



NORWEGIAN AIR AMBULANCE
FOUNDATION

ICAR Congress 2025 / Jackson Hole, Wyoming, USA

SAR helmet developement for the Norwegian Air Ambulance

by Stein Falsen Møller



About Me:



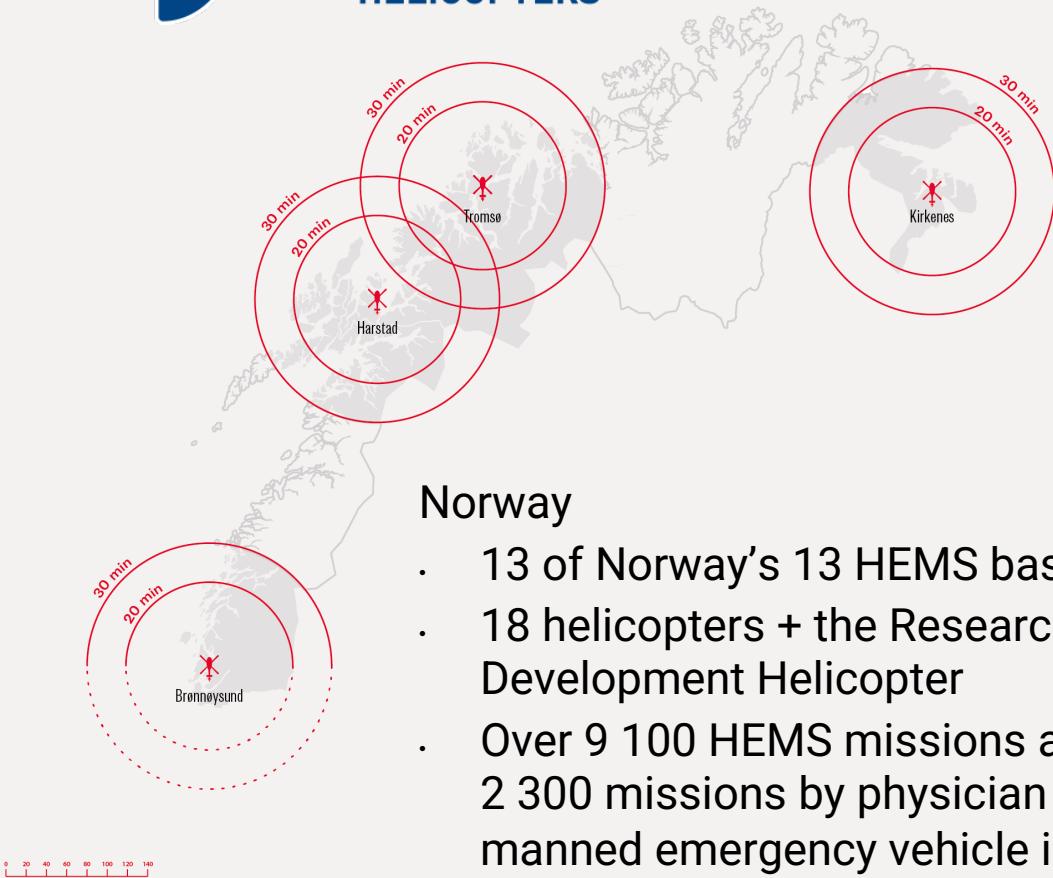
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“He’s cool”

