Performance Criteria of Rope Rescue Systems:

- A Canadian Model

ICAR 2018 CHAMONIX FRANCE

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British Columbia, 2016

Nationally funded Re-evaluation of Technical Rope Rescue Techniques and Practices

Testing: Performance Criteria were used to assess different rope rescue systems

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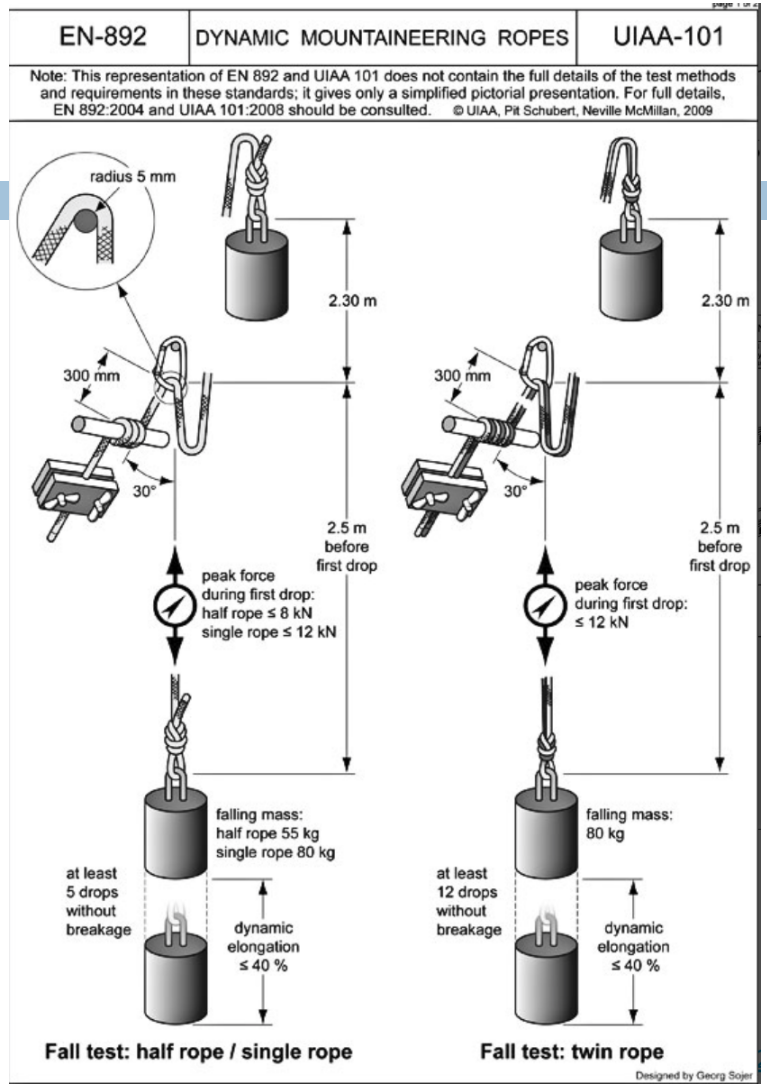
UIAA Dynamic Rope Performance Criteria

- Test method represents a relative worst-case scenario for lead climbing.
- Component Criteria, not System Performance Criteria
- Key elements:
  - Mass
  - Fall distance
  - Rope in service
  - Maximum Peak Force
  - Dynamic elongation



Why Use Rope Rescue **System** Performance Criteria?

- Safety; component compatibility
  - E.g. a change in rope type or descent control device may not perform as expected
- Baseline for comparative analysis
- Data Based Decision Making
- Evaluate against relative worst-case event

Rope Rescue System Performance Criteria

- Mainline Function Criteria
  - Working load capability
  - Self-Braking
  - Non-rope twisting
- Back-up Function Criteria
  - Maximum Peak Force
  - Minimum Slip Force
  - Maximum Stopping Distance
  - Post Fall Functionality
  - Minimum Strength Criteria
  - Human Factors

