

Manufacturers, importers and sellers of flotation suits (overalls)

Finnish Consumer Agency's Guidelines on the Safety of Flotation Suits (Overalls)

1. Background

A flotation suit (overall) is wind- and water-resistant outerwear that is commonly used in fishing, ice fishing and boating. In the flotation suits typically sold today, evenly distributed buoyancy material affects the wearer's floating position and makes it difficult to keep one's nose and mouth above the surface in choppy water. When submerged, the flotation suit and its pockets fill with water and the suit becomes heavy. This makes it difficult to reach safety on a boat or on a shore of slippery rock, for example. A wet and heavy suit also restricts arm and leg movement and impedes swimming, which further increases the risk of drowning.

According to an incident report by the Accident Investigation Board of Finland, two men who drowned off the shore of Kotka in 2004 were wearing flotation suits. The suits had been worn correctly, and the zippers were closed. Tests performed at the Finnish Institute of Occupational Health found serious safety defects in the suits that the victims had used.

2. Legislation and standards applicable to flotation suits (overalls)

Flotation suits (overalls) are protective gear, and the Government Decision on the safety of personal protective equipment (1406/1993) applies to them. Previously, flotation suits were type approved in accordance with European standard SFS-EN 393. In 2006, however, it was replaced by the international standard SFS-EN ISO 12402-5, "Personal flotation devices – Part 5: Buoyancy aids (level 50) – Safety requirements".

One-piece flotation wear, i.e., flotation suits, were excluded from the scope of application for the standard in an amendment made on 1 December 2006. The amendment was introduced by Finland, partly on the basis of the above-mentioned findings on the safety characteristics of flotation suits. Therefore, there is no harmonized standard specifically for flotation suits as referred to in Section 5 of the Government Decision on personal protective equipment.



3. On the market surveillance on the safety of flotation suits (overalls)

On 23 February 2007, the Consumer Agency and the Accident Investigation Board issued a joint press release on the safety risks involved with flotation suit use. The press release announced that the Consumer Agency would be testing flotation suits being marketed in the spring of 2007 and if necessary, intervening in their sales.

As part of the spring 2007 market surveillance, the Consumer Agency had a flotation suit safety study done by the Finnish Institute of Occupational Health. The goal of the project was to establish whether the suits being tested met the safety requirements set for them. The Institute of Occupational Health is the approved inspection body in Finland as referred to in the Personal Protective Equipment Directive (89/686/EEC). The flotation suit tests were carried out at the Meriturva Maritime Safety Training Centre in Lohja.

The Finnish Institute of Occupational Health test report findings (24/4/2007, attached in Finnish) were, inter alia, that the flotation suits examined did not fulfil the basic and additional requirements set for personal protective equipment. The products limited a user's mobility and field of view, and also restricted hearing and breathing. They were too heavy and awkward to use, and did not provide adequate support to a user in the water without an active effort. The suits had an unstable floating position, and they were difficult and exhausting to swim or move in under rescue conditions.

The Consumer Agency has been negotiating on the matter for a long time with the entrepreneurs concerned. A discussion about flotation suit safety was organized at the Consumer Agency on 28 May 2008. The event was attended by representatives of several businesses, as well as representatives of the Institute of Occupational Health and the Accident Investigation Board. The businesses were given information about the situation, and the different parties had an opportunity to present their views.

4. Factors affecting risk assessment

When assessing the safety features and possible risks of flotation suits, it must be taken into account that they are protective equipment intended specifically for protection at work or at leisure. Flotation suits are considered "Group II" products under protective equipment legislation, and thus are subject to (inter alia) type examination.

A consumer is not able to assess, and cannot be expected to assess, how a flotation suit will work and respond in an emergency situation unless he or she has specifically tried it out under the conditions in which it will be used. Furthermore, it is clear that consumers do not test protective gear in advance, especially in conditions approximating those of the intended use. Thus consumers do not have realistic expectations of what it will be like to use the product. Some of the Institute of Occupational Health findings were that extended use in choppy water will quickly exhaust even a user who is in good physical condition, that the suits do not protect

against hypothermia, and that the suits do not function well in the water when they are waterlogged.

If flotation suits do not meet the safety requirements for personal protective equipment of this type, the fact that they might provide better protection to a user than if no protective equipment were used at all, is no justification for allowing them on the market.

Protective gear such as a flotation suit gives the user a certain degree of "presumed safety" and a sense of security, which have an effect on thinking and behaviour. The user of a flotation suit, then, may take risks (such as boating in particularly hazardous weather or going out on weak/thin ice) that he or she would not take if the protective product were not available. Furthermore, a consumer may decide not to use safety gear that would provide true protection, even if the instructions for a flotation suit state that another flotation device should be used in addition to the suit. The use of an additional flotation device may also be discouraged by the fact that it is difficult to wear together with a flotation suit. When used together, a flotation suit and a life vest considerably impede a user's ability to move and work.

Another consideration is that a consumer who does not use a flotation suit may be more likely to use other protective gear (such as a suitable life vest) and equipment that together provide better overall protection than a flotation suit alone.

Due to the factors mentioned above, it is very important for protective gear to function in the manner intended and to be safe for consumers under all foreseeable circumstances.

