THE UNDERGROUND FAMILY

TREMBLER LINE CS-435

THE BURIED PICKET OF FIBRE-LINKED LISTENING NODES

A chain of buried CS-430 nodes on one fibre trunk that detects, localizes and cues a person, with nothing radiated and nothing to jam.

3+
NODES HEAR ONE EVENT FOR A POSITION SOLVE

Tens of metres
NODE INTERVAL, SURVEY-SET PER SITE

Seconds-class
DETECT TO CUE, NODE TO HEAD-END OVER FIBRE

Sub-metre
AS-BUILT SURVEY OF EVERY NODE POSITION

Years-class
BURIED NODE BATTERY, THE CS-430 BASELINE

AT A GLANCE

A PICKET MADE OF BURIED NODES. A PERSON AT THE END OF THE WIRE.

Five figures describe the line. Four reasons explain why a buyer lets it stand the watch.

THE LINE STANDS THE WATCH

NOBODY WALKS OUT TO RELIEVE A POST

The most exposed minute of a standing post is the walk to relieve it. The line stands the watch buried and silent instead, so the one moment that still needs a person is the one that matters: the confirmation before anything moves.

NOTHING RADIATED

EVERY BYTE RIDES THE BURIED TRUNK

Nodes report node to node over a dark-fibre trunk to one monitored head-end. There is no radio and no GNSS anywhere in the system, so there is no spectrum in the loop to jam, and a cut announces itself because the link dies loudly.

THE MISSION SETS THE DENSITY

SPACING FOLLOWS THE QUIETEST TARGET

Node spacing is set by the quietest source the line must catch and by whether a position is needed as well as a detection. A line specified for tunnelling alone is several times sparser than one specified to catch a person walking, and the survey settles it with the buyer.

A PERSON DECIDES

DETECT, LOCALIZE, CUE, AND NOTHING MORE

The line's whole output is information: a track, a confidence and a proposed interpose point for a person at the console. A confirmed cue can task a staged CS-425 to block the path, and no strike authority exists anywhere in the loop.

IN THIS SHEET

01 · SPECIFICATION

SYSTEM, LINK, SENSING AND LAYOUT. EACH ENTRY BESIDE ITS BASIS.

The product specification and the systems engineering behind it, grouped the way an integration lead reads a buried detection network: the system, the link, what it hears and how it places it, how it is laid out and powered, and what it hands a person.

01 THE SYSTEM

PARAMETER	VALUE	BASIS
System	Chained CS-430 sensor nodes on a dark-fibre trunk to one monitored head-end	the product specification table
Segments	Node · link · fusion · response	the system architecture
Network topology	Fibre trunk, node to node, single monitored head-end	the product specification table
Where the computing sits	At the head-end; the nodes stay simple and low-power	the station is upgraded without digging anything up
Node emplacement	Surveyed and buried on the group's horizontal-directional-drilling locate discipline	the product specification table

02 LINK AND TIMING

PARAMETER	VALUE	BASIS
Emissions, any tier	None: no radio, no GNSS anywhere in the system	the product specification table
Up the trunk	Event triggers with short buffered waveform windows	raw waveforms are never streamed, which is what keeps a node's power low
Down the trunk	Configuration and health polls	the node-to-string interface
Shared clock	Disciplined time distributed over the wire	a position solve needs one clock across the whole line
Cut detection	Intrinsic: a cut link is its own alarm	the trunk doubles as a tamper alarm
Survivability option	Dual-headed line: survives one cut with full coverage, with a second head-end	a layout choice taken with the customer
The one emitter	Calibration thumper, a known-source maintenance tool	used to calibrate the line, not part of the watch

03 SENSING AND LOCALIZATION

PARAMETER	VALUE	BASIS
Target classes	Digging · tunnelling · footsteps · vehicles	the product specification
Localization	Coarse bearing and approximate range from the arrival-time pattern	the product specification table
Position solve	Arrival-time differences across 3+ nodes	the localization principle
Calibration	In situ, from known sources at surveyed points; builds the velocity model the solve depends on	the emplacement sequence
Cross-line localization	Bought with layout: offset or staggered strings	a straight line localizes well along itself and poorly across it
Cue content	Interpose point · heading estimate · confidence	what crosses from the head-end to the console
Detect-to-cue latency	Seconds-class, node to head-end over fibre	the product specification table