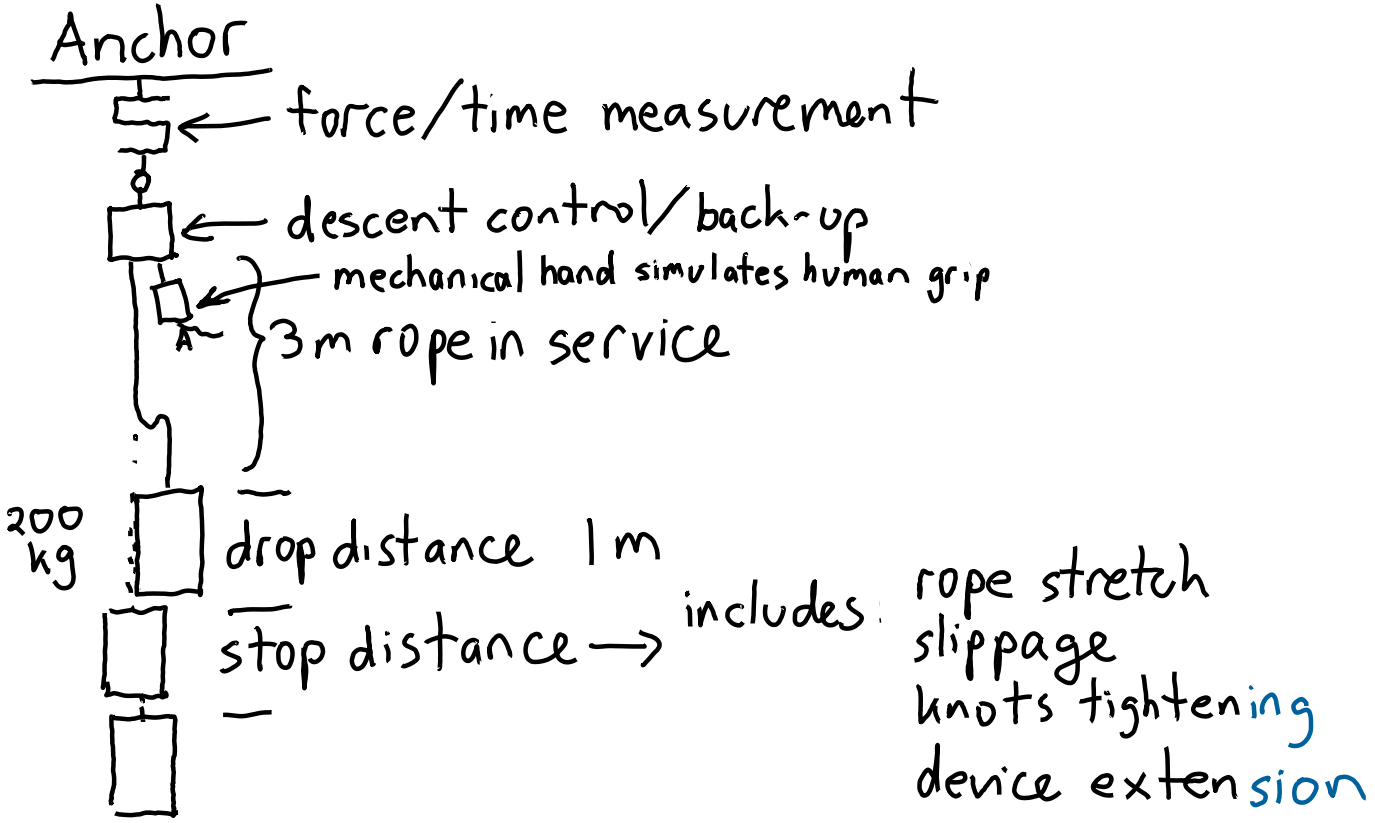
Mainline System Function Criteria

- Working Load $\leq$ 4 kN
- All techniques
- Each Rope System

Worst-Case Rescue Fall: Edge Transition

- Ropes elevated above ground
- Highest potential forces if a fall occurs
- Least amount of rope in service
- Stopping distance risk
- Test: 1m drop on 3m rope with 200 kg mass

Back-up Competency Test Method:



