# MODERNISATION OF TERRESTRIAL RESCUE EQUIPMENT AND TECHNIQUES IN THE SLOVENIAN MOUNTAIN RESCUE SERVICE

**DR. MIHA KENDA**

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# SLOVENIA

- Central Europe country
- Area: **20,271 km²**
- **78% of Slovenia** is covered by mountainous terrain
- **352 peaks** above 2,000 meters
- **Main mountain ranges**:
  - **Julian Alps** – Mt. Triglav (2,864 m)
  - **Karawanks** – Mt. Stol (2,236 m)
  - **Kamnik–Savinja Alps** – Mt. Grintovec (2,558 m)
- **Rock walls**:
  - **Highest:** Triglav North Face (1,300 m)
  - **Widest:** Loška Face (7 km)

# MOUTAIN RESCUE ASSOCIATION OF SLOVENIA

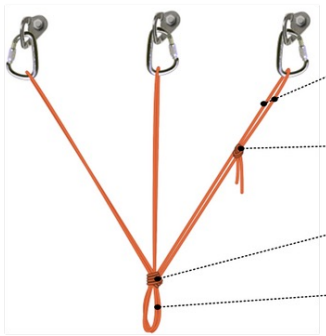
**MISSION:** Protection, rescue, and assistance in the mountain environment & response to natural and other disasters

- **Founded:** June 16, 1912
- **Structure:** Association of 18 independent stations
- **Members:** 869 active rescuers
- **Type:** Voluntary and non-profit organization

Trentarji — reševalci dr. Jos. Stojc — a 1909

# OUR EX- TECHNIQUES

- **In 90s  pioneers in rope rescue techniques**
  - **Semi-static EN 1891 A ropes** since 1993 ICAR Slovenia
  - **PETZL STOP descender** 1995
- **From 2001 to 2022** no big changes in technique
- **2022 Renovation of Recue anchors**
  - Kenda- Design of Rescue Anchorages through the 10:1 Static System Safety Factor, ICAR 2023 Toblach

Both strands of the accessory cord

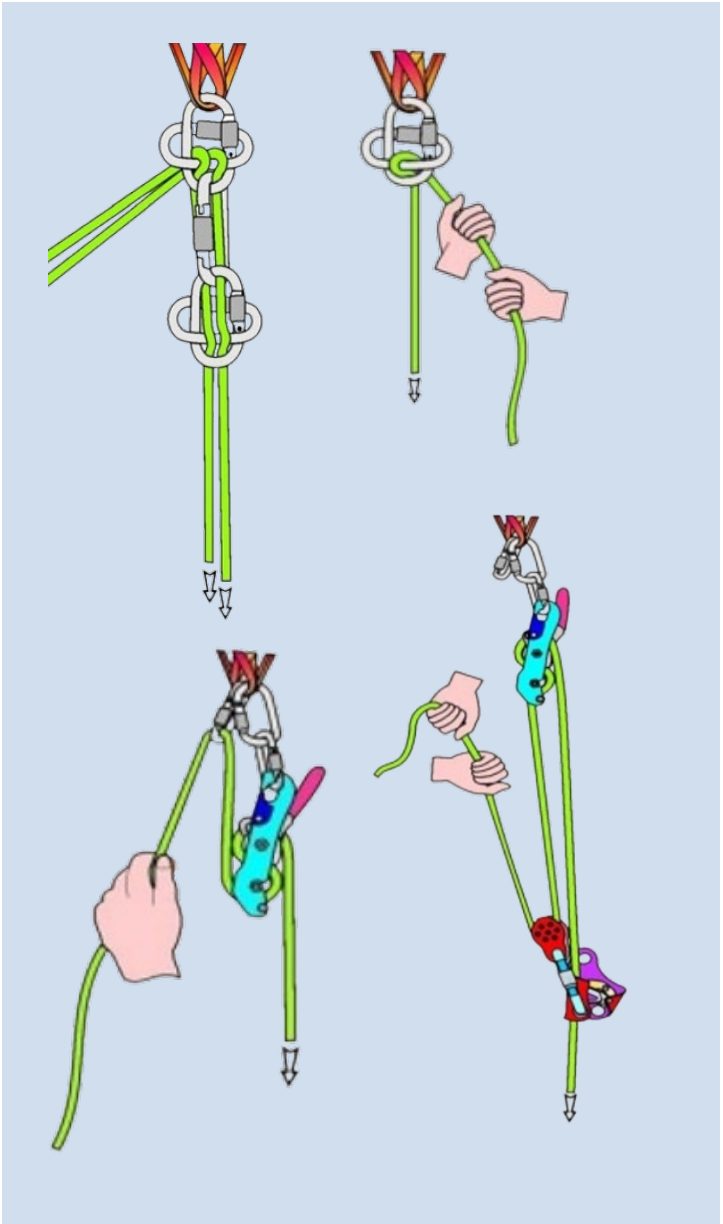
$$SSF = \frac{45\,\% \cdot 9{,}8\ \text{kN} + 9{,}8\ \text{kN}}{SRL/3} = \frac{14{,}21\ \text{kN}}{0{,}67\ \text{kN}} = 21{,}21$$

Overhand knot – rope connection

$$SSF = \frac{45\,\% \cdot 9{,}8\ \text{kN}}{SRL/6} = \frac{4{,}41\ \text{kN}}{0{,}33\ \text{kN}} = 13{,}36$$

$$SSF = \frac{65\,\% \cdot 6 \cdot 9{,}8\ \text{kN}}{SRL} = \frac{38{,}22\ \text{kN}}{2\ \text{kN}} = 19{,}11$$

$$SSF = \frac{3 \cdot 9{,}8\ \text{kN}}{SRL/2} = \frac{29{,}40\ \text{kN}}{1\ \text{kN}} = 29{,}40$$



# LIST OF REQUIREMENTS

## Main Slovenian Rope Rescue Techniques

**1.Rigging Systems:** Lowering, hauling, knot passing

1.1 **Devices operations;** Descenders, pulleys, ascenders, progress capture

1.2 **Winch Operations**

1.3 **Winter conditions load lowering & hauling;**

**2. Rope Access**

**3. Rescue Anchors**: Summer & winter setups

**4. Fixed/Safety Lines**

**5. Highline Systems**

**6. Stretcher Handling**

**7. Basic mountaineering Techniques**

# EQUIPMENT SELECTION RULES

**GOAL:** Develop a **personal technical rescue kit** that enables mountain rescuers to perform all rope-based rescue manoeuvres.

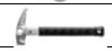
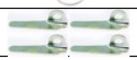
## Key Design Criteria:

1. **Minimal weight**
2. **Multi-functionality**
3. **Efficient load hauling**
4. **Simplified manoeuvres**
5. **Mechanical strength**

## KEY TECHNIQUES:

1. **Rigging Systems**
2. **Rope Access**

# PERSONAL & TEAM TECHNICAL RESCUE KIT

| # | Device/Tool Type | Commercial Name | Quantity | Weight [g] | Image |
|---|---|---|---|---|---|
| 1. | Anchor Plate | Petzl PAW S | 1 x | 60 |  |
| 1. | Self-braking Device | Petzl RIG | 1 x | 400 |  |
| 2. | Brake Carabiner | Petzl Freino Z | 1 x | 75 |  |
| 3. | Ascender | Petzl Ascension | 1 x | 165 |  |
| 4. | Pulley | Petzl Partner | 1 x | 56 |  |
| 5. | Alpine Hammer | Petzl Bongo | 1 x | 680 |  |
| 6. | Lanyard | Petzl Progress Adjust Y | 1 x | 230 |  |
| 7. | Lanyard Carabiners | Petzl Am'D TWIST LOCK | 2 x | 150 2x 75 |  |
| 8. | Multidirectional gated ring | Petzl RING OPEN | 1x | 70 |  |
| 9. | 40 cm sling | HMPE cord sling 6 mm 40 cm | 1 x | 27 |  |
| 10. | Sewn sling 120 cm | Petzl Annenau 120 | 1 x | 100 |  |
| 11. | Sewn sling 150 cm | Petzl Annenau 150 | 1 x | 135 |  |
| 12. | Oval Carabiner | Petzl OK SL | 3x | 210 3x 70 |  |
| 13. | HMS Carabiner | Petzl William SL | 3 x | 255 3x 85 |  |
| 14. | Belay Plate | Petzl Reverso | 1x | 57 |  |
| 15. | Universal Pitons | MG metal | 4 x | 352 4x 88 |  |
| 16. | Accessory Cord EN 564 Ø 7mm | 5 m Strength>10 kN *31 g/m | 1 x | 155 |  |
| 17. | Accessory Cord EN 564 Ø 8mm | 7 m Strength>15 kN *40 g/m | 1 x | 280 |  |
| | | | **Total Weight** | **3457g** | |

| # | Device / Tool Type | Commercial Name | Qty | Weight [g] | Image |
|---|---|---|---|---|---|
| 1. | Self-braking device | Petzl MAESTRO | 2 x | 1100 |  |
| 3. | Rope clamp | Petzl Rescucender | 2 x | 260 |  |
| 4. | Single pulley with swivel | Petzl SPIN L1 | 2 x | 290 |  |
| 5. | Double pulley with swivel | Petzl SPIN L2 | 2 x | 480 |  |
| | | | **Total Weight:** | **2130 g** | |

