

LASSO

Two-prong main-rope capture

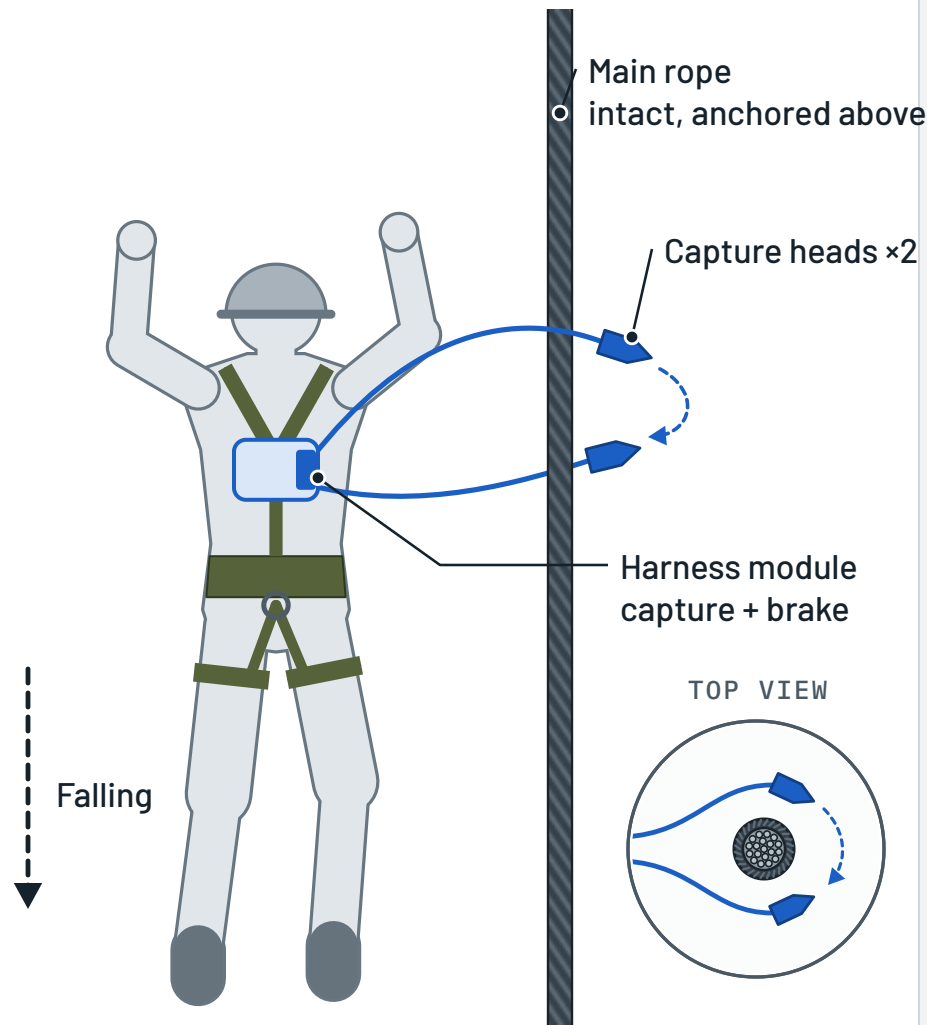
PRIORITY

FAILURE
ADDRESSED

Exploratory

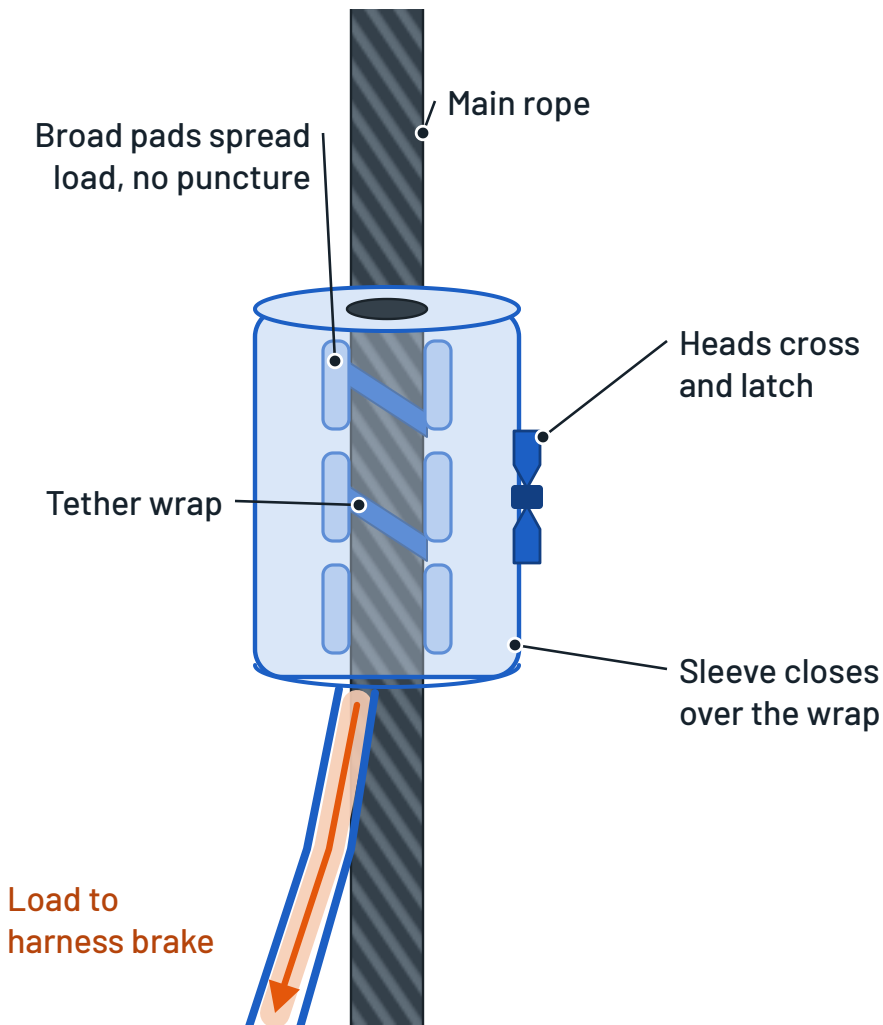
Loss of primary control or attachment while an intact, anchored main rope remains within capture range.

A Heads deploy around the rope



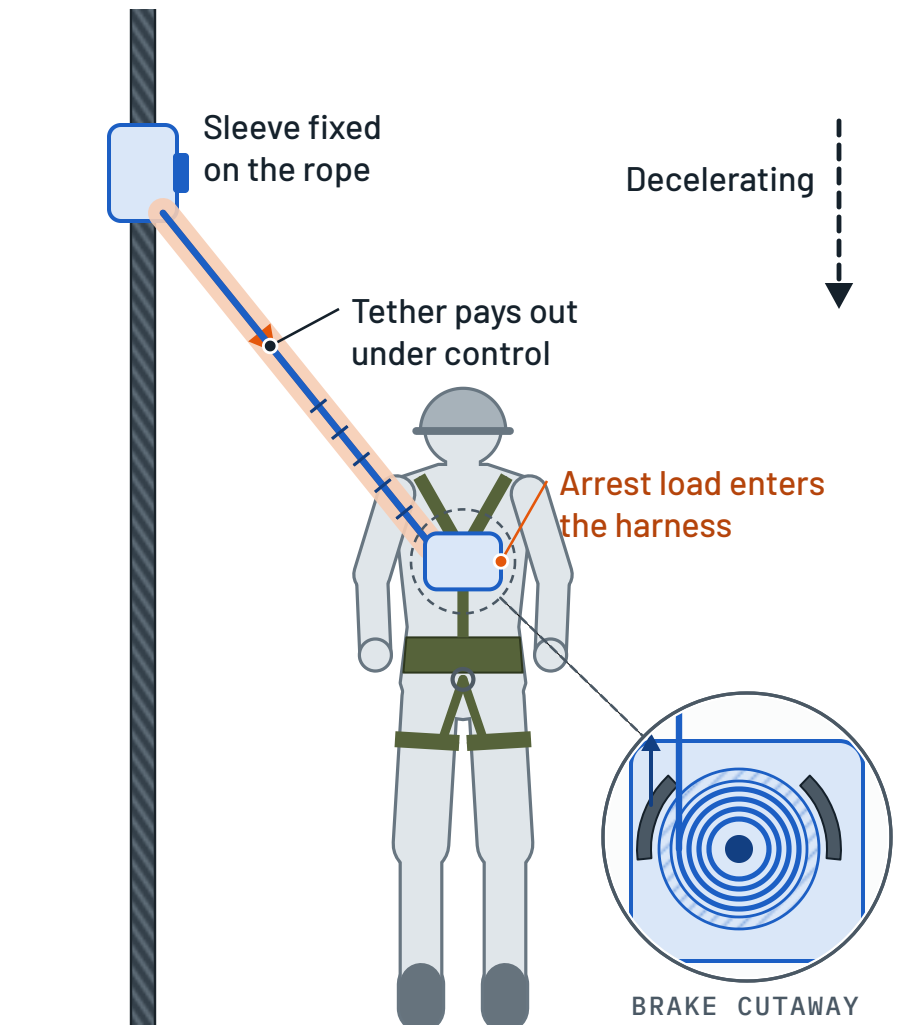
The operator separates from the primary descender but stays within capture range. Two tethered heads launch from the harness module to opposite sides of the main rope.