Rescue Back-up Performance Testing

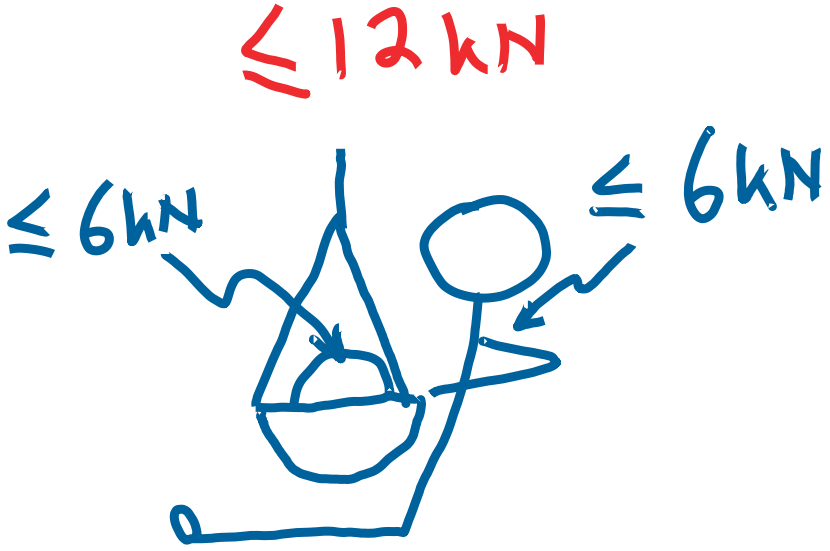
Back-Up Function Performance Criteria

- Maximum Fall Arrest Force: $\leq$ 12 kN
- Minimum Slip Force: $\geq$ 6 kN
- Maximum Stopping Distance: $\leq$ 1 m
- Remains Functional, Post Fall Arrest
- Minimum Strength: $\geq$ 20 kN
- Minimum Residual Strength Post Fall Arrest: $\geq$ 80%
- Maximum Rope Tailing Force: $\leq$ 0.1 kN
- Dynamic Strength Margin Test: 1.5m drop on 3m rope; system must not fail

Why Max Arrest Force ≤ 12 kN?

- Maximum Peak force should not exceed allowable standards/ regulations for fall arrest.

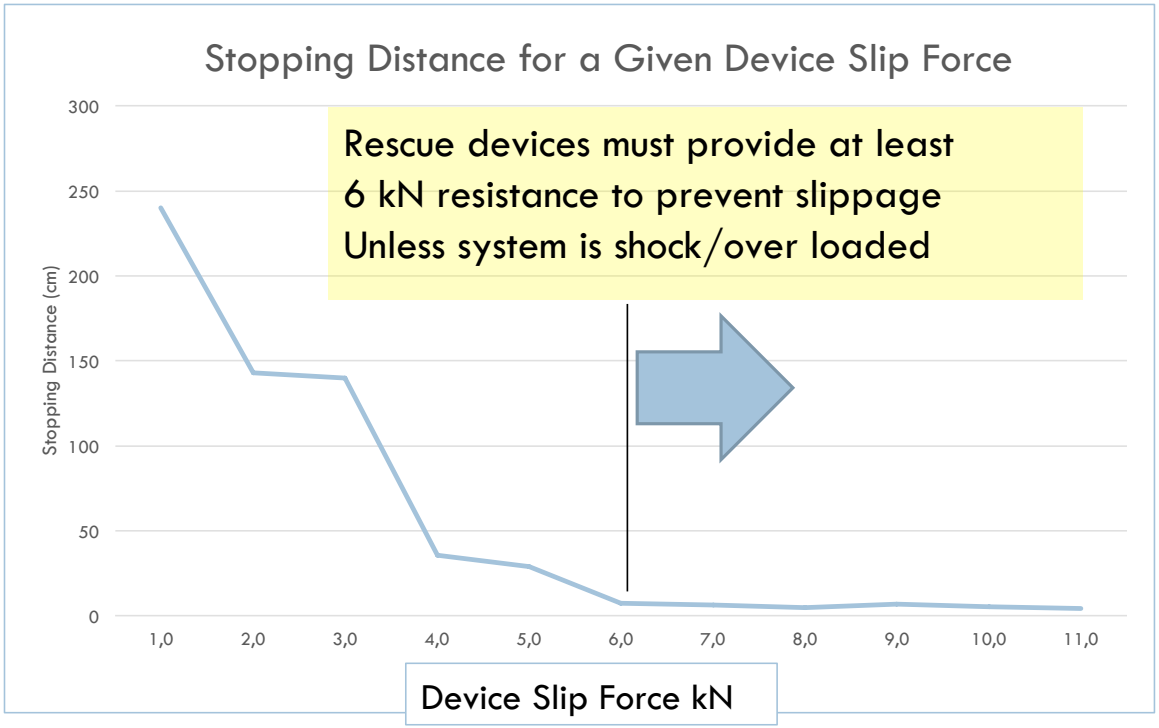
Max 6 kN



Why Min Slip Force ≥ 6 kN?