5. Guidelines on the safety of flotation suits (overalls)

The Consumer Agency is issuing these guidelines to ensure and develop consumer safety. The guidelines apply to all flotation suits (overalls), those that have been subjected to surveillance by the Consumer Agency, and all others as well, to be provided to consumers, and any products intended for the same purpose, regardless of what name is used for them in marketing, etc. In preparing these guidelines, the Consumer Agency has heard comments from the businesses concerned, the Occupational Safety and Health Division of the Ministry of Social Affairs and Health¹, the Accident Investigation Board, the Finnish Association for Swimming Instruction and Life Saving, the Institute of Occupational Health, and the Association of Finnish Suppliers of Labour Safety Equipment.

Section 3 of the Act on the Safety of Consumer Goods and Consumer Services (75/2004) provides that an entrepreneur must take all care and professional precautions called for under the circumstances to ensure that a consumer good does

¹ The Occupational Safety and Health Division of the Ministry of Social Affairs and Health has stated that it considers flotation suits (overalls) to be products that, under Section 4 of the Government Decision on the safety of personal protective equipment (1406/1993), can endanger the safety of the user. The Ministry of Social Affairs and Health has presented the view that, under the Government Decision on the selection and use of personal protective equipment (1407/1993), the products in question should not be procured or used for occupational purposes.

not pose a hazard to consumer health or property. An entrepreneur must have sufficient and accurate information about a consumer good and the risks it involves.

According to the law, the entrepreneur is responsible for product safety and must be familiar with the features of the products being sold. The entrepreneur must undertake all procedures necessary to ensure consumer safety at his or her own initiative, without any specific action being required by a surveillance authority.

Flotation suits (overalls) of the type found today can be sold until 30 June 2009 on certain conditions

Flotation suits that have been subject to surveillance by the Consumer Agency, and other flotation suits with comparable features (these features are indicated in the attached report of the Institute of Occupational Health), may be provided to consumers until 30 June 2009 on the following conditions:

- Information must be conspicuously attached to flotation suits or their packaging to indicate that when used alone, the product does not provide sufficient protection to a user who becomes waterborne, and therefore a life vest, buoyancy vest or similar product must always be used together with the flotation suit.
- This information must also be clearly stated in an announcement conspicuously posted at the product's point of sale.
- In addition, staff at the product's point of sale must orally provide the information indicated above to the consumer when presenting and selling the product.
- The same information must also be provided when advertising the product.

Compliance with the above is required from 1 September 2008 onward for the flotation suits in question.

Most of the flotation suits on the market today are likely to have safety characteristics that require the procedures described above in order to be provided to consumers.

Flotation suits (overalls) sold after 1 July 2009 must be more technologically advanced than those sold today

After 1 July 2009, the only flotation suits that can be provided to consumers will be those with features that meet the technical requirements of the Personal Protective Equipment Directive, and those of the Government Decision on the safety of personal protective equipment as well as the basic health and safety requirements of Appendix 1 of the Decision that are applicable to flotation suits. Essentially, this means that the safety of flotation suits must significantly improve, at least in terms of the factors mentioned in the Institute of Occupational Health report.

An entrepreneur will need to have the type approval documents required by the legislation. A flotation suit cannot be type approved according to standards SFS-EN 393 or SFS-EN ISO 12402-5.



From the standpoint of consumer safety, it is expedient and hoped that entrepreneurs will endeavour to shift as quickly as possible (prior to 1 July 2009), without delay, to manufacturing and selling only flotation suits that are more technologically advanced than previously.

6. Actions anticipated from entrepreneurs to improve the safety of flotation suits (overalls)

In practice, following the guidelines will require product development. Cooperation among several businesses and testing facilities will most likely be the way to accomplish this. Among other things, this would make it possible to evenly distribute the product development costs. Since the products are rather similar in terms of their basic technical features, the incentive to cooperate is strong.

Since there is currently no harmonized standard for flotation suits (overalls) under the Personal Protective Equipment Directive and Section 5 of the Government Decision on the safety of personal protective equipment, the assessment of their safety features must be based solely on the requirements of the Government Decision and the basic health and safety requirements of Appendix 1 of the Decision that are applicable to flotation suits.

The Consumer Agency emphasizes that it is particularly important to take Finnish conditions into account (special climate and snow conditions, for example) and to conduct practical tests before products are made available for use by consumers.

In the future, manufacturers and traders should consider whether it might be appropriate to develop flotation suits for more specific applications and different user groups. The conditions in which the suits are used vary considerably. They include, for example, ice fishing on a lake, where there is the danger of falling through thin ice, and boating on a stormy sea in autumn. If product features are to be developed according to intended use, the use should be carefully taken into account in product design, type approval (informing test facilities so that they are aware of the conditions for which the type approval is being sought), and product information and instructions for use.

It is expedient to notify standardization bodies of product development results so that in the long run, a standard that provides an adequate safety level for flotation suits can be prepared.

