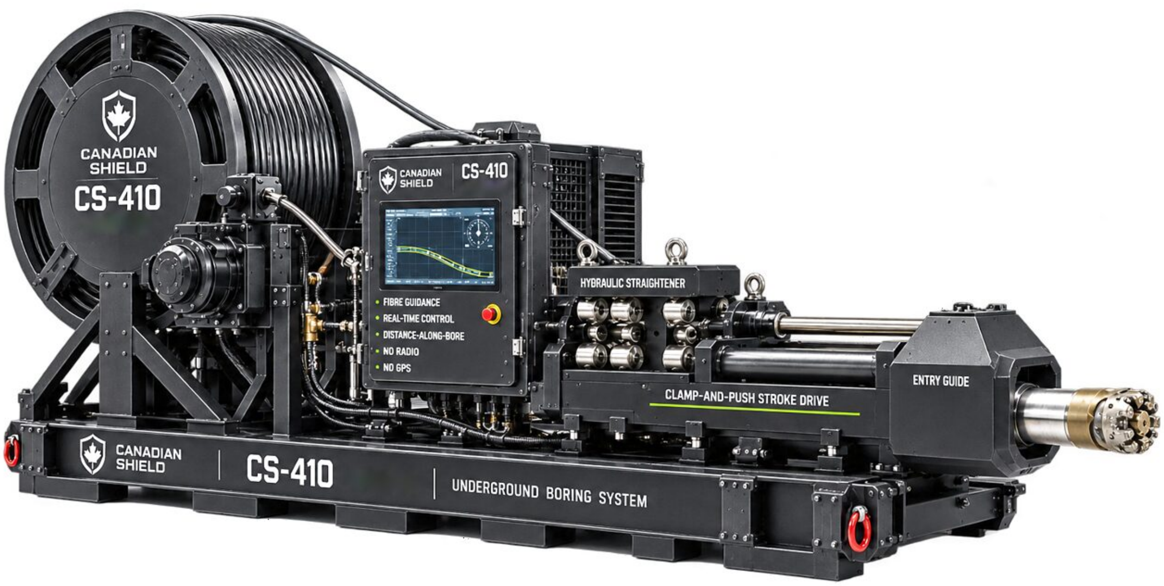
THE UNDERGROUND FAMILY

CS-410

THE COILED-TUBING SURFACE BORING PLANT

A coiled-tubing boring plant that stays on the surface, steers a fibre-guided head through ground that cannot be opened, and can leave its own tube behind as conduit.



35.0 kN
SURFACE PUSH, SET BY THE CLAMP

1.74 m
FREE-SPAN LIMIT AT THE ENTRY GUIDE

2.22–2.30×
REACTION MARGIN WITH THE TWO ANCHORS

7,044–10,859 kg
OPERATING MASS ACROSS THE TUBE LOADS

−40 °C to +40 °C
OPERATING TEMPERATURE

AT A GLANCE

THE PLANT STAYS UP HERE. THE TUBE DOES THE TRAVELLING.

Five figures that size the plant, and four reasons a buyer with ground in the way chooses it.

NOBODY IN THE HOLE

THE PLANT STAYS ON THE SURFACE

The reel, the drive, the power pack and a crew of two or three stay at the entry. Only coiled tubing and a steerable head go into the ground.

NO LINK TO LOSE

FIBRE AND STROKE COUNT, NOTHING BROADCAST

Attitude and steering ride a fibre inside the tube, and distance comes from the drive's own strokes. There is no radio and no GPS aboard in any format.

THE TUBE IS THE PRODUCT

CONDUIT LEFT IN THE BORE

On the conduit mission the tubing that followed the head in stays behind as the delivered conduit, with no spoil return and no trench.

ONE PLANT

SKID, TRAILER OR AIR-DEPLOYABLE

Three carrier formats bring the same reel, drive and entry guide to the entry line, and the plant is anchored the same way in each of them.