Stein

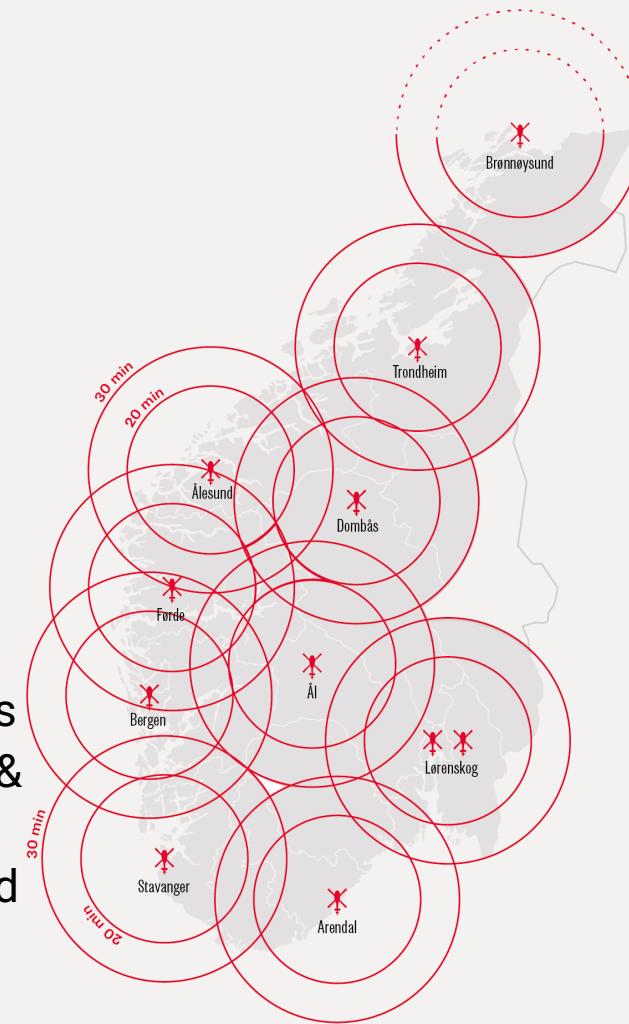


NORWEGIAN AIR AMBULANCE HELICOPTERS



Norway

- 13 of Norway's 13 HEMS bases
- 18 helicopters + the Research & Development Helicopter
- Over 9 100 HEMS missions and 2 300 missions by physician manned emergency vehicle in 2023





The foundation has:

44 researchers

15 innovation projects

800+ training sessions per year

300 000 private donors

4000 corporate supporters



NORWEGIAN AIR AMBULANCE
FOUNDATION



The purpose of the Norwegian Air Ambulance Foundation is to promote advanced pre-hospital emergency medicine.

Since 1978, we've pioneered new solutions for the sake of the critically ill and injured.

The Norwegian HEMS crew



The pilot

is responsible for the aviation safety
for the crew and patient

The HEMS crew member

evacuates the patient,
assists the physician,
co-pilots and navigates during flights

The physician

provides advanced emergency medicine
on-scene and in-flight.
directs the HEMS crew member
during static rope evacuations.

RISK ASSESSMENT

Rescue helmet for
SAR and HEMS operations

by Gábor Magyari,
Norwegian Air Ambulance Foundation

Contributors:
Stein Møller, Norwegian Air Ambulance Foundation
Ståle N. Møller, Sweet Protection

Risk Assessment

- Must be able to deal with all kinds of rescue scenarios
- Crew usually wear a pilot helmet when flying to the scene, then picks a mission specific helmet at the scene
- Mission specific helmets are not usually adapted to accessories like communication, protective eyewear etc.
- We could not find helmets that are capable of cross-over functions

= There's a need for one helmet that fits all missions



Area of use

- Static rope and hoist rescue missions
- Water rescue missions
- Ground and mountain rescue missions (summer)
- Ground and mountain rescue missions (winter)
- Protection while driving snowmobiles or ATV's



Risk Assessment

After studying different rescue tasks and operation related head injuries it **has been concluded** that **the most optimal rescue helmet** would be the one that is certified for the following three EN standards:

- **EN 1385** - helmet for canoeing and white-water sports
- **EN 1077- Class B** - helmet for alpine skiers and snowboarders (Will certify for ASTM 2040)
- **EN 12492** - helmet for mountaineers

The helmet must be certified and impact tested with all accessories mounted on the helmet.



STATIC ROPE AND HOIST RESCUE MISSIONS							
Nr	Event		Severity of Consequences	Probability for the event	Risk value severity x probability	Barriers / Interventions / Preventing regulations	
	Cause	Consequences				(1-10)	(1-5)
			(1-5)		(1-50)		
1	Hook of hoist or fixed rope slings unpredictable when HCM takes it over	Hook hits HCM on the head	1	3	3	<p>Targeting the hook toward HCM is always carried out with slow down motion so HCM has enough time to react</p> <p>Use of helmet to avoid injury</p>	
2	"Downwash" Helikopter rotor blades generate heavy wind close to ground	<p>Stone and loose objects fall and hit HCM on the head while standing on ground or hanging on the hoist</p> <p>Snow and dust particles that are taken by the downwash can hit the eyes hardy and cause injury or irritation. Vision can be blurry or eyes burning. Reduced rescue capabilities.</p>	3	4	12	<p>Using a helmet that fulfils the requirements according to side impact and penetration from above listed in EN12492</p> <p>Use of eye protections that are at least fulfilling industrial standards.</p> <p>Helmets that have integrated visor do not cover the eyes tight enough therefore it's.</p> <p>To ensure best protection it's advised to use googles that covers the eyes gap free</p>	