- Rope rescue systems are subject to ‘bounces’ or ‘jolts’, which spike rope tension; Minimum slip force must exceed spike values.
- Sudden spikes in force can be as high as 2.5 times the static load.
- Calculations and testing show that a minimum device slip force of 6 kN is required to prevent ‘inertial runaway’

Minimum Slip Force of 6 kN Prevents Runaway Loads



Rope Rescue Breaking Strength Requirement:

≤4 kN	6-12 kN	20+ kN
Working Load	Force Limiting	Strength

Breaking Strength calculated using American Society for Civil Engineering (ASCE) design principles for live (fluctuating) loads.
Requires knowledge of working loads, maximum loads, testing of worst case loads, and quality manufacturing/materials of equipment.

Two Tensioned Rope Systems

Human Factor Consideration

While lowering, the self-brake of both systems must be defeated. Therefore self-locking relies on the correct action of the operator if one rope system fails.

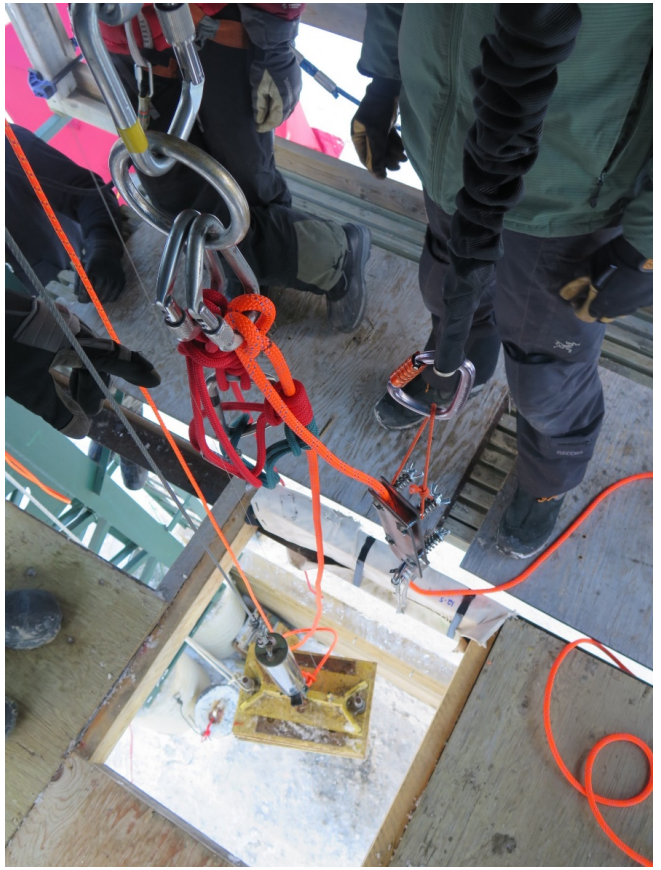
Rope Tailing – Effective Human Factor Countermeasure

Devices must not require more than 0.1 kN rope tailing requirement; requires testing to confirm.

Test: Self-Braking feature overridden, (mechanical rope tailing at 0.1 kN)

How did Systems Performance Testing Help?

- Allowed for a data-based comparative analysis between various Rescue systems that use two [static or low stretch] ropes.
- Helps reveals factors of systems that can be improved upon.



Performance Criteria Have Improved Rope Rescue Systems

- Development of Dual Capability Two-Tensioned Rope Systems (DCTTRS)
- Each rope system must meet the performance criteria for both mainline and back-up line functions.
- Share information: TER-REC0005

THANK YOU
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Rope Rescue System Performance Criteria

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