	Mountaineering and Climbing Equipment **'DYNAMIC ROPES'**	**UIAA 101**

Foreword

This UIAA Standard is only published in the English language version, which is the master text. For any validations in translation, the UIAA Safety Commission should be contacted via the UIAA Office in Bern, Switzerland.

UIAA Standards are the only 'globally recognized' standards for mountaineering equipment. In order to prevent multiplicity, the UIAA collaborates with its partner in standardization CEN; and bases UIAA standard 101 on the European Standard EN 892:2012. The EN Standards in turn are based on the original UIAA Standards, the first of their kind in the world. Additionally the UIAA publishes pictorials for each of the standards in a user-friendly way. This UIAA Standard 101 also has additional requirements over and above those in EN 892:2012.

Owing to copyright restrictions, this UIAA Standard does not state the full requirements of EN 892:2012 to which it refers. Hence it is necessary to obtain a copy of EN 892:2012. The procedure for purchasing the EN Standards is included at the end of the text of this standard. The UIAA Standards are reviewed at intervals to see whether they meet the latest technical requirements and revised if necessary.

The UIAA invites manufacturers of mountaineering and climbing equipment worldwide to become members of the UIAA Safety Commission as Safety Label Holders. Members can participate in discussions on standard requirements, test methods and revisions thereof (see the "General Regulations for the UIAA Safety Label").

A complete list of UIAA Standards for mountaineering and climbing equipment can be found on the UIAA website.

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Copyright and Version Management

This document was first published in English. The English master text is decisive in any conflict of interpretation. For any validations in translation the UIAA should be contacted via the UIAA Office in Bern, Switzerland.

UIAA declarations, standards, documents and guidelines are subject to review. Updates are recorded in the version details stated on the front page of this document.

UIAA documents are generally produced by the responsible Commission and are subject to approval in accordance with the UIAA Articles of Association.

All UIAA documents can be found on the relevant subject area on the UIAA website.

The Version number refers to the latest revision, e.g. V4 is the fourth change to the document. The last update is the date of this latest version.

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1. General Remarks on the UIAA Trademark and UIAA Label

1.1. The UIAA Trademark (see section 5.1.) is copyright protected internationally. The UIAA Label is only given to items of mountaineering and climbing equipment upon approval of prospective label holder's application from the UIAA.

1.2. The procedure to be followed by a manufacturer, when applying for a UIAA Label, is laid down in the "General Regulations for the UIAA Safety Label Certification"

2. Requirements for Dynamic ropes

2.1. The UIAA Label can only be granted for dynamic ropes that meet all the requirements of EN 892:2012, with the following exception:

2.1.1. No EN number required.

2.2. For the award of the UIAA Label, the following additional safety requirements shall be met:

2.2.1. Multidrop rope
Definition: a single rope or a half rope in accordance with EN 892, which withstands 10 or more test falls according to the aforementioned EN.

2.2.2. Diameter.
The rope diameter specified on the hang-tag shall be within +/- 0.2 mm of the diameter specified in 5.3.2. of EN 892:2004.

2.2.3. Possible shrinkage of the rope.
In the information for use there shall be a warning to the effect that ropes may shrink during normal usage.

2.2.4. Middle marker.

If a rope is provided with a middle marker the mark shall be at +/- 1 m from the real middle

Definitions:

Middle Marker: An identifier of the lengthwise middle of the rope, intended to remain for the life of the rope. Middle markers may be used to identify when half the rope has been used while belaying/lead climbing and to centre the rope when double line rappelling with a single rope.

Typical middle markers may be, but are not limited to, paints, inks, a whip stitch, and woven pattern changes. Not all ropes are sold with middle markers.

Safety Requirements:

Middle Marker Location

When tested, the middle marker (if the rope has a middle marker) shall be located less than or equal to 0.6 meters from the physical middle of the rope.

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2.2.5. Test Report
Recommendation: The slippage at the rope clamp after the last fall should be stated in the test report.

2.2.6. Storage temperature.
The minimum and maximum storage temperature shall be clearly specified in the information supplied by the manufacturer.

2.2.7. Packaging
If dynamic rope is supplied on a drum and consists of more than one piece, the ends of the pieces shall be clearly visible and not joined together; the number of pieces shall be stated on the drum.

2.2.8. Water-repellent test

When tested according to 3.2 the increase of weight *p* shall be less than 5%. A rope that passes this test may be labelled as "UIAA Water Repellent".

2.2.9 Measurement of energy absorbed before rupture

For a rope, the energy absorbed before rupture due to a fall over an edge can be declared if the test requirements described in 3.3 are satisfied.

