FreeXperience®
FREEDIVE

Safety notice! Freediving lanyards are meant to be used by trained freedivers. Freedivers are always responsible for their own safety and the safety of their fellow divers. Keep in mind that the safety lanyard is only a backup system, and it must be maintained properly for it to remain functional and in good shape. Remember to dive within your skill level and respect your limitations. Never dive alone. All information contained in this document is intended for trained freedivers and exists for informational use only.

Freediving Safety Lanyard Test Recommendation

AIDA International competition rules do not have standards for safe and reliable safety lanyard tests. Currently all lanyard tests in AIDA competitions are performed by judges in subjective and varying ways. Therefore, I have created this simple recommendation for testing and checking a lanyard. This test pattern is based on real physical facts:

1. Minimum sudden force and drop test

The force that the drop test creates on the lanyard depends on how elastic the lanyard is. The more the lanyard stretches, the smaller the force against the lanyard is. The reason for this is that when the lanyard is elastic, the weight has more time to decelerate, meaning that the impact would not be immediate.

Some examples:

When the wrist strap of the lanyard is firmly attached at a high connection point and 4 kg of weight is attached to the other end of the lanyard, and when the attached 4 kg weight is freely dropped from a height of 1 meter:

- Impact velocity is: 4.43 m/s
- Impact energy is: 39.24 J
- Impulse is: 17.72 Ns

Assuming that the lanyard has elasticity and it stretches

- 5 cm: the force = 785 N (corresponds to 80 kg, or 176 lbs)
- 2 cm: the force = 1962 N (200 kg; 441 lbs)
- 1 cm: the force = 3924 N (400 kg; 882 lbs)
- 0.5 cm: the force = 7848 N (800 kg; 1764 lbs)
- 0.2 cm: the force = 19620 N (2000 kg; 4409 lbs)
- 0.1 cm: the force = 39240 N (4000 kg; 8818 lbs)

Drawing conclusions from those numbers, I would advise freedivers to use lanyards that are slightly elastic, as such lanyards should be stronger and are less likely to harm a freediver in worst scenarios.

2. Constant force

Calculating the drag force of a freediver, when a counter ballast system is pulling him or her up, we can use the drag equation:

$$F_D = \tfrac{1}{2}\rho u^2 C_D A,$$

where:

F_D is the force of drag,
ρ is the mass density of the fluid (1,000 kg/m^3 for water),
u is the velocity of the object relative to the fluid (1.5 m/s for a normal counter ballast system),
A is the reference area (depends on the position and the size of the diver, but let's say it varies between 0.1 m^2 and 0.8 m^2), and
C_D is the drag coefficient (0.7–1.0 for a diver)

So, the maximum drag force is:

$F_d = 0.5 \times 1{,}000\ kg/m^3 \times (1.5\ m/s)^2 \times 1.0 \times 0.8\ m^2 = 900\ N = 92\ kg.$

When we also add the negative buoyancy of the diver into the calculation, the effect of which is at worst 5 kg, we end up with 97 kg.

97 kg of drag is a worst-case scenario in which a very large freediver is coming up sideways (if the lanyard is attached to a waist belt) at the speed of 1.5 m/s.

A more realistic drag would be:

$F_d = 0.5 \times 1{,}000\ kg/m^3 \times (1.5\ m/s)^2 \times 0.7 \times 0.1\ m^2 = 80\ N = 8\ kg$

Again, we add the negative buoyancy to that force (5 kg) and we end up with 13 kg. Drag in the amount of **13 kg is a more realistic scenario**, where a diver is coming up with one arm in front of the other and in a somewhat streamlined position.

Conclusions and suggestions for AIDA safety lanyard tests to be used by competition judges

A lanyard test should be safe, simple and easy to conduct by any freediver, judge or competition organizer. The purpose of the lanyard test is to make it possible to ensure that the competition lanyard has been properly manufactured and is safe enough for competition conditions. The lanyard test should also be similar (that is, standardized) for all the athletes, judges and organizers. During the test, safety precautions should be taken seriously; as a minimum, the person performing the test **must** have their eyes protected.

Lanyard manufacturers should test their lanyards regularly and keep their product specifications publicly available. Lanyard manufacturers also should carry their responsibility as a manufacturer and continually develop their product to be safer and fulfill its purpose.