TECHNICAL ANALYSIS: ELEVATOR UNINTENDED MOVEMENT, SUSPENSION FAILURE, AND PROTECTIVE SAFETY SYSTEMS

Existing elevators | Modernization projects | New installations

Prepared by: Senawi Group Consulting LLC

ATTENTION BUILDING OWNERS:

Before investing in any of these elevator safety devices or systems, I strongly encourage building owners to ask detailed questions and consider engaging a qualified, independent elevator consultant to assist with the evaluation and decision-making process.

Too often, we encounter situations where elevator contractors recommend and sell safety upgrades without fully understanding the technical requirements, compatibility limitations, or complexities involved in integrating these systems with existing equipment. The result can be costly installations that fail to operate as intended, require extensive modifications, or do not provide the level of protection originally promised or required by the code authorities. BE WARE BEFORE MAKING THE WRONG DECSION.

An independent technical assessment before committing to these upgrades can help avoid unnecessary expenses, installation complications, and potential safety concerns.

1. Executive overview

Unintended elevator movement is one of the most significant safety concerns associated with traction elevator equipment, particularly older installations containing obsolete controllers, aging machines, mechanical brakes, suspension ropes, and components that may not incorporate the protective technologies available in modern elevator systems.

An important engineering distinction must be established:

Unintended Car Movement (UCM), Ascending Car Overspeed Protection (ACOP), and protection against suspension-system failure are three different safety functions. A device designed to protect against one condition does not necessarily protect against the others.

For example, a machine-mounted emergency brake may prevent unintended movement resulting from loss of holding torque. However, if the traction sheave separates from the

machine shaft, the brake may no longer have a mechanical connection to the suspended elevator car.

Likewise, an electronic monitoring system may detect abnormal movement, but unless it activates a suitable independent stopping device, it cannot necessarily arrest the car.

For existing elevator installations, the appropriate solution depends on the elevator's mechanical arrangement, drive system, suspension configuration, existing safety devices, applicable code, and whether the building owner intends to retain or replace the machine.

2. Principal failure scenarios

The following table identifies critical failure modes and the protective methods that should be evaluated.

Failure scenario	Potential consequence	Protective measures to evaluate
Machine brake fails or releases unexpectedly	Car drifts or moves away from landing	Independent brake, UCM monitoring, certified emergency stopping system
Drive or controller commands unintended motion	Car moves with doors open or without a valid command	Independent motion detection and UCM stopping function
Traction ropes slip over the sheave	Uncontrolled car movement	Rope-gripping device, car safety system where applicable
One suspension rope breaks	Unequal loading, possible additional failures	Rope redundancy, condition monitoring, inspection and replacement
All suspension ropes fail	Loss of suspension	Car-mounted safeties acting on guide rails, subject to activation and design
Traction sheave fractures or disconnects from shaft	Loss of machine control over car motion	Protection independent of the failed sheave and its drive connection

Machine shaft or gearbox fails	Uncontrolled car or counterweight movement	Independent car/counterweight safety protection or other verified stopping arrangement
Counterweight travels upward or downward uncontrollably	Overtravel, impact, or car overspeed	Counterweight safeties where required, governor and braking provisions
Overspeed occurs in upward direction	Possible overhead impact	ACOP system with suitable sensing and stopping means
Governor or safety actuation fails	Inability to stop an over speeding car	Properly designed, maintained, tested, and independently evaluated safety chain

Critical observation: Conventional downward-acting car safeties should not be assumed to provide ascending car overspeed protection, and machine-shaft-mounted braking devices should not be assumed effective following shaft or traction-sheave separation.

3. Understanding the three principal safety systems



A. Rope-gripping emergency brake

A rope gripper clamps the suspension ropes directly, rather than relying solely on the machine brake. It can provide UCM and ACOP protection when properly rated, monitored, installed, and tested.