3. Tests Methods

3.1. Middle marker

See Annex 1

Test Method

Conditioning: None Required.

Apparatus: Pulley, karabiner, measuring scale with mm increments, and marker pen.

Procedure:

1 Mark the centre of manufacturer's middle mark. If the middle mark is a pattern change, determine start and finish of pattern change, measure the length, and mark the centre.

2 Place a pulley in the loop, at the middle marker, and secure with a karabiner or other suitable device.

3 While holding the rope ends with your hand, align the ends and stretch out the loop in line with enough force so the rope is not in contact with any surface.

4 Have an assistant use a marker to mark the rope at the top of the pulley wheel. Alternatively the rope on each side of the pulley wheel could be marked.

5 Measure and record the distance from the centre of the manufacturer's middle mark to the measured physical middle of the rope to the nearest .01 meter.

3.2. Water-repellent test

3.2.1. Apparatus.

3.2.1.1. Table for water absorption

(Figure 1) Use a run-off table made/coated with zinc. The dimensions of the table must be large enough to accommodate the rope sample, which is secured by the three fixing points as shown in the Figure 1. The water is delivered by a tube of (16 ± 0.5) mm bore and (22 ± 0.5) mm outside diameter.
The tube is fixed so that it will be parallel to the rope sample and in the plane of the table surface, with the outlet (10 ± 1) mm from the upper end of the rope sample. The water flow is regulated by a flow meter.

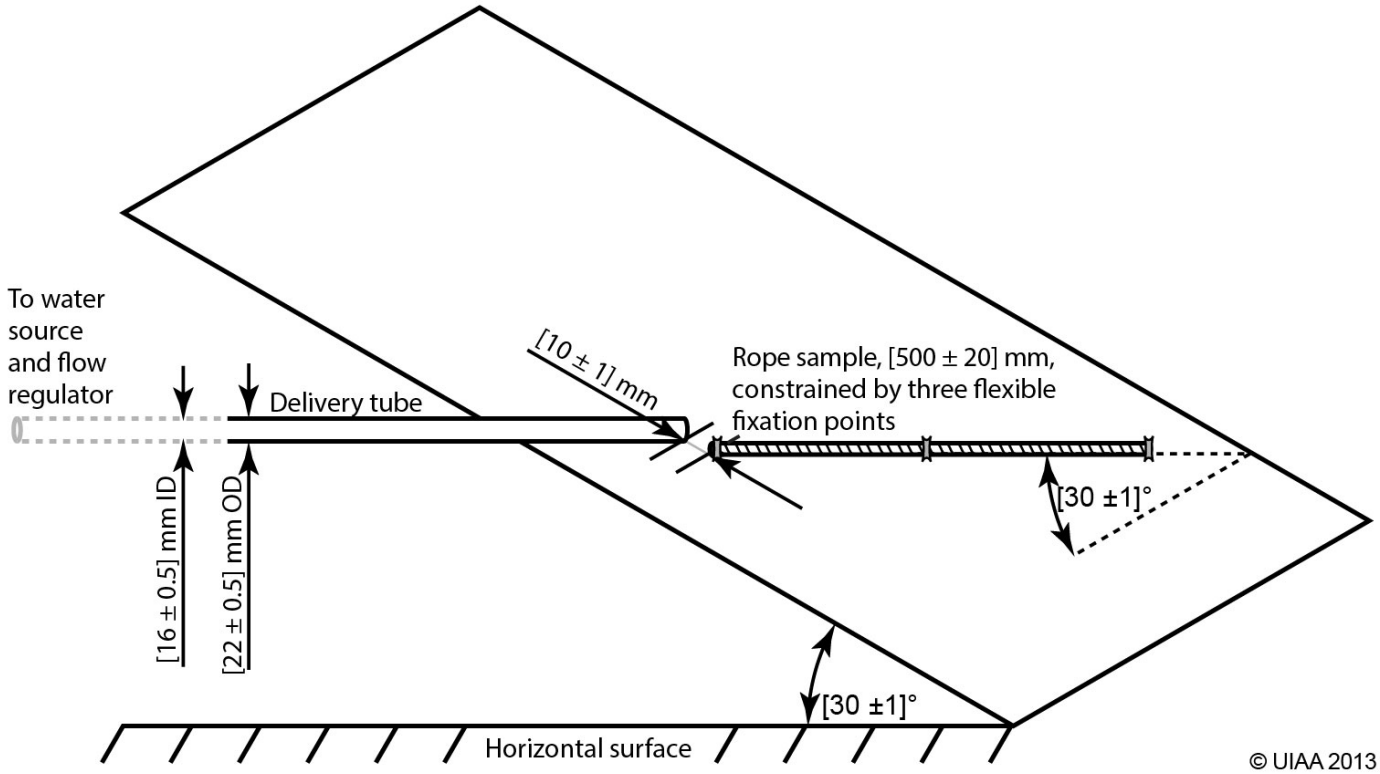

Figure 1 Table for water absorption

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3.2.1.2. Rope surface wearing apparatus