04 COVERAGE AND LAYOUT

PARAMETER	VALUE	BASIS
Node spacing	Interval class, survey-set per site; tens of metres per node	the product specification table
Spacing for detection	No more than twice the per-node detection radius	coverage geometry, at the radius of the quietest source the line must catch
Spacing for localization	About one detection radius, so one event reaches 3+ nodes	coverage geometry
Sizing class	The quietest source the line must catch	footsteps set the densest line; vehicles and tunnelling are caught at footstep spacing
Layouts	Single straight string · two offset strings · zig-zag or staggered	the topology options
As-built node position	Surveyed to sub-metre class	every position solve starts from the node coordinates

05 POWER

PARAMETER	VALUE	BASIS
Node endurance	Years-class buried battery, tied to the CS-430 baseline	the product specification table
Power model	Buried long-life battery per node; head-end on field or mains power	the product specification table

PARAMETER	VALUE	BASIS
Line power option	Tether tap or conductors where the string rides a bored conduit	removes the battery constraint where it is available

06 EMPLACEMENT

PARAMETER	VALUE	BASIS
Bored emplacement	Nodes at depth along a conduit laid by CS-410; surface undisturbed	emplacement mode: covert, deep and weather-proof
Shallow emplacement	Hand or auger burial at tens of centimetres, with trenched or surface-run fibre	emplacement mode: needs no other platform; the trench is itself a signature
Coupling check	Each node set and checked against a standard test source; a badly coupled node is re-set	the emplacement requirement: coupling is a first-order signal consequence

07 RESPONSE AND CLASSIFICATION

PARAMETER	VALUE	BASIS
Response	Cues a staged CS-425 to move to an interpose position; never strikes	the product specification table
Human decision	A person reviews every cue and only a person tasks the response	the product specification
Strike authority	None anywhere in the loop: detect, localize, cue only	the product specification table
Autonomous physical response	None exists in the system	the fusion chain ends at a proposal to a person
Munitions classification	No warhead, fuze or energetic material anywhere in the system	the product specification table
Patent status	Patent pending	the product specification table
Export control	Export-controlled; international transfer subject to Canadian government permits; counsel first	the product specification table

02 · THE SYSTEM

FOUR SEGMENTS ON ONE BURIED STRAND. THE PRODUCT IS WHAT THEY SAY TOGETHER.

Every other program in the Underground family is a machine. The Trembler Line is four segments and the discipline that joins them, and its product is what the chain reports together rather than what any one node hears.

NODE

THE BURIED LISTENERS

Passive CS-430 seismic and acoustic nodes, emplaced at survey-set intervals and left still. They are the only hardware in the system that senses.

LINK

ONE BURIED STRAND

Node-to-node fibre carrying the event data up the line, a shared clock for the position solve, and configuration and health down it. No radio anywhere.

FUSION

THE HEAD-END

Coincidence across nodes, classification, the position solve and the operator console, at one monitored end of the trunk. This is where triggers become a track.

RESPONSE

A CUE, AND A PERSON

An interpose point, a heading and a confidence, offered to a person at the console. Detect, localize and cue is the whole of the system's output.

The architecture puts the cost where it can be recovered. Computing lives at the head-end rather than in the ground, so the nodes stay simple and low-power and the station that reads them is replaced or upgraded without digging anything up. The interface between a node and the string, carrying fibre in and out, timing, data, power and pass-through on a failed node, is the one that turns node revisions, string lengths and layouts into configurations rather than redesigns.

The line adds no new sensor and no new machine. CS-430 supplies the buried ear and CS-425 the legs that move on a confirmed cue. The system's own engineering is the fibre network, the localization logic that ties the two together, and the rule that keeps a person deciding.

03 · THE LINK

EVERY BYTE RIDES THE BURIED TRUNK. A CUT ANNOUNCES ITSELF.

The fleet's premise is that the link is the vulnerability, so this system carries no spectrum in the loop at all.

No radio and no GNSS appear anywhere in the network, and under ground that costs nothing to hold. A wired line also solves what a radio network would struggle with: a position solve needs the same clock at every node along the picket, and disciplined time distribution over a wire is ordinary engineering. The one emitter in the system is the calibration thumper, a known-source tool used to set the velocity model, and it is maintenance equipment rather than part of the watch.

A cut is loud. Link death is its own alarm, so tamper detection is intrinsic to the trunk rather than a sensor added to it. How much of the picket survives a cut is a layout decision taken with the customer: a dual-headed line survives one cut with full coverage and pays for it with a second head-end, and a node that passes traffic through when it fails degrades the picket instead of blinding it.

> DOCTRINE
>
> **NO RADIO. NO GPS. NOTHING RADIATED, NOTHING TO JAM.**
>
> Human safety comes first, on every line. The line stands the watch a person would otherwise walk, its output is information for a person, and there is no warhead, fuze or energetic material anywhere in the system and no strike authority anywhere in the loop.

