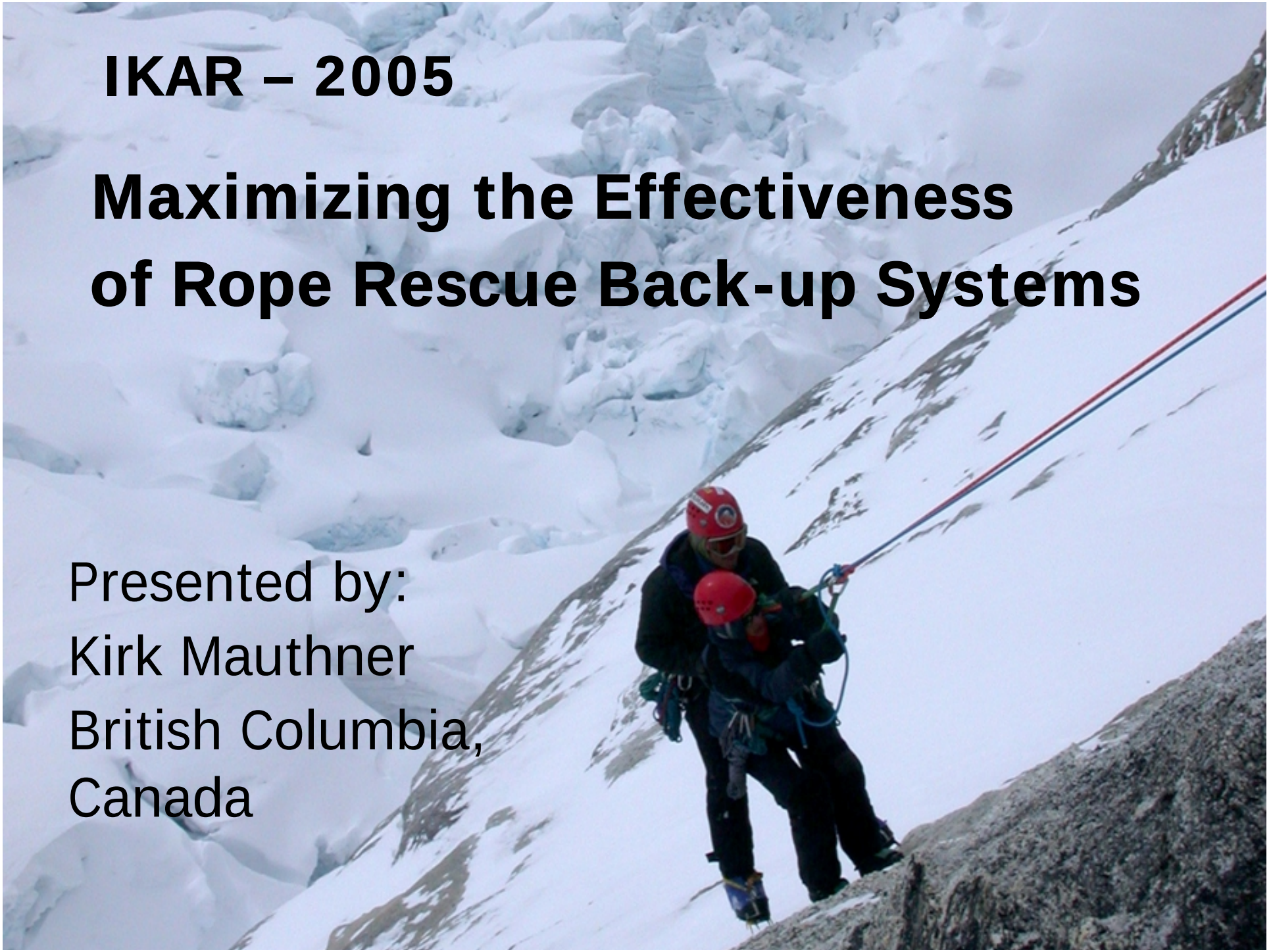


IKAR – 2005

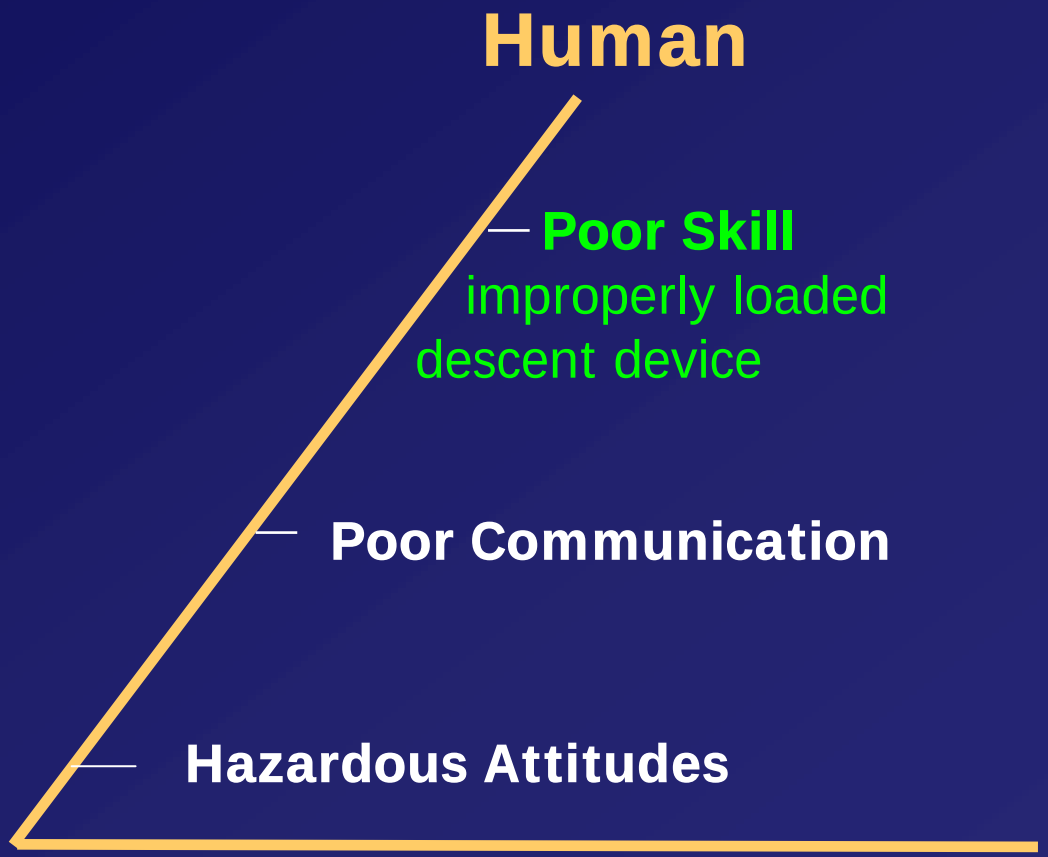
Maximizing the Effectiveness of Rope Rescue Back-up Systems