The apparatus used for sheath slippage must be adapted to wear the test sample. The three spacers that are about 10 mm thick in the original apparatus must be $12\,^{+0}_{-0.3}$ mm thick. The three moving plates that are about 9.8 mm thick in the original apparatus must be $13\,^{+0}_{-0.2}$ mm thick. In the three moving plates the round hole shall be replaced by a hexagonal hole into which an ISO 4032 M14 nut is inserted (Figure 2). Place a zinc plated M14 nut, steel 8.8, according to ISO 4032 in each moving plate hole.
The weights of 5 kg used in the sheath slippage apparatus remain the same. The three nuts must be new for each water repellent test, which means that they are used for three test samples only.

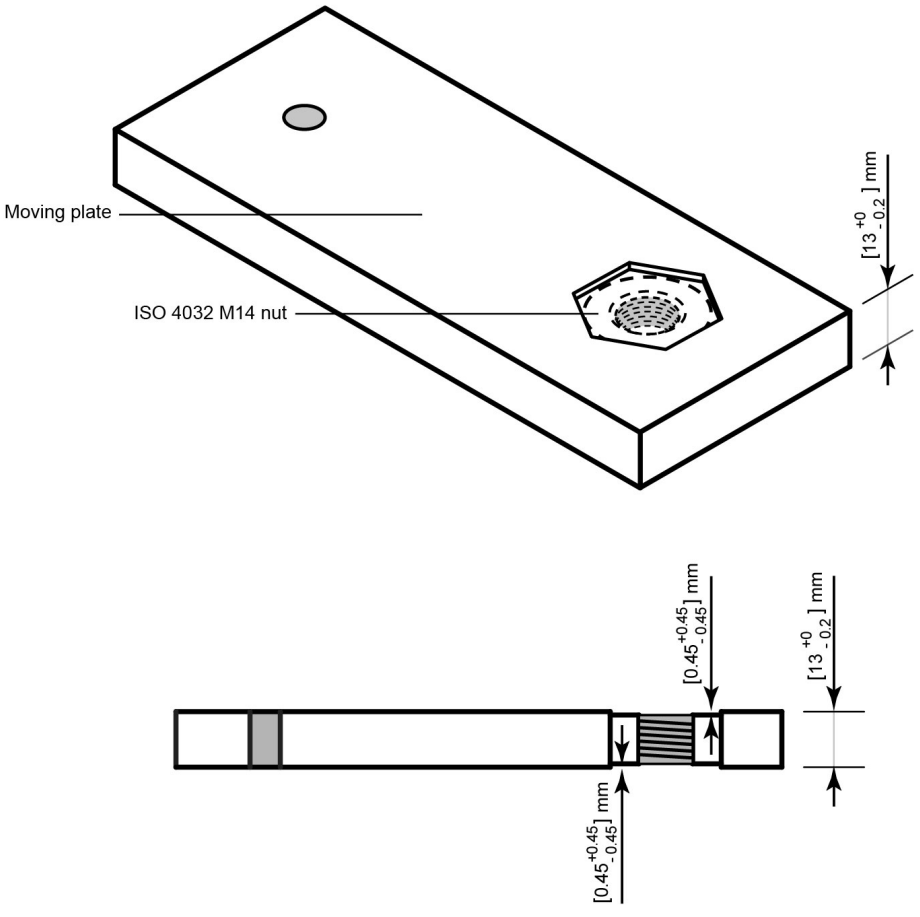

Figure 2 The modified moving plate

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3.2.2. Preparation of the test sample

3.2.2.1.Take a sample of rope, 1.5 m long

3.2.2.2 Make 2 marks, one at 25 cm from each end.

3.2.2.3 Pull the rope by hand 30 times (15 times forward and 15 times back in succession) through the wearing apparatus between these 2 marks at rate of [0.5 ± 0.2] m/s.