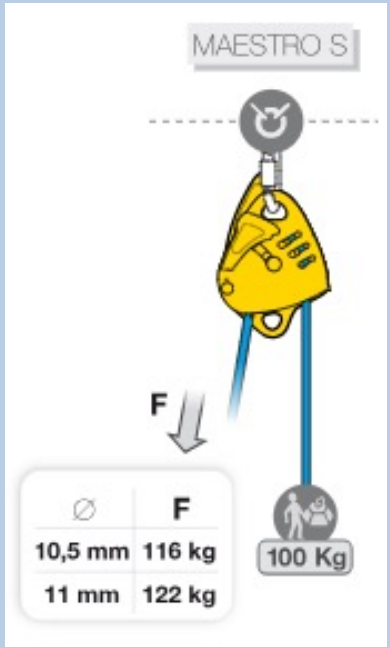
* 2 sets for every rescue station

**Key Design Criteria:**

1. Minimal weight
2. Multi-functionality
3. Elements strength
4. **Simplified manoeuvres**
5. **Efficient load hauling**

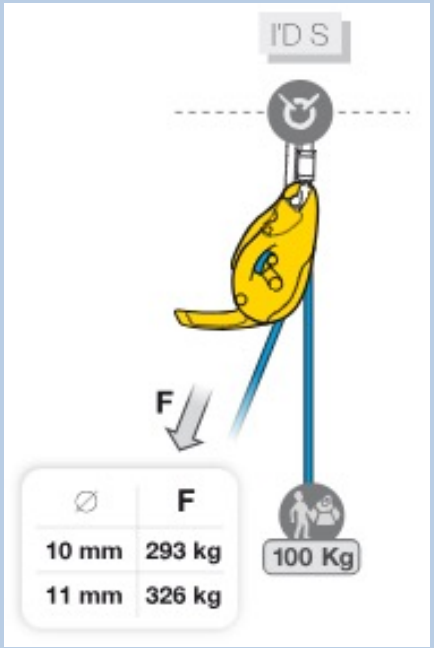
# EFFICIENT LOAD LIFTING

**SIMPLE DIRECTIONAL (1:1)**




$$\eta = \frac{100\ kg}{116\ kg} = 86\%$$

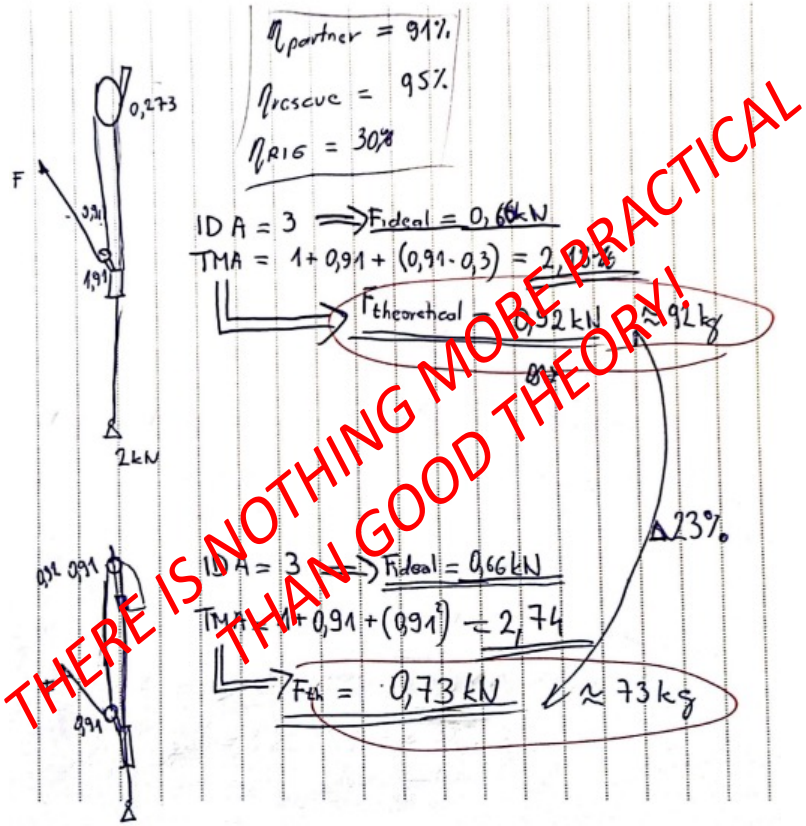
SRL 200 kg .... 232 kg



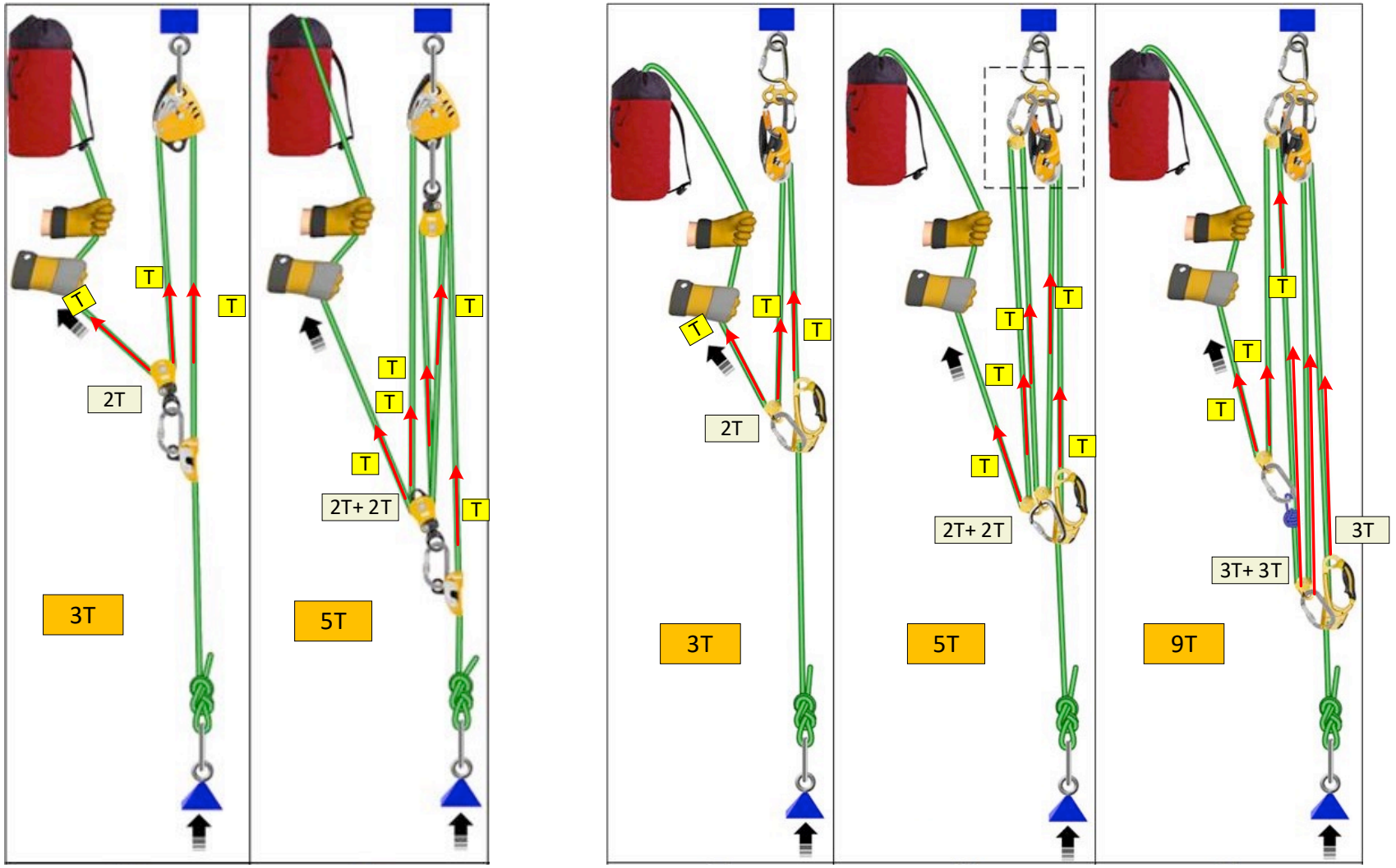

$$\eta = \frac{100\ kg}{293\ kg} = 34\%$$

SRL 200 kg .... 586 kg !?