Presented by:
Kirk Mauthner
British Columbia,
Canada

Back-up Rope Systems are used because mainline system failures can and have occurred.

Causes of Mainline System Failures:

Factors Affecting Mainline System Failures:

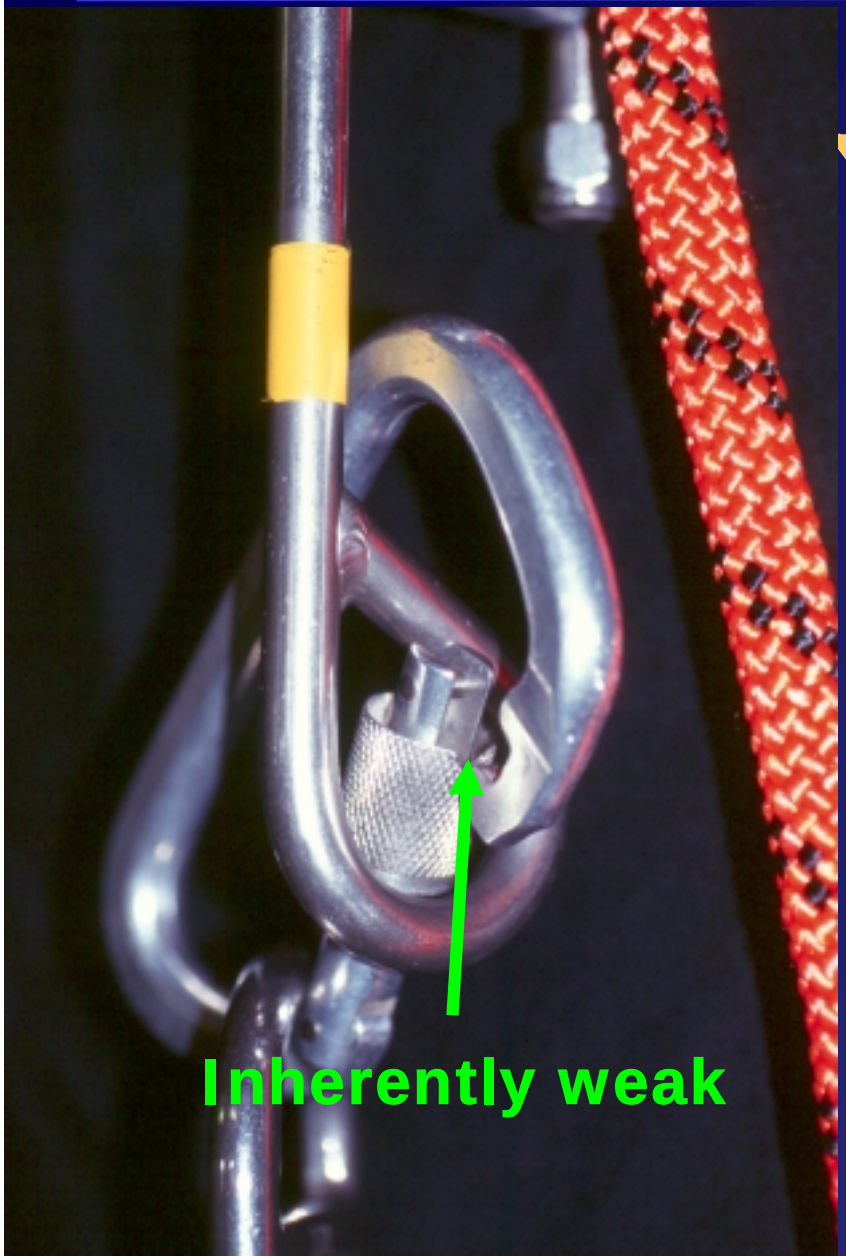


Factors Affecting Mainline System Failures:

Methods

- **Low Safety Factors**
  (e.g. certain rope grabs)
- **Limited / Difficult Control**
- **Unsuitable for terrain**
- **No Autolock**