3.2.2.4. Make 2 new marks at 25 cm apart from the middle of the sample.

3.2.2.5. Cut the sample on the new marks with a hot knife to obtain a sample [500 ± 20] mm in length.

3.2.2.6. Weld carefully both ends of the sample with the hot knife.

3.2.2.7. Weigh the sample with an accuracy of 0.1 g. Call this weight W_a.

3.2.3. Water impregnation.

3.2.3.1. Fix the sample on the clean and dry table with the three flexible fixing points, the rope starting at the level of the orifice of the pipe as shown in Figure 1. Ensure that the whole length of the rope sample is in contact with the surface of the table.

3.2.3.2. Adjust the water flow with the flow-meter at a value of [2 ± 0.2] l/min. This adjustment must be achieved within 15 s.

3.2.3.3. As soon as the correct water flow rate is achieved, start measuring a water impregnation time of [900^{+15}_{-0}] s. Then stop the water flow, remove the sample and start the drainage within 30s.

3.2.4. Drainage.

3.2.4.1. Hold by hand one end of the rope test sample on the water absorption table and put the rope in a horizontal position forming an angle of 30° with the table.

3.2.4.2. Release the rope sample and let it fall onto the table by gravity.

3.2.4.3. Turn the rope of 45° around the rope's axis and repeat steps 3.2.4.1 and 3.2.4.2.

3.2.4.4. Turn the rope again of 45° and repeat steps 3.2.4.1 and 3.2.4.2.

3.2.4.5. Then hold by hand the other end of the rope test sample on the table and repeat steps 1 to 4. Thus the rope sample will have been released 6 times.

3.2.4.6. Weigh the sample with an accuracy of 0.1 g. Call this weight W_b.

Note. Take care to move the rope to a dry area for each release. The drainage and weighing must be achieved within 60 s.

3.2.5. Water absorption.

3.2.5.1. Calculate the water absorption: $p_1 = (\frac{W_b - W_a}{W_a}) \times 100\%$

3.2.5.2. Repeat the test 2 times from 3.2.2 to 3.2.4.

3.2.5.3. Calculate the water absorptions p_2 and p_3.

3.2.5.4. Calculate the average value $p = (p_1 + p_2 + p_3)/3$

3.3. Test method to determine energy absorbed before rupture

3.3.1. Apparatus

The basic apparatus required for the evaluation of energy absorption is the DODERO with the following modifications. Schematically, the test apparatus looks like **FIG. 3.3.1.**

The DODERO apparatus shall comply with the requirements of guidance rails rigidity and friction requested in EN 892:2012, point 5.6.2.
The mass shall be [100 ± 1] kg.
The force data acquisition system (the only recorded data requested for the present test) shall comply with EN 892:2012, point 5.6.2.5 but the data shall not be filtered.
NOTE: This is the only recorded data required with the present method.