04 · WHAT THE GROUND CARRIES

FOUR SOURCES, FOUR SIGNATURES. THE QUIETEST ONE SIZES THE LINE.

Digging, tunnelling, footsteps and vehicles are different signals, and the array hears each of them differently.

SOURCE CLASS	SIGNAL CHARACTER	WHAT IT MEANS FOR THE LINE
Footsteps and personnel	Impulsive, low-energy ground-contact transients; short range and strongly ground-dependent	The quietest class: it sets node spacing and so the node count
Hand digging	Repetitive tool-on-soil strikes with a distinctive rhythm, more energetic than footsteps	Periodicity is hard for nature to fake, which gives the classifier a distinctive signature
Machine tunnelling	Continuous machinery tones over broadband ground working; the most energetic and most persistent source	Persistent enough to track into a heading over hours: the case the array is soundest for
Vehicles on the surface	Continuous broadband with engine harmonics coupled through wheels or tracks; high energy	Rarely the class that sizes a line

Seismic amplitude falls with spreading and again with absorption in the soil, and absorption climbs with frequency, so every detection radius moves with the site's ground and noise. That is why no range is quoted as a catalogue figure: the survey measures what this ground carries before the layout is drawn.

05 · SPACING

NAME THE QUIETEST TARGET. THE NODE COUNT FOLLOWS FROM IT.

Detection alone needs the nodes no more than two detection radii apart. A position needs the same event on three or more nodes, which brings them to about one radius.

Both rules are read at the radius of the weakest source the line must catch, so footsteps, the quietest named class, set the density. Vehicles and machine tunnelling are caught at footstep spacing without adding a node. A line specified only for tunnelling or vehicles can be several times sparser, which makes the mission statement the sizing decision and puts that trade in front of the buyer at the start rather than inside the engineering.

Spacing is therefore an output of the site survey, not a catalogue number. The product specification carries it as an interval class, survey-set per site, of tens of metres per node. A dense line is only sensible if each node stays simple, so the computing sits at the head-end and the node stays a moulded housing with a bought-in sensing element.

06 · LAYOUT

ALONG THE LINE IS EASY. ACROSS THE LINE IS BOUGHT WITH LAYOUT.

A linear array places a source well along its own length and poorly across it. Where cross-line localization matters, the answer is geometry rather than a better sensor.

SINGLE STRING

THE BASELINE PICKET

The simplest layout and the weakest off-axis. The solve says where along the fence an event is, and only coarsely how far out.

TWO OFFSET STRINGS

A LOCALIZATION FENCE

Cross-line observability bought outright, paid for in nodes and in bore length. Where the cue has to name an interpose point ahead of a heading, this is the layout that makes the point worth naming.

ZIG-ZAG OR STAGGERED

THE COMPROMISE

One bore path with part of the cross-line gain. Short perpendicular stubs do the same work where the approach is already known.

The design centre of this system is the array rather than the node. A modest sensor in a well-coupled, well-timed and well-laid array outperforms an excellent sensor strung badly: geometry buys localization, and density sets the detection floor.

07 · EMPLACEMENT

WHERE THE SYSTEM STOPS BEING SOFTWARE. COUPLING AND COORDINATES ARE SET ONCE.

How well each node is coupled and how well its position is known are first-order performance items, and both are bought at the install.

Laid by bore. A CS-410 lays the conduit and the fibre, and the nodes are emplaced at depth along the bore. The surface stays undisturbed, the conduit is the fibre path, and it can carry a tether tap for power and backhaul. A deep node hears deep tunnelling better than a shallow one does.

Buried shallow. Hand or auger burial at tens of centimetres with trenched or surface-run fibre. It needs no other platform, the trench is itself a signature during the install, and a shallow node hears footsteps better, and deep tunnelling worse, than a deep one.

Each node is coupled and checked against a standard test source, and a badly coupled node is re-set rather than corrected in software. As-built node positions are surveyed to sub-metre class, because every position solve starts from the coordinates it is given. In-situ calibration from known sources at surveyed points builds the velocity model the line depends on.

08 · THE FUSION CHAIN

ONE NODE TRIGGERING IS A HEALTH EVENT. SEVERAL AGREEING IS AN ALARM.

A picket that alarms on rain and frost is a fence nobody watches, so the chain is built around agreement between nodes rather than sensitivity at any one of them.

AT THE NODE

TRIGGER, THEN A SHORT WINDOW

A low-power detector runs in the ground and sends triggers with short buffered waveform windows up the fibre. The line never streams raw waveforms, and that choice sets each node's power budget.

AT THE HEAD-END

COINCIDENCE, CLASS, POSITION

Triggers are correlated across nodes, classified against a library and solved for position on confirmed events. A single-node trigger is treated as a health event, not an alarm.

