Safety notice! Freediving lanyards are designed to be used by trained freedivers. Freedivers are always responsible for their safety first and then also the safety of their fellow divers. Remember that the safety lanyard is only a backup system and must be adequately maintained 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 only for trained freedivers and for informational use only.

Freediving Safety Lanyard Test Recommendation

Currently, there are no standards for freediving lanyards to ensure their quality. Still, all lanyard tests in freediving competitions are performed mainly by judges or the competition organizers in subjective and varying ways. Therefore, I have created this simple recommendation for testing and checking a lanyard. This test pattern is based on actual physical facts.

NOTE! For lanyard tests, the lanyard should be appropriately attached, as used in the water. A round pole for the wrist attachment connection point is recommended. Also, the lanyard closing mechanisms should be appropriately used, i.e., Velcro should be adequately closed by pressing it to ensure it is attached properly. A lanyard can only be safe if it is appropriately sealed, and any of these tests or recommendations may not deliver proper results if these recommendations are followed.

1. Minimum sudden force and drop test

The drop test aims to simulate a situation when an unconscious freediver, connected with the lanyard to the dive rope, falls underwater, and the counter ballast system is launched (1.5 m/s speed).

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 pressure against it and its parts is. This is because when the lanyard is flexible, the weight has more time to decelerate, meaning the impact would not be immediate.

When the wrist strap of the lanyard is firmly attached at a high connection point, 4 kg is attached to the other end of the lanyard, and when the attached 4 kg, the 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 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.)

Concluding those numbers, I advise freedivers to use slightly elastic lanyards, as such lanyards should be more robust and not so easily harm a freediver in the worst scenarios.

2. Constant force

The pull test's purpose is to simulate a situation when an unconscious freediver is pulled up by the counter ballast system (1.5 m/s speed).

We can use the drag equation to calculate the drag force of a freediver when a counter ballast system is pulling them up :

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

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

Conclusions and suggestions for freediving lanyard safety tests

A lanyard test should be safe, simple, and easy to conduct by any lanyard manufacturer or freediver. 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 standard should also be similar for all. During the test, take safety precautions seriously; at minimum, the person performing the test must have their eyes protected.

These kinds of lanyard tests should not be conducted before any freediving competitions; tests like these weaken lanyards and make them less safe. Lanyard manufacturers should test their products regularly and keep their specifications publicly available. Lanyard manufacturers should also carry their responsibility as a manufacturer and develop their products relentlessly safer for their purpose. Freediving organizations should work for the test standards by using available resources and assets to improve freediving safety.

Meanwhile, a 4 kg drop test from 1 meter, repeated a minimum of five times, can ensure that the lanyard works and can save the athlete in the worst scenario. Any freediving lanyard should be able to survive that test without any visible damage. The tested lanyard should never be used for diving, and it should be destroyed after the tests.

NOTE! All FreeXperience lanyards pass these tests and are regularly tested by the manufacturer. In FreeXperience lanyard drop tests, we use 5 kg weight. Our test results and lanyard specifications are publicly available at www.freexperince.com.