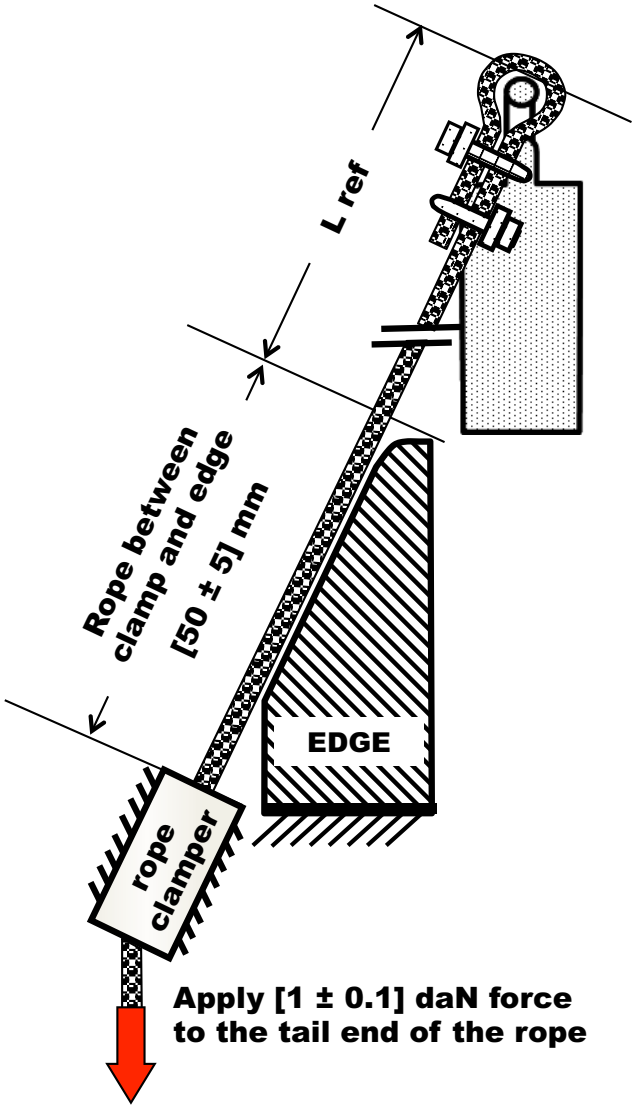

Figure 3.3.1. Test apparatus to determine the energy absorbed before rupture

3.3.1.1. Substitution of the orifice plate with a straight edge

The standard DODERO orifice plate shall be substituted by a straight horizontal edge. The edge shall be manufactured from steel with a surface hardness of at least 52 HRC according to EN ISO 6508-1. The geometry of the edge cross section is represented in **FIG. 3.3.2.**

3.3.1.2 Rope clamping system

The rope clamping system is aimed at reducing slippage, hence energy absorption. The maximum allowed slippage is 2 mm. The rope-mass connection can be made with conventional clamps. It shall be done according to **FIG. 3.3.3**, and the fixed point shall be obtained by a sort of clamper capable of keeping the rope slippage below 2 mm; if possible, the clamper should squeeze the rope keeping its shape circular.

3.3.1.3. Rope specimen preparation and conditioning

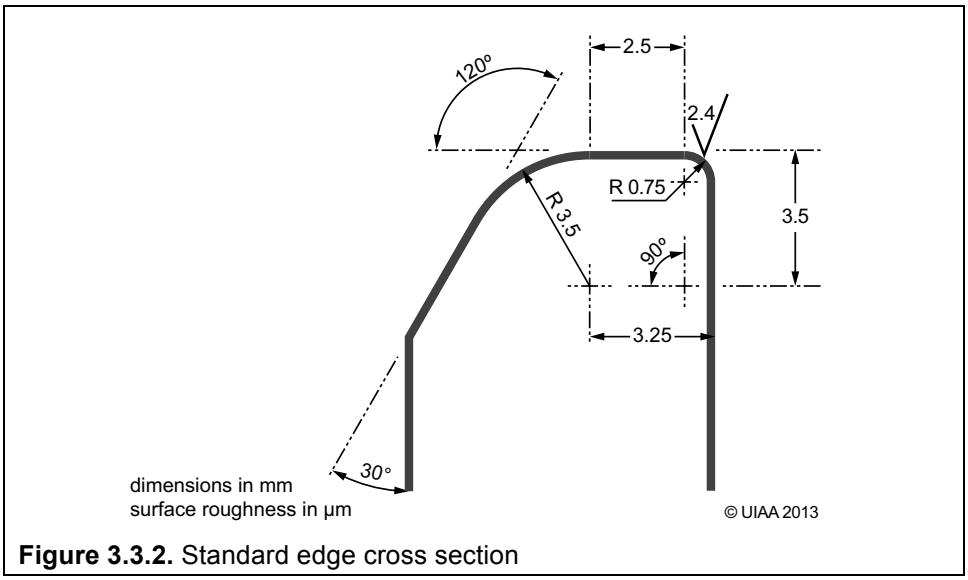

Figure 3.3.2. Standard edge cross section

The test shall be done over 3 rope specimens. They shall be coherent with reference length, L_{ref} = [2300 ± 10] mm according to **FIG. 3.3.1**. The specimens shall be conditioned according to EN 892:2012, point 5.2 with a final relative humidity of 50% and temperature 23 °C in the cell.

3.3.2. Procedure

The test procedure is:

- Connect the tope to the mass according to **FIG. 3.3.3.**

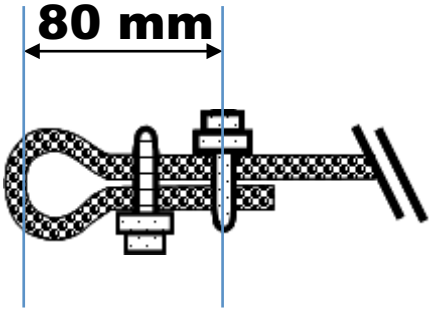

Figure 3.3.3. Connection of the rope to the mass

- Lift the mass to the top level, such as to achieve the L_{ref} distance between the edge and the mass (see **FIG.3.3.1.**). Record the mass position.
- Preload the rope by applying a force of [1 ± 0.1] daN, e.g. by hanging a mass; the preloading shall be done leaving the rope clamper open with the rope free to slide.
- Block the rope clamper temporarily and lower the mass at low speed; leave the mass hanging for [60 ± 1] sec.
- Raise the mass to the recorded top level and leave it to a rest for [10 ± 1] min.
- Release the rope clamper allowing the preload to take place.
- Close definitively the rope clamper.
- Release the mass. The test is considered valid if the rope breakage occurs only over the edge; breakage, although partial, of the rope at the mass connection or at the rope clamper is not admitted.
- Record the force time history.
- The complete procedure shall be repeated for all the 3 specimens.