B Wrap retained by a closing sleeve



The heads cross and latch, the tethers wrap the rope, and an integrated sleeve closes over the wrap to grip under downward load without puncturing the rope.

C Harness brake pays out tether



With the grip established, the harness-mounted brake pays out tether under control, decelerating the operator, then holds the load for recovery.

DECISIVE UNKNOWN

Whether a free-deploying wrap can repeatedly become a load-bearing grip during rotation, misalignment, or partial capture. A visually successful wrap is insufficient evidence.

- Main rope
- Arrest load path
- Concept hardware
- Motion

SLEEVE

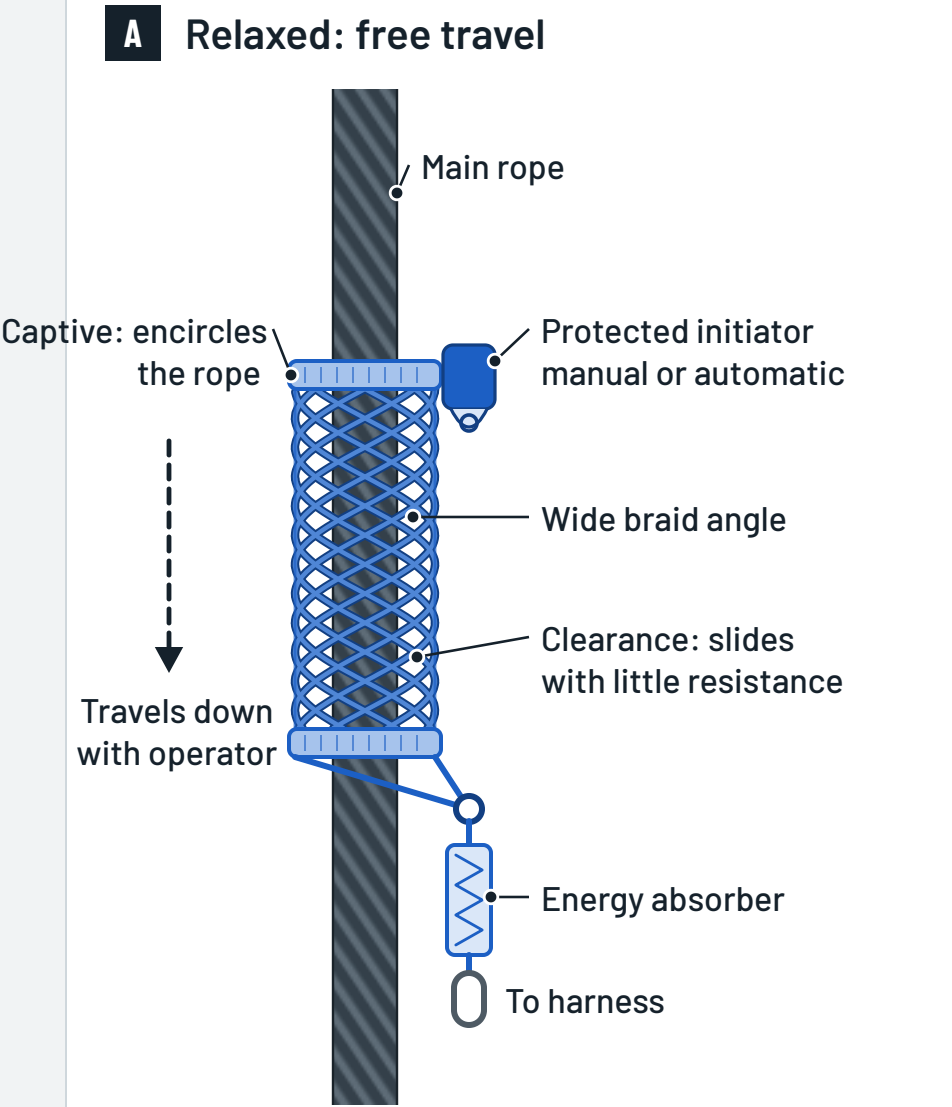
A contracting textile brake

PRIORITY

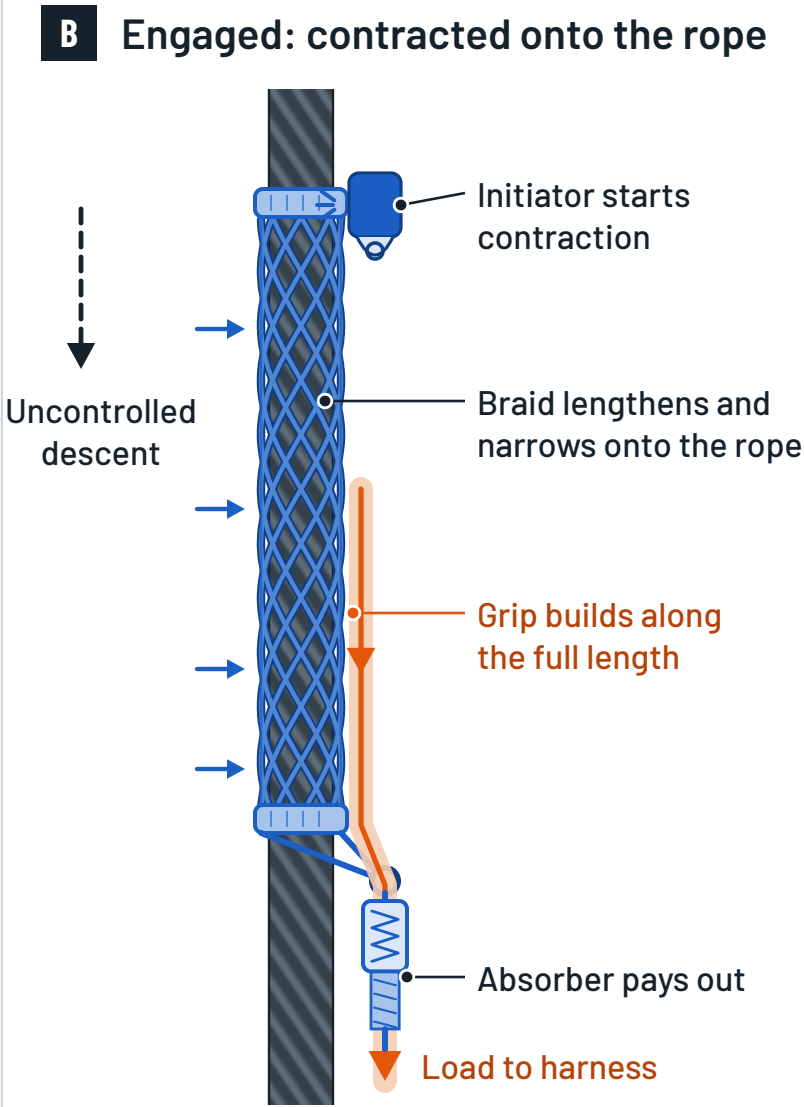
FAILURE
ADDRESSED

