a 2.0 kWh pack give 139 km at 0.91 m/s with the inertial navigator and the Doppler log live, in still water. The quiet last kilometre belongs to the creeper it carries.

ONE INTERFACE

ONE BAY, MANY CARTRIDGES

A 20 kg / 20 L bay at the centre of buoyancy behind an interface defined once. Every cartridge is neutral by rule, so fitting or releasing one leaves the trim where it was.

DOCTRINE

A CARRIER, NOT A MUNITION

No warhead, no fuze and no energetic material in any cartridge, and no radio or GPS aboard. The acoustic modem is a sparse check-in and never a control channel.

IN THIS SHEET

01 · SPECIFICATION

EVERY FIGURE THE ENGINEERING CARRIES. EACH WITH THE BASIS BESIDE IT.

The selected baseline of CS-310, grouped the way an integration engineer reads it: form, pressure hull, collapse, mass, drive, endurance, bay, crossings, guidance and recovery.

01 VEHICLE AND ARRANGEMENT

PARAMETER	VALUE	BASIS
Form	Torpedo-form body of revolution	a dry pressure hull inside a free-flooded moulded fairing
Overall length	2.60 m	design value, the selected baseline
Fairing diameter	Ø345 mm	design value; the widest section of the vehicle
Fineness ratio	7.5	calculated, 2,600 mm over 345 mm
Wetted surface	2.94 m²	calculated; fairing, nose, tail and fins
Control surfaces	Four cruciform stern planes	top, bottom, port and starboard; effective with way on
Dry core, forward to aft	Variable-ballast tank and pump · battery pack · moving-mass trim rail · avionics, INS and compute · thruster motor and drive electronics	the general arrangement
Outside the pressure hull	Acoustic-modem transducer · down-looking DVL · ventral wet bay · ventral drop weight · shrouded propeller	the general arrangement
Pressure-hull material	Glass-filled nylon	design value, the selected baseline
Fairing	Free-flooded moulded polymer, eligible for recycled PET	nose, mid and tail shells; no pressure differential and no structural load

02 PRESSURE HULL

PARAMETER	VALUE	BASIS
Outer diameter	Ø240 mm	design value, the selected baseline
Wall	12 mm	design value, the selected baseline
Cylinder length	1,500 mm	design value, the selected baseline
End closures	Hemispherical, 8 mm	design value; 6 mm closures would govern the hull
Ring frames	Four internal frames, 40 × 25 mm section	design value, the selected baseline
Frame pitch	300 mm	design value, the selected baseline
Critical length	1,224 mm	calculated; each 300 mm bay is a short cylinder

PARAMETER	VALUE	BASIS
Clear bore between frames	Ø216 mm	calculated from the wall
Clear bore at a frame	Ø166 mm	calculated from the wall and the frame depth
Proof test	Every hull, hydrostatically, before its first wet use	a rule on every hull built

03 COLLAPSE AND SAFETY FACTORS

PARAMETER	VALUE	BASIS
Design depth	100 m	the littoral and continental-shelf work band
External pressure at 100 m	1.006 MPa	calculated, seawater
Knock-downs in every collapse figure	Creep ×0.50 on modulus · ovality ×0.70 on the cylinder · ×0.25 on the spherical closures	the method every collapse figure on this sheet is calculated with
Governing mode	Inter-bay shell buckling	Windenburg–Trilling short-cylinder relation
Governing collapse pressure	2.73 MPa	calculated
Nominal collapse depth	271 m	calculated from the governing pressure
Safety factor at 100 m	2.71	calculated
Safety factor at 50 m	5.42	calculated
General instability, shell and frames	2.84 MPa · safety factor 2.82	calculated, Bryant relation at n = 2; clear of the governing mode
End closures, 8 mm	4.11 MPa · safety factor 4.09	calculated, classical sphere relation; clear of the governing mode