3	Unwanted contact or collision with objects by lifting up HCM from ground	HCM and/or patient hits obstacles either controlled or uncontrolled that can cause front or side impact injury of the head	3	3	6	<p>To avoid pendulum or reduce the risk of unwanted collision the helicopter must hover straightest possible above HCM.</p> <p>Mandatory use of proper helmet that is compatible with intercom to ensure clear verbal communication between pilot and HCM.</p> <p>Mandatory use of proper helmet that ensures obstacle free visual communication between crew member on board above and HCM on ground.</p> <p>Using a helmet that fulfills the requirements according to side impact and penetration from above listed in EN12492</p>
4	<p>Uncontrolled spin while HCM is lifted from the ground. One of the procedures to stop the spinning is to touch HCM gently on the surface of water or on a treetop</p> <p>Eye injury of obstacles (tree branches, bushes)</p>	<p>HCM can hit lighter obstacles like branches of trees.</p> <p>Side, front and back impact can occur and cause head injury</p>	4	3	12	<p>Get the helicopter into a forward motion to stabilize spinning</p> <p>Extend rope length to reduce downwash effect</p> <p>Mandatory use of proper helmet that fulfills impact and penetration requirements listed in EN12492 and EN1077 at the same time capable for using intercom for verbal communication with pilot</p>
			3	4	12	<p>Mandatory use of industrial strength eye protector (grade EN166 B or higher) to avoid eye injury</p> <p>To ensure best protection it's advised to use googles that covers the eyes gap free</p>

WATER RESCUE MISSIONS						
5	HCM loosing balance while jumping into water from helicopter	HCM falls uncontrolled and hits head in the skids	3	2	6	HCM is wearing drysuit, lifejacket and helmet that gives good protection against impacts. Helmet must be able to deal with impacts listed in EN1077
6	HCM jumps into water from 2 meter or higher (maximum 5 meter)	Edges of the helmet meets resistance with water surface. Helmet's fastening system pulls jaw heavily.	1	4	4	HCM presses helmet down to head while jumping to reduce pulling effect on fastening system. Applying soft padding on straps increases comfort significantly.
7	HCM is taken by the stream and ends up far below target	HCM can hit both hidden and visible obstacles before reaching safe zone	1	5	5	HCM is taken by the stream only when they do training. At real rescue conditions HCM goes into the water always with safety rope that is secured by another crew member from the ground
8	Unsuspected floating objects coming by the stream toward HCM	Floating objects can hit HCM from behind	3	3	9	One crewmember on ground is in duty to monitor the river and gives alert to HCM when obstacles are ahead. Wearing of helmet is essential to avoid injury in case of collision.
9	Helicopter hovering right above HCM	Water particles can cause irritation in the eyes. Reduced visibility.	1	5	5	Using of proper googles is essential to secure visibility and right conditions for operation
10	Helmet shell does not cover the forehead described in EN1385	Helmet does not fully meet the requirements described in EN1385	1	10	10	It is essential to apply changes in forehead coverage to be able using eye protection googles against downwash and debries. The helmet protrude far away from the face of the user providing sufficient protection in this area.