First

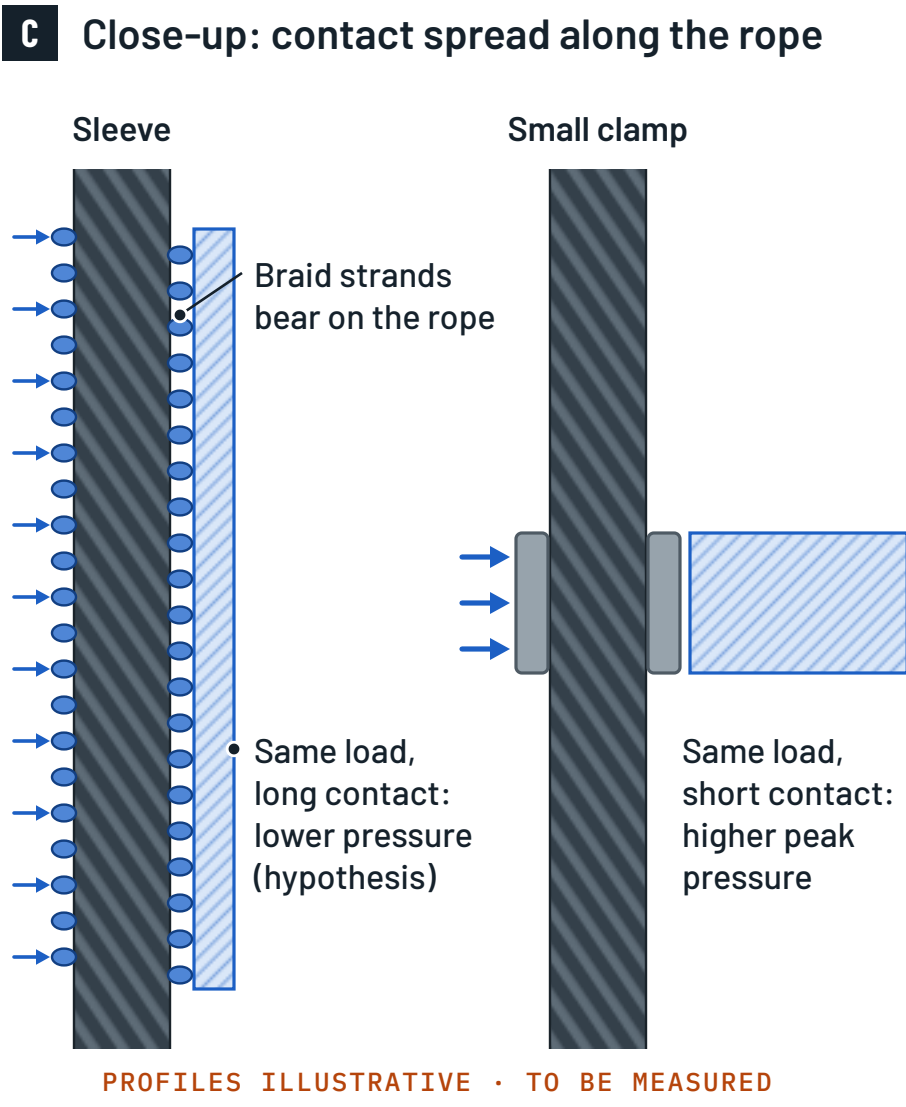
Loss of grip or primary descent control while the sleeve remains correctly positioned on the rope.



In normal descent the wide-angle braid leaves clearance, so the captive sleeve follows the operator down the rope with little resistance.



A protected initiator starts contraction; the operator's load then lengthens the braid, shrinking its diameter so grip builds. A separate absorber manages the catch.



Potential benefit: the same grip spread over a long contact length instead of one small clamp face. The real pressure profile must be measured.

DECISIVE UNKNOWN

Predictable engagement and holding across rope construction, wear, water, grit, and contamination. Jamming, heat, and rope damage are central test questions.