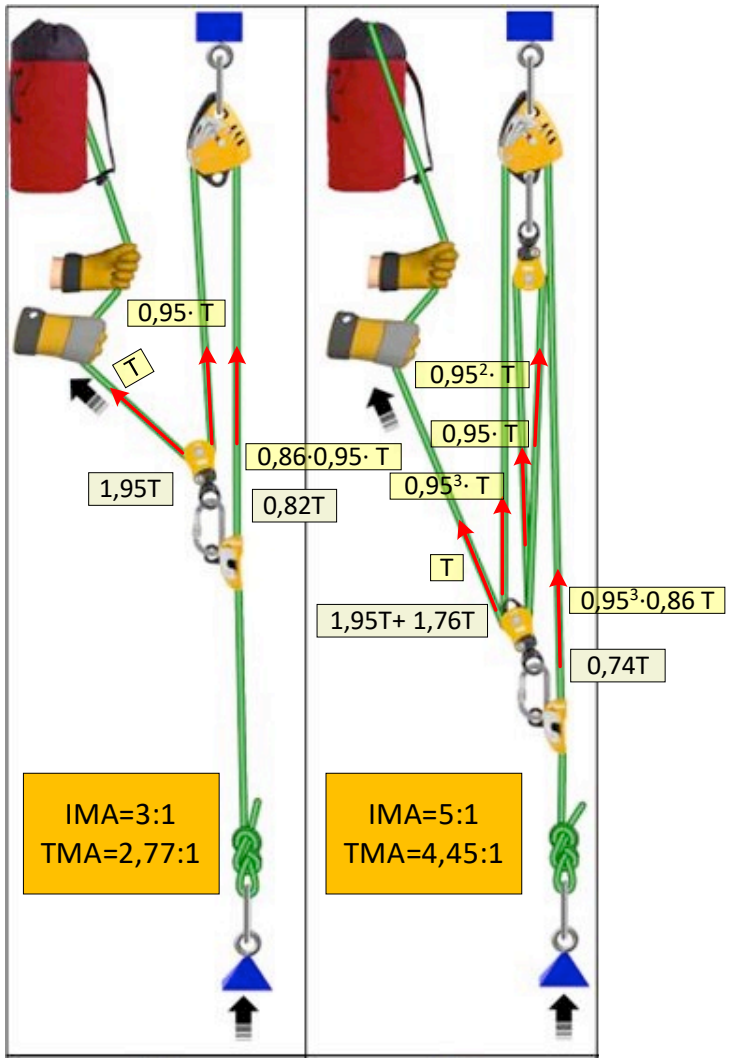
Pulley system efficiency tests with
MAESTRO, I'D S, PRO TRAXION, ROLLCLIP

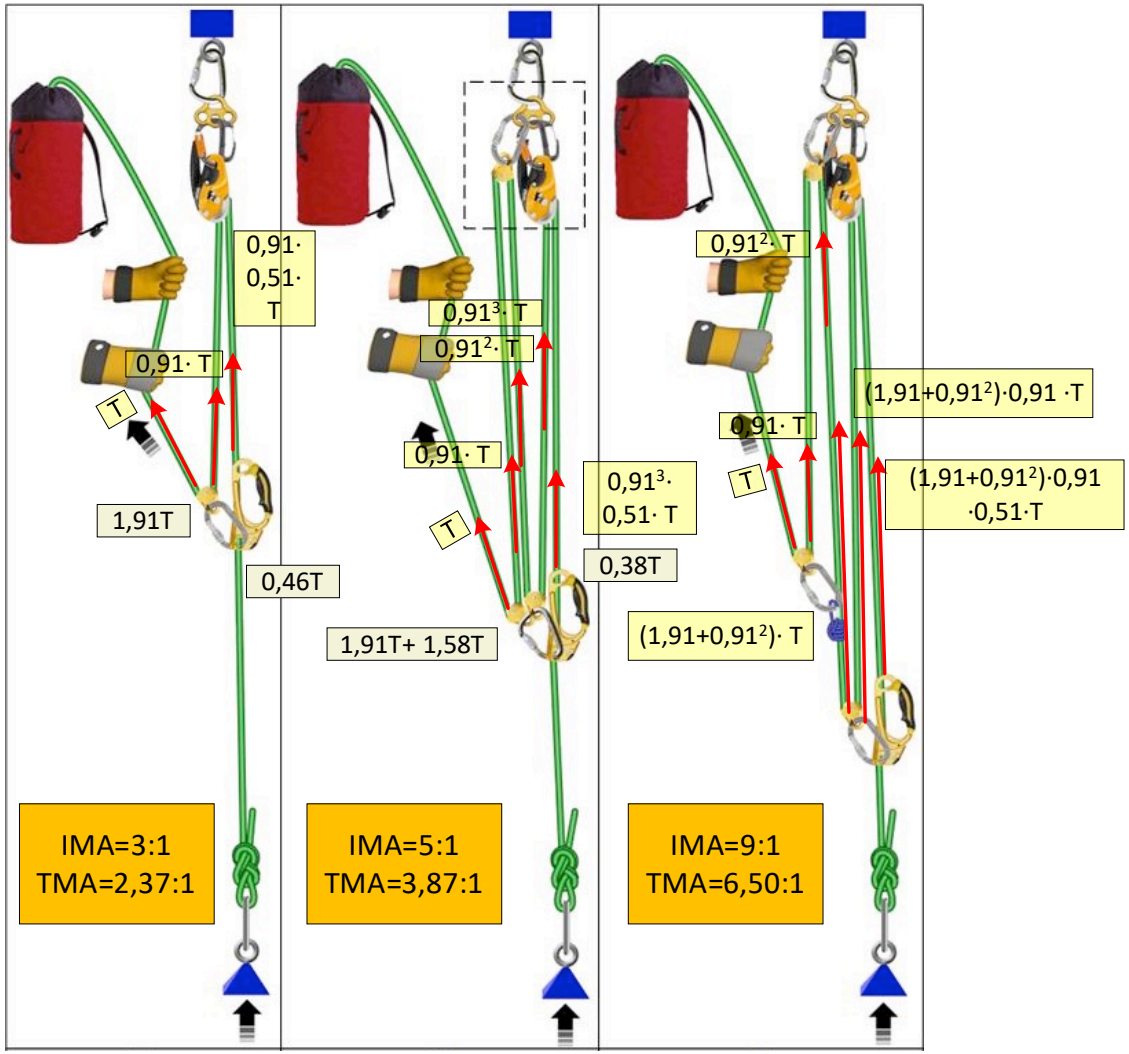


# EFFICIENT LOAD HAULING



# EFFICIENT LOAD HAULING



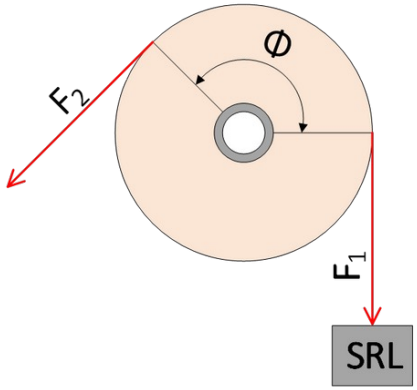
# EFFICIENT LOAD HAULING

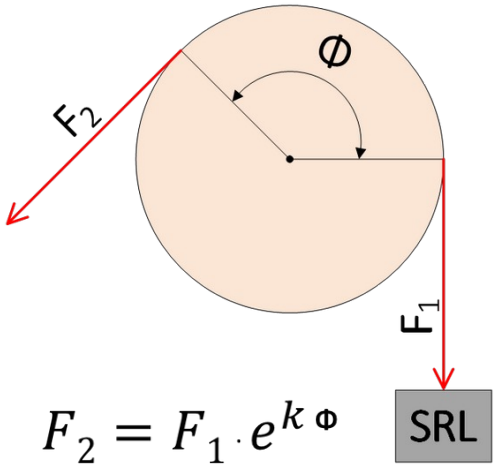
| Device | IMA | TMA | Ft @2kN [kN] |
|---|---|---|---|
| RIG | 3:1 | 2,37:1 | 0,84 |
| RIG | 5:1 | 3,87:1 | 0,51 |
| RIG | 9:1 | 6,50:1 | 0,31 |
| MAESTRO | 3:1 | 2,77:1 | 0,73 |
| MAESTRO | 5:1 | 4,45:1 | 0,45 |