IN THIS SHEET

01 · SPECIFICATION

EVERY FIGURE THE PLANT CARRIES. EACH ONE WITH ITS BASIS.

Grouped the way an integration engineer reads a boring plant: the plant, the tube, the push, the open span, the reaction, the reel and fibre, guidance, and what travels.

01 THE PLANT

PARAMETER	VALUE	BASIS
Architecture	Coil reel, hydraulic straightener, clamp-and-push stroke drive, entry guide	design value; a self-contained coiled-tubing micro-bore plant on the surface
What enters the ground	The coiled tubing and the steerable head only	design value; the plant, its power and its crew stay on the surface
Bore method	Displacement and compaction; no spoil return	design method; the ground is moved radially to form the bore and nothing is cut loose and carried back
Bore diameter class	~50–150 mm (2–6 in)	design class
Downhole head	Steerable compaction head with an HDD-type bit face, tricone or PDC to suit the formation	design value; the head is larger than the tube behind it, and the overcut gives the tube its annular clearance
Delivered product	Conduit: the coiled tubing left in the bore	design value, the conduit mission
Power pack	Diesel-hydraulic, or an electric-hydraulic option	design value
Crew	2–3 operators, all on the surface	design value
Operating temperature	−40 °C to +40 °C	design range

02 THE TUBE

PARAMETER	VALUE	BASIS
Coiled tubing, short and medium tube loads	38.10 × 3.18 mm	design value, selected tube
Coiled tubing, long tube load	50.80 × 3.96 mm	design value, selected tube; the one change of tube size in the plant
Coiled-tubing outside diameter class	~38–60 mm (1.5–2.375 in)	design class
Tube bore	31.7 mm · 42.9 mm	calculated, 38.10 mm and 50.80 mm tubes
Bending stiffness	1.07×10^4 N·m² · 3.22×10^4 N·m²	calculated, 38.10 mm and 50.80 mm tubes
Plastic moment	2,139 N·m · 4,790 N·m	calculated, 38.10 mm and 50.80 mm tubes

03 THE PUSH

PARAMETER	VALUE	BASIS
Surface push, 38.10 mm tube	35.0 kN	calculated; governed by the clamp, flat-die ring collapse on a 0.40 m grip at die friction 0.30
Surface push, 50.80 mm tube	40.7 kN	calculated; governed by the clamp in the same mode
Clamp squeeze limit	117 kN · 136 kN	calculated, four-hinge ring collapse under a flat die, 38.10 mm and 50.80 mm tubes
Stroke cylinder capability	157.1 kN	calculated, the cylinder's mechanical maximum; not the governing limit
Tube axial yield	193.0 kN	calculated, the 38.1 mm tube in pure axial compression; not the governing limit
Governing push limit	The clamp, on every tube size considered	calculated across five coiled-tubing sizes
Drive cycle	Clamp, stroke, release, reset: a fixed increment per stroke	design value; a continuous tube has no connection to make between strokes

04 THE ENTRY GUIDE AND THE OPEN SPAN

PARAMETER	VALUE	BASIS
Free-span limit, 38.10 mm tube	1.74 m	calculated, Euler pinned-pinned at the adopted push
Free-span limit, 50.80 mm tube	2.79 m	calculated, Euler pinned-pinned at the adopted push
Slenderness at the free span	140 · 168	calculated; long-column range, so Euler is the governing relation
Entry guide on a skid	Flush with the frame end and the ground	design value; the span stays short by construction
Entry guide on a trailer	Oversails the tailboard	design value; the span is set by ride height and deck overhang and is checked for the configuration

05 REACTION AND ANCHORING

PARAMETER	VALUE	BASIS
Reaction anchors	Two, 25 kN each, carried in every format	design value, the onboard reaction package with its beam
Self-weight reaction at operating mass	39 % to 144 % of the push	calculated across ground friction 0.20 to 0.55 and the three tube loads
Reaction margin with the anchors	2.22× to 2.30×	calculated at ground friction 0.40 and operating mass, both anchors counted
Trailer levelling	Drop-leg jacks bridge the suspension for the bore	design value; jacked rigid, the trailer bears on the ground like a skid
Trailer coupler	Pintle ring	design value; gross trailer weight sits above consumer hitch classes