Main rope
Concept hardware
Arrest load path
Motion

GOVERNOR

A mechanical overspeed brake

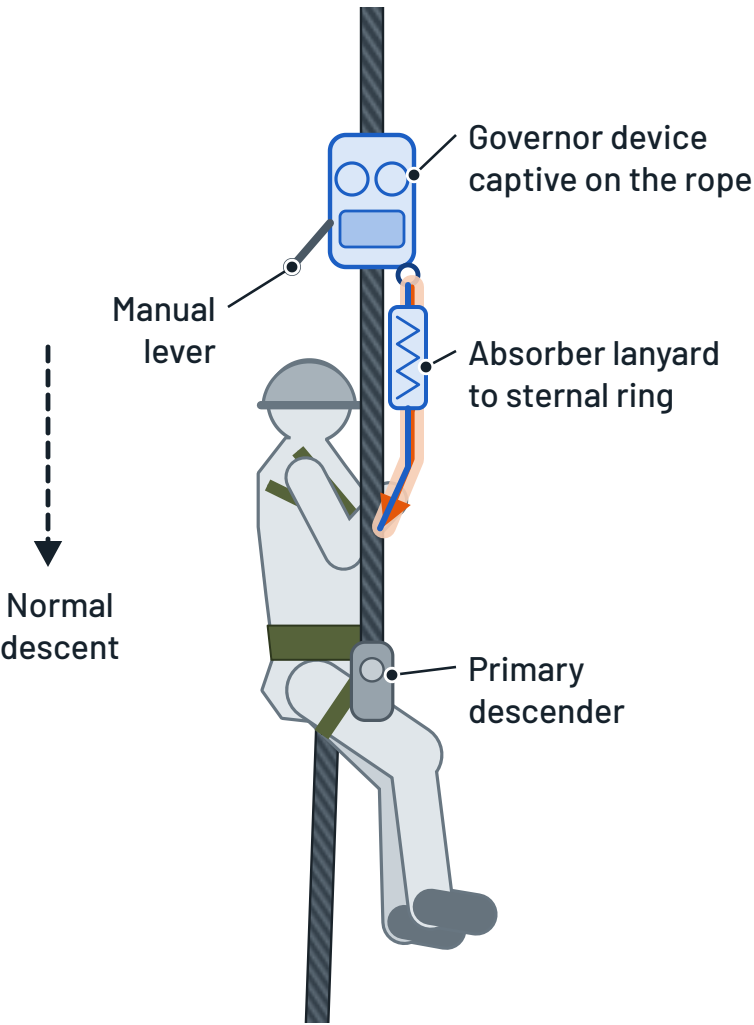
PRIORITY

First

FAILURE
ADDRESSED

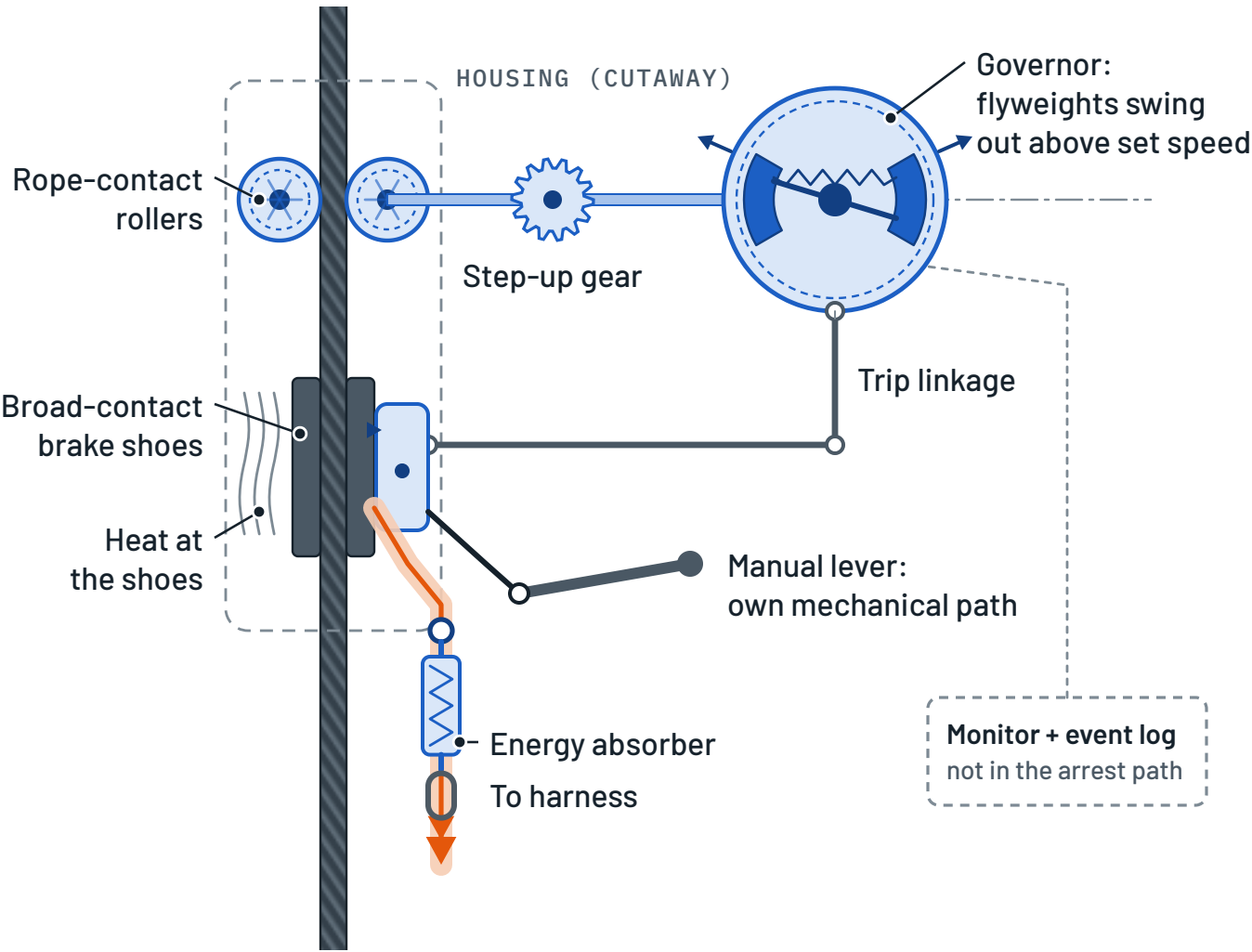
Uncontrolled acceleration or excessive descent speed,
including cases where the operator cannot act.

A Rides the main rope



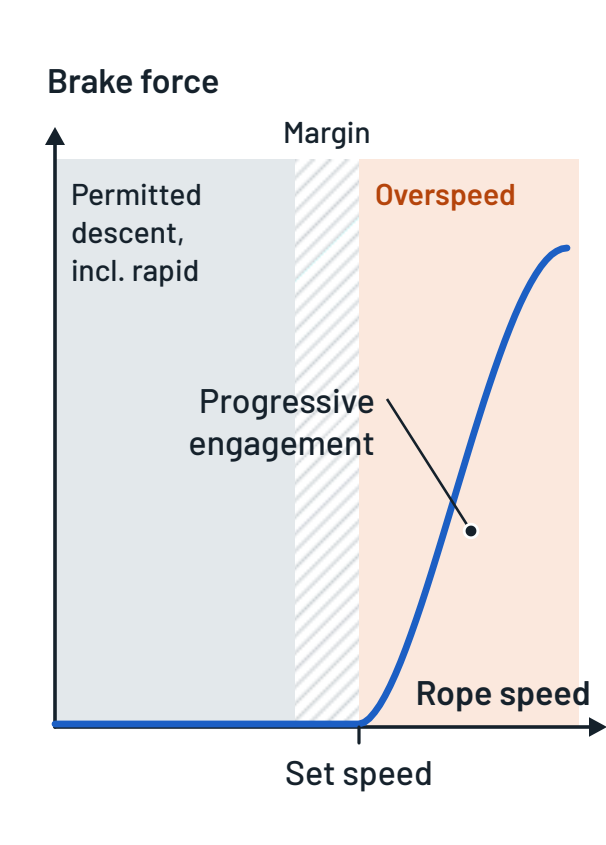
The captive device rides the main rope above the primary descender; an absorber lanyard ties it to the harness.

B Exploded cutaway: rope to harness



Rope movement drives the rollers; above the set speed the governor trips the progressive brake. The manual lever reaches the brake by its own mechanical path; electronics only monitor and log.

C Response to rope speed



Regulating an ordinary descent does not show the device can catch an established fall.

No braking within the tested range; above the set speed, braking rises progressively.

DECISIVE UNKNOWN

Maintaining traction without damaging the rope, rejecting permitted rapid descents, and controlling heat during braking.