| TMA-η=0,34 | Ft @2kN [kN] |
|---|---|
| 2,22:1 | 0,90 |
| 3,75:1 | 0,53 |
| 6,08:1 | 0,33 |

$$Ft = \frac{SRL}{TMA}$$

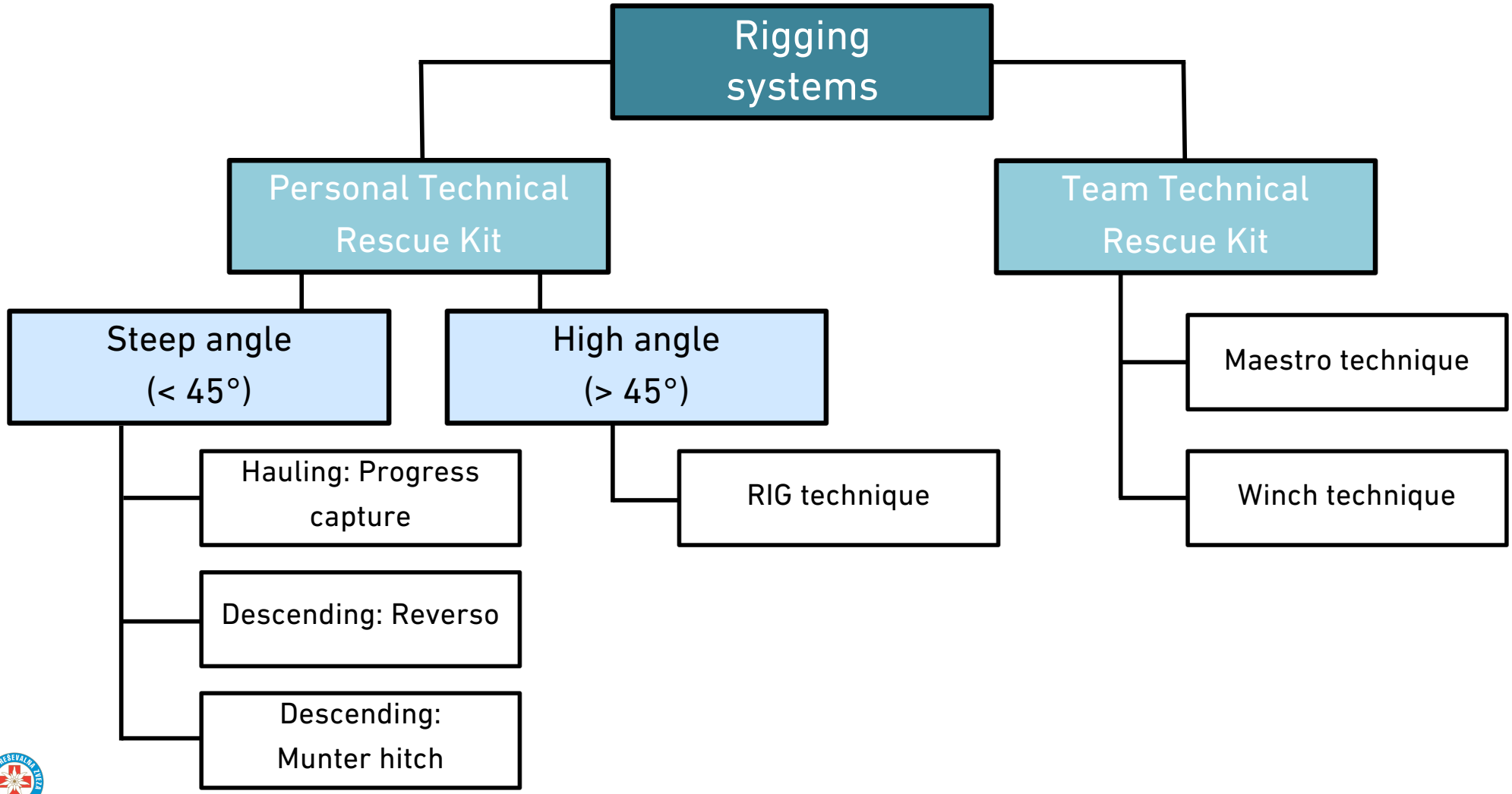
Ft values for single-rope hauling. In a two tensioned rope system, the values are further halved.