04 MASS AND DISPLACEMENT

PARAMETER	VALUE	BASIS
Pressure hull, 8 mm closures and four frames	24.55 kg · 75.10 L	calculated, the mass and displaced-volume ledger
Fairing, control surfaces and thruster duct	15.89 kg · 11.77 L	calculated; free-flooded
Battery pack, 2.0 kWh	14.29 kg	calculated, packaged pack; inside the hull
Thruster motor and drive electronics	3.00 kg	ledger allocation; inside the hull
Propeller, shaft and coupling rotor	1.00 kg · 0.40 L	ledger allocation; wet side
Four control-plane actuators and linkages	2.50 kg · 1.50 L	ledger allocation; wet side
Avionics, INS and compute	4.00 kg	ledger allocation; inside the hull
DVL and acoustic-modem transducers	2.00 kg · 1.20 L	ledger allocation; wet side
Variable-ballast machinery	4.00 kg	ledger allocation; dry, inside the hull
Ballast water at half fill	2.50 kg	the neutral datum

PARAMETER	VALUE	BASIS
Moving-mass trim rail	1.20 kg	ledger allocation; inside the hull
Penetrators, harness and connectors	3.00 kg · 0.50 L	ledger allocation
Drop-weight abort, cast iron	3.00 kg · 0.38 L	ledger allocation; wet side
Dry mass	80.93 kg · 90.85 L	calculated, the sum of the ledger
Displacement in seawater	93.12 kg	calculated
Fixed trim ballast and reserve	12.19 kg	calculated; 13% of displacement
Payload cartridge	20.00 kg	neutral by interface rule
Vehicle wet displacement	113.12 kg	calculated, with the cartridge fitted
Fresh-to-salt buoyancy swing	2.27 kg	calculated on this displacement
Variable-ballast authority	±3 kg	requirement; set above the fresh-to-salt swing

05 PROPULSION, TRIM AND POWER

PARAMETER	VALUE	BASIS
Propulsor	One shrouded low-RPM propeller in a duct	low tip speed and low blade loading; the duct guards against snags
Motor	Brushless motor inside the pressure hull	turns the propeller through a magnetic coupling
Coupling	Magnetic, torque only	no dynamic seal and no crossing of the pressure boundary
Coupling loss at best range	~1.1 W · about 0.8% of range	calculated: 8% of ~14.3 W shaft power at 0.91 m/s, against a 47 W total budget
Battery	2.0 kWh	design value; inside the pressure hull
Pitch trim	Battery on a lead-screw moving-mass rail	static pitch without spending control-plane authority
Depth and density trim	Pumped variable-ballast tank inside the hull	density change and payload-release compensation
Station-keeping	Tunnel-thruster hover module, about 6 L of the bay	bolt-in; fitted on the missions that hold station

06 DRAG AND ENDURANCE

PARAMETER	VALUE	BASIS
Drag model	ITTC-57 friction line × form factor 1.25 × appendage factor 1.30	over 2.94 m² wetted at a 2.60 m reference length
Drag area at 1.5 m/s	0.01802 m²	calculated
Equivalent frontal drag coefficient	0.193	calculated, on the fairing's frontal area
Hotel load, INS and DVL live	30 W	the load the Tier 3 endurance figures are calculated at

PARAMETER	VALUE	BASIS
Hotel load, preset dead-reckoning	6 W	the load the Tier 1 endurance figures are calculated at
Best range, INS and DVL live	0.91 m/s → 42.7 h, 139 km	calculated on 2.0 kWh at a propulsive efficiency of 0.45, still water
Passage speed, INS and DVL live	1.50 m/s → 20.1 h, 108.8 km	calculated, still water
Best range, preset dead-reckoning	0.51 m/s → 212.8 h, 391 km	calculated, still water
Into a 0.25 m/s current	Holds 1.06 m/s → 0.81 m/s over the ground, 104 km	calculated, speed re-optimized against the set; 75% of still-water range
Into a 0.50 m/s current	Holds 1.26 m/s → 0.76 m/s over the ground, 75 km	calculated, speed re-optimized against the set; 54% of still-water range
Representative emplacement leg	15 km out and 15 km back: 9.2 h, 22% of the battery	calculated at 0.91 m/s, still water