7. Basis for the guidelines

- Government Decision on the safety of personal protective equipment (1406/1993)
- Act on the Safety of Consumer Goods and Consumer Services (75/2004)
- Report of the Finnish Institute of Occupational Health (24/4/2007)
- Report by the Accident Investigation Board of Finland (B 4/2004 M): Boating accident off the shore of Kotka, 3/7/2004



- Market surveillance cases of the Consumer Agency, and viewpoints expressed in the discussion organized by the Consumer Agency on 28/5/2008
- Consumer Agency's risk assessment
- Viewpoints of entrepreneurs and stakeholder groups solicited during the preparation of these guidelines.

8. Compliance with the guidelines

An entrepreneur is responsible for ensuring that only safe products are provided to consumers.


These guidelines will be supplied to affected entrepreneurs known to the Consumer Agency, and published on the Consumer Agency's website. The Consumer Agency will issue a press release on the matter.

The Consumer Agency will conduct market surveillance on the compliance with these guidelines. If necessary, the Consumer Agency shall ensure consumer safety through administrative enforcement as provided in the Act on the Safety of Consumer Goods and Consumer Services.

Director General


Marita Wilska

Director


Tomi Lounema

Appendix

- Report of the Finnish Institute of Occupational Health (24/4/2007, in Finnish)

CC:

- Erä-lehti magazine
- Kippari-lehti magazine
- the Consumer Agency's website
- The Finnish Maritime Administration
- Accident Investigation Board of Finland
- The Finnish Grocery Trade Association
- Ministry of Social Affairs and Health, Occupational Safety and Health Division



- Federation of Finnish Commerce
- Finnish Standards Association SFS
- Association of Finnish Suppliers of Labour Safety Equipment
- The Finnish Association for Swimming Instruction and Life Saving (SUH)
- Finnish Customs Administration
- Ministry of Employment and the Economy, Working Life and Markets Department
- Finnish Institute of Occupational Health
- Vene-lehti magazine



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Reference: Your order KUV/782/53/2007; 20.2.2007

TRANSLATION

As a requested advisory opinion, the Finnish Institute of Occupational Health presents the following:

1 General

1. 1 Legislative obligations

The treaty on the European Economic Community entered into force on January 1, 1994. The treaty includes among other things two directives (89/686/EEC and 89/656/EEC), regarding personal protection equipment, that were brought into force in Finland by decisions of the Council of state (VNp 1406 and 1407).

1.1.1 Decision of the Council of state 1406/93 on personal protection equipment (Directive 89/686/EEC)

The decision of the Council of state (VNp 1406/93) on personal protection equipment regards the safety requirements of personal protection equipment used both at work and in leisure time and the procedures required from manufacturers to place the equipment on the market. The basic requirements regarding protection equipment that protection equipment must fulfil have been presented as an appendix to the decision. To clarify the requirements so-called harmonized standards have been prepared; these are voluntary for the manufacturer; it however, is the easiest way for the manufacturer to show the products' conformity to the requirement by conforming to these harmonized standards. If a protective device conforms to the requirements of the harmonized EU standards, it is considered to fulfil the basic requirements listed in the directive, regarding health and safety.

Placing on the market requires that the conformity to requirements is ascertained (certification). Personal flotation devices (PFD) belong to the class II for which a precondition is that the product is type examined by an approved notified body. A certified protection device fulfilling the requirements can be recognized by the CE-marking.

According to the decision on personal protection equipment, PFD must also fulfil all the basic requirements applied to protection equipment, regarding health and safety (VNp 1406/93, Appendix 1.1, article 1) as well as the additional requirements set for personal protection equipment (PPE) and buoyancy aids meant for emergency situations and to be taken rapidly into use or taken off (Appendix 1.1, articles 2.7 and 3.4.1).

The additional requirement text *"Clothing which will ensure an effective degree of buoyancy, depending on its foreseeable use, which is safe when worn and which affords positive support in water. In foreseeable conditions of use, this PPE must not restrict the user's freedom of movement but must enable him, in particular, to swim or take action to escape from danger or rescue other persons."* is very generic and open to various interpretations. It provides hardly any help to a type

In unsure situations the official version (In Finnish) applies.



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examiner not having personal experience of protection devices used on waters. A precondition for securing the requirement is to carry out long-term and versatile performance tests in water.

1.2 European and international standards regarding rescue equipment

New standards regarding rescue equipment EN ISO 12402: parts 1-10, entered into force in 2006. They replace the EN standards EN 393, 394, 395, 396 and 399 with their amendments and the technical report CR 13033.

The new standards define the requirements for the performance of a product at a more specific level than the EN standards that were previously in force. In the new standards requirements and test methods have been separated from each other: the safety requirements set for products have been listed in parts 1-6, the requirements set for materials and components in part 7, while the requirements set for accessories and test methods in part 8 and the performance tests for the whole product in part 9. Part 10 replaces the technical report CR 13033.

1.2.1 EN 393: 1993/A.1:1998 Buoyancy Aids 50 N (not valid any longer)

Buoyancy Aids in accordance with the standard (EN 393:1993/A1:1998) have a buoyancy of no less than 50 N for the average adult. According to the standard, this buoyancy aids has been *"intended for use in sheltered waters when help is close at hand and the user is a swimmer, in circumstances where more bulky or buoyant devices would impair the user's activity or actually endanger him"*.

The requirements of the standard have been prepared primarily for vest type buoyancy aids. To function according to its purpose, the structure must be such that the buoyancy material is placed only in the upper part of torso, and particularly on the front side of torso. Based on the standard, a few manufacturers have succeeded in designing a functioning flotation jacket.

