Research report on main recovery-related problem areas in the rescue of persons in distress at sea and recovery-related requirements to be met by life-saving appliances

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As at: Thursday 19 August 2010

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1 Foreword

In 1979, the dangers involved in the vertical recovery of persons from the water, especially those suffering from hypothermia and exhaustion, were brought to the attention of the general public as a result of the fatalities during the *Fastnet Race* in the Irish Sea. Fifteen years later, Dr Wolfgang Urbach, a major in the medical corps of the Federal Armed Forces, stated: **"A life-saving appliance for use in rough seas for the horizontal and gentle recovery of persons is not available anywhere in the world"**.

Another 13 years later, in a series of articles published in 2007, Captain Peer Lange from the Ship Safety Division of *Berufsgenossenschaft für Transport und Verkehrswirtschaft*[*] [short: BG Transport] (formerly the Ship Safety Department of *Seeberufsgenossenschaft*), also came to the conclusion that there had been no decisive improvements compared with the situation in 1994.

However, against the background of further serious maritime accidents, the International Maritime Organization (IMO) had, in 2006, called for seagoing ships to be equipped, **as of 2012**, with life-saving equipment with the help of which **10 persons per hour** could be taken on board **with a significant wave height of 3 metres**.

It has not been possible to achieve this objective for a seagoing ship in a cost-effective manner using the life-saving appliances available to date.

The Rescue Lifting System (RLS) research project, conducted by Hildesheim University of Applied Sciences and Arts, has been working in this field since 1989, exploring options for technical solutions to the problem of recovering persons from rough seas in a manner that is largely horizontal, to minimize the risk of shock. In 2006, its activities were widened to cover work on a cost-effective solution for commercial shipping.

The research activities were carried out in close cooperation with

- the *SARRRAH project* (Search and Rescue, Resuscitation and Rewarming in Accidental Hypothermia), a collaborative project involving the *German Maritime Search and Rescue Service, Bremen, the Naval Institute of Maritime Medicine, Kronshagen*, supervised by the *Department of Anesthesiology, University Medical Center Schleswig-Holstein (UK S-H), Campus Lübeck*, coordinated by Dr. Wolfgang Baumeier;

* Flag State Administration of Germany

- the coordinating *Ship Safety Division of the BG Transport* represented by Captain Peer Lange;
- the *School and Training Centre for Maritime Policing of the Federal Police (Maritime)*, supervised by Chief Inspector Lademann.

2 Research bases and procedures

2.1 Research findings taken into account

With the research findings described below (literature, lessons learned), the *Forschungs- und Konstruktionsbüro Prof. Michael Schwindt, RLS - Rettungstechnologie GbR, Hildesheim*, working in close cooperation with the aforementioned and following institutions (research establishments, universities/higher education institutions), was able to make a contribution towards solving the problems associated with recovering persons from the water in rough seas from merchant ships in a manner that minimizes the risk of shock.

Research establishments universities / higher education institutions	**Literature Lessons learned**
University of Applied Sciences and Arts, HAWK Hildesheim, Germany Rescue Lifting System (RLS) research project	Literature on the problems involved in the rescue of persons in distress at sea, published by the Federal Bureau of Maritime Casualty Investigation
Medical research SARRRAH project University Medical Center Schleswig-Holstein, Campus Lübeck	Literature on the World Congress on Drowning, Amsterdam, June 2002
Hannover Medical School and Coastal Research Centre, Hannover, Braunschweig University of Technology	Lessons learned by maritime search and rescue services and agencies
Forschungs- und Konstruktionsbüro Prof. M. Schwindt, Hildesheim RLS-Rettungstechnologie GbR	Publications by Berufsgenossenschaft for Transport, Ship Safety Division, and lessons learned from the rescue of persons in distress at sea

Figure 1: Research findings of the following institutions taken into account and literature

