



VEYRUM ROBOTICS STANDARD



VRS-IND-101

Industrial — Detection and Safe-Stop Evidence Protocol

The method and apparatus reference for Industrial detection and safe-stop evidence — what documentary evidence must show at the Verified tier and what VRS-IND-110 witnesses at the Certified tier.

VEYRUM RESEARCH INSTITUTE

DOCUMENT
VRS-IND-101

VERSION
1.0.0

STATUS
Draft

DATE
16 September 2026

Contents

1 1 Scope

2 2 Normative references

3 3 Terms and definitions

4 4 What the evidence must show

5 5 Admissible evidence forms

6 6 Evidence-dimension matrices (target-independent)

7 7 Worked example (informative)

8 8 Consumption and recording

9 Bibliography

10 Change history

Foreword. This Test Protocol is the Industrial sector’s method and apparatus reference for the **detection and safe-stop** dimension: it states what detection and safe-stop evidence must demonstrate and against which anchor regimes, and it is the document VRS-IND-110 cites when it witnesses those functions live. It defines no bench test parameters of its own — the anchor standards own the test regimes and VRS consumes their results: **ISO 3691-4:2023** for driverless industrial trucks (the **mobile** application class) and **ISO 10218-2:2025** for robot applications and cells (the **manipulator** class); the minimum-distance and stopping-distance methodology is **ISO 13855:2024** (all verified this run; Bibliography). In the VRS 2026 edition the sector’s application classes are **mobile · manipulator · legged-other** (VRS-IND-201 §7.3); the earlier class names map once here — the former **mobile-logistics** class is now **mobile**, and the former **fixed-cell** and **collaborative-application** classes are now **manipulator**. Evidence is expressed **by tier**, not by a grade ladder: **documentary** forms (accredited-laboratory reports, third-party certificates, QMS-witnessed instrumented results) serve the **Verified** rows of the VRS-IND-201 criteria named in Clause 6; **witnessed** forms are the live steps of VRS-IND-110 and serve the **Certified** tier. The detection/safe-stop evidence dimensions are fixed by the anchor regimes and are therefore **target-independent** (Clause 6); the declared envelope values that populate them for a model (its speeds, payloads, sensing configuration, floor limits) are a **declared field** recorded per Clause 8 (VRS-GEN-009). A first-of-model assessment is an ordinary assessment under cold-start parity (VRS-GEN-005 §6); an application class the assessed envelope does not include is recorded **not covered**, never guessed. No robot holds a Veyrum rating. Requirements use “shall”; recommendations use “should”.

1 Scope

This Protocol defines the evidence requirements for the **detection and safe-stop** dimension of Industrial assessments (hazard groups H1/H2, VRS-IND-001 Clause 5) for the **mobile** and **manipulator** application classes (VRS-IND-201 §7.3): what evidence must show (Clause 4), admissible evidence forms by tier (Clause 5), the target-independent evidence-dimension matrices (Clause 6), a worked example (Clause 7), and consumption and recording (Clause 8). It defines no test apparatus or procedure of its own and does not restate the anchor regimes’ detection-field, zone, braking, or approach-speed parameters.

Excluded: collaborative-application contact-force and separation evidence, which is the subject of VRS-IND-102 and the body-region taxonomy it holds; the live witnessing procedure itself (VRS-IND-110); the rating mathematics (VRS-GEN-005/006, VRS-IND-201); and sector applicability and hazard taxonomy (VRS-IND-001).

2 Normative references

- **VRS-IND-001**, Industrial Sector Standard; **VRS-IND-201**, Industrial AR Assessment Protocol (the criteria whose Verified rows this evidence serves; application classes §7.3); **VRS-IND-110**, Industrial Demonstration Protocol (the witnessed steps this evidence feeds); **VRS-IND-102**, Collaborative-Application Contact Evidence Protocol (body-region taxonomy and contact evidence);

VRS-GEN-012, Evidence and Data Requirements (cited for provenance and consent only); **VRS-GEN-101**, IR category safety_incidents; **VRS-GEN-005**, IR Methodology (§6 cold-start parity); **VRS-GEN-009**, Registry schema (all as dated at assessment).