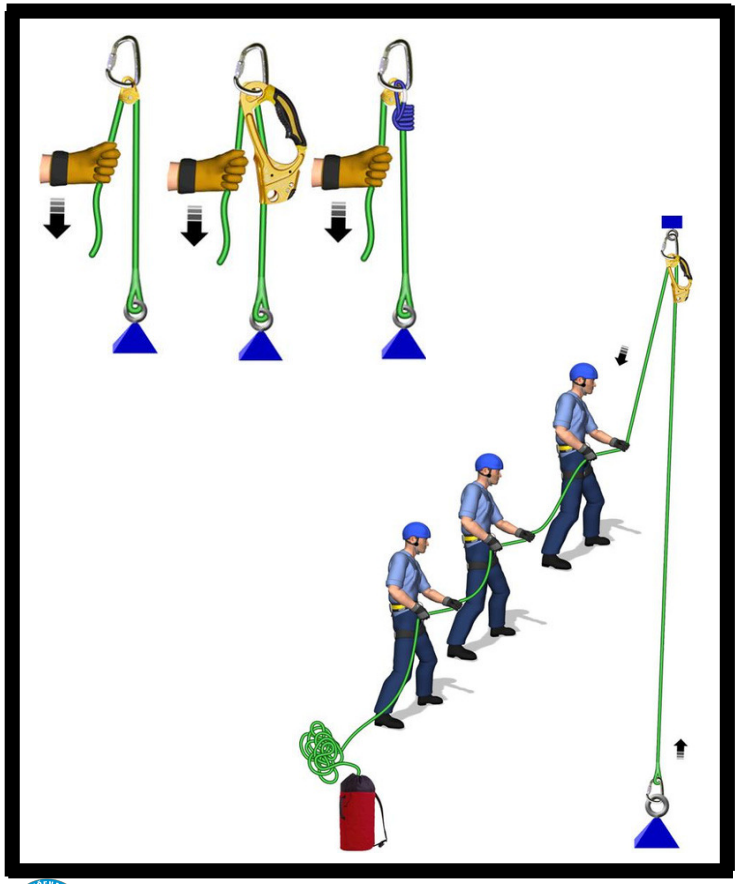

$$F_2 = F_1 \cdot e^{k\,\Phi}$$

# RIGGING SYSTEMS

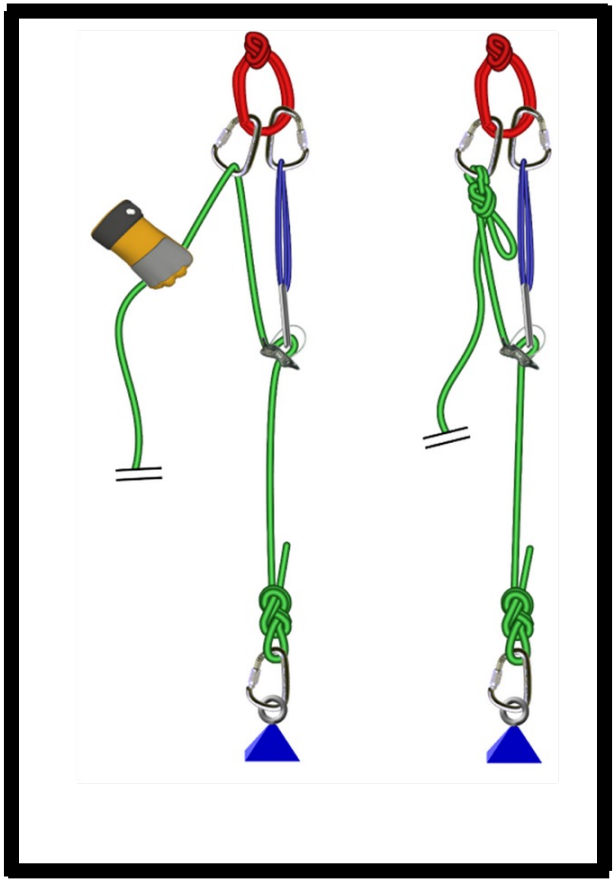


# PTRK: STEP ANGLE <45°

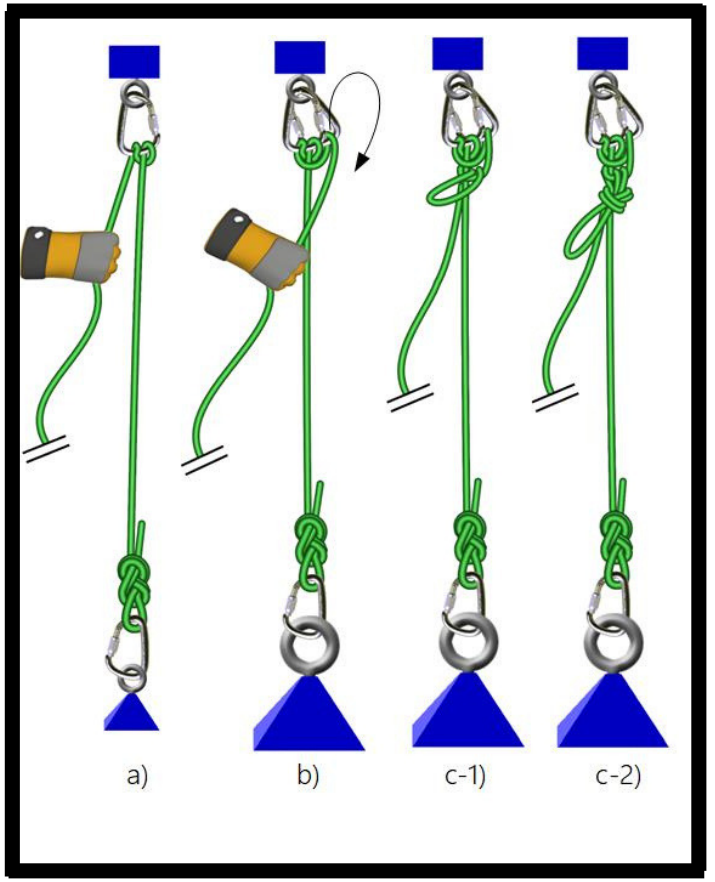
## HAULING: PROGRESS CAPTURE



## DESCENDING: REVERSO

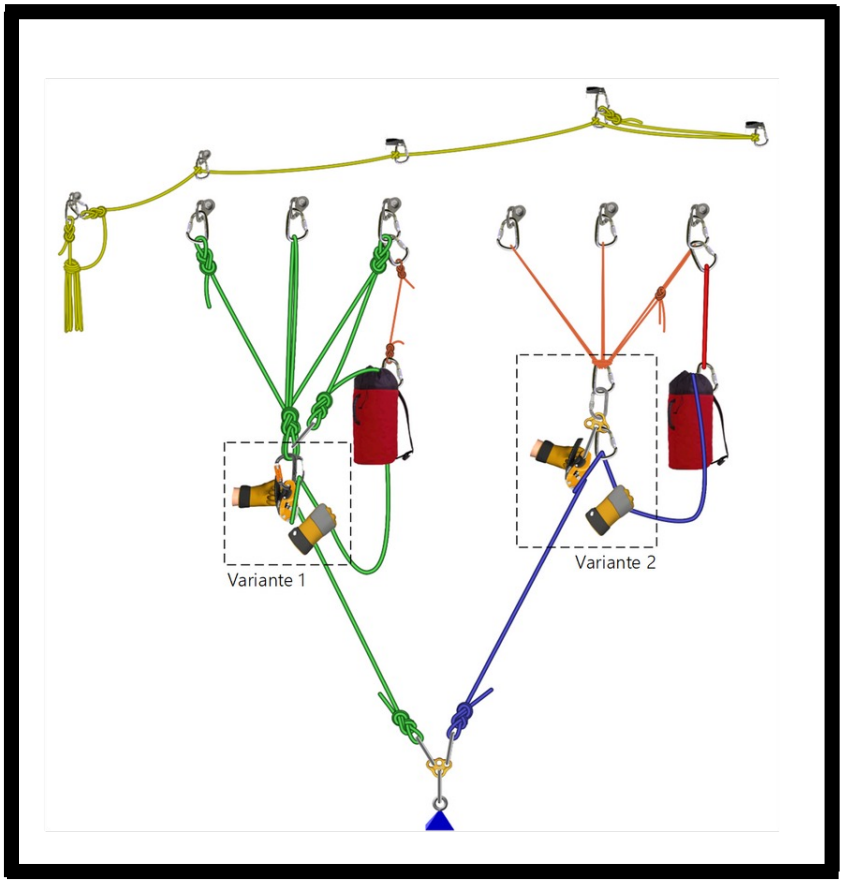


## DESCENDING: MUNTER HITCH

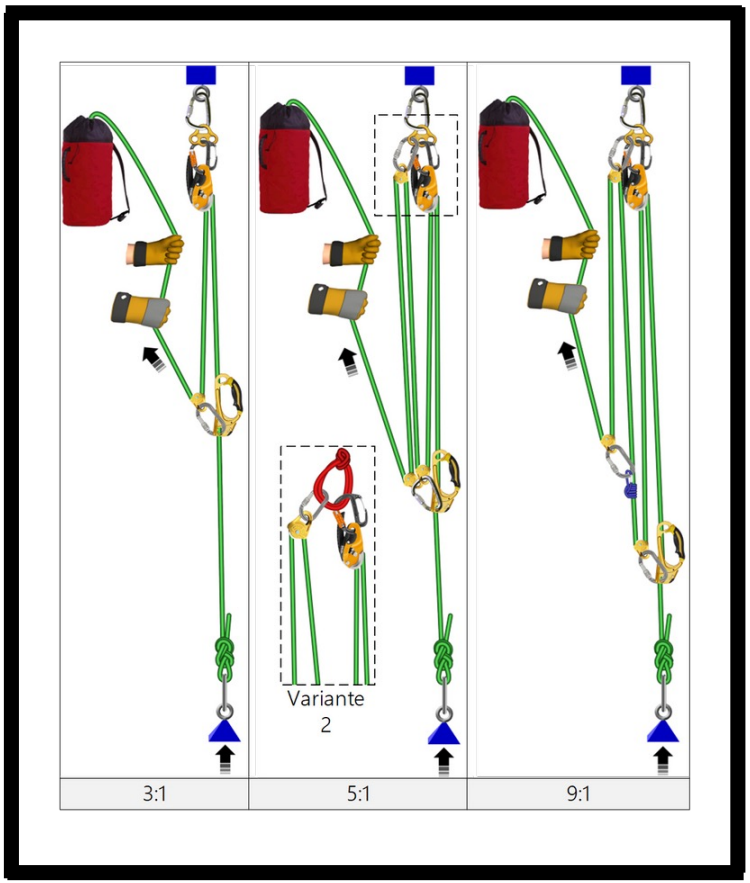