GROUND AND MOUNTAIN RESCUE MISSIONS						
Nr	Event		Severity of Consequences	Probability for the event	Risk value severity x probability	Barriers / Interventions / Preventing regulations
	Cause	Consequences				
11	Rescue task in slippery and rough terrain	HCM slides and hits ground by head. Side and back impact on helmet.	3	5	15	Wearing helmet that is EN1077 certified Wearing ice cleat or crampons if necessary
12	Rescue task in tight and narrow environment for example: car wreck, basement or a canyon	Head is one of the most exposed parts of the body when it comes to narrow places HCM hits objects by its head	1	5	5	Wearing helmet to avoid injury Minimalizing external devices attached on the outer surface of helmet to reduce risk of being hooked up on obstacles
13	Extracting patient from a traffic accident	Objects that are under stress can unexpectedly release and cause high impact strike	5	3	15	Wearing helmet that is EN 1077 and EN12492 certified Eye and ear protection strongly recommended
14	HCM working on an avalanche exposed terrain	HCM gets taken by an avalanche	8	3	24	Mandatory use of helmet that is EN1077 certified Mandatory use of avalanche airbag to keep HCM on the surface of avalanche
15	Using a snowmobile or ATV as approach vehicle when helicopter landing is not possible because of conditions	Snowmobile or ATV turns over and falls on driver / passenger	8	3	24	Only skilled personnel with certificate allowed driving Mandatory use of helmet that is EN1077 certified
		Snowmobile or ATV collides with objects at higher speed than 25 km/h	8	2	16	Only skilled personnel with certificate allowed driving Mandatory use of helmet that is EN1077 certified

Risk Severity		Risk Probability				
		Extremely improbable 1	Remote 2	Occasional 3	Probable 4	Frequent 5
Very high						
Catastrophic	10	10	20	30	40	50
High,						
Critical	8	8	16	24	32	40
Medium,						
Marginal to critical		5	10	15	20	25
Low,						
Marginal	3	3	6	9	12	15
Very low,						
Insignificant	1	1	2	3	4	5
<hr/>						
Risk Index	Tolerability	Action required				
32-50	Extreme Risk	STOP Operation immediately, risk is unacceptable. Control measures to reduce risk must be enforced.				
24-31	High Risk	WARNING Operation must be risk assessed prior to continuation. Risk mitigation shall normally be performed				
11-23	Tolerable Risk	CAUTION Review and perform risk mitigation as necessary				
7-10	Low Risk	REVIEW Risk mitigation and review is optional but encouraged.				
1-6	Negligible Risk	NO ACTION REQUIRED Risk is acceptable. No mitigation normally required				

Accident #1 Pendulum side impact



Accident #2

Debris from above due to helicopter downwash



Accident #3 Falling off from ATV



Reviewed helmets:



OPS-CORE FAST BUMP HELMET

EN 1385: 2012
ACH CO/PD 05-04: 2007
Obs-Core PS-1145

TEAM WENDY® SAR TACTICAL™

EN 1385: 2012
EN 12492:2012

KONG LEEF

EN 397
EN 12492
ANSI Z89.1 Type I Class C
EAC
GB 2811-2019

PETZL VERTEX® VENT

EN 397
EN 12492
ANSI Z89.1 Type I Class C
EAC
GB 2811-2019

PETZL STRATO® VENT

EN 12492
ANSI Z89.1 Type I Class C
UKCA

About Sweet Protection

Sweet Protection was founded in Trysil, in the year 2000.

In the midst of the Norwegian mountain and forest wilderness, a group of enthusiastic skiers, snowboarders, cyclists and kayakers started building products they could not find in the market.

Since then, they have made it their mission to create the best possible products blending industry-leading innovation with the finest craftsmanship.



→ sweet

The helmet:

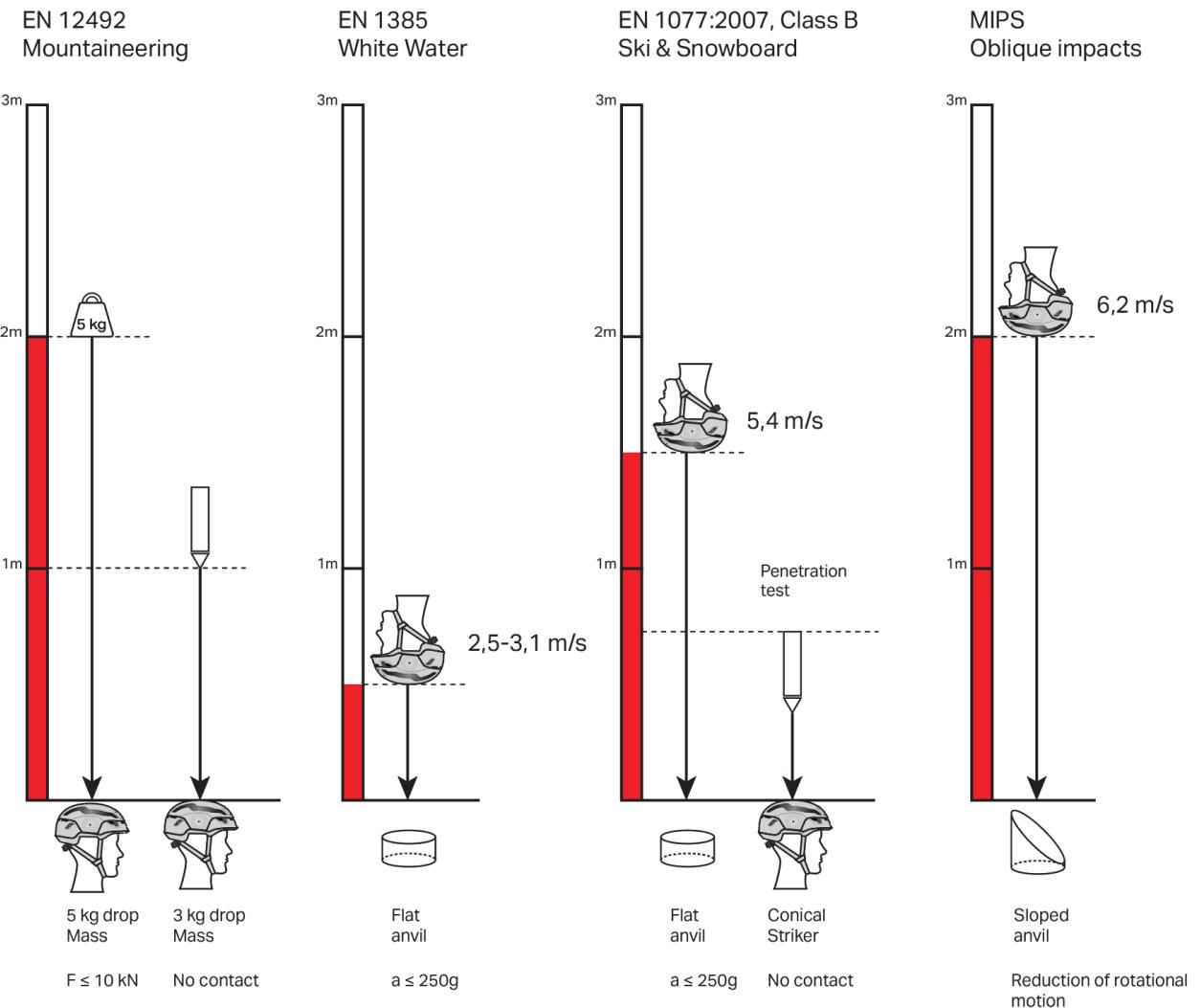
- Triple-certified SAR helmet
- Incredibly strong carbon fiber hybrid construction
- Multi-density shock absorbing structure
- Mips implementation to reduce rotational forces on the brain
- Extremely light weight and low volume
- Clockwork SAR protective goggle compatible
- Mounts for headphones and goggles
- Mounts for lights, cameras and NVG in the front
- One helmet for all operations