- Consumed test regimes (the compliance floor VRS rates above — verified 2026-09-16):
 - **ISO 3691-4:2023** — driverless industrial trucks and their systems; detection fields, speed-adaptive protective zones, safe-stop for AGV/AMR (**mobile** class).
 - **ISO 10218-1:2025 / ISO 10218-2:2025** — robot and robot-application safety, including the safety-rated monitored stop and other safety functions (**manipulator** class).
 - **ISO 13855:2024** — positioning of safeguards with respect to the approach of the human body; the minimum-distance / stopping-distance methodology safe-stop evidence is computed against (cited, not reproduced — single source, VRS-GEN-002 §7).
 - **ISO 13849-1:2023** — safety-related parts of control systems (SRP/CS); Performance Level PL a—e verification of detection and stop safety functions.
 - **IEC 62061:2021** — functional safety of safety-related control systems (SCS); SIL — the alternative control-system-integrity regime a manufacturer may already hold.

3 Terms and definitions

Per VRS-GEN-001 and VRS-IND-001. For this Protocol:

- **Detection evidence** — measured results demonstrating the model's person/obstacle detection performance (detection-field geometry, response, and reliability) under the anchor regime's conditions.
- **Safe-stop evidence** — measured results demonstrating stopping behaviour — stopping distance (m) and stop-function response time (ms) — within the anchor regime's criteria for the assessed application class and declared speeds/loads.
- **Protective (detection) field** — the sensor-monitored region whose intrusion triggers a protective response; its size, shape, and switching are declared configuration.
- **Speed-adaptive zone** — a protective-field set that switches with travel speed (ISO 3691-4:2023 concept for driverless trucks).
- **Declared envelope** — the assessed combination of speeds (m/s), payload (kg), sensing configuration, floor/travel-surface limits, and safety-function architecture. It is a **declared field** (§8.2), corroborated at assessment, not assumed by this Protocol.
- **Not covered** — a state recording that an application class or evidence dimension lacks admissible evidence, so it is excluded from the assessed envelope rather than assumed compliant.

4 What the evidence must show

4.1 For each application class in the assessed envelope (VRS-IND-201 §7.3), evidence shall demonstrate every evidence dimension of the applicable Clause 6 matrix: (a) detection performance under the anchor regime's conditions for that class; (b) safe-stop behaviour — stopping distance (m) and stop response time (ms) — meeting the anchor regime's criteria at the declared speeds (m/s) and loads (kg); © behaviour at the declared envelope **limits**, not only at nominal conditions.

4.2 Evidence shall reflect the **declared envelope** assessed. A change of sensing configuration, maximum speed, payload, or floor/travel-surface class that raises stopping distance or degrades detection shall require re-measurement or an envelope contraction recorded in the assessment record (§8.2); results for one configuration shall not support a different one.

4.3 Evidence shall cover the **degraded conditions** the anchor regime tests — sensor obscuration, worst-case approach geometry, and floor/travel-surface limits — where the declared envelope includes them.

4.4 Which application classes are in the assessed envelope is a **declared field** (§8.2), not assumed by this Protocol. A class the envelope does not include shall be recorded **not covered** (VRS-IND-201 §7.3), not carried as an open placeholder. A first-of-model assessment is an ordinary assessment under cold-start parity (VRS-GEN-005 §6); any envelope contraction is recorded in the assessment record.

4.5 Where the application relies on a safety-related control function to bound speed, detection response, or stopping, evidence shall include the required Performance Level (PL, ISO 13849-1:2023) or SIL (IEC 62061:2021) verification for that function; a detection or safe-stop claim whose underlying safety function lacks PL/SIL verification shall not be admissible (Clause 5).