07 WET BAY AND CARTRIDGES

PARAMETER	VALUE	BASIS
Bay	Free-flooded, ventral, at the centre of buoyancy	a release disturbs trim minimally
Bay length	~700 mm	design value
Cartridge envelope	20 kg / 20 L, nominal	one cartridge at a time
Cartridge buoyancy	Neutral, ±1 kg in seawater	interface rule; each cartridge is ballasted at build
Interface	Mount rails · wet-mate connector for power and data · retention and release · buoyancy bookkeeping	defined once, so a new cartridge is tooling rather than a redesign
Cartridges	Seabed sensor node · acoustic relay node · environmental sampler · inspection package · emplace and retrieve · one CS-320	non-kinetic, by rule
CS-320 in the bay	16.34 kg / 15.95 L: 18% margin on mass, 20% on volume	calculated against the bay envelope
Release transient	Zero	every cartridge is neutral by rule
Node settling offset	Roughly 50 m downstream	released at 0.91 m/s over a 30 m water column, sinking at an order of 0.5 m/s

08 PRESSURE-BOUNDARY CROSSINGS

PARAMETER	VALUE	BASIS
Electrical crossings	5, from 10 on a naive layout	the selected harness layout; each crossing is a leak path and a pressure-test item
Shore umbilical	Charge and data	blanked in the water

PARAMETER	VALUE	BASIS
Tail multi-way	Four plane actuators, power and position feedback	one crossing for all four
DVL transducer	The down-looking Doppler velocity log	one crossing
Acoustic-modem transducer	The sparse check-in link	one crossing
Payload-bay wet-mate	Power, data and the release command	the cartridge interface
Thruster drive	No crossing	magnetic coupling, torque only

09 GUIDANCE, AUTONOMY AND COMMUNICATIONS

PARAMETER	VALUE	BASIS
Tier 1	Preset dead-reckoning	magnetic heading, depth cell, water-speed estimate and time
Tier 2	Fibre-guided	a person in the loop over optical fibre from a payout spool
Tier 3	Inertial navigation corrected by a Doppler velocity log	bottom lock; bought-in and export-gated in its own right
Radio and GPS	None aboard	RF and GPS do not penetrate seawater
Acoustic modem	Check-in, abort and retask	sparse by design and never a control channel; silent-running segments are a planned mode
Mission authority	Pre-planned mission in geofenced corridors	human authority held in the mission plan and the abort criteria
Loss of navigation confidence	Loiter or bottom-sit, then surface at a planned point	safety function
Communications timer lapse	Return to recovery	safety function
Critical fault	Drop-weight abort to the surface	safety function

10 ABORT, HANDLING AND RECOVERY

PARAMETER	VALUE	BASIS
Drop weight	3.00 kg, cast iron, ventral	ledger allocation; cast iron because every abort leaves it on the seabed
Release	On command, on timer lapse or on loss of power	the weight goes and the vehicle rises
Recovery	A planned rendezvous at the surface; the drop weight off-nominal	the hull, the battery and the data come home
Handling	Two people, on a dolly or a davit	the ~113 kg class; not an unaided lift
Launch points	Shore, pier or vessel of opportunity	no dedicated mothership required

PARAMETER	VALUE	BASIS
Shore support	Battery charging and mission upload before the dive; data offload after	over the shore umbilical

11 CONSTRUCTION

PARAMETER	VALUE	BASIS
Non-metallic posture	Polymer pressure hull and polymer fairing	costs about 2.3 kg, roughly 2% of displacement, against an unstiffened aluminium hull sized to the same safety factor
Tooling	Moulds cut on the fleet's own 5-axis die shop	fairing and non-structural mouldings

02 · THE ARCHITECTURE

ONE DRY CYLINDER INSIDE A SHELL THE SEA FILLS.