# PTRK – RIG TECHNIQUE FOR HIGH ANGLE (>45°)

## DESCENDING: TWO TENSIONED ROPE SYSTEMS

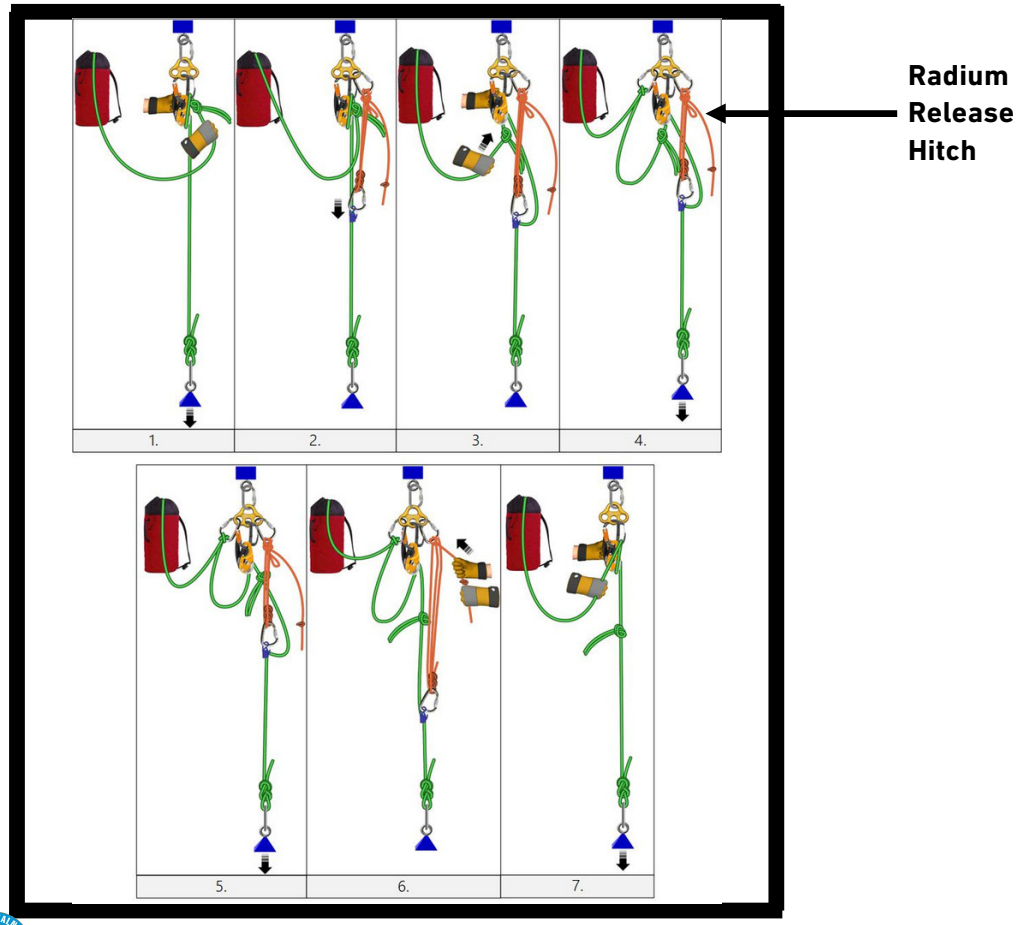



## HAULING SYSTEMS



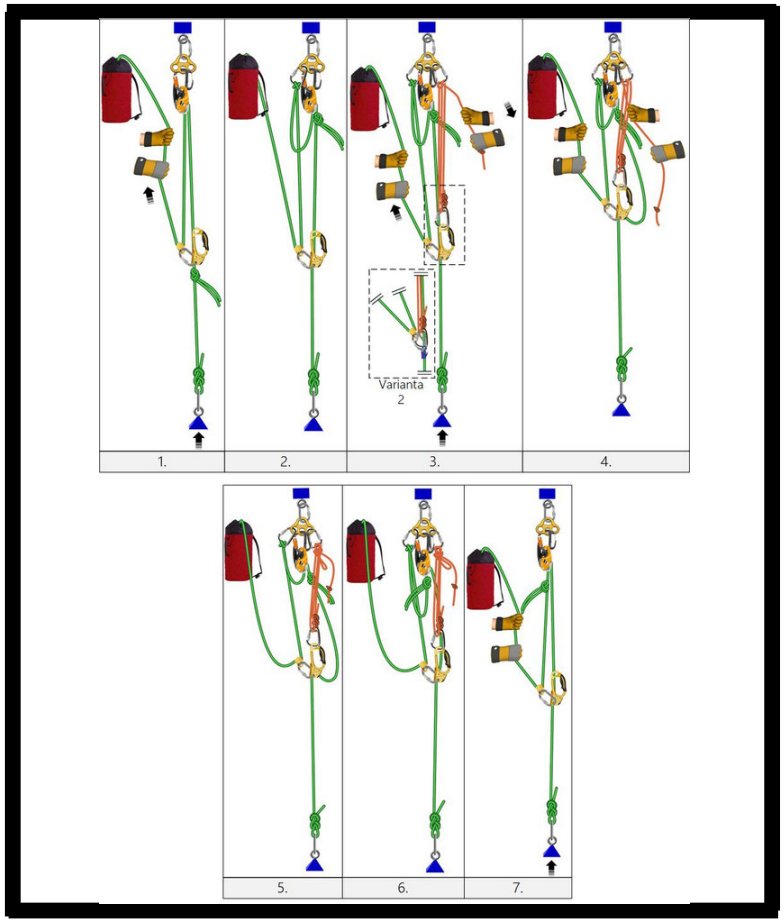
# PTRK – RIG TECHNIQUE: KNOT PASSING

## KNOT PASSING: DESCENDING



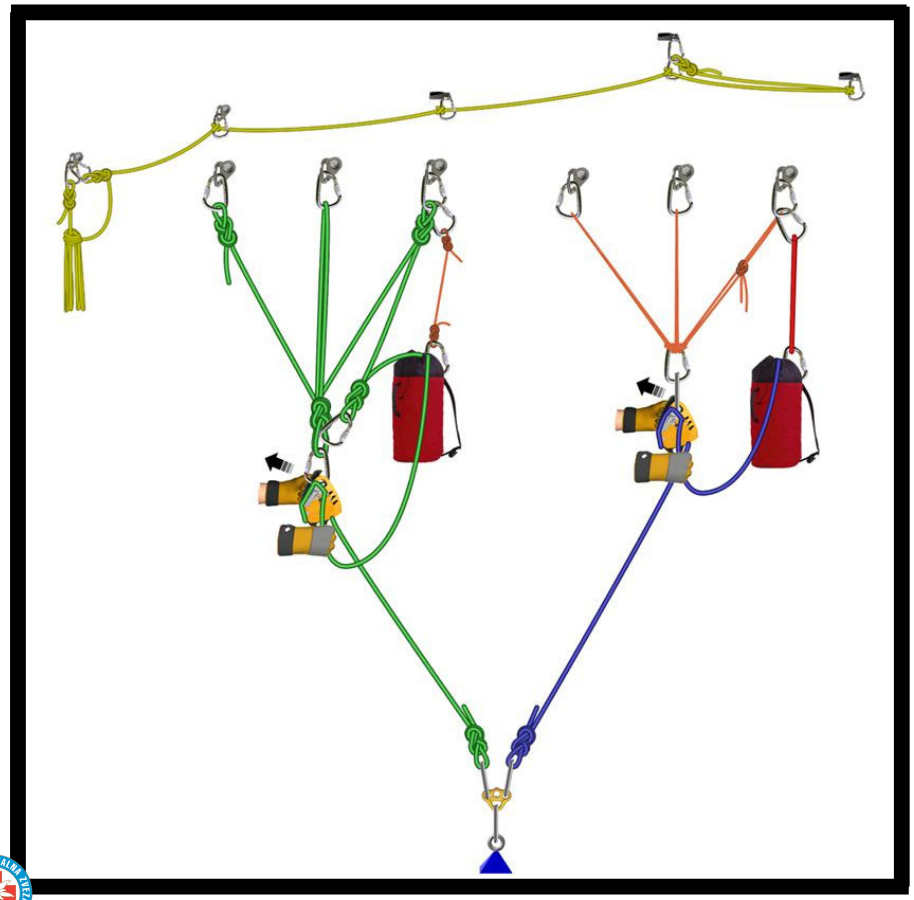

**Radium Release Hitch**

## KNOT PASSING: HAULING

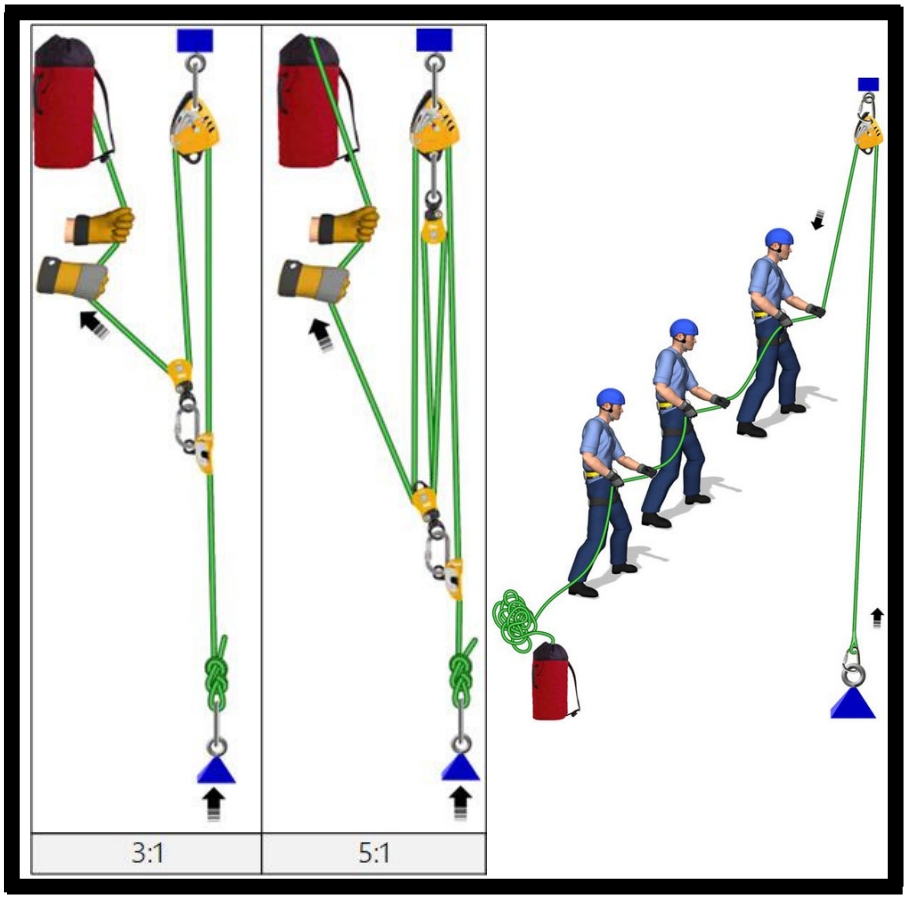