- Main rope
- Arrest load path
- Concept hardware
- Motion

CLASP

A close-range capture clamp

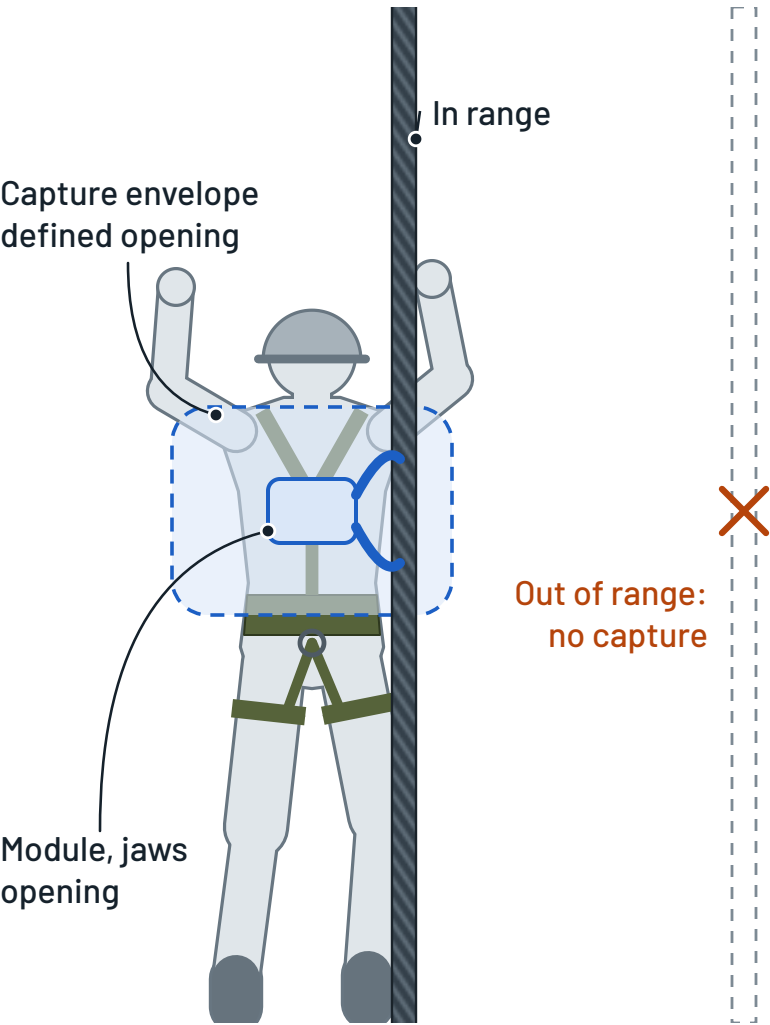
PRIORITY

FAILURE
ADDRESSED

Second

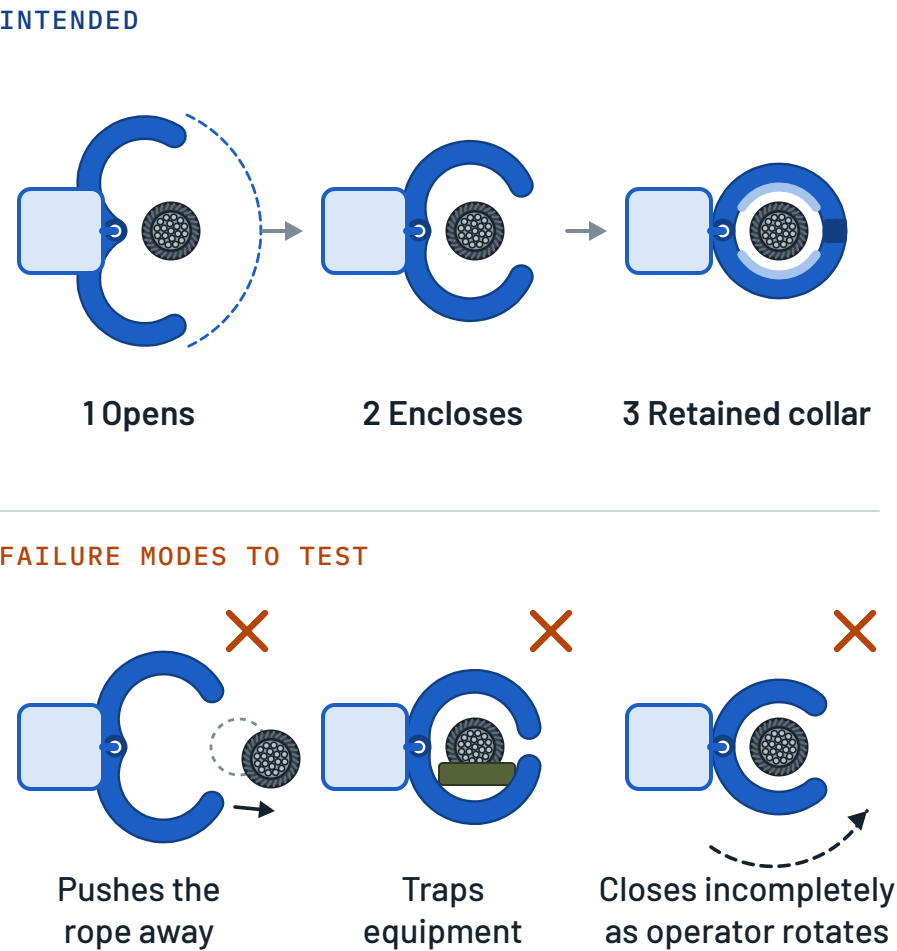
Loss of control or primary attachment while the rope remains close to the capture module.

A Front view: capture envelope



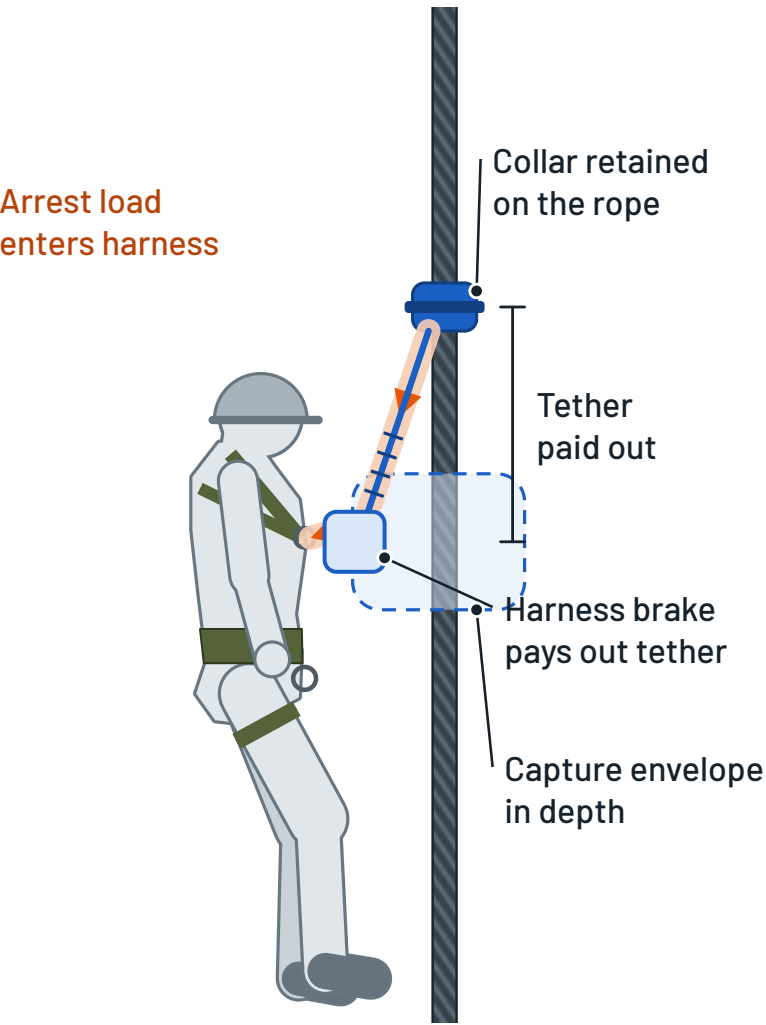
The rope must pass within the module's defined capture opening. A rope outside the envelope cannot be captured: the concept trades reach for a constrained motion.

B Top view: closure sequence



Intended: open, enclose, close into a retained collar with broad pads. The failure modes below are the decisive test cases, not solved problems.

C Side view: collar holds, tether pays out



After capture the collar holds on the rope while a short tether pays out from the harness brake, decelerating the operator before it holds the load.

DECISIVE UNKNOWN

Whether the closure can engage without pushing the rope away, trapping equipment, or closing incompletely as the operator rotates.