4.6 Safe-stop distance evidence shall be evaluated against the minimum-distance / stopping-distance methodology of **ISO 13855:2024** (approach speeds and overall system stopping performance); this Protocol cites that methodology at clause level and does not reproduce its parameters.

5 Admissible evidence forms

5.1 Detection and safe-stop measurements shall be **instrumented** — measurement-device results against the anchor regime’s method. Demonstration videos, operator recollection, and marketing claims shall not be admitted as detection or safe-stop evidence.

5.2 Admissible evidence is expressed **by tier**, not by a grade ladder:

- **Documentary (Verified tier).** Accredited-laboratory results against the anchor test regime, third-party reports and certificates, and manufacturer instrumented results witnessed under an audited QMS shall be admissible as documentary evidence and serve the **Verified** rows of the VRS-IND-201 criteria mapped in Clause 6. Manufacturer self-declared instrumented results are admissible as documentary evidence only where corroborated.
- **Witnessed (Certified tier).** Live measurement performed and observed under VRS-IND-110 in a demonstration session shall be the witnessed form; it serves the **Certified** tier of the same criteria. Each witnessed dimension names the VRS-IND-110 step that produces it (Clause 6).

Provenance and consent for either form are recorded per VRS-GEN-012; that reference governs labelling only and assigns no weight or score.

5.3 Evidence measured against a superseded anchor edition shall be admitted only where the measured configuration matches the assessed declared envelope; otherwise it shall be treated as not applicable and re-measurement required before it supports a Verified or Certified determination (edition changes trigger review, §8.3).

5.4 Incomplete coverage shall block the affected envelope, not degrade it silently: if any evidence dimension (Clause 6) for an in-envelope class lacks admissible evidence, that class shall be recorded

not covered for the affected dimension rather than assumed compliant.

6 Evidence-dimension matrices (target-independent)

The evidence dimensions below are fixed by the anchor regimes and are therefore target-independent: they state **what** evidence must demonstrate for a class, regardless of any specific model. The declared envelope values that populate each dimension for an assessed model (its speeds, payload, sensing configuration, floor limits) are a declared field recorded per §8.2. For each dimension of the applicable matrix, evidence shall demonstrate the stated result at the declared envelope limits. The final column names, for each dimension, the documentary form that serves the VRS-IND-201 Verified row and the VRS-IND-110 step that witnesses it at Certified.

6.1 mobile class (AGV/AMR) – anchor regime ISO 3691-4:2023.

EVIDENCE DIMENSION	CONSUMED EVIDENCE SHALL DEMONSTRATE	ANCHOR REFERENCE	DOCUMENTARY (VERIFIED) / WITNESSED (CERTIFIED)
Detection field and speed-adaptive zones	Detection-field geometry and speed-adaptive-zone performance across the declared speed range (m/s), including switching-field-set transitions	ISO 3691-4:2023 detection/zone clauses	documentary — serves VRS-IND-201 §6.3 Verified row; witnessed field-set switching feeds VRS-IND-110 step IND-110.05
Safe-stop on detection	Stopping distance (m) and stop response time (ms) within the anchor criteria at the declared speeds, with the safety function at its rated PL/SIL	ISO 3691-4:2023 safe-stop; ISO 13855:2024 methodology	documentary — serves VRS-IND-201 §6.2 Verified row; witnessed at declared maximum speed feeds VRS-IND-110 step IND-110.01
Braking under load	Safe-stop distance and stability at the maximum declared payload (kg), including attachment/cart dynamics where declared	ISO 3691-4:2023 braking/stability clauses	documentary — serves VRS-IND-201 §6.2 Verified row; witnessed at declared maximum payload feeds VRS-IND-110 step IND-110.02
Sensing-condition envelope	Detection performance within the declared ambient-light and sensing envelope (e.g. lx boundary), including behaviour at the immunity boundary	ISO 3691-4:2023 sensing conditions	documentary — serves VRS-IND-201 §6.3 and §6.5 Verified rows; witnessed at the declared ambient-light boundary feeds VRS-IND-110 step IND-110.06
Travel-surface conditions	Stop performance on the declared floor slope, obstacle-height, and gap limits, at limits not nominal	ISO 3691-4:2023 travel-surface conditions	documentary — serves VRS-IND-201 §6.2 Verified row; witnessed feeds VRS-IND-110 steps IND-110.03 (maximum slope) and IND-110.04 (worst floor)
Emergency stop and reset	E-stop actuation and safety-reset function within the declared safety-function architecture	ISO 3691-4:2023; ISO 13849-1:2023 / IEC 62061:2021	documentary — serves VRS-IND-201 §6.6 Verified row; witnessed unauthorised-reset refusal feeds VRS-IND-110 step IND-110.11
Degraded conditions	Behaviour under sensor obscuration and worst-case approach geometry where the anchor regime tests them	ISO 3691-4:2023 degraded-condition clauses	documentary — serves VRS-IND-201 §6.5 Verified row; witnessed worst-case approach geometry feeds