Flotation suits (overalls) delivered by the Consumer agency to the Finnish Institute of Occupational Health have been type examined in accordance with EN 393.

1.2.2 CR 13033:fi: Lifejackets and buoyancy aids. Guide for selection and use (not valid any longer)

CR 13033:fi is a technical report, a guideline, prepared by a European working committee, meant for an aid for those responsible for the use of PFD and those considering their purchase. It determines the purpose of use of flotation wear in a manner more detailed than the standard EN 393:1993/A1:1998. According to CR 13033:fi *"50 N Standard buoyancy aid is intended for use of those who are competent swimmers and who are near to bank or shore or who have help and rescue close at hand. These garments have minimal bulk and cost, **but they are of limited use in disturbed water, and cannot be expected to keep the wearer in safety for long period of time.** They do not have sufficient buoyancy to protect people who are unable to help themselves"*.

The guide also brings out the fact that several deaths when being immersed in water are due to hypothermia, particularly in the Northern waters where the water temperature is during the entire year only for a few weeks above 15°C. Nevertheless, the most recent studies show that the very first minutes in water are the most critical ones due to cold shock. Therefore, PFD must work with their fullest immediately after one is immersed in water.

1.2.3 EN ISO 12402: 2006 Personal flotation devices -Part 5: Buoyancy aids (level 50) - Safety requirements

The PFDs conforming to the new standard are products meant for good swimmers to be used in the nearness of a shore or jetties, when there is help available. They have only limited performance in waves and they are not expected to protect the user for prolonged periods of time. Their buoyancy



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and floating capacity are not sufficient enough to protect a person not able to act. They require active participation from the user.

The PFD should be comfortable to use and they should have adequate buoyancy (for an average adult the minimum of 50 N) to secure a conscious user's breathing activity in calm waters.

The requirements of the standard have been prepared primarily for **vest type buoyancy aids**. The standard, however, facilitates the manufacturing of a functioning *buoyancy jacket*. In order to function according to its purpose of use in water, the structure of the protection device, however, must be such that the buoyancy material is located only in the upper part of torso and particularly in the front side of torso.

There isn't any separate standard for flotation suits (overalls); there however are plenty of flotation suits (overalls) on the market, for which there has been a market niche particularly in Finland where ice fishing is one of the most common pastimes during winter. Manufacturers have aimed at combining two protection devices: clothing providing protection against cold and a PFD, when less attention has been paid to the functional requirements set for the product. The flotation suits (overalls) available on the market are either without the CE-marking or equipped with the CE-marking and as a rule type examined according to the buoyancy aids standard EN 393:1993 and its amendment that already have become obsolete.

During the last few years there have been several accidents in Finland that have taken place in waters/on ice that have lead to death and where the victim has been wearing a flotation suit (overall). Before the standard EN ISO 12402–5 becoming effective, an amendment was registered on the Finnish initiative that **standard is not applicable to one-piece suits**. This means that new products cannot thus be type examined according to this standard.

2 Tested flotation suits (overalls)

2.1 Visual inspection (see Test Reports 27115T01 - 27119T01))

All the examined flotation suits (overalls) were new ones. With the exception of one overall, based on markings or other information obtained, it was not possible to estimate when the products have been *type examined*. The proto type of Shakespeare overall imported by Marinepool had been type examined in 1998. The marking, however, was incorrect (CE98), because the marking practice was changed as early as on 1.1.1997.

The *date of manufacture* required for PFD was not found in the Nordic Sea overall. Other overalls were manufactured in 2005 and 2006.

The materials used in the suits were rigid and heavy. The abundant, over-dimensioned amount of buoyancy material increased the *weight* of the products that weighed on an average 2.5 (2.1 – 3.6) kg.

The hoods in all the overalls resembled the hoods of overalls providing protection against cold. They did not fulfil the requirements set for PFD: shall not unduly restrict the vision, hearing, breathing of the user when worn both ashore and in water. The fastening mechanisms of hoods were poor: danger of seizing or detachment possible (see videos).

Retroreflective materials are not compulsory in PFD according to EN 393. EN ISO 12402-5 standard however requires all the PFD to have retroreflective material fulfilling the SOLAS requirements. All the tested overalls did have some kind of in-sewn retroreflecting tapes, nevertheless, only two of them (IMAX and Sea Fox) had a retroreflective tape equipped with the SOLAS-marking, i.e. meant for products to be used on water. Other retroreflective tapes used on overalls were meant for ordinary and work and leisure-wear. Their retroreflecting features were poor, when the product becomes wet



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due to rain or splash water. In water their visibility was almost non-existent. The retroreflectors give the buyer a wrong kind of sense of safety when moving on waters, because the operating instructions do not contain a mention about the retroreflecting features.

Sizing

Based on visual observation and by comparing two sizes (S and L or M and XL) one could draw a conclusion that common sizing principles were hardly applied when manufacturing different sizes. Small sizes were disproportionately wide. On the other hand, in IMAX and Otso President overalls the size of the product had been expanded almost exclusively by means of making legs and sleeves longer.