Two bodies, and only one of them is dry. The fairing gives the vehicle its shape and floods; the cylinder inside it is the one part built to hold out the sea.

THE DRY CORE

Ø240 × 12 MM, 1,500 MM LONG

A glass-filled nylon cylinder with 8 mm hemispherical closures and four internal ring frames at 300 mm pitch. It holds the ballast pump, the battery, the avionics and the thruster motor at one atmosphere.

THE FAIRING

Ø345 MM, FREE-FLOODED

Nose, mid and tail shells flood freely and carry no pressure load, so they are light, inexpensive and shaped for drag. Unloaded parts are eligible for recycled PET.

THE WET BAY

VENTRAL, AT THE CENTRE OF BUOYANCY

A flooded bay about 700 mm long that takes one nominal 20 kg / 20 L cartridge behind one interface. A release from the centre of buoyancy disturbs trim minimally.

The vehicle is 2.60 m overall over the Ø345 mm fairing, a fineness ratio of 7.5. Inside the dry core the variable-ballast tank and pump sit forward, then the battery pack and the moving-mass trim rail, then the avionics, inertial navigator and compute, with the thruster motor and its drive at the stern closure. Outside it, the acoustic-modem transducer sits on top and a down-looking Doppler velocity log below, the wet bay and the drop weight sit ventrally, and four cruciform stern planes and a shrouded propeller close the tail.

Putting the whole pressure problem into one tube with two end caps is a manufacturing decision as much as a structural one. The fairing and the other non-structural mouldings come off the fleet's own tooling, and the one part that answers to depth is proof-tested hydrostatically before its first wet use.

03 · THE WALL

A POLYMER TUBE BUCKLES BEFORE IT YIELDS. THE WALL IS SIZED FOR THAT.

External pressure at 100 m is 1.006 MPa. Collapse resistance follows stiffness rather than strength, a polymer loses stiffness under sustained load, and a real tube collapses below the perfect-geometry prediction.

Two knock-downs therefore come off every collapse figure before anything is called a pass: creep at 0.50 on the modulus and ovality at 0.70 on the pressure. Applied to a plain Ø250 mm cylinder 2.0 m long, which has a critical length of 1,425 mm and sits in the long-cylinder regime, they decide the matter.

PLAIN WALL, Ø250 MM	SHORT-TERM COLLAPSE	NOMINAL DEPTH	AFTER CREEP AND OVALITY	SAFETY FACTOR AT 100 M	RESULT
10 mm	0.88 MPa	87 m	0.31 MPa	0.30	Fails outright
15 mm	2.95 MPa	294 m	1.03 MPa	1.03	Fails a safety factor of 2
19 mm	6.00 MPa	597 m	2.10 MPa	2.09	Passes, on mass

No plain wall reaches a safety factor of 2 at 100 m short of 19 mm, and at 19 mm the wall is eating the payload. The way out of a long-cylinder problem is to stop having a long cylinder: ring frames divide the shell into short bays, where the end restraint carries load.

04 · FRAMES AND CLOSURES

FOUR RINGS MAKE THE RATING. EIGHT MILLIMETRES OF DOME KEEP IT.

Ring frames at 300 mm pitch put every bay in the short-cylinder regime. Stiffening a shell also opens a second mode, general instability of shell and frames together, and the frame has to be sized against it.

RING FRAME	INTER-BAY BUCKLING	GENERAL INSTABILITY	GOVERNING MODE	SAFETY FACTOR AT 100 M	RESULT
20 × 15 mm	2.73 MPa	0.74 MPa	General instability	0.73	Fails
40 × 18 mm	2.73 MPa	1.52 MPa	General instability	1.51	Fails
40 × 25 mm, selected	2.73 MPa	2.84 MPa	Inter-bay	2.71	Passes

An under-sized frame moves the failure from one mode to another at essentially the same pressure. The same Ø240 × 12 mm shell with no frames reaches 0.60 MPa after the knock-downs, a safety factor of 0.60, so the depth rating exists because of the frames.