EVIDENCE DIMENSION	CONSUMED EVIDENCE SHALL DEMONSTRATE	ANCHOR REFERENCE	DOCUMENTARY (VERIFIED) / WITNESSED (CERTIFIED)
			VRS-IND-110 step IND- 110.07

6.2 manipulator class (industrial robot cell/arm, incl. collaborative applications) – anchor regime ISO 10218-2:2025.

EVIDENCE DIMENSION	CONSUMED EVIDENCE SHALL DEMONSTRATE	ANCHOR REFERENCE	DOCUMENTARY (VERIFIED) / WITNESSED (CERTIFIED)
Presence detection / safeguarded space	Detection of personnel entering the safeguarded space, triggering the protective response, across the declared cell layout	ISO 10218-2:2025 safeguarding clauses	documentary — serves VRS-IND-201 §6.3 Verified row; witnessed worst-case approach feeds VRS-IND-110 step IND-110.07
Safety-rated monitored stop	Stop is initiated and maintained on intrusion; stop-function integrity at the required PL/SIL	ISO 10218-2:2025; ISO 13849-1:2023 / IEC 62061:2021	documentary — serves VRS-IND-201 §6.2 Verified row; witnessed at declared maximum speed feeds VRS-IND-110 step IND-110.01
Stopping distance / overrun	Robot stopping distance (m) and time (ms) at declared speed and payload, evaluated against the minimum-distance methodology	ISO 10218-1:2025; ISO 13855:2024 methodology	documentary — serves VRS-IND-201 §6.2 Verified row; witnessed at declared maximum payload feeds VRS-IND-110 step IND-110.02
Safeguard positioning	Minimum safeguard distances consistent with the measured stopping performance and declared approach directions	ISO 13855:2024	documentary — serves VRS-IND-201 §6.4 Verified row; witnessed protective separation distance feeds VRS-IND-110 step IND-110.10 where speed-and-separation monitoring is declared
Emergency stop and reset	E-stop actuation and controlled safety-reset within the declared cell safety-function architecture	ISO 10218-2:2025; ISO 13849-1:2023 / IEC 62061:2021	documentary — serves VRS-IND-201 §6.6 Verified row; witnessed unauthorised-reset refusal feeds VRS-IND-110 step IND-110.11
Degraded conditions	Behaviour under a faulted or bypassed sensor and worst-case approach geometry where the anchor regime tests them	ISO 10218-2:2025	documentary — serves VRS-IND-201 §6.5 Verified row; witnessed obscuration and worst-case geometry feed VRS-IND-110 step IND-110.07, and, where sensing is optical, IND-110.06