With regard to donning the suit and the convenience of use, the *distance between shoulder and crotch* is an essential measure in overalls. If the crotch length is too short, the overall compresses one's neck, shoulders and is tight at the crotch: it is difficult to move and to swim and the use of the suit is inconvenient. It may also be difficult to don.

The *allowance in width* of the overall also affects the usability; if the overall is too slim it may impede movements and there is not enough space for warm clothing to be worn under the overall. On the other hand, if the allowance in width is too big, it may impede movements and increase the risk of seizure. Excessive looseness may even impede swimming, when the extra width remains under arms as 'pouches'. The pouches become filled with water entering via neck which impedes the arm movements.

More space there is for water within the overall and more open neck the overall does have, more water also enters the overall replacing air and thus deteriorating buoyancy. A big moving amount of cold water also cools a person quickly. When floating the water contained by the suit does not weigh, nevertheless, the water penetrated into the suit impedes rescue activities: for instance climbing or ascent to a boat, onto the shore or onto the ice becomes more difficult.

The problems described above and related with sizing became evident during the performance tests (see videos).

2.2 Buoyancy of PFD (see Test Reports)

Standard EN 393:1993/A1:1998 contains several requirements set for inherent buoyancy material and its testing. The most important requirements affecting buoyancy have been listed below (the numbers in parentheses refer to the article of the standard).

Inherent buoyancy material (4.10)

(4.10.1)

Each *inherent* buoyancy material used to achieve buoyancy must stand compression and wear appearing in normal use without significant decrease in the buoyancy. The maximum decrease in the buoyancy must not exceed 10 % in case of any buoyancy material composed of foamed plastic or grains, when three representative samples are being tested according to the standard.

(4.10.2)

Each buoyancy material must be thermically stable when tested according to the standard. The maximum loss of volume must not exceed 5 % in case of any sample.

(4.11.6)

The measured total buoyancy must be sufficient in each test, although the maximum loss percentage measured in section 4.10 is subtracted from it.



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Table 1: *Minimum buoyancy*

User's weight, kg	Minimum buoyancy, N
over 30-40	35
Over 40-50	40
Over 50-60	40
Over 60-70	45
Over 70	50

The buoyancy was measured for Shakespeare and Sea Fox overalls (both sizes). They were selected to be tested based on performance tests, because the buoyancy of both tested overall models decreased visibly after approx. 10-15 floating/swimming. It was not possible to calculate the exact minimum buoyancy for the tested suits because there was no information available about the used buoyancy materials and the measurements carried out on them according to the standard (4.10.1 and 4.10.2). With regard to the PFD type examined by the Finnish Institute of Occupational Health, the 'required over-dimensioning' of minimum buoyancy has been on an average 5 %. Calculated based on this, the buoyancy of the flotation suits (overalls) tested now should not be less than 52.5 N.


In case of Shakespeare overall, there was sufficient buoyancy in size S, the change taken place during 24 hours, however, was too big. In size L the buoyancy was close to the limit value (Test Report 27117T01).

In case of Sea Fox overall there was abundantly floating material in both size categories, with regard to the requirements, this making the suit feel stiff. In size L the change taken place during 24 hours was close to the limit value. Despite of the extra buoyancy material, the characteristics in water were poor and the float position was deep (see video and test report 27119T01).

2.3 Markings and user information in flotation suits (overalls)

VNp 1406, Appendix 1.1, article 1.4 requires all the personal protection equipment to have permanent markings as well as exact and comprehensible user information in both Finnish and Swedish languages.

In case of the tested flotation suits (overalls) one (Nordic Sea) had the markings and user information only in Finnish. Shakespeare overall did not have any user information at all.

The markings or user information of any product did not meet the requirements. All the markings lacked the pictogram  i.e. recommendation to become familiar with the user information.

Among the most severe **faults** in the texts with regard to the safety of the end user were the *misleading* or even *misrepresented* information about the operating conditions (fishing, sailing or ice fishing) or the lack of it and in particular information about *protection against hypothermia*.

The user information and markings of Otso President overall contained a table presenting the estimated protection time. The table had been extracted from the immersion suit standard (EN ISO 15027-1). The use of this table requires also measurements with persons during cold water flotation, and it cannot be applied to flotation wear. The user information also contains a promise that there can be a fourfold survival time when wearing this suit.

Based on studies, flotation suits (overalls) do not give protection against hypothermia (see Fig. 1) in cold water (cf. immersion suits, Fig. 2). The water moving around the torso cools rapidly. In test situation the water temperature was approx. 21–22 °C. Regardless of this, all the persons participating in the test complained about cold as early as in the middle of the test, and in case of most people, the shivering mechanism started to keep the system warm. One of the tested persons (slenderly built) felt particularly cold.