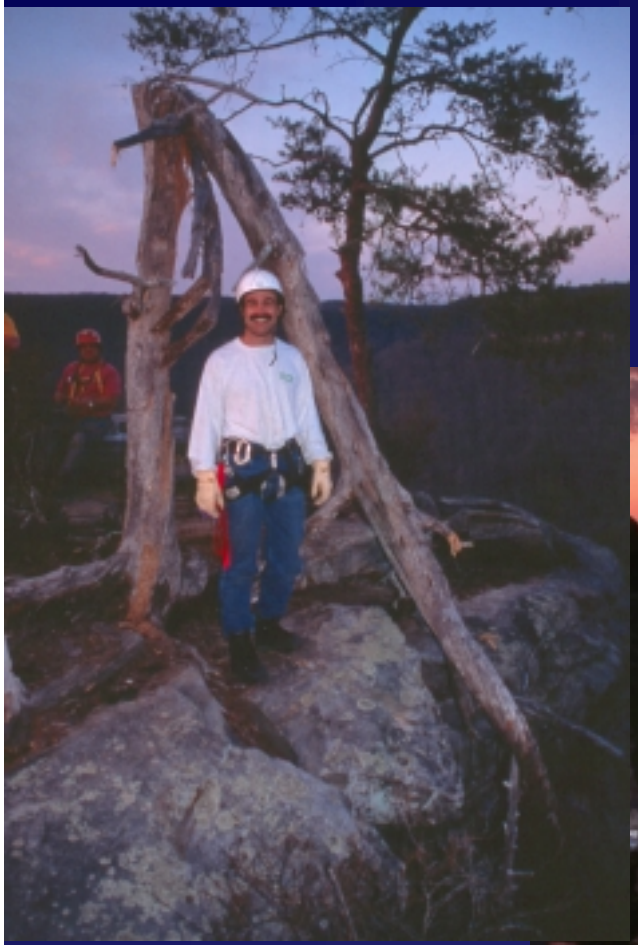
Factors Affecting Mainline System Failures:

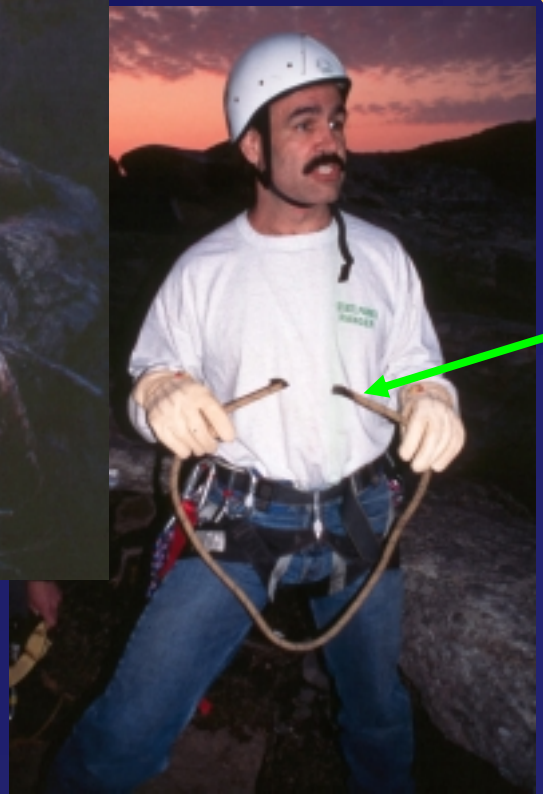


- Design Weakness
  (inherently weak against gate)
- Abused
- Defective
- Fatigued / Worn Out

Equipment

Factors aAfecting Mainline System Failures:





- Rockfall / Avalanche
- Sharp Edges & Pinch Points
- Weak Anchors
- Temperature, Chemical
- Lightning, Animals
  (lightning struck rope during training)

Environment

Proper training, good technique and good communication can prevent most causes of mainline system failure...

...but not all...and the consequence of failure is severe!

Using a Back-up provides safety to the rescuer and patient…

…but requires managing the right risk, at the right time.

Rope Choices in North America:

Conforming to Cordage Institute Standard 1801-98

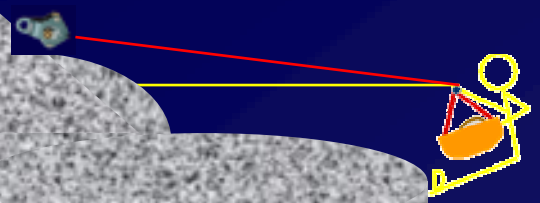
Static: Elongation of $\leq$ 6% when tensioned to 10% of its rated breaking strength.

Low Stretch: Elongation of 6 $\leq$ 10% when tensioned to 10% of its rated breaking strength.