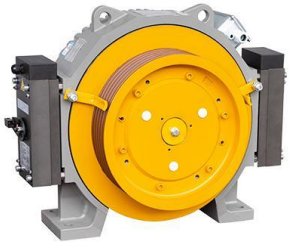
It can remain effective after certain machine shaft or brake failures, provided the ropes remain intact and the load path through the rope-gripping assembly is maintained.



B. Car-mounted rail-gripping safety gear

Safety gear is attached to the elevator car frame and acts directly on the guide rails. It does not depend on traction between the suspension ropes and machine sheave.

A suitably engineered bidirectional safety arrangement can provide protection against both upward and downward uncontrolled motion, including some scenarios involving loss of traction or suspension.



C. Independent machine or sheave brake

An additional electromechanical brake can act on a machine shaft, brake drum, or brake disc. Properly designed systems can provide redundant braking against uncontrolled movement.

Their effectiveness depends on the structural connection between the braking surface and the suspended load. A shaft-mounted brake does not necessarily protect against sheave or shaft separation.

4. Manufacturers and commercially available protective systems

The following are identifiable products and product families relevant to existing traction elevators and modernization work. Manufacturer suitability, U.S. code acceptance, listing, installation availability, and compatibility must be verified for the specific application.



1. Hollister-Whitney Elevator Corporation

Product: Rope Gripper®, models 620, 621, 622, 624, 625, 626 and variants.

Application: Existing geared or gearless traction elevators where suspension ropes are accessible and the required mounting and structural arrangements can be provided.

Capabilities: UCM and ascending car overspeed protection through direct rope braking, with appropriate sensing and control integration.

Limitations: Not a substitute for car safeties after complete rope failure. Requires rope compatibility, proper load rating, mounting strength, clearance, and stopping-performance verification.

Manufacturer documentation identifies these Rope Gripper models for ACOP and UCMP applications.

Manuals+

Vantage Elevation / Hollister-Whitney



2. G.A.L. Manufacturing

Product: FMG1 Elevator Safety Monitor.

Application: Retrofit of existing elevator controllers, including compatible non-GAL systems.

Capabilities: Monitors motion, door zone, controller signals, governor and brake status, and can activate a Hollister-Whitney Rope Gripper upon detected faults.

Limitations: The monitoring unit is not itself a mechanical stopping device. The sensing, control and brake must be validated as a complete protective system.

The published product description includes encoder-based speed feedback and optional second-encoder monitoring.

G.A.L. Manufacturing

GAL Manufacturing



3. Argus Elevator

Product: A300-UCM Unintended Car Movement Protection.

Application: Retrofitting existing elevators with an independent motion-monitoring and emergency stopping interface.

Capabilities: Detects unintended motion and triggers a compatible electric or hydraulic rope gripper.

Limitations: Requires verification of controller interfaces, the rope-gripping mechanism, stopping performance and AHJ acceptance.

Argus markets the A300-UCM specifically for existing elevators and identifies ASME A17.1 Section 2.19.2 applications.

Argus Elevator

A300-UCM product information



4. Atwell / VG Rope Brake

Product: VG Rope Brake and associated uncontrolled movement monitoring.

Application: Existing traction installations where a rope-gripping assembly can be installed in a suitable orientation.

Capabilities: Manufacturer literature describes single- or bidirectional rope braking and overspeed/UCM protection with the appropriate controller.

Limitations: Primarily documented to European requirements. U.S. certification, availability and AHJ acceptance require confirmation.

The supplier identifies multiple mounting orientations and integration with a UMD-SRB01 controller.

Whitesmith Solutions

VG Rope Brake product information



5. Wittur

Product family: Progressive safety gears, overspeed governors and ascending overspeed protection devices.

Application: New elevator installations and substantial modernization projects involving car frames, safeties and governors.

Capabilities: Provides rail-based stopping solutions, including configurations for bidirectional protection.

Limitations: Not every Wittur safety gear is bidirectional. Correct product selection, guide-rail compatibility, operating load and complete system integration are essential.