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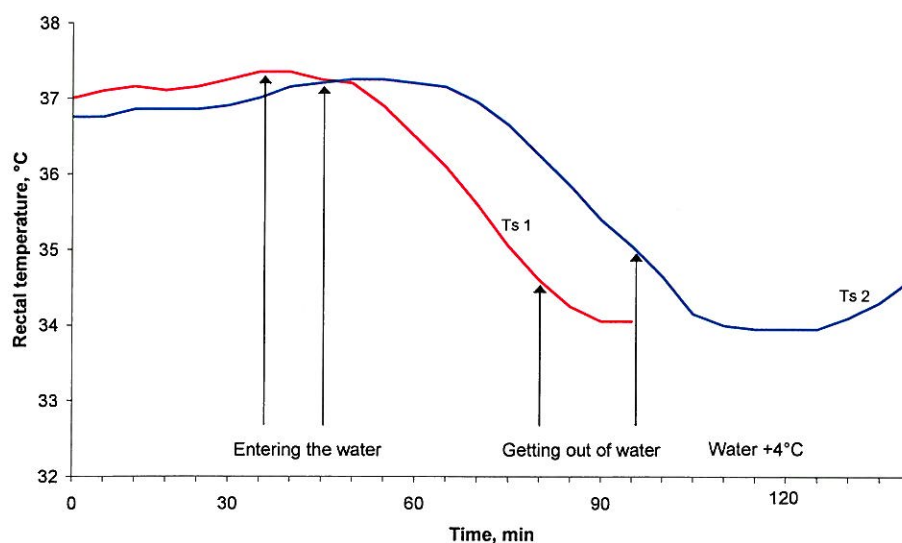


Fig 1. The rectal temperature of two tested persons when testing a flotation suit (overall) in 4-degree water. Underwear and middle layer were worn under the overall. Both tested persons cooled to the hypothermic level ($\leq 35^{\circ}\text{C}$) in 45-60 minutes. After-cooling decreased the temperatures by a further degree. (The study was carried out for a Finnish manufacturer in March 1993).

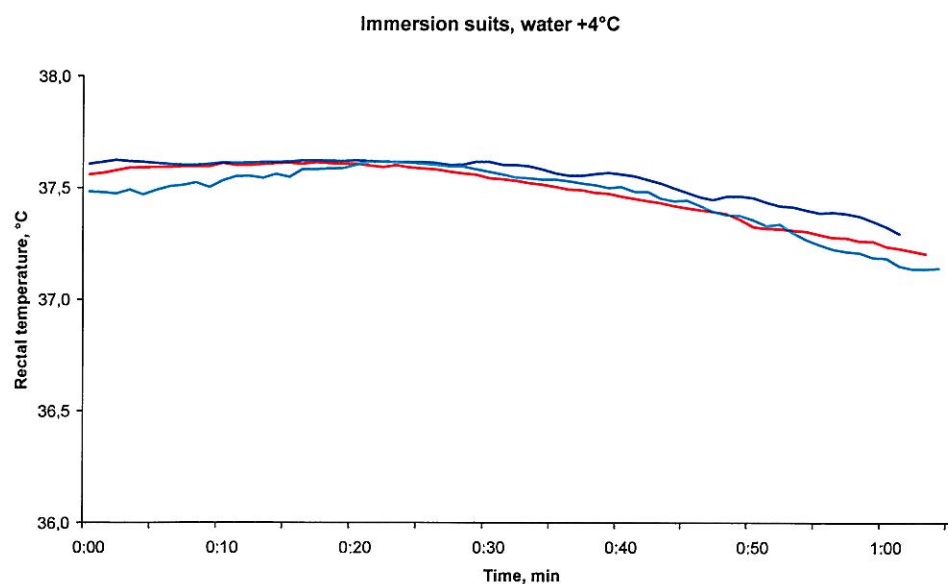


Fig 2. The rectal temperature of three tested persons when testing an immersion suit meant for continuous use in 4-degree water. Underwear and middle layer were worn under the overall. The decrease in the temperature in case of all the tested persons only less than 0.5°C during an hour's floating. (Measurements carried out to a Finnish manufacturer in connection with type inspection in 2002).

The most serious **defects** in both markings and user information were about the limitations of use. Neither one of the overalls contained a mention about the suit not being suitable for use in waves or open seas, about danger situations when wearing the suit on ice, about the thermal stress caused by the suit in connection with physical activities or about the suit becoming filled with water when getting



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immersed into a hole in ice or in open water. In case of the IMAX overall the references contained by the markings create an image that the suit would be fit for use offshore.

There were suspenders in the inside of the Sea Fox overall that make it easier to adjust the suit according to the user; they, however, allow the suit to be worn with the zipper open and the upper part taken off. In this case there is a risk of drowning when falling into water, because the lower part has the entire buoyancy of the suit, which means that the head falls easily under water. There wasn't any warning about this.

2.4 In-Water performance tests (See Test Reports 27115T01 – 27119T01, 2007-04-18 and videos)

Performance tests were carried out at the Meriturva Maritime Safety Training Centre in Lohja on March 4, 2007. Several tests included in the type examination were repeated during the test (jump, swimming, climbing and measurement of freeboard and flotation angle) and long-term exposure to water in calm water and waves was simulated. The water temperature in the test pool was approx. 21–22 °C and the height of the wave 0–110 cm. The duration of the test was 1½ – 2 hours.

The group of test subjects (N = 10) was composed of young men and women in good condition. The test subjects did not represent particularly well the typical users of flotation overalls (fishers, ice fishers in particular and small boaters), because some of them had abundantly previous experiences of the testing of PFDs and they had trained the most difficult performances (e.g. ascent to a raft) for several times. Among the test subjects there were also professional rescuers, one fireman and a policeman. The good condition of the test subjects and their experience as testers may have affected the test results; nevertheless, due to ethical and safety reasons, it was not possible to choose subjects without sufficient information about their health and physical condition to be tested.