Dynamic: Conforming to UIAA/EN 792 Standards

Back-up Devices in North America

4 Phases of Managing the Back-up Rope

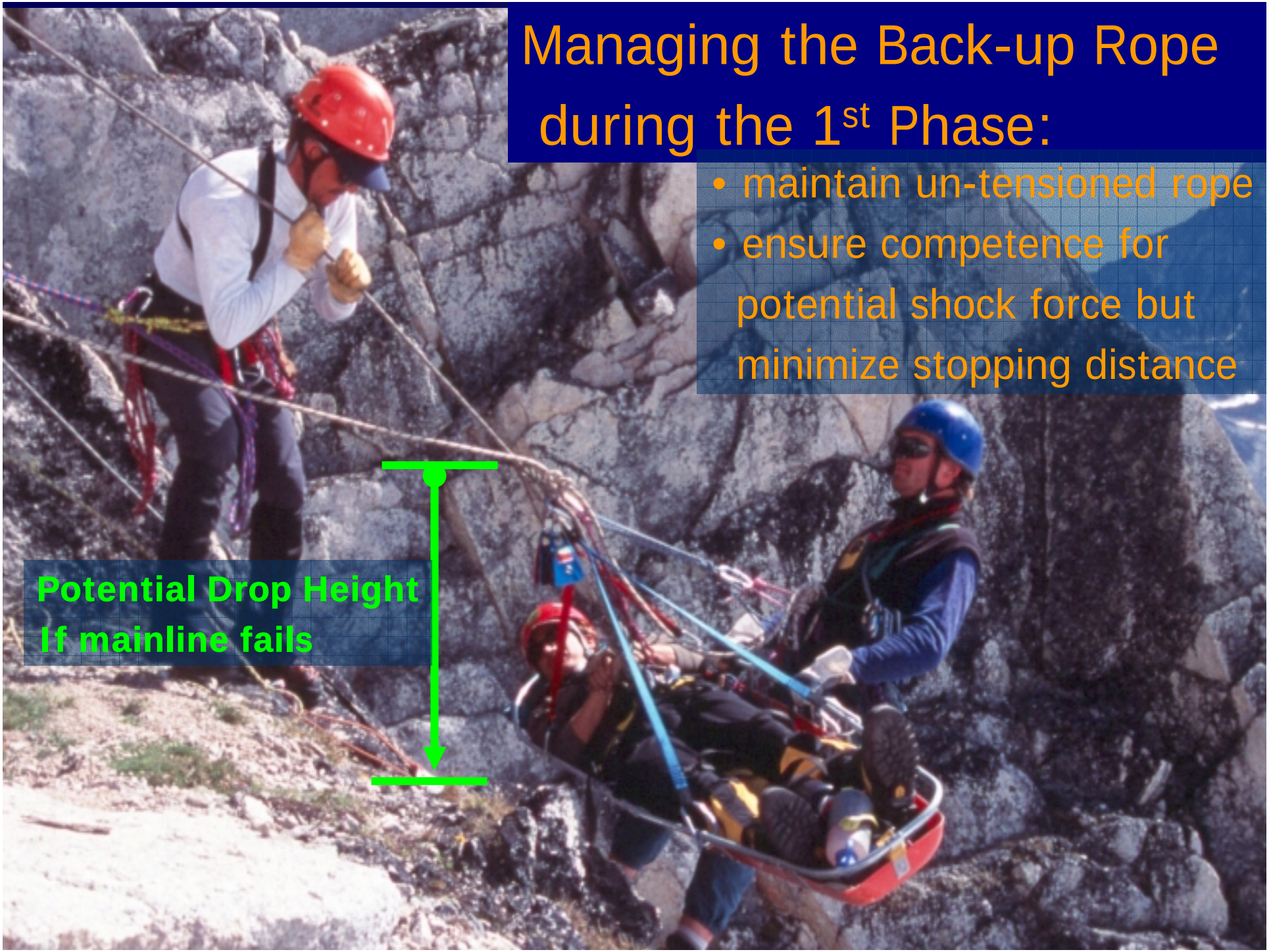


1st Phase: Edge Transition

2nd Phase: within 30 m of descent

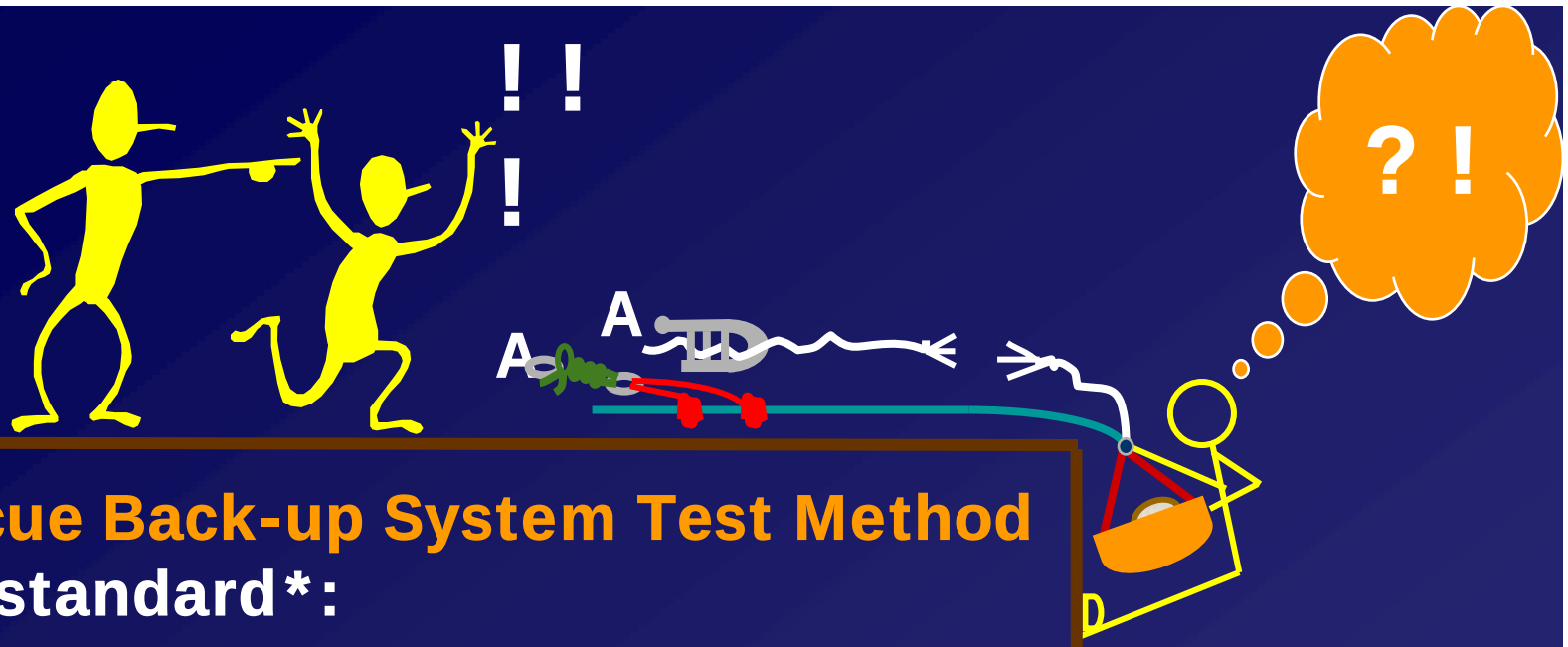
3rd Phase: after 30 m of descent

4th Phase: when angle decreases



Managing the Back-up Rope during the 1st Phase:

- maintain un-tensioned rope
- ensure competence for potential shock force but minimize stopping distance



Rope Rescue Back-up System Test Method
minimum standard*:

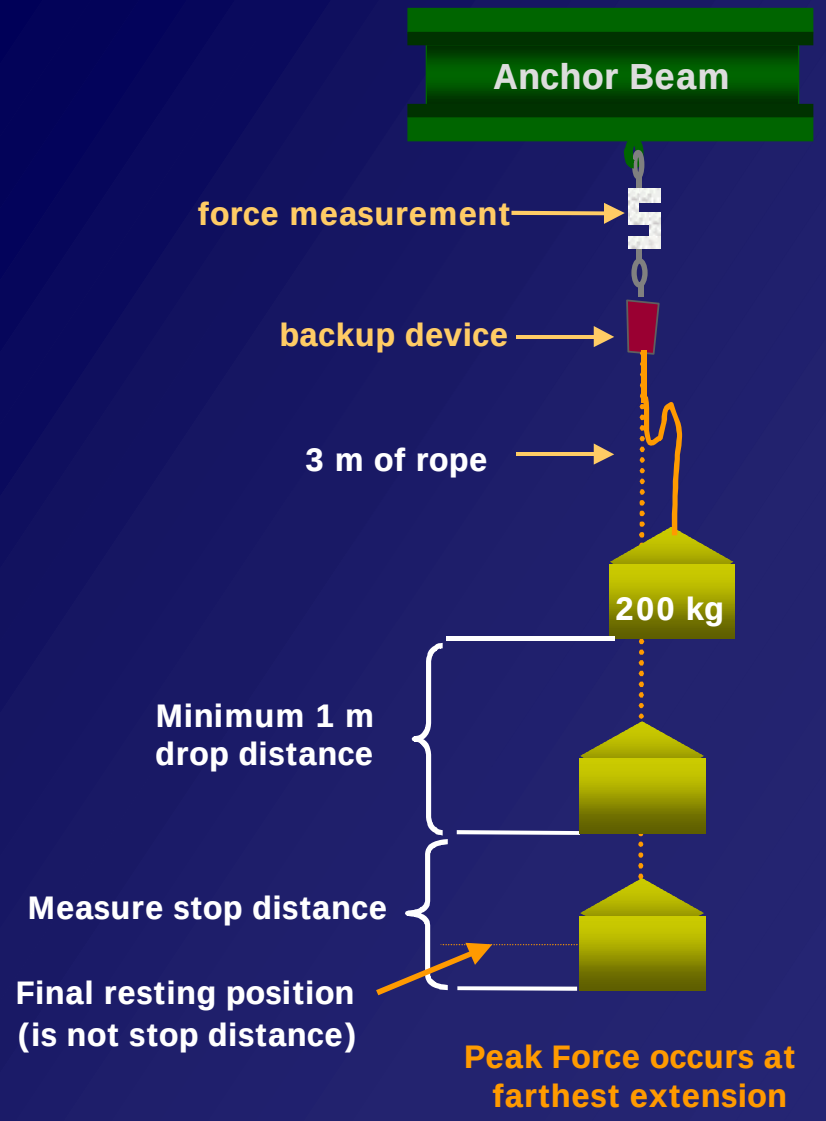
1 metre drop **of a**

200 kg mass **(two people + gear) tied to**

3 metres of rope

* Represents the relative worst-case event of an edge transition

Test Method Set-up

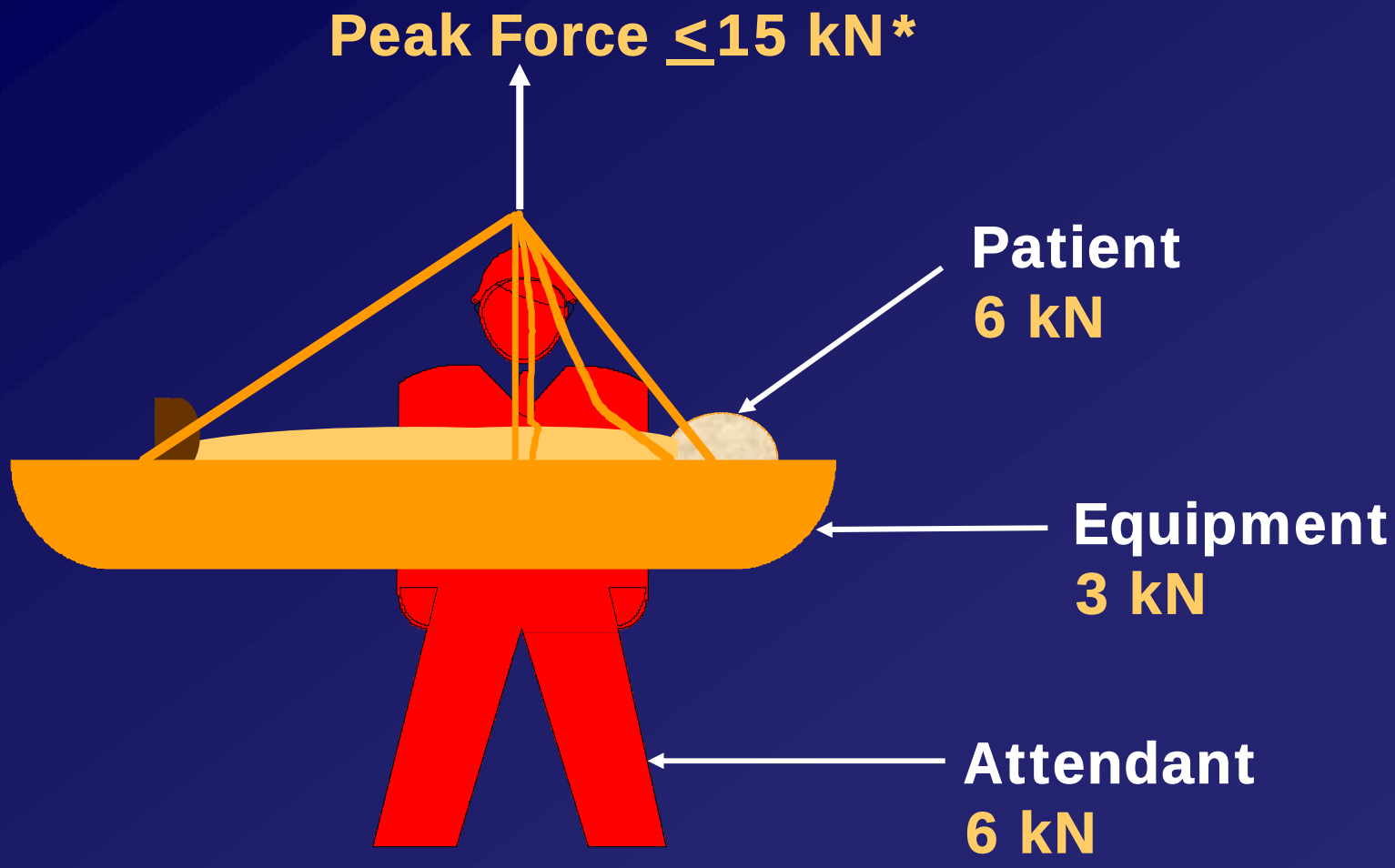


Back-up System Competence Criteria:
(British Columbia),

- Stop distance must be **within 1 metre**
- Peak force must be **15 kN or less**
- Post-drop, the system must be **functional**
- Residual rope strength at least **80%**

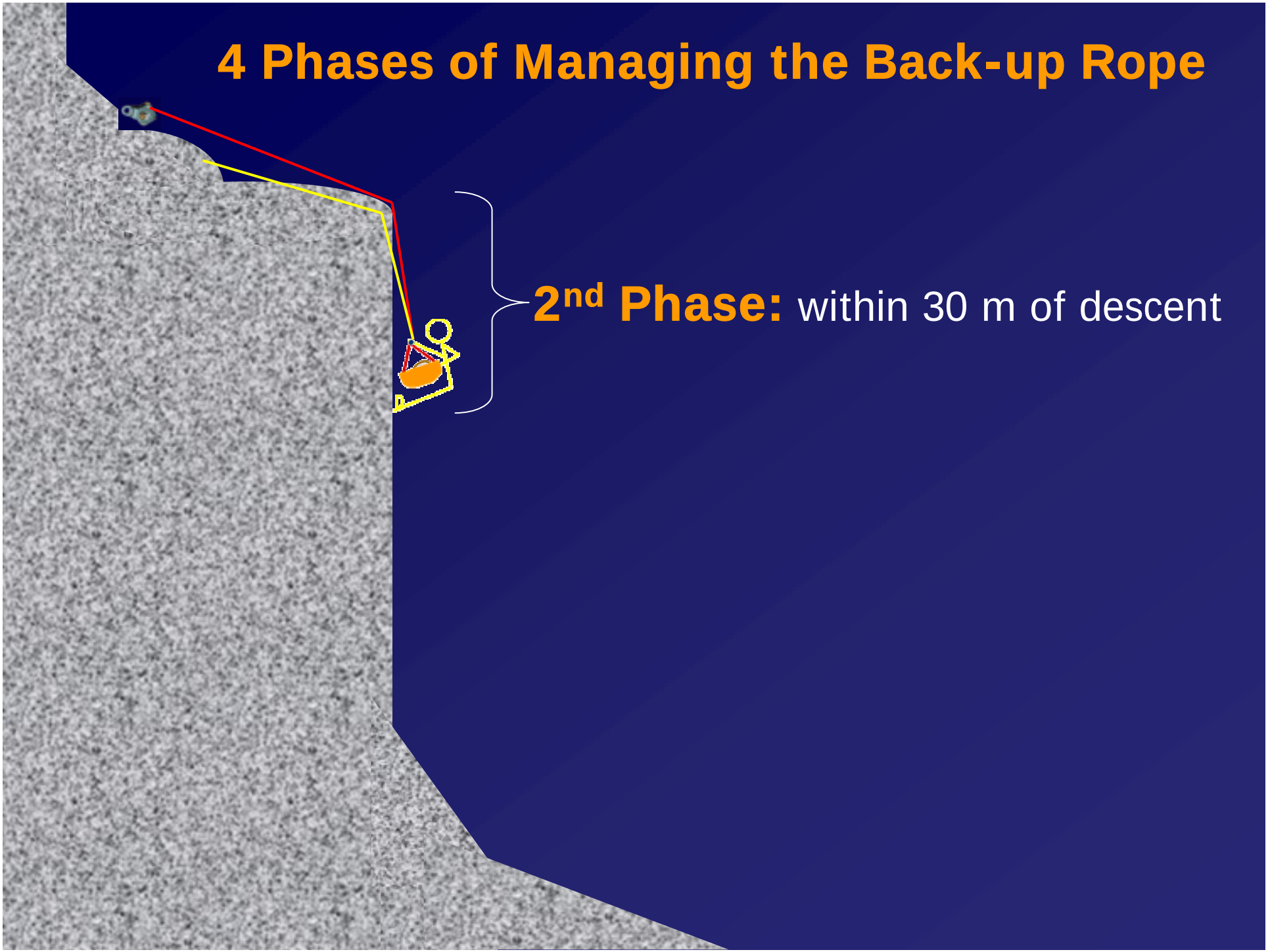

540°

Dynamic Force Distribution



* Typical peak force is less than 12 kN

4 Phases of Managing the Back-up Rope



2nd Phase: within 30 m of descent


2nd Phase
During the first 30m of descent
Maintain only hand-tight tension on back-up rope

2nd Phase:

How much rope stretch occurs if the mainline system fails within the first 30 m?

Demonstration Tests:

- Mainline failure
- 30 m of rope in service
- 200 kg mass
- Settle into back-up rope

- Compare stopping distance of:

  Static to Low Stretch


Static
0
1
2
3
4
5

Peak Force and Stretch with 30 m rope in service

Rope	Peak (kN)	Stretch (m)	Stretch (%)
11 mm Static	4.7	2.4	8.0
11 mm Low Stretch	4.5	4.7	15.8

Essentially the same peak force but double the stretch

If there is no freefall*, then peak force (kN) is essentially the same,regardless of rope type

Rope in Service	2 m	3 m	4 m	30 m
11 mm Static	5.3	4.9	5.2	4.7
11 mm Low Stretch	5.3	5.0	4.8	4.5
11 mm Dynamic	5.4	4.8	5.1	N/A

*failed mainline, settle into back-up rope; 200 kg

Dynamic rope should never be used as a Back-up rope for rescue loads!