3.3.3. Evaluation of the energy absorption

This evaluation shall be done by successive integrations from the recorded force time history $F_{(t)}$. Special care shall be taken to avoid any force offset (mean value on the force noise) between zero time and the instant (see below t_{tens}) when the specimen starts to stretch.

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The step by step procedure is:

- Evaluate the mass displacement $S_{(t)}$ according the formula:

$$S_{(t)} = \iint_{t_{tens}}^{t} \frac{(gM - F_{(t)})}{M} dt\,dt$$

variable	description	units
t	time	s
g	gravitational acceleration (9,806 m/s^2)	m/s^2
L_{ref}	rope reference length (see **FIG. 3.3.1.**)	m
M	falling mass	Kg
$F_{(t)}$	tension measured in the rope as a function of time	N
$S_{(t)}$	displacement of the mass as a function of time	m
V_{tens}	speed of the test mass at the onset of rope stretching $\sqrt{2g(2L_{ref})}$	m/s
subscript		
tens	refers to the start of rope stretching	
rupt	refers to rope rupture	

- Evaluate the total energy E_{rupt} absorbed by the rope until the full rupture of the specimen:

$$E_{rupt} = \int_{S_{tens}}^{S_{rupt}} F_{(S)}\, dS$$

where the function $F_{(S)}$ is obtained from the time functions $F_{(t)}$ and $S_{(t)}$; S_{tens}= S at time t_{tens}, and S_{rupt}= S at time t_{rupt}.

The numerical integration shall be carried out by the trapezoidal method.

- The integration range shall be defined as follows:

t_{tens} Tension point: the tension starting point is based on the shape of the $\boldsymbol{F}_{(t)}$ curve: from the point where F reaches the value of 200 daN, the preceding points of the curve are followed backwards until the value F=2 daN is reached: this is taken as the integration starting point (see **FIG. 3.3.4.**)

t_{rupt} Rupture point: this is defined as the point where, after the maximum tension peak, the force has decreased to 200 daN (see **FIG. 3.3.5.**)

- The energy absorbed per unit rope length is: $E_u = E_{rupt}/L_{ref}$

The computer program for the evaluation of the absorbed energy, written in "SCILAB" language, is available on the UIAA DMS (interfaces may have to be written in order to adapt the program according to the format of the recorded data available to the user).

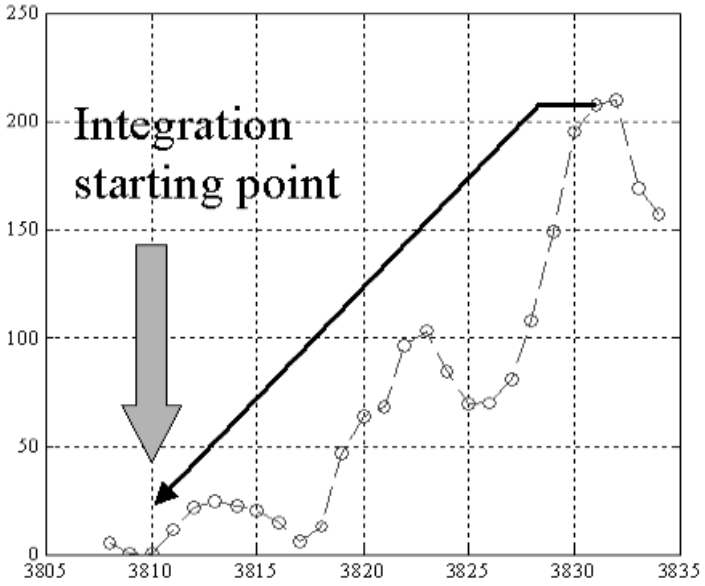

Figure 3.3.4. Sample tension vs. time data showing the tension point at which integration of energy begins.