Donning

The standard EN 393 does not have any requirement for donning time (cf. life jackets ≤ 2 min.). According to VNP 1406/93 the donning time must be as short as possible, and it should be easy to don. In EN ISO 12402-5 the requirement is ≤ 1 min. Only one tested person was able to don the overall (Nordic Sea) in less than 2 minutes, and in case of one tested person it took 3 min and 10 s (IMAX) to don. The ease and speed of donning is affected by various fastening mechanisms and clamps. In an emergency situation it probably is very slow to don any of the tested overalls, for instance with sturdy shoes on. The tested persons wore now sports shoes.

According to the requirements, the personal protective equipment (PPE) is not allowed to increase the user's thermal stress unreasonably. Each test subject complained about the suit being warm during donning (light physical activity) and merely during waiting. Based on field tests, it is known that the suits are that warm that they are being used with the zipper open even in winter conditions.

Jump

According to the requirements a PFD must bring the user to the surface rapidly and in the correct position.

All the tested overalls brought the user slowly to the surface. In three cases the tested persons were on face-down position after a jump (IMAX, Sea Fox and Nordic Sea). Each test subjects had initially after the jump difficulties in getting their feet under the surface and starting to swim. One of the test subject had a slight 'feeling of panic' because during the jump he fell into the overall (Nordic Sea) and his feet ascended first to the surface.

All the test subjects said they got wet as early as during the jump. Whereas manufacturers promise the user to stay dry.

Flotation angle and freeboard

In case of all the rescue equipment, including PFD, the floating position should be one shown in Fig. 3 (flotation angle 30–90 °). In case of flotation suits (overalls) the buoyancy material placed evenly in

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the whole suit changes the float position to almost horizontal (Fig. 4). The flotation angle measured after a jump was on an average 15.8 ($6\text{--}32$)° and after floating correspondingly 27.9 ($9\text{--}44$)° i.e. the flotation angle was slightly improved by the equipment getting wet, nevertheless, the decrease in freeboard (distance between mouth and surface of water) simultaneously made it more difficult to keep respiratory passages open, especially in waves.

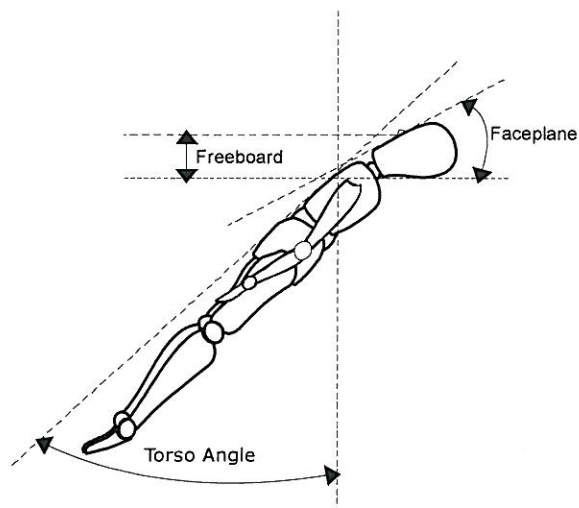


Fig. 3. Flotation angle required from flotation wear.

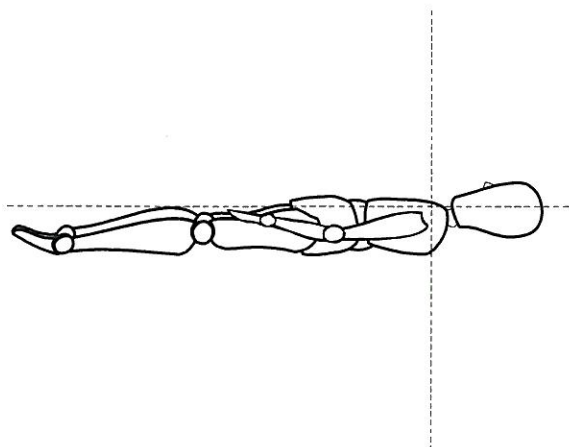


Fig.a 4. Typical float position when wearing a flotation suit (overall)

EN 393 standard does not contain any requirements for the freeboard of a flotation suit (overall) (cf. 8 cm for lifejackets), even though it has a great importance for breathing, especially when one has to stay in water where there are some waves. After the jump the freeboard was on an average 98 (72–131) cm and after floating 79 (46–118) cm. The measured results give an image of the situation slightly better than what it actually is, because for the test, the test subject must first ascend to upward position (fixing of the measuring instrument), when more air flows into the upper part of the suit thus increasing the buoyancy. Results however show that the freeboard is clearly impaired by the suit getting wet, and in case of several test subject it is almost non-existing when swimming in waves and breathing is difficult (see video). In a real-life situation this exhausts the user quickly when one has to hold his or her head up over the water surface.

Swimming

Backstroke was difficult to almost everyone, while breaststroke was almost impossible, because the buoyancy material lifted the feet on the surface when kicks were ineffective to move forward. Swimming was possible only by using one's arms: exhausting.