The closures were checked on the classical sphere relation with a 0.25 knock-down, because a spherical shell is far more sensitive to imperfection than a cylinder. At 6 mm a closure reaches 2.31 MPa and would set the rating of the whole hull below its cylinder. At 8 mm it reaches 4.11 MPa and hands the governing mode back to the cylinder, for 0.98 kg across the pair.

2.73 MPa
GOVERNING COLLAPSE, INTER-BAY

271 m
NOMINAL COLLAPSE DEPTH

2.71
SAFETY FACTOR AT 100 M

5.42
SAFETY FACTOR AT 50 M

INTER-BAY

2.73 MPA · GOVERNS

Shell buckling between frames on the Windenburg–Trilling short-cylinder relation. The critical length of 1,224 mm sits far beyond the 300 mm bay.

GENERAL INSTABILITY

2.84 MPA · CLEAR

Shell and frames buckling as one assembly on the Bryant relation at n = 2, a safety factor of 2.82 at 100 m.

END CLOSURE

4.11 MPA · CLEAR

The 8 mm hemispherical closures on the classical sphere relation with a 0.25 knock-down, a safety factor of 4.09 at 100 m.

05 · DIAMETER AND MASS

STRENGTH WANTS A SMALL HULL. BUOYANCY WANTS A LARGE ONE.

Collapse pressure rises as roughly $(t/D)^{2.5}$ and displacement as D^2, so the two pull in opposite directions. Swept at a 12 mm wall with 40 × 25 mm frames at 300 mm and the battery at its packaged mass, Ø240 mm closes on geometry alone, with a 12.2 kg reserve and nothing bought in.

HULL	SAFETY FACTOR AT 100 M	HULL MASS	TOTAL DRY	BUOYANCY	RESERVE	WET DISPLACEMENT	RESULT
Ø200 × 1,400 mm	3.54	18.7 kg	73.4 kg	64.3 kg	−9.1 kg	84.3 kg	Sinks
Ø225 × 1,500 mm	2.98	22.7 kg	78.6 kg	83.1 kg	4.4 kg	103.1 kg	Closes on a thin reserve
Ø225 × 1,500 mm with 8 L of buoyancy	2.98	22.7 kg	80.6 kg	91.3 kg	10.6 kg	111.3 kg	Closes, buying in a material class
Ø240 × 1,500 mm, selected	2.71	24.6 kg	80.9 kg	93.1 kg	12.2 kg	113.1 kg	Closes on geometry alone
Ø250 × 1,800 mm	2.51	30.3 kg	88.8 kg	116.7 kg	27.9 kg	136.7 kg	Over-buoyant, carries trim lead

The Ø225 mm hull with 8 L of closed-cell buoyancy is the lower-drag vehicle, but the two closing options differ by 1.9 kg wet and 9% of frontal area, and the foam brings a material class and a hydrostatic qualification item with it. The Ø240 mm hull closes with nothing bought in, and the buoyancy-module route is kept as a quantified upgrade.

80.93 kg
DRY MASS, EVERY ITEM PAIRED WITH ITS VOLUME

93.12 kg
DISPLACEMENT IN SEAWATER

12.19 kg
FIXED TRIM AND RESERVE, 13%

113.12 kg
WET, WITH A NEUTRAL 20 KG CARTRIDGE

Every line of the ledger carries a mass and a displaced volume, so displacement is a sum rather than an estimate. Carrying a 20 kg payload to 100 m in polymer lands at about 113 kg: a shore crew of two with a dolly or a davit, rather than an unaided lift. The fresh-to-salt swing on this displacement is 2.27 kg, and the ±3 kg of variable-ballast authority is a requirement set above it.