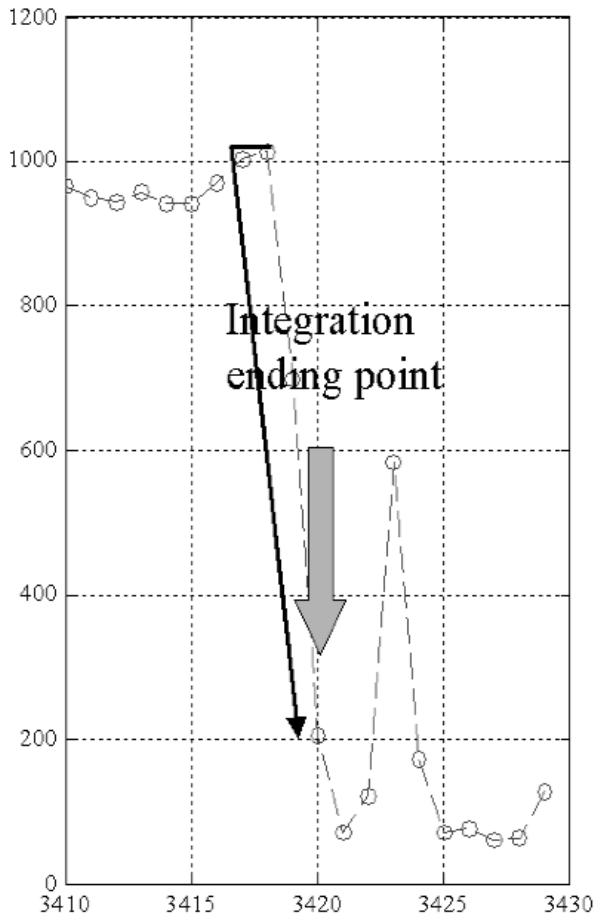

Figure 3.3.5. Sample tension vs. time data showing the rupture point at which integration of energy ends.

3.3.4. Expression of the result

The absorbed energy will be obtained as the mean value over three valid tests and may be included in the information provided by the manufacturer. Figure **FIG. 3.3.6** shows a possible graphical display of the absorbed energy; in the figure a result of 1,72 kJ/m is reported for a single rope.

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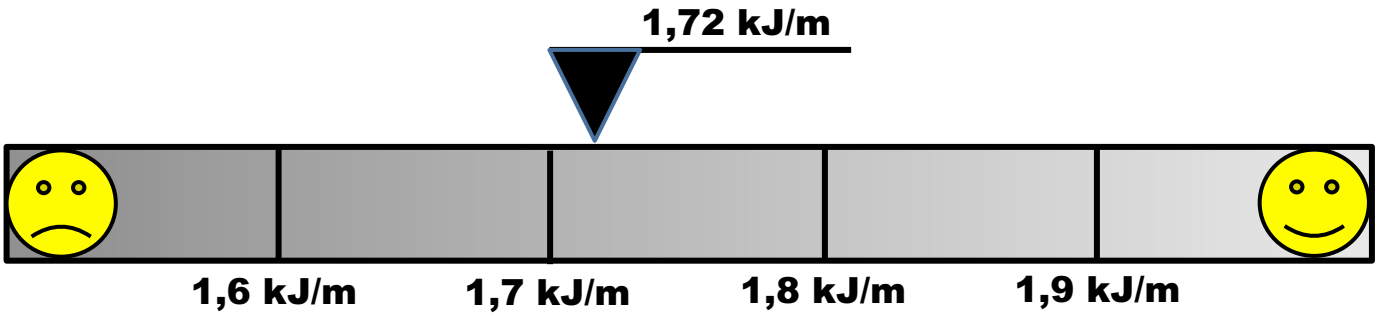

Figure 3.3.6. An example of a presentation of the energy absorbed before rupture test results for a single rope

4. Demonstrating that the Requirements are met

4.1. The requirements of section 2.1 shall be satisfied by a test report from a UIAA-approved test laboratory.

4.2. The requirements of section 2.2 shall be satisfied by the manufacturer certifying on the Safety Label Test Template Form that the product meets these particular requirements.

5. Information to be supplied

5.1. The information to be supplied (in accordance with EN 892:2012) shall be given in English, or at least in the language of the country in which the product is sold.

6. Attachment of the UIAA Label

6.1. For any model of mountaineering equipment, which has been awarded the UIAA Label, the UIAA recommends that the UIAA Trademark (see below) or the four letters "UIAA" be marked clearly and indelibly on each item sold in accordance with the branding guidelines specified in the "General regulations for UIAA Safety Label".