Wittur identifies uni- and bidirectional safety gear and modernization applications.

Rise without limits

Wittur safety devices



6. Sautter Lift Components (SLC)

Product: BF2D and SG2D safety gear configurations, A3/UCM modernization packages.

Application: Extensive modernization projects, particularly where an independent rail-based stopping arrangement is desirable.

Capabilities: Integrated monitoring, governor activation, and car-mounted progressive safety gear. SLC expressly describes protection that responds to loss of traction.

Limitations: European EN 81 certification does not automatically establish U.S. ASME acceptance. Engineering modifications may be required to the car frame, guide rails and governor system.

SLC offers coordinated packages incorporating detection, triggering, braking, governor rope, tension weight and emergency power provisions.



SLC

+1

SLC complete UCM solutions

5. Critical engineering issue: Rope breakage versus traction sheave failure

This is an area where modernization specifications should be particularly precise.

A. Single suspension rope failure

Most conventional traction elevators use multiple suspension ropes. If one rope fails, the remaining ropes may temporarily support the elevator, depending on their condition, design and loading.

However, the failure may cause:

- Redistribution of suspension loads.
- Increased tension in the remaining ropes.
- Car or counterweight misalignment.
- Damage to rope terminations and hitch assemblies.
- Progressive failure where multiple ropes have deteriorated under similar conditions.

Recommended protective approach: Properly engineered rope redundancy, compliant rope inspection and retirement criteria, and verification of the existing governor and safety gear.

A rope gripper should not be represented as a device that prevents individual rope failure.

B. Complete suspension rope failure

If all suspension ropes fail or their connections to the car are lost, a machine brake and rope gripper generally cannot support or stop the disconnected elevator car.

The primary protection is the car's rail-gripping safety gear, provided the governor or another independent activation system remains functional and is capable of triggering the safeties.

There is an important qualification: a conventional rope-driven governor is designed to respond to excessive car speed, but its effectiveness depends on the integrity of the governor rope, its connection to the safety mechanism, and the activation arrangement.

Recommended protective approach: A properly rated car safety system with a mechanically independent governor or an approved alternative triggering arrangement.

C. Traction sheave failure

A traction sheave can experience several distinct failures.

Type of failure	Technical concern	Protective consideration
Groove wear	Reduced traction, rope slip	Groove and rope evaluation, replacement as necessary
Sheave rim fracture	Possible loss of traction or rope containment	Independent rope or rail-based stopping means
Sheave-to-shaft connection failure	Machine brake no longer controls sheave	Rope gripper or independent rail-based system
Main shaft fracture	Loss of mechanical connection to drive and brake	Stopping means outside failed shaft load path
Sheave support or bearing failure	Misalignment, rope displacement, potential loss of traction	Independent protective system and structural evaluation

A particularly relevant real-world example is the July 2023 Hollister-Whitney safety announcement concerning certain GT-series machines. The manufacturer reported main drive shaft failures and directed that identified machines lacking Rope Grippers be removed from service until appropriate protection could be installed.

This illustrates why relying exclusively on a machine brake may be insufficient for certain failure scenarios.

D. Rope repairs and replacement

Rope repairs deserve separate treatment from rope-break protection.

A safety modernization program should address:

- Broken wire limits, corrosion, diameter reduction and abnormal wear.
- Rope tension equalization.
- Sheave groove profiles and traction compatibility.
- Rope termination and hitch integrity.
- Rope replacement as a coordinated set where required.
- Compatibility of new suspension means with existing grippers and traction sheaves.

Field splicing or localized repair of load-bearing suspension ropes should not be assumed permissible. Replacement or repair must follow the applicable code, suspension-means manufacturer instructions and approved procedures.

Recommendation: Where significant rope deterioration is identified, replacing suspension ropes and correcting the underlying traction or alignment problems is preferable to installing a protective device as a substitute for necessary mechanical repairs.