The non-metallic hull has a price, and it is small. An unstiffened 6061-T6 aluminium hull sized to the same safety factor of 2 at 100 m over the full 1,500 mm needs a 6.0 mm wall and weighs 22.3 kg against the polymer hull's 24.6 kg: 2.3 kg, about 2% of displacement.

06 · DRIVE AND THE PRESSURE BOUNDARY

THE MOTOR STAYS DRY. TEN CROSSINGS BECOME FIVE.

Every wire that crosses the pressure boundary is a leak path, a pressure-test item and a cost line, so the harness is laid out to remove crossings rather than to route them.

Propulsion is one low-RPM propeller in a duct that doubles as a guard against snags, at low tip speed and low blade loading. A brushless motor inside the pressure hull turns it through a magnetic coupling, so torque crosses the wall and no shaft, dynamic seal or wire does. At the 0.91 m/s best-range point the electrical propulsion draw is 16.8 W and shaft power about 14.3 W, so an 8% coupling loss is about 1.1 W against a 47 W budget, roughly 0.8% of range.

The coupling removes the motor's crossing outright, and a single tail multi-way carries all four stern-plane actuators with their power and position feedback. A naive layout needs ten crossings of the pressure boundary; this one needs five.

CROSSING	CARRIES	NOTE
Shore umbilical	Charge and data	Blanked in the water
Tail multi-way	Four plane actuators, power and position feedback	One crossing for all four
DVL transducer	The down-looking Doppler velocity log	Bottom lock for the top guidance tier

CROSSING	CARRIES	NOTE
Acoustic-modem transducer	The sparse check-in link	Never a control channel
Payload-bay wet-mate	Power, data and the release command	The cartridge interface
Thruster drive	Torque only	A magnetic coupling, not a crossing

Trim is done by moving mass. The battery rides a lead-screw rail for static pitch, which keeps control-plane authority free for manoeuvring, and a small pumped variable-ballast tank inside the hull handles density change and the compensation a payload release needs. The stern planes work only with way on, so station-keeping is bought as a bolt-in tunnel-thruster module that takes about 6 L of the bay on the missions that need it.

07 · ENDURANCE

THE OPTIMUM IS 0.91 METRES A SECOND. FASTER IS FOR WHEN THE CLOCK MATTERS.

Drag comes from an ITTC-57 friction line with a 1.25 form factor and a 1.30 appendage factor over 2.94 m² of wetted surface, because the fairing, not the pressure hull, is the widest section. The equivalent frontal drag coefficient is 0.193.

SPEED THROUGH THE WATER	DRAG	TIER 1, 6 W HOTEL	TIER 1 RANGE	TIER 3, 30 W HOTEL	TIER 3 RANGE
0.50 m/s	2.90 N	217.0 h	390.6 km	60.2 h	108.4 km
0.80 m/s	6.71 N	111.6 h	321.4 km	47.7 h	137.4 km
1.00 m/s	10.01 N	70.8 h	254.9 km	38.3 h	137.8 km
1.20 m/s	13.90 N	46.4 h	200.6 km	29.8 h	128.8 km
1.50 m/s	20.78 N	26.6 h	143.5 km	20.1 h	108.8 km
2.00 m/s	34.96 N	12.4 h	89.2 km	10.8 h	77.7 km

Every row is still water, on 2.0 kWh at a propulsive efficiency of 0.45. With the inertial navigator and the Doppler log live, the best-range speed is 0.91 m/s for 139 km over 42.7 h, and at that optimum the 16.8 W electrical propulsion draw is about half the 30 W hotel draw. On preset dead-reckoning with neither instrument powered, the optimum is 0.51 m/s for 391 km over 212.8 h.

Power is set by speed through the water and range by speed over the ground, and the gap is the current. Allowed to re-optimize against the set, the hull holds 1.06 m/s into 0.25 m/s for 0.81 m/s over the ground and 104 km, 75% of its still-water range, and 1.26 m/s into 0.50 m/s for 0.76 m/s and 75 km, 54%. Into an adverse current the right answer is to speed up, because time in the water costs hotel energy.