# TTRK – MAESTO TECHNIQUE

## DESCENDING: TWO TENSIONED ROPE SYSTEMS

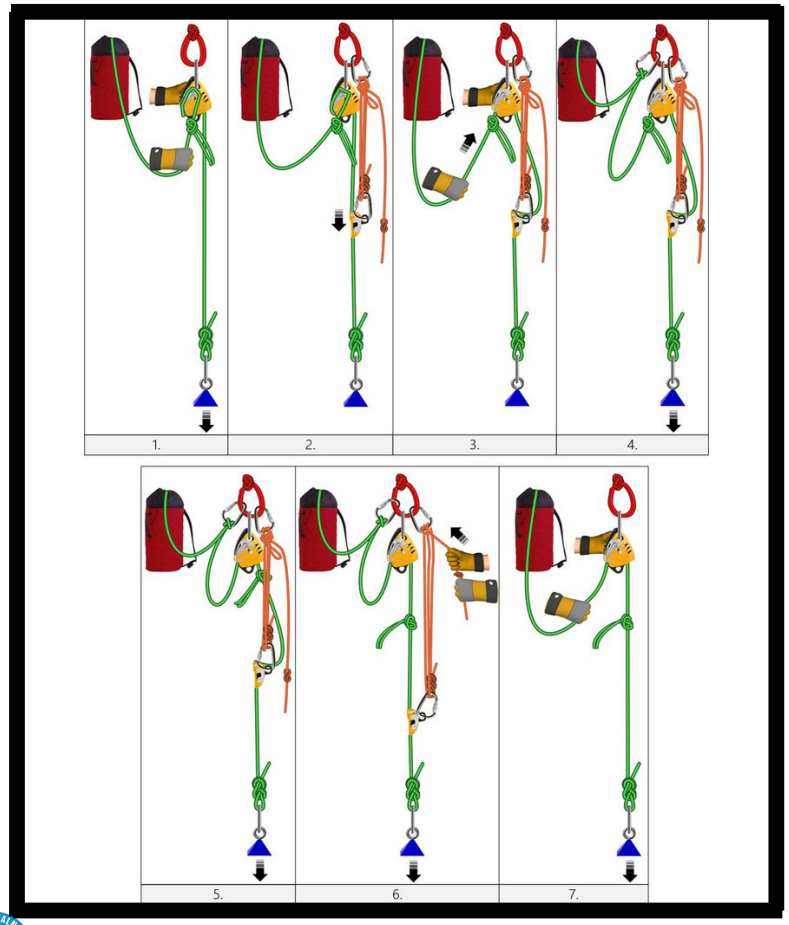


## HAULING SYSTEMS

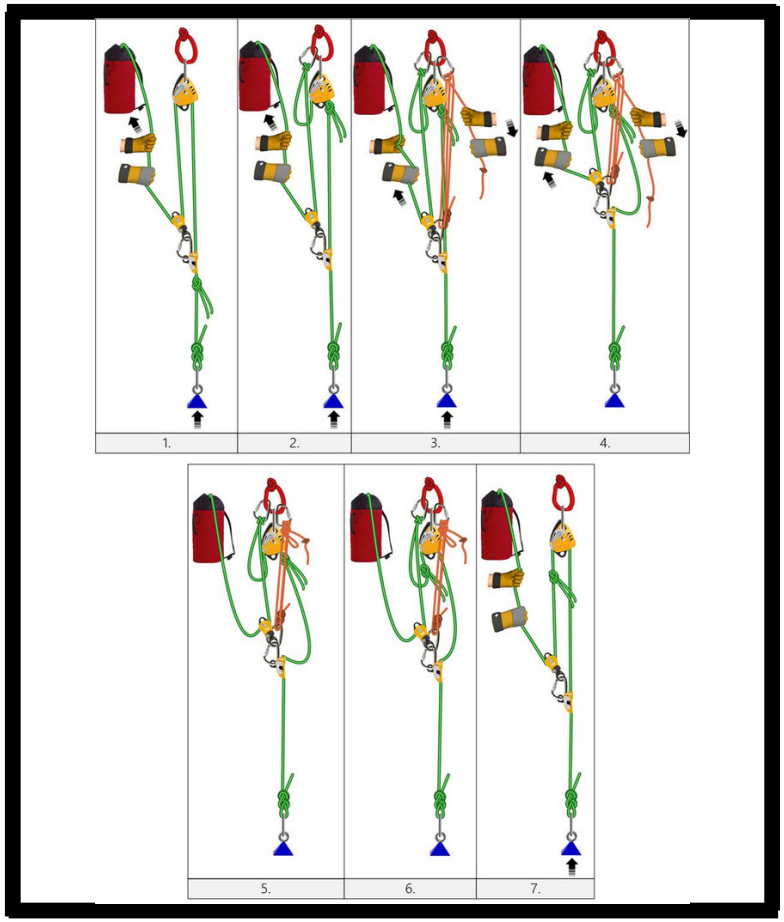


# TTRK – MAESTRO TECHNIQUE: KNOT PASSING

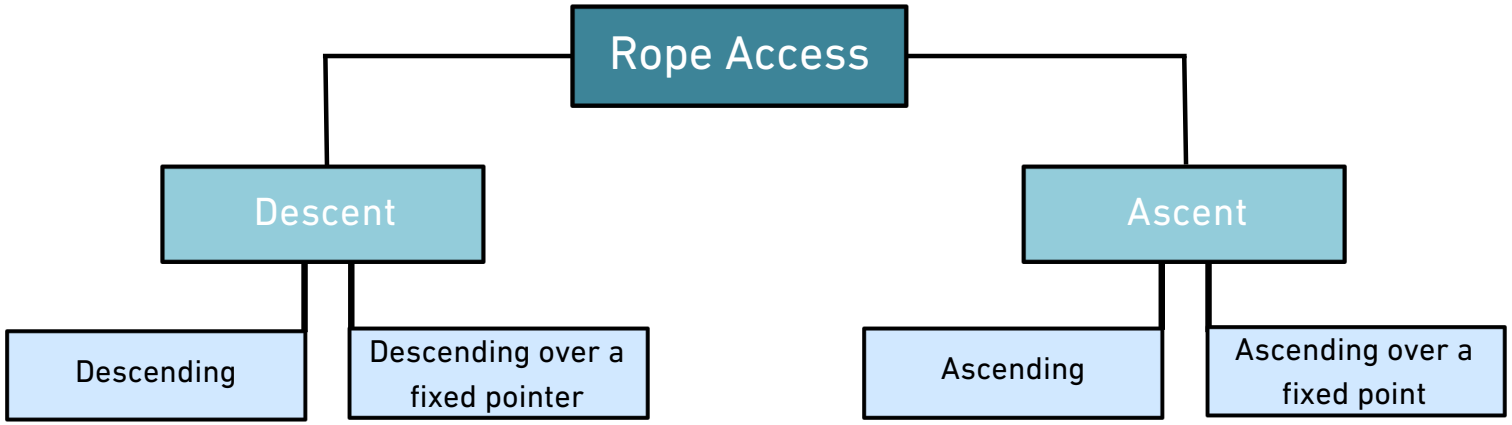
## KNOT PASSING: DESCENDING




## KNOT PASSING: HAULING

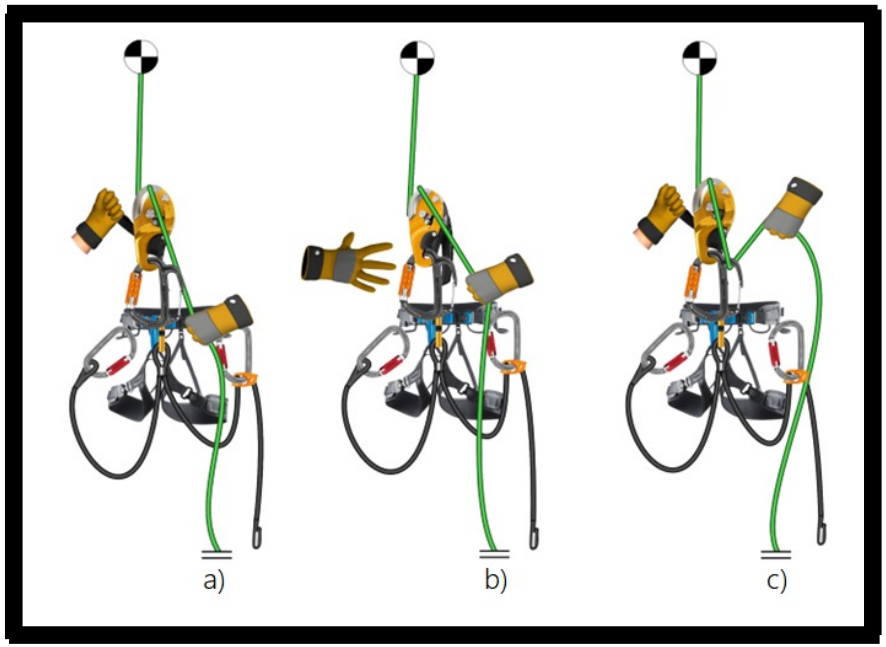


# ROPE ACCESS SYSTEMS




# ROPE ACCESS SYSTEMS

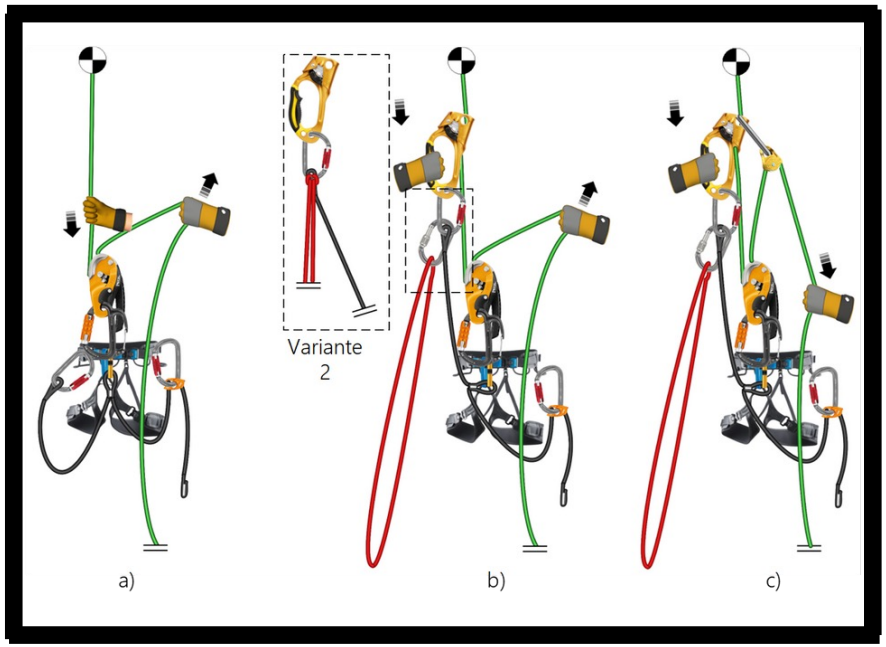