The problem with using Dynamic rope as a Back-up

3rd Phase:

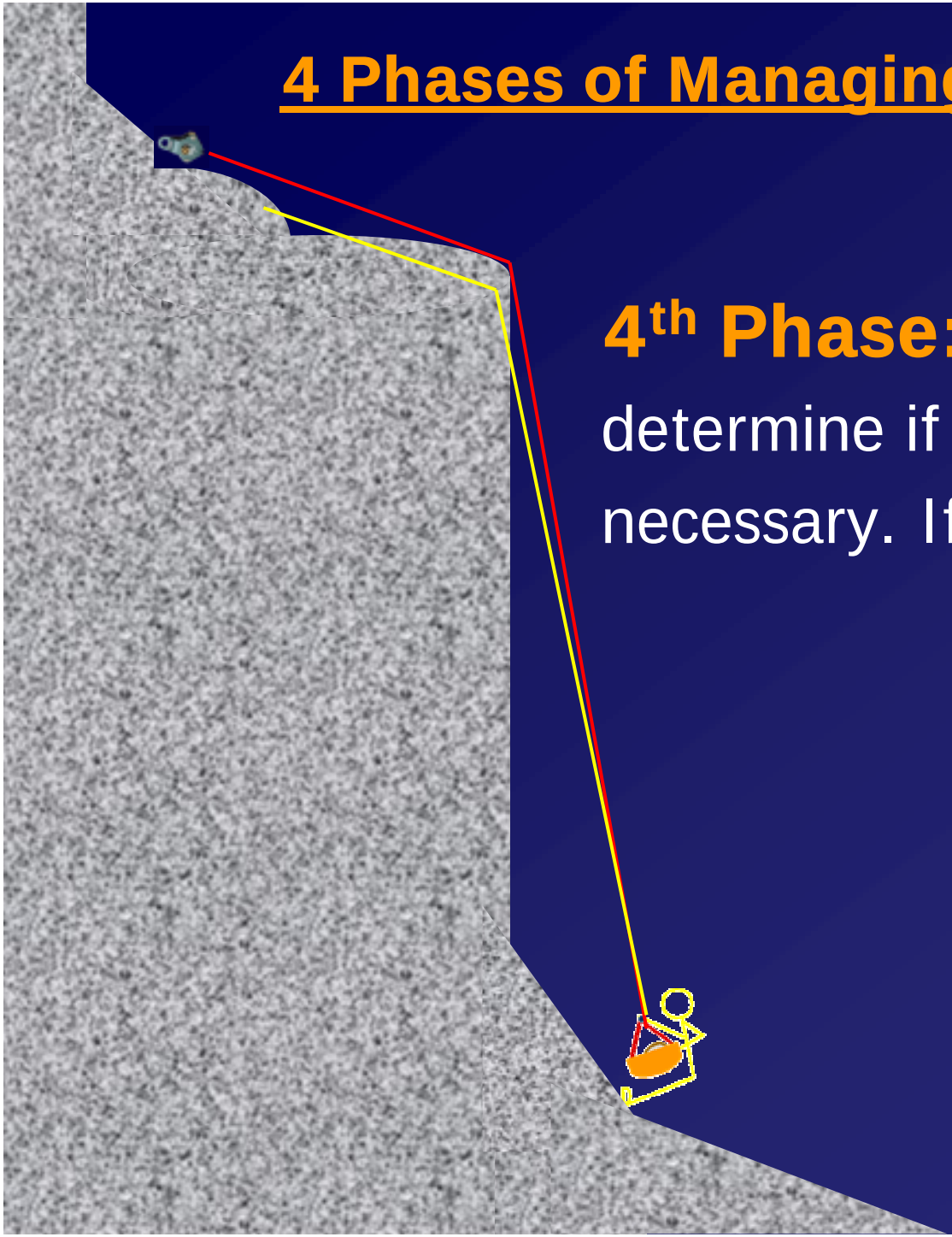
Considerations after 30 m of rope in service:

- long stopping distance if mainline system fails
- un-tensioned back-up rope can pull rocks down
- rescuer has good control of load therefore pendulum less likely