0.91 m/s	139 km	9.2 h	22%
BEST RANGE, INS AND DVL LIVE	OVER 42.7 H, STILL WATER	15 KM OUT AND BACK, STILL WATER	OF THE BATTERY FOR THAT LEG

08 · THE WET BAY

EVERY CARTRIDGE NEUTRAL. EVERY RELEASE TRIM-NEUTRAL.

One envelope, one bay, many cartridges. The interface is defined once, as mount rails, a wet-mate connector, retention and release, and the buoyancy bookkeeping, so a new cartridge is tooling rather than a redesign.

One rule pays for itself three times: every cartridge is neutrally buoyant to ±1 kg in seawater. The vehicle trims the same whichever cartridge is fitted, a release is trim-neutral at the moment the vehicle is trying to hold position, and carrying the family's creeper becomes cheap rather than a stability problem. The cost is a fixture and a scale, because every cartridge is ballasted at build.

SEABED SENSOR NODE

EMPLACED AT SURVEYED POINTS

Passive acoustic or environmental packages for persistent harbour and approach monitoring. Released at 0.91 m/s over a 30 m water column, a node settles roughly 50 m downstream of the release point.

ACOUSTIC RELAY NODE

CARRIED OUT AND MOORED

Extends an acoustic network without a surface vessel.

ENVIRONMENTAL SAMPLING

WATER COLUMN AND SEDIMENT

Water-quality sondes and sediment samplers: the civil work, on the same hull as the survey.

INSPECTION PACKAGE

HULLS, PIERS, PIPELINES, INTAKES

A camera or imaging-sonar cartridge for structure inspection, with the hover module fitted where the vehicle has to hold against a set.

EMPLACE AND RETRIEVE

AN INERT PACKAGE

Low-signature delivery or recovery of tags, beacons and instrumentation where a surface presence is unwanted. Export-sensitive in its own right.

ONE CS-320

CARRIED, THEN RELEASED ONE WAY

The creeper closes at 16.34 kg and 15.95 L, inside the bay with 18% margin on mass and 20% on volume, and leaves on the release command the interface already carries.

The list ends there by rule rather than by omission: no warhead, no fuze, no energetic material and no terminal-effect payload, in any cartridge, in any variant, for any customer. Carriage of the creeper is a cartridge fit, not a docking system. CS-310 transits and releases, the creeper runs the last leg and surfaces at a planned point for its own recovery, and because it is neutral by rule the release transient is zero.

09 · GUIDANCE AND AUTONOMY

AUTONOMOUS BETWEEN CONTACTS. AUTHORIZED IN THE PLAN.

Under water the no-radio, no-GPS doctrine is the operating condition, because RF and GPS do not penetrate seawater. The vehicle runs a pre-planned mission in geofenced corridors, and the person holds authority at mission grain rather than joystick grain.

BEFORE THE DIVE

THE PLAN AND THE ABORT CRITERIA

Mission plan, corridors and abort criteria load at the shore station over the shore umbilical, which is blanked in the water.

NAVIGATION CONFIDENCE LOST

LOITER, THEN SURFACE

The vehicle loiters or sits on the bottom, then surfaces at a planned point.

CONTACT TIMER LAPSES

RETURN TO RECOVERY

The vehicle comes back to the recovery point on its own.

CRITICAL FAULT

DROP THE WEIGHT

The drop weight goes and the vehicle rises to the surface.

DOCTRINE

NO RADIO. NO GPS. THE SEA ENFORCES IT.

The acoustic modem takes a check-in, an abort or a retask at a contact and never flies the vehicle, which is autonomous between contacts. Silent-running segments with no transmissions are a planned mode, because acoustic emissions cost signature too.

What is fitted decides the tier. A preset hull flies pre-programmed legs on heading, depth, speed through the water and time. A fibre-guided hull trails a physical thread from a payout spool with a person on the far end. The top tier is an inertial navigator corrected by a Doppler velocity log with bottom lock, bought rather than built and export-gated in its own right. The three builds are set out below.