- Main rope
- Concept hardware
- Arrest load path
- Motion

WAYPOINT

A rope with engineered arrest stations

PRIORITY

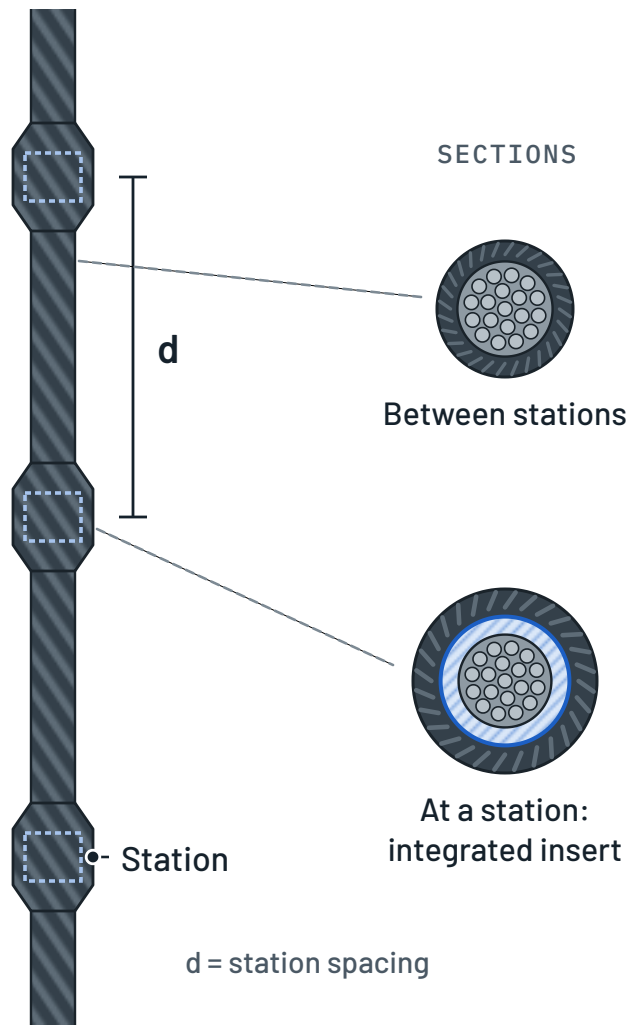
FAILURE

ADDRESSED

Dedicated-system research

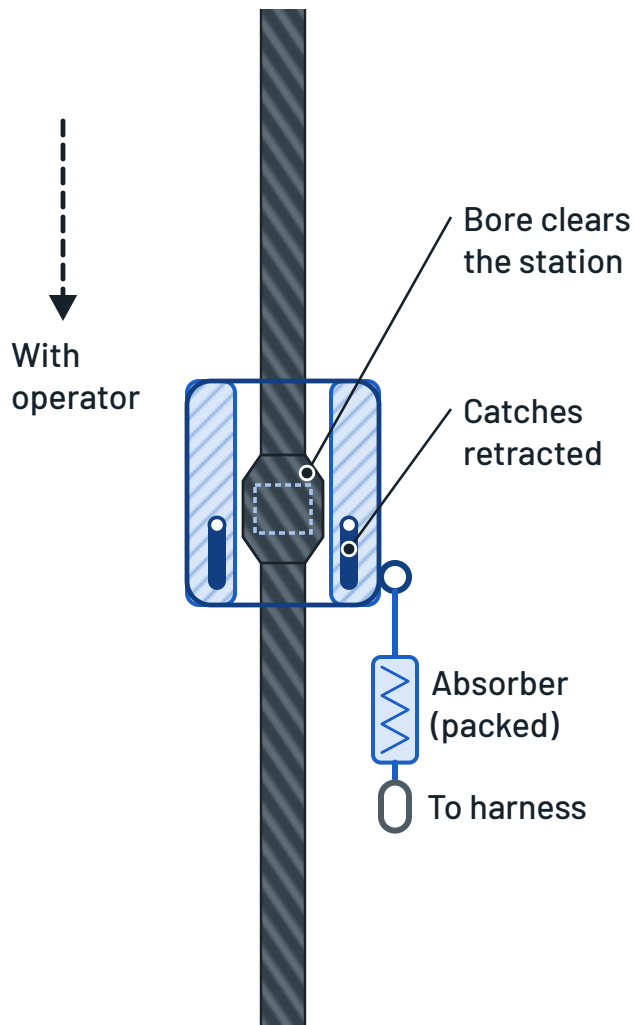
Loss of descent control on a dedicated rope system whose follower remains attached.

A Purpose-built rope and stations



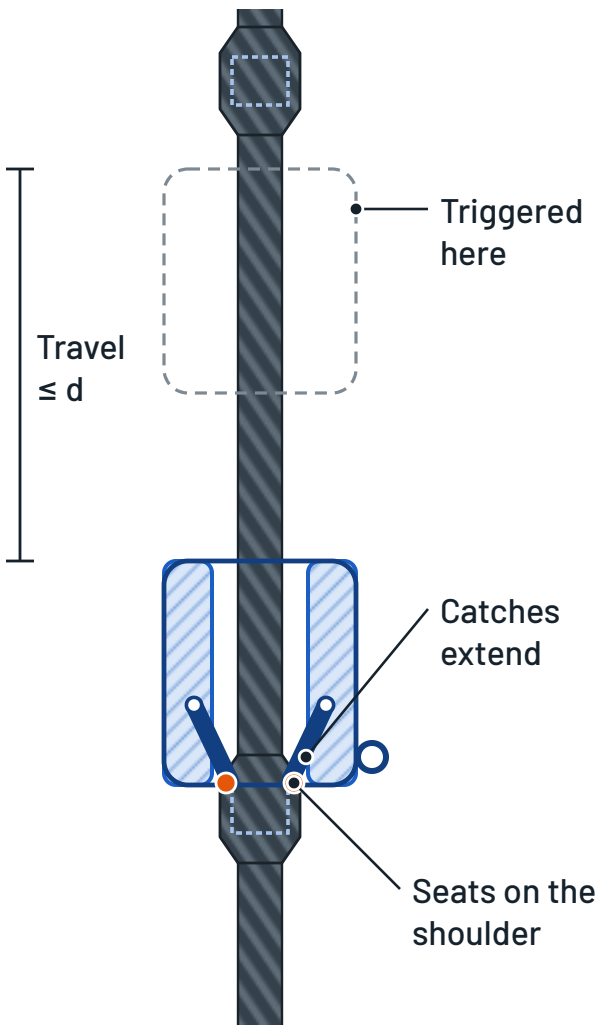
Load-transfer stations are made into the rope during manufacture. Knots or clip-on collars would not demonstrate the concept's structural performance.

B Follower passes a station



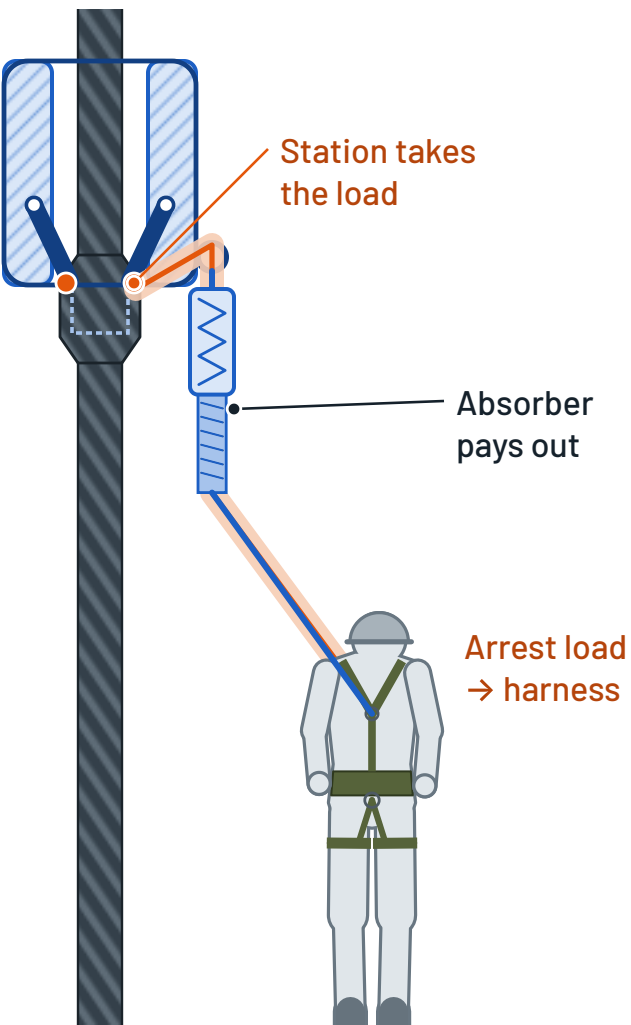
In normal descent the catches stay retracted, so each station passes through the bore.

C Engages the next station



A manual command or automatic trigger extends the catches; the follower travels on and seats on the next station.

D Load into the absorber



The station carries the load into the rope while the absorber pays out; spacing and deployment set the clearance.

DECISIVE UNKNOWN

Preserving rope strength, flexibility, handling, and compatibility with other equipment. Station spacing also affects travel before engagement and required clearance.