06 REEL, FIBRE AND PAYLOAD

PARAMETER	VALUE	BASIS
Reel core radius	0.83 m · 1.11 m	calculated for fifty round trips of tube life, 38.10 mm and 50.80 mm tubes
Tube strain crossing the drum	2.29 %	calculated at the core layer, every tube load
Reel outside diameter on a 0.70 m drum	1.97 m to 3.13 m	calculated across the tube loads
Reel for the long tube load on a trailer	1.30 m drum, 5 layers, 2.72 m outside diameter	design value, adopted for the trailer
Reel structure	14–15 % of dry mass	calculated, the mass ledger
Fibre unit	Fibre-in-metal-tube unit on centralizers, on the tube axis	design value; a fibre at the tube wall would see 1.910 % to 1.936 % strain on the drum
Optical loss, longest tube load	Under 1.2 dB including two connectors	calculated at 0.20 dB/km
Largest rigid payload through the tube	Ø12.7 mm · Ø18.3 mm slug	calculated beside the centralized fibre unit, 38.10 mm and 50.80 mm tubes

07 GUIDANCE AND CONTROL

PARAMETER	VALUE	BASIS
Guidance tier	Tier 2: fibre-guided, human in the loop	design value
Downhole sensing	Attitude behind the head, carried to the operator on the fibre	design value
Odometry	Stroke count from the drive: distance along the bore	design value; no emission
Steering	Head-local orientation of an asymmetric face; the tube transmits no rotation	design value; pushing with orientation steers
Emissions	None: no radio and no GNSS in any tier	design value
On uncertain ground or a lost attitude read	The drive stops and holds	design value

08 MASS, TRANSPORT AND HANDLING

PARAMETER	VALUE	BASIS
Package dry mass	3,894 kg to 7,709 kg	calculated, the mass ledger, across the tube loads
Package operating mass	7,044 kg to 10,859 kg	calculated: dry package plus 3.0 m³ of lube, 3,150 kg
Package less tube	2,853 kg to 3,683 kg	calculated; the mass the frame is built around
Travel state	Dry; lube filled on site	design value, every format

PARAMETER	VALUE	BASIS
Crane to lift the skid dry	6.0 t to 11.8 t	calculated: dry mass and base frame × 1.5 dynamic factor; the reel end carries most of the weight
Air-deployable frame	7,500 kg gross-mass cap	design value, the frame's fixed cap
Air-deployable attenuation	Mechanical crush stage; no pyrotechnics anywhere in the deployment chain	design rule

02 · THE ARCHITECTURE

A PLANT ON THE SURFACE. ONLY THE TUBE GOES INTO THE GROUND.

CS-410 stays where the crew is and pushes one continuous tube, and one steerable head on the end of it, into ground that cannot be trenched or opened.

THE COIL REEL

ONE CONTINUOUS DRIVE MEMBER

Coiled tubing in the ~38–60 mm class, wound on a drum sized for the tube's fatigue and paid out as the bore advances.

THE STRAIGHTENER

HYDRAULIC AND IN LINE

Takes the reel-set curvature out of the tube before the drive grips it. Every pass is charged against the tube's life.

THE STROKE DRIVE

CLAMP, STROKE, RELEASE, RESET

A clamp grips the straightened tube, a stroke advances it a fixed increment, and the clamp releases and resets. The coil-tube drive is patent pending.

THE ENTRY GUIDE

WHERE THE PLANT ENDS

Sets the initial heading and carries the tube across the open span between the drive and the ground.