10 · THE ABORT

WHEN EVERYTHING ELSE HAS FAILED, A WEIGHT DROPS AND THE HULL RISES.

The drop weight is a 3.00 kg cast-iron assembly on the ventral keel. On command, on timer lapse or on loss of power, the weight goes and the vehicle rises.

It is the one subsystem aboard that has to work when nothing else does, and loss of power is one of the three things that release it, so a vehicle that loses its power still ends on the surface.

The weight is cast iron rather than lead because every abort leaves it on the seabed. Recoverability is an environmental requirement and an economic one: nominal recovery is a planned rendezvous at the surface, off-nominal recovery is the weight, and either way the hull, the battery and the data come home.

LAUNCH

TWO PEOPLE, A DOLLY OR A DAVIT

From a shore, a pier or a vessel of opportunity, with no dedicated mothership. The hull is about 113 kg wet with its cartridge fitted.

WORK

THE LINE, ON THE FITTED TIER

The hull runs its survey lines carrying its cartridge at the centre of buoyancy, with silent-running segments where the mission calls for them.

RECOVER

RENDEZVOUS, OR THE WEIGHT

A planned rendezvous at the surface, or the drop weight. Charging, mission upload and data offload run over the shore umbilical.

11 · BUILDS

ONE HULL, THREE GUIDANCE FITS. THE WORK PICKS ONE.

The hull, the bay and the abort are common to every build. What differs is what is fitted to navigate, and whether the bay gives 6 L to a hover module.

TIER 1

PRESET DEAD-RECKONING

Pre-programmed legs on magnetic heading, a depth cell, a water-speed estimate and time, at a 6 W hotel load: best range 391 km at 0.51 m/s in still water. Position error grows with distance, so it suits short, forgiving legs.

TIER 2

FIBRE-GUIDED

A person in the loop over optical fibre from a payout spool, with no launch shock and low speeds. The natural build for inspection work, with its reach set by the spool's volume.

TIER 3

INS AND DVL

Inertial navigation corrected by a Doppler velocity log with bottom lock, at a 30 W hotel load: best range 139 km at 0.91 m/s in still water. The capable build, and the one with export treatment of its own.

HOVER MODULE

STATION-KEEPING, BOLTED IN

Tunnel thrusters in a module that takes about 6 L of the 20 L bay, fitted for pier and intake work or precise emplacement. The base hull keeps its five crossings and its low drag.

12 · DOCTRINE AND SAFETY

INSTRUMENTS, RELAYS AND SAMPLERS ONLY. A FAULT BRINGS THE HULL TO THE SURFACE.

These lines hold on every build of the hull and for every customer.

- ✓ Carriers, not munitions: no warhead, no fuze, no energetic material and no terminal-effect payload, in any cartridge, in any variant, for any customer.

- No radio and no GPS aboard, and nothing guides on a link: the acoustic modem is a sparse check-in, abort and retask link and never a control channel.
- Human safety comes first, on every line: a shore crew of two launches the hull on a dolly or a davit, and any critical fault drops the weight and brings the vehicle to the surface.
- Human authority lives in the mission plan and the abort criteria, written at the shore station before the dive.

THE CONVERSATION

TELL US THE WATER AND THE LEG. THE HULL IS SCOPED FROM THERE.

A first conversation needs the approach you have to know, the depth band, the current the work is timed to, and the job at the far end of the leg. Enquiries are screened before anything is discussed.

Start a screened enquiry at cdnshield.ca/enquiries.

DOCUMENT	CDN-PROD-SPC-007 · CS-310 · Specification sheet
REVISION	R1.0 · issued 2026-09-10
WEB VERSION	cdnshield.ca/systems/water/spec-sheets/cs-310 · carries the current revision
RELATED SHEETS	CS-320 · KMM-01
ISSUED BY	Canadian Shield · cdnshield.ca