- Main rope
- Concept hardware
- Arrest load path
- Motion

BELAY

Automatic ground intervention

PRIORITY

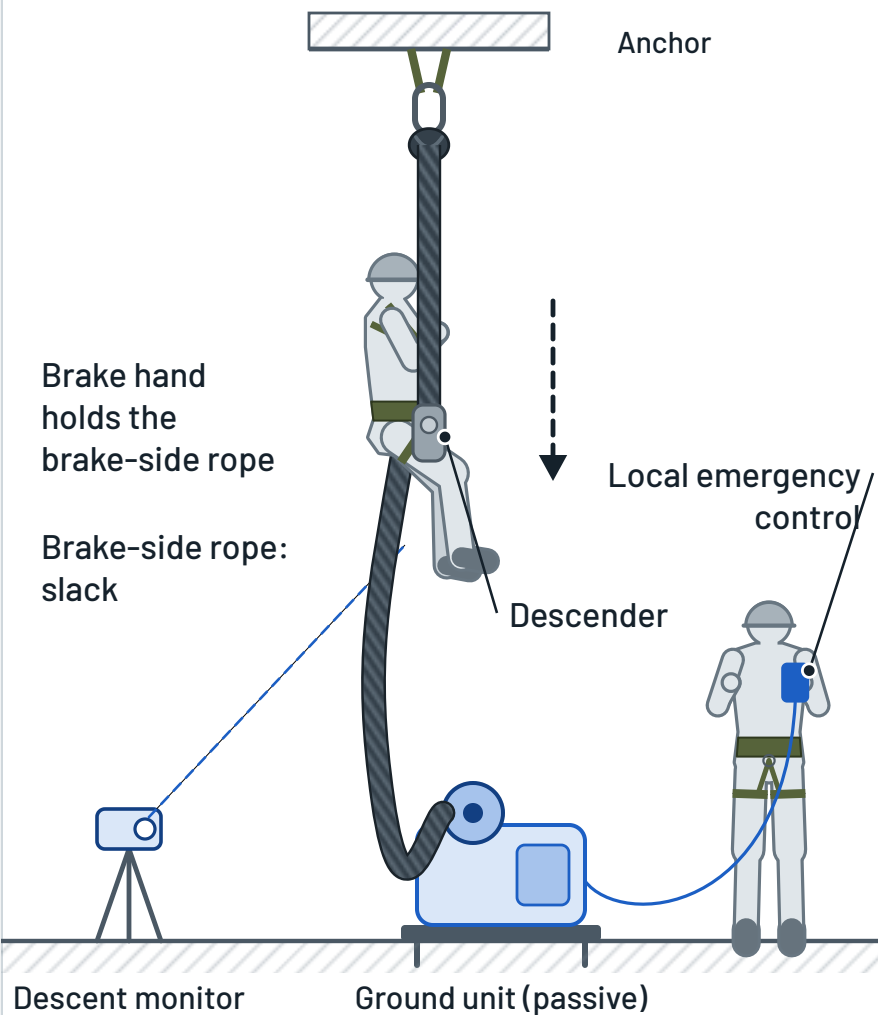
FAILURE

ADDRESSED

Application-specific

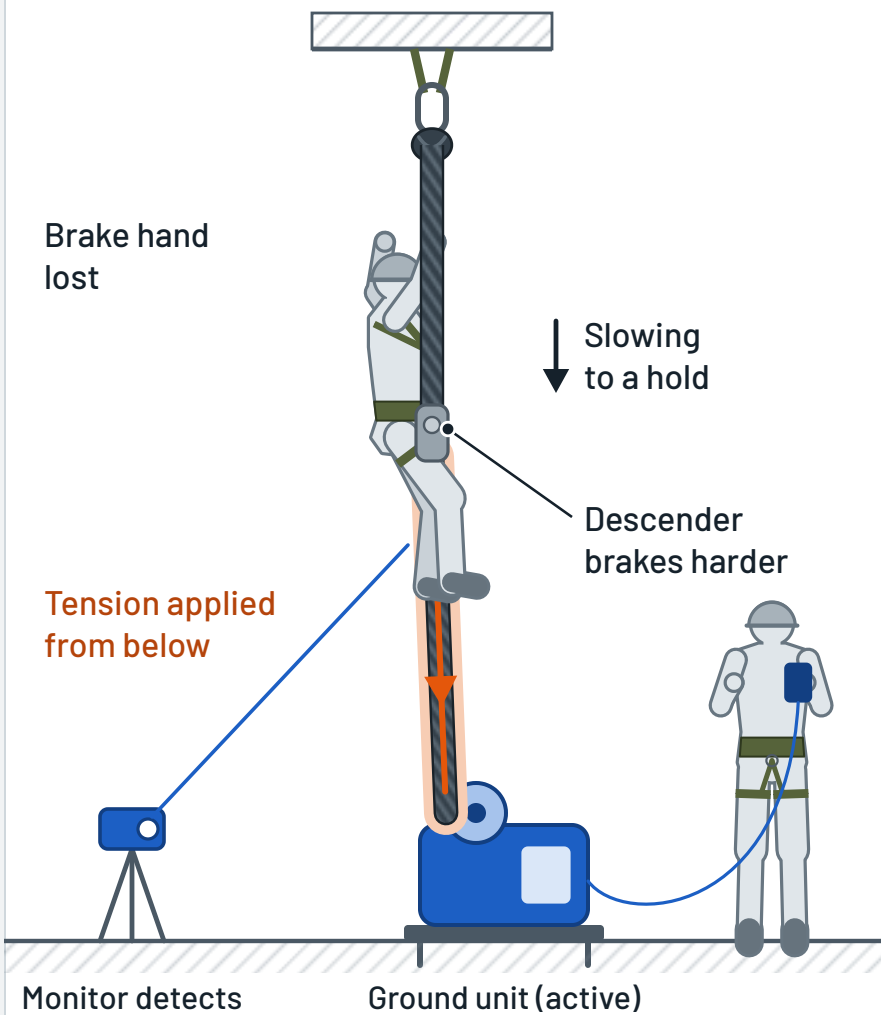
Loss of brake-hand control in a compatible harnessed rappel.

A Normal descent: unit passive



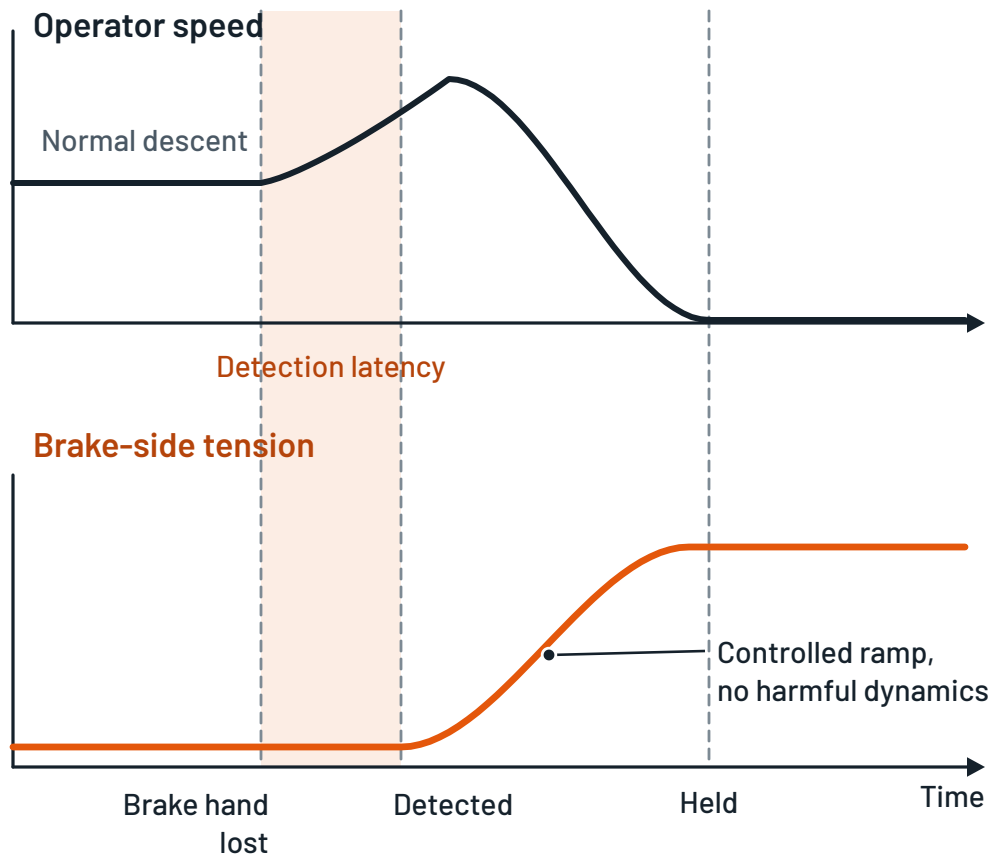
The operator controls the brake-side rope by hand. The ground unit stays slack and passive while the monitor watches the descent.

B Brake hand lost: unit tensions rope



The ground unit tensions the brake-side rope below the descender to increase braking. Needs a compatible descender; not for unattached fast-ropeing.

C Detection-to-hold timeline



Ordinary descents, including fast ones, must not trigger an intervention.

The intervention depends on fast, reliable detection and a tension ramp that slows the operator without harmful rope dynamics. Qualitative: no values implied.

DECISIVE UNKNOWN

Detecting trouble and applying appropriate tension quickly without disrupting ordinary descents or introducing harmful rope dynamics.