Everything that decides a bore sits on the surface within reach of a crew of two or three: the console, the drive and the power pack, which is diesel-hydraulic with an electric-hydraulic option. The tube does three jobs at once. It is the member that is pushed, the path the head follows, and the umbilical that carries lube, fibre and payload down its bore.

A tube left in the bore as conduit spends one deployment of fatigue life rather than a round trip.

03 · THE BORE

THE GROUND MOVES ASIDE. NOTHING IS CARRIED BACK.

The head displaces and compacts the soil radially to form the bore. Nothing is cut loose, so there is no spoil return, no cuttings to handle and no trench.

Most of the plant follows from that choice. With no cuttings to lift, the lube sent down the tube relieves the face and lubricates the tube in its own bore rather than carrying spoil back, and there is no spoil pile at the entry and no open cut across whatever the bore passes under.

The head comes back out through the bore it made, so its profile is retrievable by construction, with no back-facing shoulders to anchor it in the wall. Its bit face is HDD-type, tricone or PDC to suit the formation, and it is larger than the tube behind it: the overcut gives the tube its annular clearance and the lube its path.

- Push alone closes in soft ground and not in dense ground. Denser ground calls for relief at the face, not a larger drive.
- Steering comes from an asymmetric face oriented at the head. The tube transmits no rotation, so pushing with orientation steers and pushing without it does not.

04 · THE PUSH

THE CYLINDER IS NOT THE LIMIT. THE CLAMP THAT GRIPS THE TUBE IS.

The stroke cylinder delivers 157.1 kN and the tube yields in pure axial compression at 193.0 kN. The push the plant puts through its tube is set lower, by the squeeze a flat die can apply before it flattens the tube it holds.

157.1 kN	193.0 kN	35.0 kN	40.7 kN
STROKE CYLINDER, MECHANICAL MAXIMUM	TUBE AXIAL YIELD	CLAMP-SET PUSH, 38.10 MM TUBE	CLAMP-SET PUSH, 50.80 MM TUBE

A ring squeezed between two opposed line loads forms four plastic hinges, and the collapse load per metre of grip is the steel's yield stress times the wall thickness squared over the radius. Multiplied by the die friction, that is the push the clamp can transmit, and on every tube the plant draws from it is the lowest of the three limits.

COILED TUBING	SQUEEZE LIMIT, 0.40 M DIE	GRIP AT DIE FRICTION 0.30	GOVERNS
31.75 × 2.77 mm	106 kN	31.9 kN	The clamp
38.10 × 3.18 mm, short and medium tube loads	117 kN	35.0 kN	The clamp
44.45 × 3.40 mm	114 kN	34.3 kN	The clamp
50.80 × 3.96 mm, long tube load	136 kN	40.7 kN	The clamp
60.33 × 4.00 mm	117 kN	35.0 kN	The clamp

Grip sits between 32 and 41 kN across the whole board, so a bigger tube buys stiffness, weight and reel size and no push. Die conformity is the clamp question that matters: a matched-radius die spreads the squeeze as pressure rather than a line load and lifts the bound, and past a conformity factor of about two the tube's own limit inside its helix takes over.

05 · THE ENTRY GUIDE

THE LAST METRE HAS NO WALL. SO THE ENTRY GUIDE IS STRUCTURE.

Inside the bore the wall supports the tube. Between the drive and the ground nothing does, and a thin-walled tube in compression over an unsupported span is a column.

UNSUPPORTED SPAN	CRITICAL LOAD, EULER PINNED-PINNED, 38.1 × 3.2 MM TUBE
0.5 m	~425 kN
1.0 m	~106 kN
1.5 m	~47 kN
2.0 m	~27 kN

Critical load falls with the square of the span. Worked against the adopted push, the free-span limit is 1.74 m on the 38.10 mm tube and 2.79 m on the 50.80 mm tube, at slenderness ratios of 140 and 168, deep in the long-column range where Euler governs.

On a skid the entry guide sits flush with the frame end and the ground, so the span is short by construction. On a trailer it oversails the tailboard, the span is set by ride height and deck overhang, and it is checked for that configuration rather than inherited.