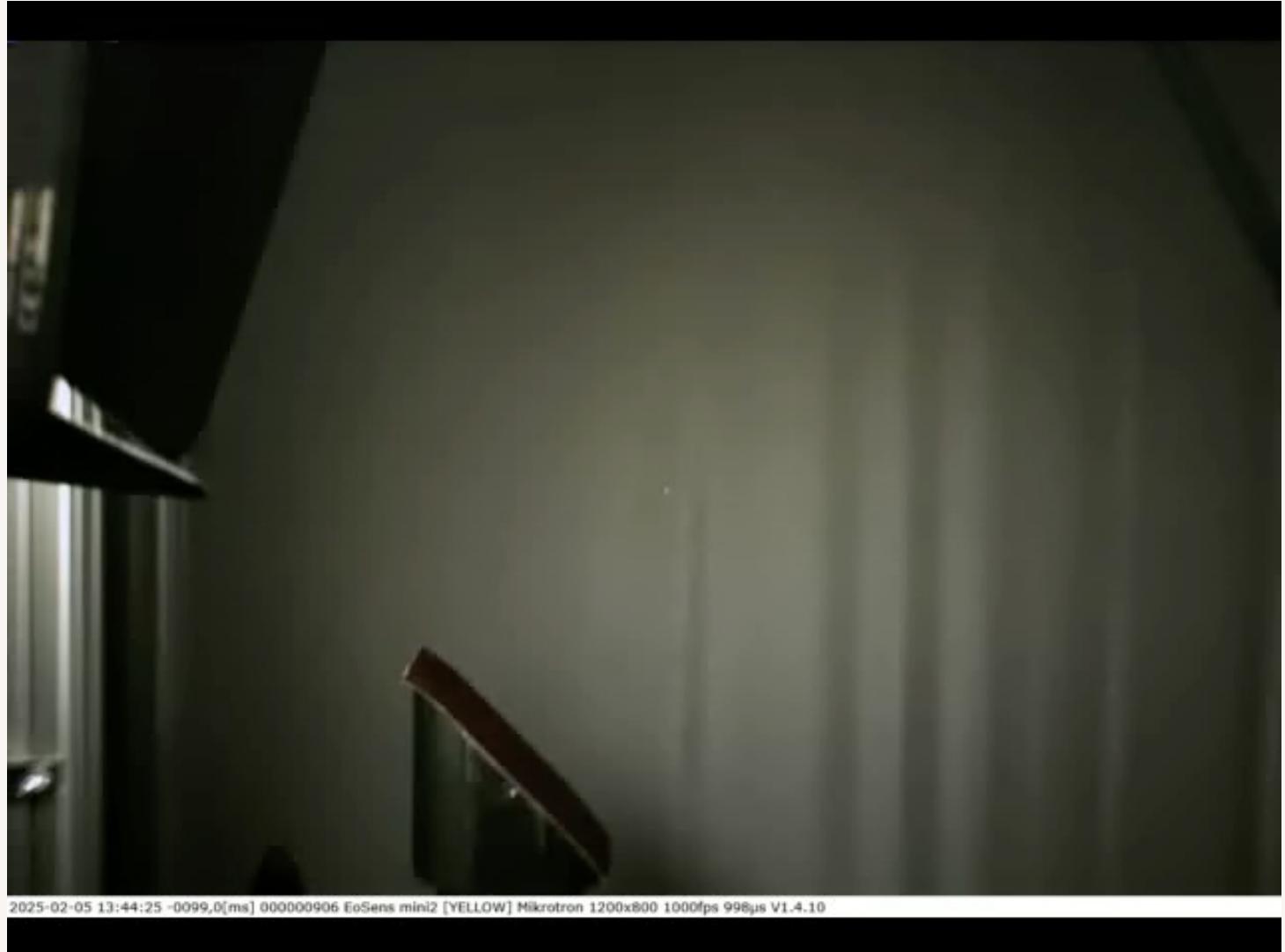
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Testing:

- Extensive impact and penetration testing according to three different standards + separate Mips test for reducing rotational forces
- Tested both with and without accessories mounted
- Conditioned before testing:
 - Hot
 - Cold
 - Ambient
 - Artificial aging
 - Wet (submerged)
- In addition to impact testing:
 - Retention system (chin strap) strength
 - Retention system effectiveness (roll off)



Testing:



2025-02-05 13:44:25 -0099,0[ms] 000000906 EoSens mini2 [YELLOW] Mikrotron 1200x800 1000fps 998μs V1.4.10

The helmet:

- **Sizes:**
S/M (53-56)cm, M/L (56-59) cm, L/XL (59-61) cm, XXL (61-64) cm
- **Helmet weight (size M/L):**
500g
- **Helmet certifications:**
 - EN 12492 (Helmet for mountaineering)
 - EN 1077 - Class B (Helmet for skiing & snowboarding) *
 - conforms to all requirements according to EN 1385 (White Water Kayaking) with exception for coverage
- **Goggle certification:**
 - ISO 16321-1 (CT) (Eye and face protection for occupational use)



* Will as well meet ASTM 2040 (North American Ski & Snowboard standard) for fall/winter 2026

 sweet

The helmet:



 **sweet**

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**Thank you for
your attention!**





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