AT THE CONSOLE

TRACK, CONFIDENCE, HISTORY

A confirmed, classified, localized event becomes a track with its confidence and its history, and a cue proposal beside it. A person takes it or leaves it.

Coincidence across nodes is the first and best false-alarm filter: a real source moves plausibly and shows up on its neighbours, while a sensor fault or a patch of local noise does not. The library carries reject classes alongside the target ones, rain, thunder, traffic, trains, animals and frost action, and those reject classes are won with data from the site itself. A fixed line in fixed ground is well placed to collect it. The head-end is designed to learn each node's normal daily and seasonal rhythm, grow the library with every labelled event and keep a per-node ledger of trigger-rate drift, sensitivity against calibration thumps and battery draw-down, so nodes are revisited on data rather than on failure.

09 · THE CUE

SLOW THREATS GET AN INTERPOSE. FAST ONES GET AN ALARM AND A TRACK.

Transport along the fibre is negligible and detect-to-cue is seconds-class. The timeline that matters is confirmation and the person, and against the target set it decides what a cue can be.

MACHINE TUNNELLING

ADVANCES SLOWLY, PERSISTS FOR HOURS

The cue timeline is generous and the source can be tracked into a heading. This is the interpose mission.

A PERSON ON FOOT

CROSSES A DETECTION RADIUS QUICKLY

Detection and tracking hold up; a physical response inside that window is credible only with a responder already staged nearby. Alarm and track is the product for this class.

A VEHICLE

FASTER STILL

Alarm and track. The line reports it, times it and places it, and nothing in the loop pretends a physical response can be put in its path.

That split, interpose for slow subterranean threats and alarm and track for fast surface ones, follows from how fast each threat moves rather than from a preference. What crosses to the console is an interpose point, a heading estimate and a confidence. A person takes it or leaves it, and a confirmed cue tasks a CS-425 already staged near the line to move ahead of the intrusion path. It blocks the way. It does not strike, nothing upstream of it has the authority to order one, and no autonomous physical response path exists in the system.

10 · CONFIGURATIONS

ONE SET OF HARDWARE. FOUR MISSIONS LAID FROM IT.

The array is the envelope and the mission is the variant: the same nodes and the same fibre, laid out and tuned to what the line must catch.

PERIMETER PICKET

FOOTSTEP-DENSITY LINE

Spaced for the quietest class, so a person on foot is caught and everything louder comes free. The densest configuration, for a walked perimeter being replaced.

ANTI-TUNNELLING LINE

A SPARSE LONG LINE

Spaced for machine tunnelling, the persistent source the array tracks best. Several times sparser than a footstep line over the same length.

LOCALIZATION FENCE

TWO OFFSET STRINGS

Cross-line observability bought with a second string, where the cue has to name an interpose point ahead of a heading rather than only a place along the fence.

CIVIL RIGHT-OF-WAY

THE SAME NODES, A DIFFERENT LIBRARY

Pipeline leak and seismic monitoring and third-party strike detection along a buried right-of-way, on the same nodes and fibre with a different classification library.

11 · DOCTRINE AND SAFETY

IT DETECTS, LOCALIZES AND CUES. NOTHING IN THE LOOP CAN ORDER A STRIKE.

The lines that hold in every layout, in every ground and for every customer.

- ✓ Carriers, not munitions: there is no warhead, no fuze and no energetic material anywhere in the Trembler Line CS-435, and no strike authority anywhere in the loop.
- ✓ Nothing in the system transmits by radio and nothing navigates on a satellite signal. Every byte rides the buried fibre trunk, and the only emitter is the calibration thumper, a maintenance tool.
- ✓ Human safety comes first, on every line. The line stands the watch a person would otherwise walk, a person decides every response, and no autonomous physical response path exists.

THE CONVERSATION

NAME THE LINE AND THE QUIETEST THREAT. THE LAYOUT FOLLOWS FROM BOTH.

A first conversation needs the length and ground of the line, the quietest source it must catch, whether a responder is staged or a person is alerted, and whether the surface may be disturbed at the install.

Start a screened enquiry at cdnshield.ca/enquiries.

DOCUMENT	CDN-PROD-SPC-014 · Trembler Line CS-435 · Specification sheet
REVISION	R1.0 · issued 2026-09-10
WEB VERSION	cdnshield.ca/systems/underground/spec-sheets/cs-435 · carries the current revision
RELATED SHEETS	CS-410 · Aquifer CS-411 · CS-425 · CS-430 · CS-460
ISSUED BY	Canadian Shield · cdnshield.ca