06 · THE REACTION

EVERY NEWTON PUSHED COMES BACK INTO THE FRAME.

The ground pushes back on the plant, and the load goes out through whatever holds the frame down. Self-weight alone does not hold it reliably; the two onboard anchors do.

TUBE LOAD	SURFACE PUSH	SELF-WEIGHT REACTION AT GROUND FRICTION 0.40	SHARE OF THE PUSH
Short	35.0 kN	27.64 kN	79.0 %
Medium	35.0 kN	30.55 kN	87.3 %
Long	40.7 kN	42.61 kN	104.7 %

Friction on a real pad is not a constant. Across a band from a wet clay pad at 0.20 to frozen or gravelled ground at 0.55, self-weight covers 39 % to 144 % of the push. Two reaction anchors at 25 kN each travel with the plant in every format, and with both counted the margin is 2.22× to 2.30× at friction 0.40. Anchoring, between deploy and bore, is a structural step.

The anchors are also what make the formats equivalent at the entry guide. Jacked rigid on its drop legs, a trailer bears on the ground for the duration of the bore, and its wheels, suspension and pintle-ring coupler are not in the reaction path. A skid has none of them to begin with, which makes it the most tolerant format.

07 · THE REEL AND THE FIBRE

THE DRUM IS SIZED FOR FATIGUE. THE FIBRE RIDES THE AXIS.

Core radius is set by the strain the tube takes every time it crosses the drum, and a fibre inside the tube takes the same bend. Where the fibre sits decides whether it survives its first spooling.

0.83 m
REEL CORE, 38.10 MM TUBE

1.11 m
REEL CORE, 50.80 MM TUBE

2.29 %
TUBE STRAIN CROSSING THE DRUM

14–15 %
REEL STRUCTURE, SHARE OF DRY MASS

Bending strain across the drum is the tube's outside diameter over twice the core radius, and the core that delivers fifty round trips of tube life, at 1.147 % strain amplitude, is 0.83 m on the 38.10 mm tube and 1.11 m on the 50.80 mm tube. Length beyond that goes into layers, so the reel structure stays at 14–15 % of dry mass. The tube is the heavy part and the consumable, and on a trailer the long tube load is carried on a 1.30 m drum: five layers and a 2.72 m outside diameter.

AT THE TUBE WALL

1.910 % TO 1.936 % STRAIN

A fibre strapped to, bonded into or resting against the wall takes that strain on every pass across the drum, and it fails.

ON THE AXIS

FIBRE-IN-METAL-TUBE ON CENTRALIZERS

Held on the tube axis, the fibre crosses the drum with no bending strain. Optical loss over the longest tube load is under 1.2 dB including two connectors.

Centring the fibre also sets the payload envelope. A rigid article has to pass beside the unit on the axis, so the largest slug is Ø12.7 mm in the 38.10 mm tube and Ø18.3 mm in the 50.80 mm tube: a slim sensor node travels down the tube, and anything with a body is carried by the head.

08 · MASS AND TRANSPORT

THE PLANT TRAVELS DRY. THE LUBE GOES IN ON SITE.

Package mass is built item by item against a load path, and the frame is built around the plant less its tube. The lube tank is filled after the plant is set down, in every format.

TUBE LOAD	PACKAGE DRY	PACKAGE OPERATING	PACKAGE LESS TUBE	REEL OUTSIDE DIAMETER, 0.70 M DRUM
Short	3,894 kg	7,044 kg	2,853 kg	1.97 m
Medium	4,636 kg	7,786 kg	2,910 kg	2.12 m
Long	7,709 kg	10,859 kg	3,683 kg	3.13 m

Operating mass is the dry package plus 3.0 m³ of lube, 3,150 kg, the same at every tube load. The frame is built around 2,853 kg to 3,683 kg. The short and medium loads are the same machine on the same tube, differing in consumable and reel diameter; the real break is the change to the 50.80 mm tube, which brings a larger straightener, clamp and reel core with it.