## DESCENDING SYSTEMS ONE ROPE



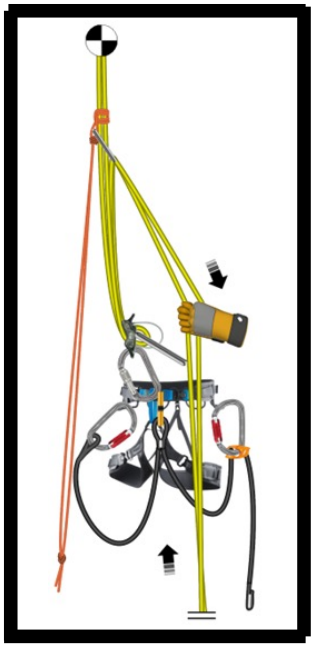

## DESCENDING SYSTEMS TWO ROPES

# ROPE ACCESS SYSTEMS

## ASCENDING SYSTEMS ONE ROPE

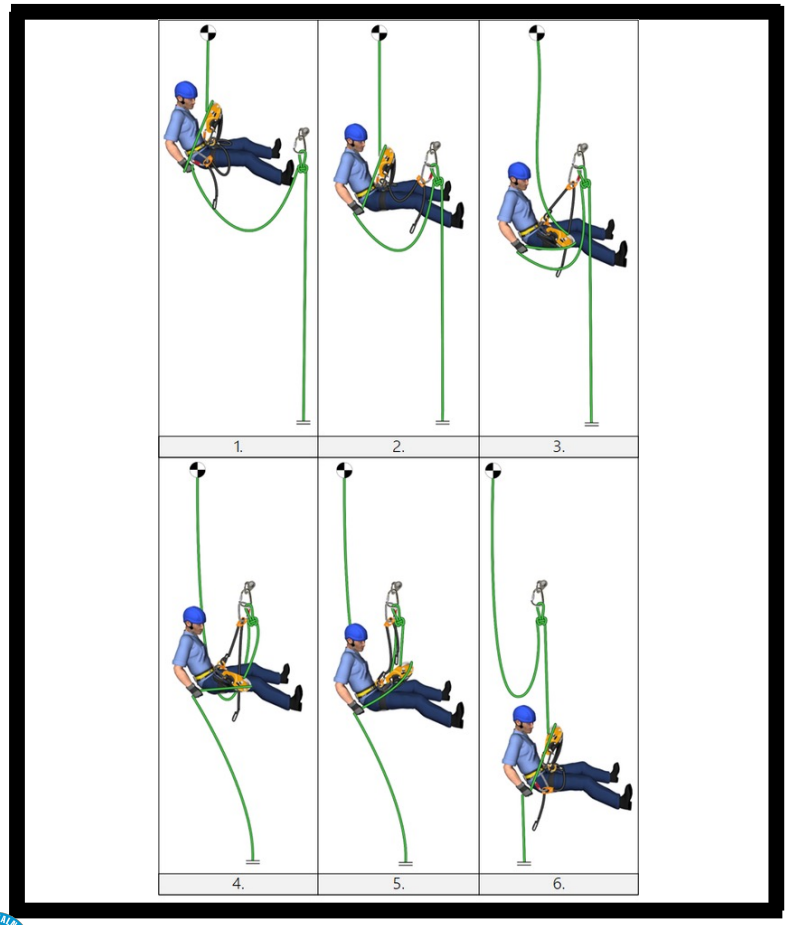



## ASCENDING SYSTEMS TWO ROPES

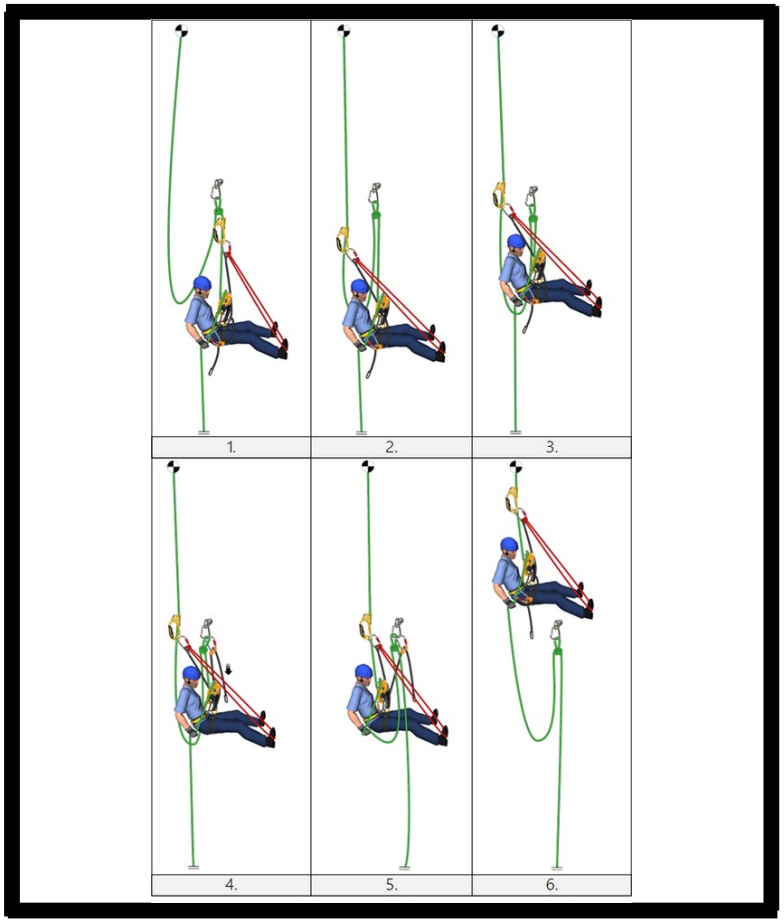


# OVERCOMING FIXED POINTS

## DESCENDING




## ASCENDING



# THANK YOU FOR YOUR ATTENTION!