Power-and-force-limiting contact per reachable body-region class is out of this Protocol's scope: the body-region taxonomy, contact types and per-region limit values are held in VRS-IND-102, and the corresponding witnessed steps (quasi-static and transient contact) are VRS-IND-110 steps IND-110.08 and IND-110.09. A dimension the assessed envelope does not reach need not be evidenced only where the envelope excludes it and that exclusion is recorded (§8.2); otherwise every dimension of the applicable matrix shall be evidenced in full, or the affected dimension shall be recorded not covered

(§5.4). The **legged-other** class carries no dedicated anchor regime in this edition; where such a model declares a detection or safe-stop function, the applicable matrix is the one matching its declared configuration, and any dimension the declared configuration does not reach is recorded not covered.

7 Worked example (informative)

Example only — not a real product; no robot holds a Veyrum rating. A fictional warehouse AMR declares a **mobile** envelope: maximum travel speed 1.8 m/s, docking speed 0.3 m/s, maximum payload 120 kg including a towed cart, a safety LiDAR with a declared ambient-light immunity boundary of 1,500 lx, and a floor envelope of maximum slope 1.0°, obstacle height 5 mm, gap 10 mm. Its speed-limiting and stop functions are declared at PL-d.

Verified (documentary) path. The submission is an accredited-laboratory report against ISO 3691-4:2023 giving detection-field and speed-adaptive-zone performance across 0–1.8 m/s with the field-set switching verified; measured safe-stop distance and stop response time at 1.8 m/s and at the 120 kg loaded-cart condition, within the anchor criteria and consistent with the ISO 13855:2024 minimum-distance methodology; detection at the 1,500 lx boundary; stop performance at the floor limits; E-stop and safety-reset function; and an ISO 13849-1:2023 PL-d verification of the speed-limiting and stop functions. Every §6.1 dimension has admissible documentary evidence, so the **mobile** class is **covered** at the Verified tier: the report serves the Verified rows of VRS-IND-201 §6.2 (safe-stop, braking, travel surface), §6.3 (detection, sensing envelope), §6.5 (degraded conditions) and §6.6 (E-stop and reset).

Certified (witnessed) path. In a VRS-IND-110 session the same functions are witnessed at the declared limits: the protective stop at 1.8 m/s (IND-110.01), at 120 kg (IND-110.02), on the 1.0° slope (IND-110.03) and on the worst floor (IND-110.04); switching-field transitions (IND-110.05); detection at the 1,500 lx boundary (IND-110.06); worst-case approach geometry (IND-110.07); and refusal of an unauthorised reset (IND-110.11). The witnessed marks serve the Certified tier of the same criteria; no arithmetic is performed in this Protocol (VRS-IND-201 and VRS-GEN-005/006 own the determination).

Not-covered contrast. The same submission with **no travel-surface measurement at the declared 1.0° slope** does not lower any result — under §5.4 the travel-surface dimension is recorded **not covered**, the envelope is contracted to exclude slopes beyond what was measured, and the assessor records the contraction per §8.2. A submission relying on results at a **lower speed configuration** (e.g. 1.2 m/s) to support the 1.8 m/s envelope is inadmissible under §4.2. The AMR's **manipulator** class is simply **not covered** (§4.4) — it is absent from the declared envelope, not an open placeholder.

8 Consumption and recording

8.1 Documentary evidence serves the Verified rows of VRS-IND-201 §6.1–§6.6 and the safety evidence of the safety_incidents category (VRS-GEN-101); witnessed measurement is recorded as the corresponding VRS-IND-110 steps in the Session Record and serves the Certified tier. This Protocol records evidence and its coverage; it assigns no points and computes no rating (VRS-GEN-005/006, VRS-IND-201).

8.2 The assessment record shall identify: the anchor regime edition tested against; the declared envelope (application class, speeds in m/s, payload in kg, sensing configuration, floor/travel-surface limits, safety-function architecture and PL/SIL); the laboratory or witness and the evidence form

(documentary or witnessed); the test report or Session Record identifiers and dates (to day precision); whether the assessment is a first-of-model assessment under cold-start parity (VRS-GEN-005 §6); and any envelope contraction applied (§5.4).