6. Engineering comparison of protective technologies

The table describes typical capability, not certification of any particular product. “Conditional” requires system-specific engineering verification.

Failure / protection	Rope gripper	Machine brake redundancy	Bidirectional rail safety
Brake fails to hold	Yes, with UCM controls	Conditional	Yes, with appropriate detection
Controller commands unwanted motion	Yes, with UCM controls	Conditional	Yes, with appropriate detection
Machine shaft breaks	Often, if ropes remain captured	Usually no	Yes, if properly activated
Sheave disconnects from shaft	Often, if rope path remains intact	Usually no	Yes, if properly activated
Traction is lost	Conditional	Generally no	Yes, if properly activated
All suspension ropes break	No	No	Potentially, with independent triggering
Upward overspeed	Yes, when ACOP-rated	Conditional	Yes, if upward-acting and activated
Downward overspeed	Conditional, if rated	Conditional	Yes, with suitable safety gear
UCM at an open landing	Yes, with UCM controls	Conditional	Yes, with UCM detection and actuation

A rail safety is not automatically effective merely because it is bidirectional. Its triggering system must detect the relevant failure quickly enough, and the complete installation must achieve the required stopping distance and deceleration.

7. Alternative protective arrangements for existing elevators

Alternative 1 — Retain existing machine and install a Rope Gripper

Preferred retrofit candidate

This is often the most practical option when the existing machine is serviceable, the suspension ropes are conventional steel wire ropes, and suitable space exists.

Typical scope:

1. Evaluate the existing traction machine, sheave, shaft, bearings and brakes.
2. Determine elevator capacity, speed, suspension arrangement and rope specifications.
3. Select a properly rated rope-gripping device.
4. Design the mounting support to withstand the specified stopping loads.
5. Provide a compatible UCM and ACOP detection system.
6. Integrate fault monitoring, shutdown and reset provisions with the controller.
7. Complete manufacturer-required and AHJ-required testing.

Advantage: The machine and car safety gear may be retained, subject to engineering approval.

Disadvantage: This does not independently protect against complete loss of the suspension ropes.

Alternative 2 — Replace or upgrade the machine brake

This arrangement may involve a redundant spring-applied, electrically released braking system.

It is particularly relevant when installing a new gearless machine with a properly certified emergency braking arrangement.

Advantage: Compact, potentially less mechanical alteration and well suited to integrated modernization packages.

Disadvantage: A second brake acting on the same failed shaft does not create an independent load path.

A redundant brake should not be specified as comprehensive protection against sheave or shaft separation without documented proof that the relevant failure modes are addressed.

Alternative 3 — Install bidirectional car safeties

This approach is appropriate for a substantial modernization or where the owner specifically requires protection that does not rely on the traction sheave or suspension ropes to transmit braking force.

The design may require replacement or modification of the safety plank, car frame, governor, governor rope and guide-rail system.

Advantage: Direct braking against the guide rails, independent of the traction machine's ability to transmit torque.

Disadvantage: Higher engineering complexity, greater installation cost and potential structural alterations.

Alternative 4 — Install independent electronic UCM detection with a separate stopping device

A stand-alone monitoring system may evaluate car position, speed, door status, brake feedback and controller commands.

When unintended movement is detected, it initiates the emergency stopping system.

For older relay-based or obsolete controllers, this may be an alternative to replacing the complete controller, but only if the detection and braking functions form an accepted safety system.

A critical specification requirement is that the detection system must not rely solely on the same failed component it is intended to monitor.

For example, a motor-shaft encoder alone may not detect actual car movement if the shaft-to-sheave connection fails.

Alternative 5 — Complete traction equipment modernization

For obsolete machines or installations with extensive mechanical deterioration, a complete modernization may provide the most effective long-term solution.

This could include a new traction machine, controller, brake system, governor, safeties, suspension equipment and independent monitoring.

However, even a new installation does not automatically protect against every conceivable catastrophic mechanical failure. The protection must be established by the selected equipment and its approved design.