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6.2. In addition, the UIAA Trademark or the four letters "UIAA" may be included in the instructions for use and/or on a swing ticket as well as in catalogues and other publications of the manufacturer. In the last case, the illustration and/or the text must clearly apply only to the equipment which has been awarded the UIAA Label.

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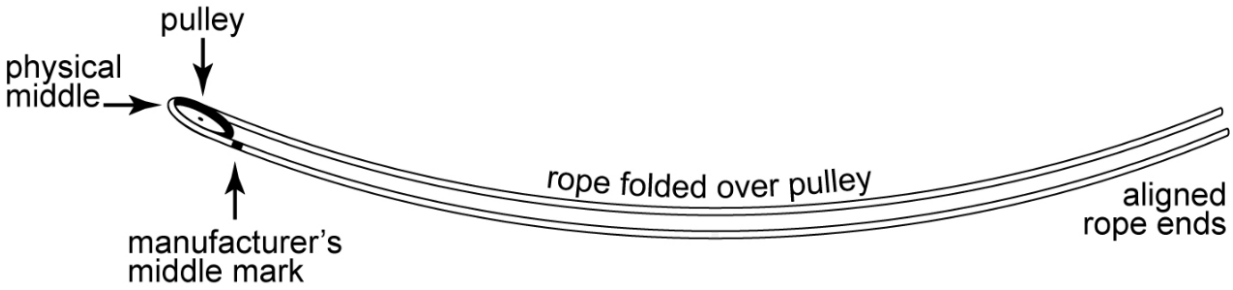
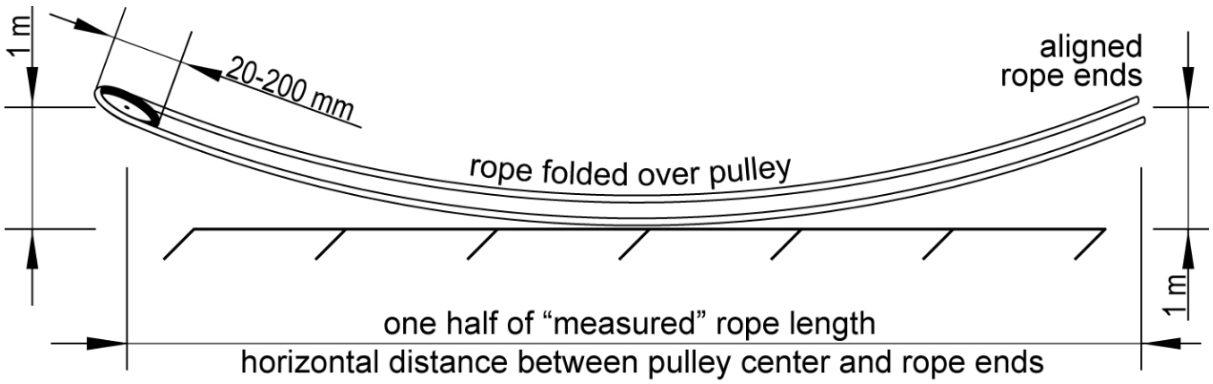
ANNEXES

Annex 1 Middle mark:



Annex 2 Informative Annex on measuring ropes:



Test Method for Rope Length Measurement

Apparatus: Metric tape measure, pulley with a sheave root diameter of 20-200 mm, karabiner, sling, meter stick.

Procedure: Secure the centre of the rope in a pulley mounted 1 meter high. Align the ends of the rope to be even. Pull the ends of the rope at a height of 1 meter this pulling may be done by hand. Pull with a force enough to just lift the low point of the rope off the ground. Use a meter stick as a "plumb-bob" to mark a position on the floor equal with the ends of the rope. Use a tape measure to measure between the anchor point and the mark under the ends. Multiply this measurement by two, and round down to the nearest 0.1 meter.

Last Updated	Remarks
May 2016	Correction to equation and note of single-rope for edge energy example
June 2014	Inclusion of 2.2.9 Measurement of energy absorbed before rupture and 3.3 on Test method to determine energy absorbed before rupture. Minor proof-read edits, especially inclusion of ± sub/superscripts that did not appear in the previous version in .pdf format.
October 25, 2013	Corrections of 2.2.8 &3.2 cf. water repellent test
March 8, 2013	Corrections of last EN norm + in point 4
August 30, 2010	Correction of 2.2.4: Middle Marker: The definitions and requirements were added.
	Correction of 3: Test methods: The procedure was added.
	Inclusion of Annexes: Middle Mark and Length Measurement: Figures and text were added based on the decisions of the Safety Commission Meeting in 2008.

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