In back flotation where the user should be able to rest when necessary, the instability of position makes flotation heavy, because it requires the user to be active all the time: exhausting.

During swimming and floating the overall material getting wet, the pockets and the entire overall getting filled with water affected the flotation angle and depth: in waves the freeboard of a flotation suit (overall) was non-existing and it was difficult to breathe. In an accident situation, in a similar float position, the victim easily breathes water in. The freeboard of Sea Fox and Shakespeare overalls had become almost non-existing as early as after being for approx. 10 min in water. For this reason, the buoyancy of the suits was measured after the performance test.

If the hood had stayed on the test person's head, the field of vision was poor when swimming. Hoods became detached or fell off one's head easily in waves and already during the jump.



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Climbing

Ascend 'onto the ice' was an impossible task to everyone. Everyone except one test person, whose suit (IMAX) was very stiff and heavy even as dry (see video) succeeded in ascending onto a survival craft (equipped with a rope ladder).

The water flowing inside the suit and in particular that flown from the back pouch into the legs made the test subjects' ascend to the rope ladder hanging on the 'boat' side and their climbing the distance of 5 metres seemingly difficult. After ascending on the rope ladder, the overalls contained still on an average 10.5 (7.8 – 12.6) litres of water.

3 Summary

The examined flotation suits (overalls) did not fulfil the basic and additional requirements set for PPE.

The products limited the user's freedom of movement, field of vision, impaired hearing and breathing. They were heavy and awkward to use, and they did not provide adequate support to the user in water without him or her being active. The floating position of overalls was not stable, and it was difficult and exhausting to swim or act in a rescue situation while wearing them.

With regard to their structure and protection capacity, the examined flotation suits (overalls) were rather outdoor wear or clothing providing protection against cold, with added buoyancy. By lining the whole suit with buoyancy material, it has been easy to achieve the minimum buoyancy according to EN 393, while making the overall at the same time warm; even too warm for physical activity. A thick buoyant lining impaired the operating characteristics of the overall and had a reducing impact on the functions in operating circumstances foreseeable according to the purpose of use.

Based on the examined products

1. Flotation suits (overalls) are suitable only for good swimmers who have good physical condition, because their use in water requires active participation to maintain a safe position. During long-term exposure overalls do not provide any help to persons with poor condition, and they do not help a victim who is not fully conscious.
2. Flotation suits (overalls) are not suitable to be used in rough sea, offshore or on ice where there is a risk of getting into cold water. Despite of the manufacturer's promises, overalls do not give any protection against hypothermia.
3. The minimum buoyancy of overalls does not guarantee safe performance in water. Long-term exposure in rough sea exhausts even the user with good physical condition.
4. While wearing a heavy suit, rescue activities become almost impossible.
5. The construction of flotation suits (overalls) does not comply with the structural requirements set for personal flotation devices. Adequate buoyancy to secure respiration is achieved if the buoyancy material is placed only on the upper body area, not as a lining to the entire product.
6. Getting water-soaked impairs the performance of the product in water.
7. During physical activity flotation suits (overalls) are too warm.
8. A danger of cold shock when getting unexpectedly immersed in cold water (one's system reacts vigorously to the rapid change of temperature on neck and body).
9. There are serious defects and faults in the markings and user information. An end user is being sold images and wrong kind of safety. No information is given about the limitations regarding use.



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Literature

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2. Council Directive 89/656/EEC of 30 November on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace.
3. CR 13033:fi *"Personal protective devices. Life jackets and flotation wear. Selection and use of life jackets"*. SFS 1998.(in Finnish)
4. EN ISO 12402-5, Personal flotation devices -Part 5: Buoyancy aids (level 50) - Safety requirements.
5. EN ISO 12402-10, Personal flotation devices -Part 10: Selection and application of personal of flotation and other relevant devices.
6. EN ISO 15027-1: Immersion suits. Part 1: Constant wear suits, requirements including safety
7. EN 393: 1993 Lifejackets and personal buoyancy aids -Buoyancy aids 50 N.
8. EN 393:1993/A1:1998 (Amendment A 1).
9. Ilmarinen R: *"Protective clothing for working in waters. Personal protection equipment at work"*. Finnish Institute of Occupational Health, the Centre for Occupational Safety, Ministry of Social Affairs and Health, Helsinki, 2007, 94-97 (in Finnish).
10. Korhonen E: *"Legislative requirements for protective devices"*. "Regards from Work", Bulletin of the Finnish Institute of Occupational Health, "Personal protection equipment", 4/97, 4-5 in Finnish).
11. Decisions of the Council of state on personal protection equipment, No. 1406/1993 in Finnish.
12. Decisions of the Council of state on the selection and application at work of personal protection equipment, No. 1407/1993 in Finnish).

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Appendices:

1. Image collage: Meriturva 7.3.2007
2. Test report 27115T01, 2007-04-18 (in Finnish and in English)
3. Test report 27116T01, 2007-04-18 (in Finnish and in English)
4. Test report 27117T01, 2007-04-18 (in Finnish and in English)
5. Test report 27118T01, 2007-04-18 (in Finnish and in English)
6. Test report 27119T01, 2007-04-18 (in Finnish and in English)
7. 2 CDs (videotaped performance tests)

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