Main rope

Applied tension

Concept hardware

Motion

RECOVER

Arrest followed by deliberate rescue

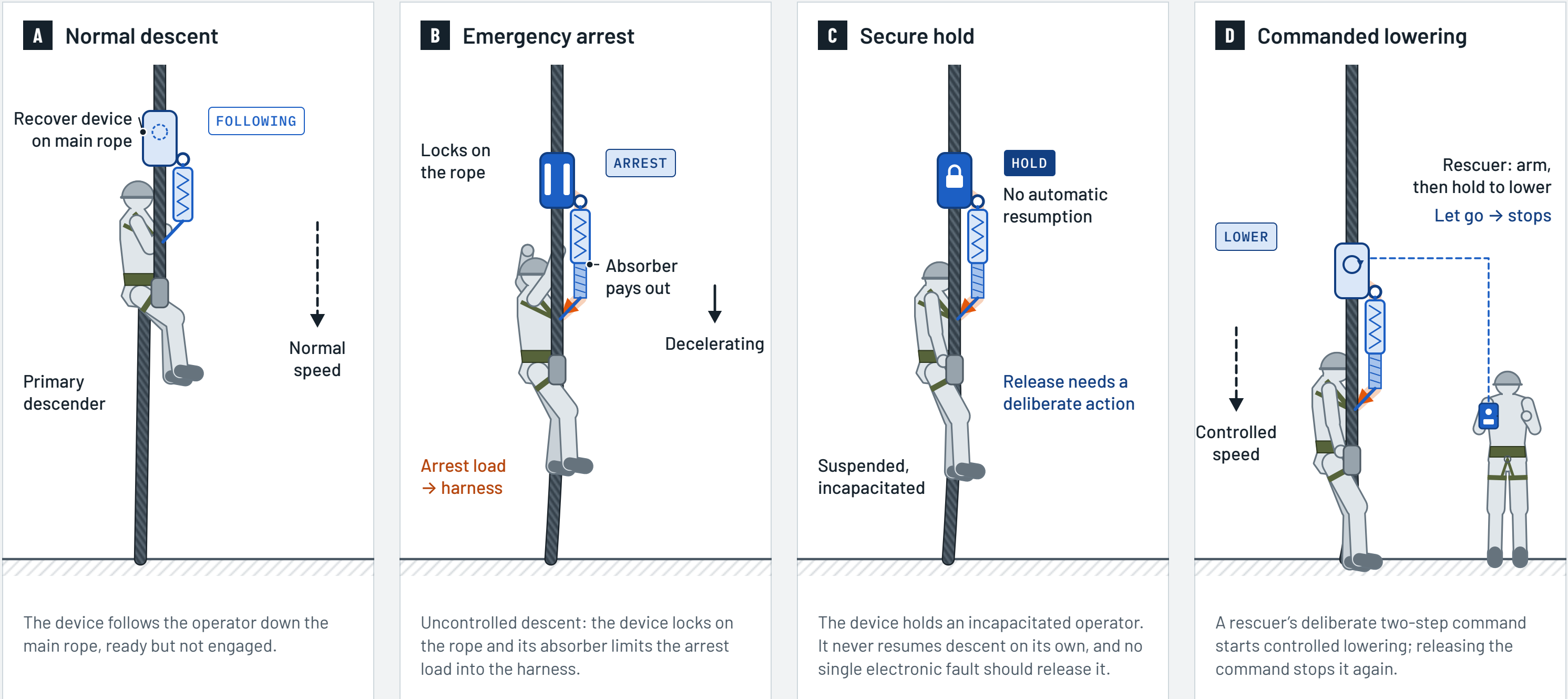
PRIORITY

FAILURE

ADDRESSED

System integration

Uncontrolled descent followed by inability to self-rescue.



DECISIVE UNKNOWN

Reliable transitions between arrest, holding, and lowering under load, including loss of power or communications. No single electronic fault should cause an unintended release.

SENTINEL

Recovery for the whole rope team

PRIORITY

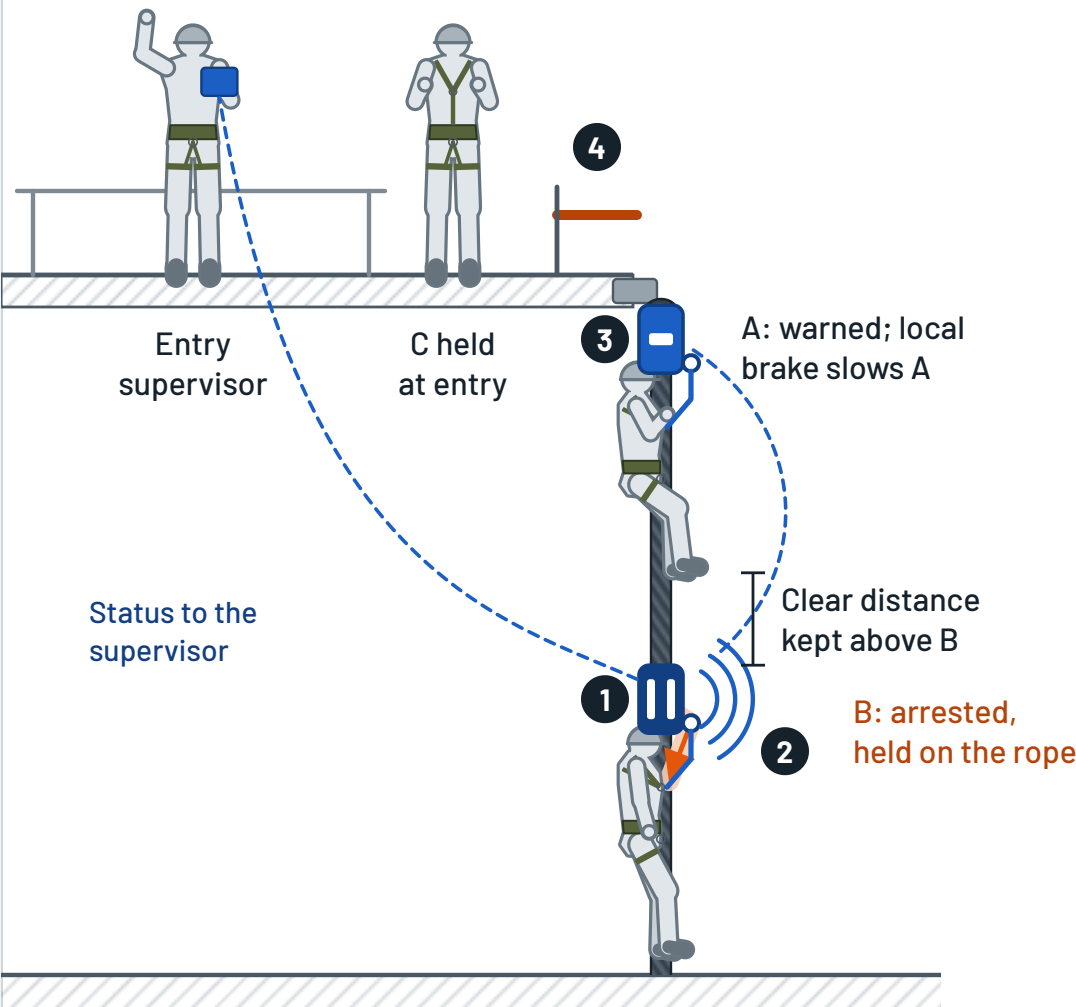
System integration

FAILURE

A cascading incident in which personnel descend into an arrested operator.

ADDRESSED

A One operator arrests mid-rope



Operator B arrests mid-rope. Warnings reach operator A above and the entry supervisor, who halts further entry, so no one descends into B.

B Event sequence

- 1 B arrests mid-rope**
B's own device locks and holds. The arrest is local and needs no network message.
- 2 Arrest event broadcast**
Occupancy, position and state go to the entry supervisor and the operators above.
- 3 A warned; local brake slows A**
A compatible local brake keeps A clear of B. Its limits must be validated separately.
- 4 Supervisor halts rope entry**
C holds at the top until the rope is clear and B is recovered.

Messages coordinate the team; they never gate an individual brake.

Each arrest stays local; communications add coordination. Any intervention on another operator needs its own validated limits.

DECISIVE UNKNOWN

Shared-rope dynamics, message delays, missed warnings, and whether coordinated interventions create additional hazards.

Main rope

Concept hardware

Arrest load path

Status signal