A skid is lifted dry, with a crane of 6.0 t to 11.8 t across the tube loads, and the pick is not an even four-way split because the reel end carries most of the weight. The air-deployable frame wraps the same plant in a shell, a frame, a sacrificial crush stage and a canopy under a fixed 7,500 kg gross-mass cap, and no pyrotechnics are used anywhere in its deployment chain.

09 · GUIDANCE

THERE IS NOTHING TO JAM BECAUSE THERE WAS NEVER A LINK.

Underground the fleet's no-radio, no-GPS doctrine is also a physical fact: rock and soil absorb a radio signal outright. The loop runs on a fibre inside the tube, with a person at the console for the whole run.

THE FIBRE

ATTITUDE UP, STEERING DOWN

Attitude sensing behind the head rides the fibre to the operator, and steering goes back down the same thread. Tier 2 of the fleet's guidance ladder.

THE ODOMETRY

DISTANCE FROM THE STROKE COUNT

The drive counts its own strokes, so distance along the bore comes out of the machine with no emission at all.

THE HOLD

STOP, HOLD, WAIT FOR A PERSON

On uncertain ground or a lost attitude read the drive stops and holds. If a run ends early the string stays exactly where it stopped.

DOCTRINE

NO RADIO. NO GPS. THE FIBRE IS THE LOOP.

Nothing in the plant transmits and nothing guides on a link. The crew of two or three stays on the surface, and nobody goes into the hole.

10 · CONFIGURATIONS

THREE WAYS TO THE ENTRY LINE. ONE PLANT WAITING AT THE END.

The carrier formats change how the plant arrives. The reel, the drive, the entry guide, the anchors and the guidance are the same in all three.

SKID

ONE STRUCTURE FROM ANCHOR TO ENTRY GUIDE

No suspension, no tire sidewall and no coupler between the anchor bolts and the entry guide, and no road weight or height ceiling of its own. Lifted dry by crane and set on the entry line; the most tolerant format.

TRAILER

ROAD-MOBILE, JACKED RIGID TO BORE

The drive is mounted to the deck rather than craned off it. Drop-leg jacks bridge the suspension for the bore, the coupler is a pintle ring, and the open span at the entry guide is checked for the trailer's geometry.

AIR-DEPLOYABLE

THE SAME PLANT IN A SHELL AND A CRUSH STAGE

Under a fixed 7,500 kg gross-mass cap, delivered dry, with a mechanical crush stage and no pyrotechnics in the deployment chain. Anchored and filled on site before the first stroke.

11 · DOCTRINE AND SAFETY

THE TUBE GOES INTO THE GROUND. PEOPLE AND SIGNALS STAY OUT.

The lines that hold on every CS-410, in every format and for every customer.

- ✓ Carriers, not munitions: no warhead, no fuze and no energetic material anywhere in the plant, the tube or the head.
- ✓ Nothing aboard transmits: attitude and steering ride a fibre inside the tube, and there is no radio and no GPS in any format.
- ✓ Human safety comes first: the crew stays on the surface, a person holds the loop for the whole run, and the drive stops and holds on uncertain ground or a lost attitude read.

THE CONVERSATION

BRING THE CROSSING.
WE BRING THE PLANT.

A first conversation needs what lies between the two ends: the crossing, the cover, what the ground investigation says, and what has to be left in the bore.

Start a screened enquiry at cdnshield.ca/enquiries.

DOCUMENT	CDN-PROD-SPC-010 · CS-410 · Specification sheet
REVISION	R1.0 · issued 2026-09-10
WEB VERSION	cdnshield.ca/systems/underground/spec-sheets/cs-410 · carries the current revision
RELATED SHEETS	Aquifer CS-411 · CS-425 · CS-430 · Trembler Line CS-435 · CS-460
ISSUED BY	Canadian Shield · cdnshield.ca