8.3 Anchor-regime edition changes (e.g. a future ISO 3691-4 or ISO 10218-2 amendment) shall trigger evidence review per VRS-GEN-004 §7; a superseded-edition report shall be re-mapped or re-measured before it supports a Verified or Certified determination.

9 Bibliography

- ISO 3691-4:2023 (iso.org/standard/88615.html; edition 2, 2023-06) — Industrial trucks — Safety requirements and verification — Part 4: Driverless industrial trucks and their systems.
- ISO 10218-1:2025 (iso.org/standard/73933.html; edition 3, 2025-02) — Robotics — Safety requirements — Part 1: Industrial robots.
- ISO 10218-2:2025 (iso.org/standard/73934.html; edition 2, 2025-02) — robot applications and robot cells (TS 15066 absorbed; explicit cybersecurity requirements).
- ISO 13855:2024 (iso.org/standard/80590.html; edition 3, 2024) — Safety of machinery — Positioning of safeguards with respect to the approach of the human body. Supersedes ISO 13855:2010 (now withdrawn).
- ISO 13849-1:2023 (iso.org/standard/73481.html; edition 4, 2023-04) — Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (Performance Level).
- IEC 62061:2021 (webstore.iec.ch/en/publication/59927; edition 2) — Safety of machinery — Functional safety of safety-related control systems (SIL).

10 Change history

DATE	VERSION	STATUS	CHANGE	AUTHORITY
2026-09-16	1.0.0	Draft	VRS 2026 rewrite: recast as the detection/safe-stop method and apparatus reference for VRS-IND-110. Evidence now expressed by tier (documentary → VRS-IND-201 Verified rows; witnessed → VRS-IND-110 Certified steps) with the §5.2 grade ladder removed; scoring language (points, sub-scores, op-hours exposure denominator, null-vs-zero inputs, “C1”) removed. Application classes aligned to VRS-IND-201 §7.3 (mobile · manipulator · legged-other); former mobile-logistics → mobile and fixed-cell/collaborative-application → manipulator, stated once in the Foreword. Every witnessed dimension now names its VRS-IND-110 step (IND-110.01–.07, .10, .11); PFL contact deferred to VRS-IND-102 / IND-110.08–.09. VRS-GEN-201 and cold-start-margin references removed; first-of-model recast as an ordinary assessment under cold-start parity (VRS-GEN-005 §6). Removed the word “provisional”. No constant/weight/band changed (TP holds none; no -501 twin). See GEN-005 §6.	Curator; VRS 2026 rewrite Batch D
2026-09-13	0.3.0	Draft	DEEPEN: brought to publishable depth on the IND-102 pattern; separated anchor-derived, target-independent evidence-dimension matrices from the per-target declared envelope; added dated anchors incl. ISO 13855:2024, PL/SIL integrity rule, stopping-distance methodology, admissibility ladder + not-covered gate, worked example. Net words 751→2,374; shall 5→26.	Curator Run #115; charter DEEPEN
2026-09-05	0.2.0	Draft	Mobile-logistics class evidence matrix completed against the first assessment target; other classes reserved	WL-030 WS-4
2026-09-05	0.1.0	Draft	Evidence-consumption shell; class matrices reserved	CEO 2026-09-05

About Veyrum Research Institute

Veyrum Research Institute is the research arm of Veyrum — the independent intelligence and trust layer for the robotics industry (research, ratings and registry, advisory, data, and specialist insurance & finance introductions).

Disclaimer

The opinions in this document are independent and current as of the date of publication, based on information believed reliable; they are not guarantees or warranties of safety, fitness, or compliance, and are not engineering, legal, or financial

advice. This document may be revised. © 2026 Veyrum.

Contact: hello@veyrum.com · VRS-IND-101 · Version 1.0.0