8. Code requirements and important exclusions

The principal U.S. code references to review are:

Code / standard	Relevance
ASME A17.1/CSA B44, Section 2.19	Ascending car overspeed and unintended car movement protection
ASME A17.1/CSA B44, Section 2.17	Car and counterweight safeties

ASME A17.1/CSA B44, Section 2.18	Speed governors
ASME A17.1/CSA B44, Section 2.20	Suspension means and related equipment
ASME A17.1/CSA B44, Section 2.24	Driving machines and sheaves
ASME A17.2	Inspection and testing guidance
ASME A17.3	Safety requirements for existing elevators where adopted
ASME A17.6	Suspension, compensation and governor systems
ASME A17.7/CSA B44.7	Performance-based alternative safety approaches

An especially important code distinction: The published ASME A17.3-2023 provisions for ACOP and UCM expressly exclude suspension means and traction drive sheaves from certain prescribed failure scenarios. Consequently, meeting a standard UCM requirement should not be represented as proving protection against complete rope breakage or every sheave failure.



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Michigan application

For Michigan projects, the applicable edition and requirements must be confirmed against the state's adopted elevator rules and the specific installation or alteration permit.

The project review should distinguish:

- Requirements applicable to an existing elevator remaining in service.
- Requirements triggered by modernization or alteration.
- Requirements for a completely new installation.
- Additional protective measures voluntarily requested by the owner.

A retrofit product's compliance with an ASME provision or European EN 81 standard does not, by itself, establish approval for installation in Michigan.

I have not independently verified the current Michigan administrative interpretation for every retrofit configuration discussed here. Written AHJ acceptance should be obtained before finalizing a nonstandard system.

9. Recommended engineering approach by elevator type

Elevator condition	Recommended starting approach
Older geared traction machine, mechanically sound	Rope Gripper with compatible independent UCM/ACOP monitoring
Older gearless machine with obsolete DC motor	Rope Gripper retrofit or complete machine modernization
Existing machine with suspected shaft deterioration	Immediate qualified engineering evaluation; consider removing from service pending findings
Modern gearless traction machine	Evaluate certified integrated emergency braking and UCM/ACOP functions
Traction elevator with insufficient rope-gripper clearance	Evaluate rail-based protection or replacement equipment
High-rise elevator with significant mechanical deterioration	Comprehensive modernization with independent protective systems
New traction installation	Integrated UCM/ACOP protection, with additional independent rail-based protection where the risk assessment justifies it
Hydraulic elevator	Separate analysis of valve failure, leakage, unintended descent, rupture protection and related hydraulic safeguards

10. Testing and commissioning requirements

Any modernization specification should require documented testing of the entire protective system rather than only the individual brake or monitoring unit.

The acceptance plan should address the following:

Commissioning checklist

0 of 10

Verify the UCM detection system recognizes movement away from an open-door landing

Demonstrate the required emergency stopping function under manufacturer-prescribed test conditions

Verify ascending overspeed detection and activation where applicable

Verify stopping distance and deceleration against the approved criteria

Verify loss-of-power and applicable sensor-fault responses

Verify that a fault prevents automatic return to normal operation where required

Confirm controller, brake and safety-device status feedback

Verify mounting integrity, rope engagement, clearances and electrical interfaces

Complete AHJ-witnessed testing where required

Provide test reports, revised wiring diagrams, operating instructions and maintenance procedures

Copy checklist

Testing should use the approved manufacturer's procedures and applicable code requirements. Deliberately inducing actual suspension or machine-shaft failure is not an appropriate field acceptance test.

11. Proposed modernization specification language

The following can serve as a starting point for Senawi Group Consulting modernization specifications. It would require editing for the actual installation and applicable code.

Unintended Car Movement and Ascending Car Overspeed Protection

A. General Requirements

The Contractor shall furnish and install a complete, engineered protective system designed to detect and arrest unintended elevator car movement and ascending car overspeed, as applicable to the equipment and governing code.