With ≤ 30 m rope in service,
Back-up rope is kept hand tight only

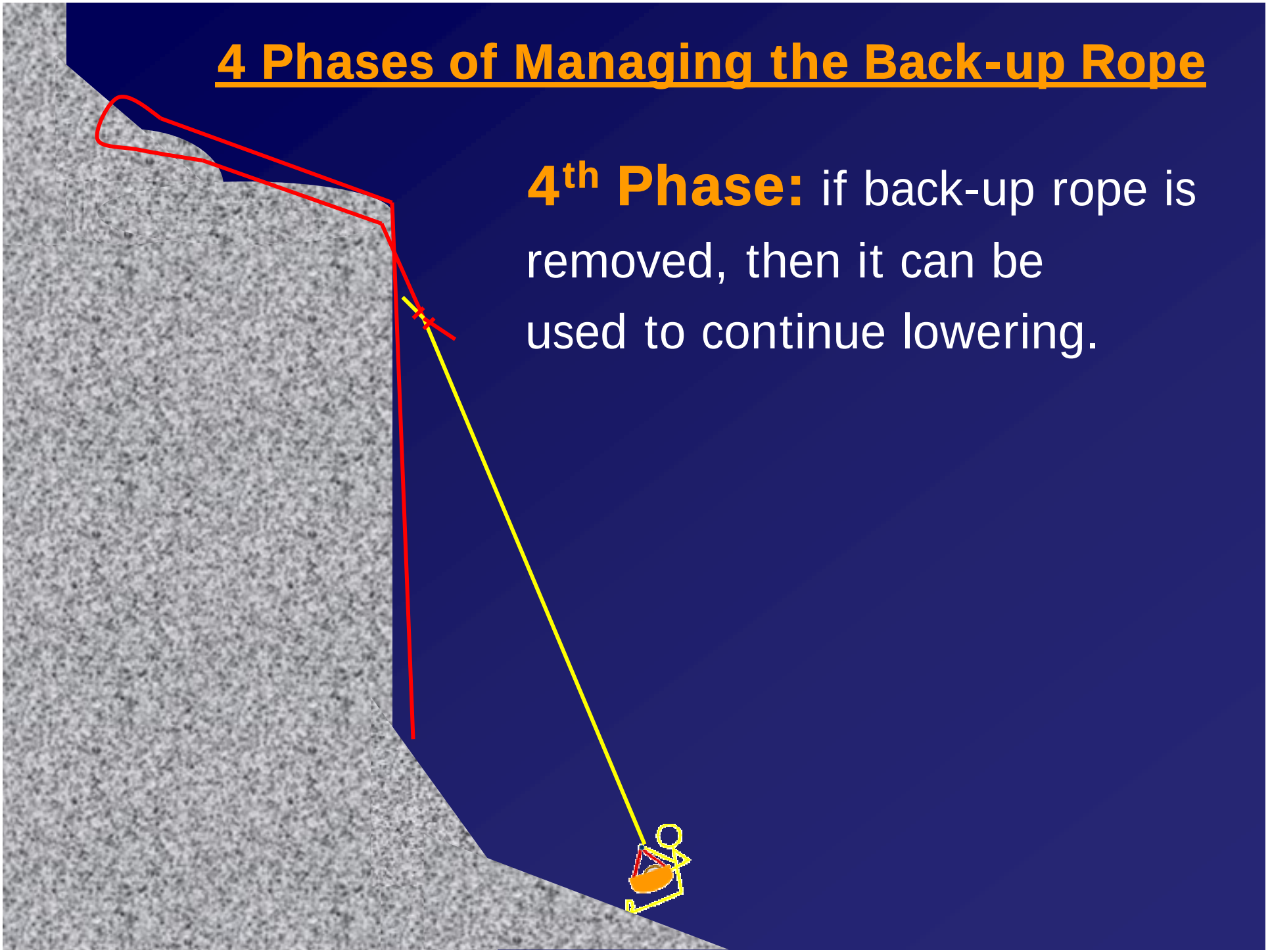

After 30 m, add friction to
Back-up rope to remove
undue stretch.

4 Phases of Managing the Back-up Rope



4th Phase: when angle decreases, determine if back-up rope is still necessary. If not, then remove it.

4 Phases of Managing the Back-up Rope



4th Phase: if back-up rope is removed, then it can be used to continue lowering.

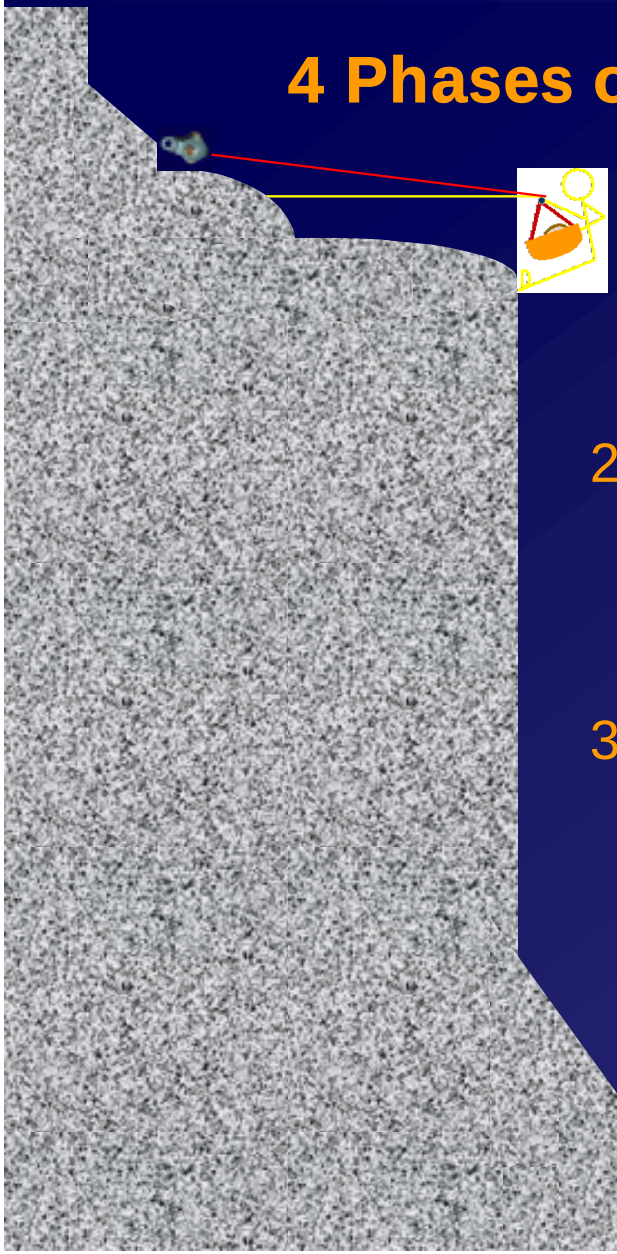
Summary:

- **select low elongation rope so that:**
  - peak force is acceptable
  - shorter stopping distance improves rescuer safety

- **use competent back-up devices that can:**
  - withstand shock forces and remain functional
  - limit stopping distance

Summary:

4 Phases of Managing the Back-up Rope



1st Phase: Edge Transition

- hand-tensioned back-up

2nd Phase: within 30 m of descent

- hand-tensioned back-up

3rd Phase: after 30 m of descent

- share tension between back-up and mainline ropes

4th Phase: when angle decreases

- decide if still need back-up


Grazie
Merci
Danke
Thank-you
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Kirk Mauthner, Canada