The system shall include all required detection devices, braking equipment, structural supports, control interfaces, safety circuits, monitoring, reset provisions, documentation, and testing.

B. Existing Equipment Evaluation

Before selecting the protective system, the Contractor shall evaluate the existing traction machine, main shaft, traction sheave, brake assembly, suspension ropes, rope terminations, governor, car safeties, guide rails, and controller.

The Contractor shall identify the failure modes addressed by the proposed system and specifically disclose those that remain unprotected.

C. Emergency Stopping System

Where a rope-gripping system is proposed, the device shall be suitable for the elevator's rated load, speed, suspension arrangement, rope diameter, rope quantity, and intended operating conditions.

Where an independent rail-based stopping system is proposed, the Contractor shall verify the adequacy of the car frame, safety gear, guide rails, rail brackets, and associated structural supports.

D. Independent Detection

The protective system shall provide appropriate monitoring of actual car movement and required safety signals. Detection shall not depend exclusively upon a mechanical component whose failure would prevent the system from recognizing the hazardous movement being addressed.

E. Mechanical Failure Protection

The Contractor shall document whether the proposed system provides effective protection in the event of machine brake failure, drive or control failure, machine shaft failure, traction sheave separation, loss of traction, and suspension-means failure.

No device shall be represented as providing protection against a particular failure without supporting manufacturer documentation and engineering verification.

F. Compliance and Approval

All components and their integrated application shall comply with the governing elevator code and applicable authority requirements. The Contractor shall submit equipment certifications, engineering calculations, installation drawings, and test procedures for review before installation.

G. Acceptance Testing

The Contractor shall perform all manufacturer-required and code-required functional tests, document the results, correct deficiencies, and provide final acceptance documentation before returning the elevator to normal service.

H. Maintenance and Documentation

The Contractor shall provide complete maintenance instructions, inspection intervals, testing procedures, replacement criteria, troubleshooting information, and all applicable equipment manuals and wiring diagrams.

12. Engineering conclusions and recommendations

For existing traction elevators with serviceable machines

The Hollister-Whitney Rope Gripper combined with a compatible independent monitoring system is a strong candidate for evaluation. It can provide a practical retrofit solution without necessarily replacing the entire machine and controller.

For installations with significant shaft or sheave concerns

Prioritize evaluation of protective systems that do not rely on the machine shaft to transmit braking torque. A rope gripper may address some failure scenarios, but loss of rope containment or suspension requires a different analysis.

For complete modernizations and new installations

Evaluate bidirectional rail-based protection in addition to the required UCM and ACOP provisions, particularly where the owner's risk objectives extend beyond the minimum prescribed code failure scenarios.

My recommended direction for Senawi Group Consulting

I would establish three levels of protection in the firm's engineering evaluations:

Protection level	Scope	Typical application
Level 1 — Code compliance	Applicable UCM and ACOP protection	Existing equipment alterations and new installations
Level 2 — Enhanced mechanical protection	Level 1 plus independent rope braking or other suitably independent stopping means	Aging geared and gearless traction machines
Level 3 — Comprehensive risk mitigation	Level 2 plus appropriately engineered rail-based protection and assessment of suspension failure scenarios	High-consequence facilities and major modernization projects

These are proposed consulting risk categories, not official ASME classifications.

The important difference is that Level 1 addresses applicable code requirements, while Levels 2 and 3 introduce additional owner-directed engineering objectives.

For hospitals, residential towers, institutional buildings and facilities with aging traction machines, I would consider an assessment of machine-shaft failure, sheave failure, suspension integrity and the independence of the emergency stopping system a worthwhile addition to a conventional modernization study.

Manufacturer technical references

- Vantage Elevation / Hollister-Whitney
- G.A.L. Manufacturing
- Argus A300-UCM
- Wittur Safety Devices
- Sautter Lift Components UCM Systems
- Atwell VG Rope Brake and Safety Gear

Best regards,
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