2.2 Methodology and structure of the procedures

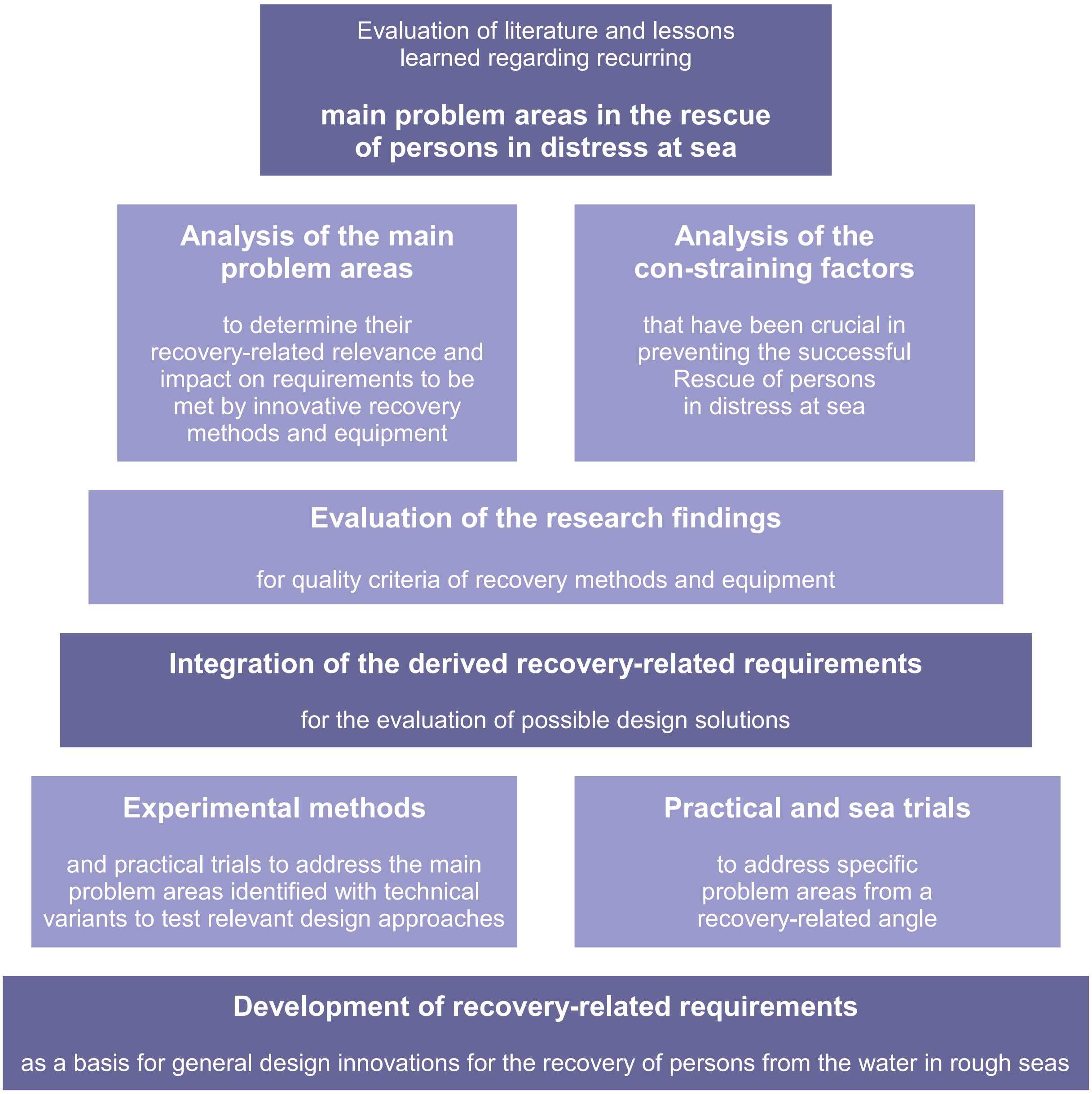

Figure 2: Methodology and structure of the procedures

3 Main problem areas in the rescue of persons in distress at sea

On the basis of an analysis and representation of recurring **main problem areas** in the rescue of persons from the water, it has been possible to pursue newer innovative approaches and methods.

The following **main problem areas and tasks** of a recovery operation and appropriate recovery equipment, **which are to be addressed by recovery technology**, emerged as the most significant:

1. Safe transfer of persons from dynamic motion (sea) to the recovery vessel's (ship's) own dynamic motion.
2. Clarity of operation and purpose of the life-saving appliance for the persons in the water who are to be recovered.
3. Free access to the life-saving appliance when casualties swim towards it.
4. Meeting the basic medical requirement that persons be recovered in a manner that minimizes the risk of shock.
5. Automatic securing of persons against falling out to ensure that they are safely brought aboard and protected against being injured by the life-saving appliance and the side of the ship.
6. The equipment for bringing people aboard (launch and recovery equipment).
7. Mastering increasingly rough seas with wave heights of up to at least three metres.

These main problem areas are **closely interrelated** and in some cases are mutually dependent.

In other cases, however, they are diametrically opposed to each other, which has made technical realization significantly more difficult because of the conflicting requirements. Extremely time-consuming and diverse practical trials under real-life conditions at sea were therefore necessary before it was possible to find adequately simple and effective solutions.

The following diagram shows the **evaluated main problem areas** in their relationship to the basic requirement for safe transfer from one dynamic system to another.

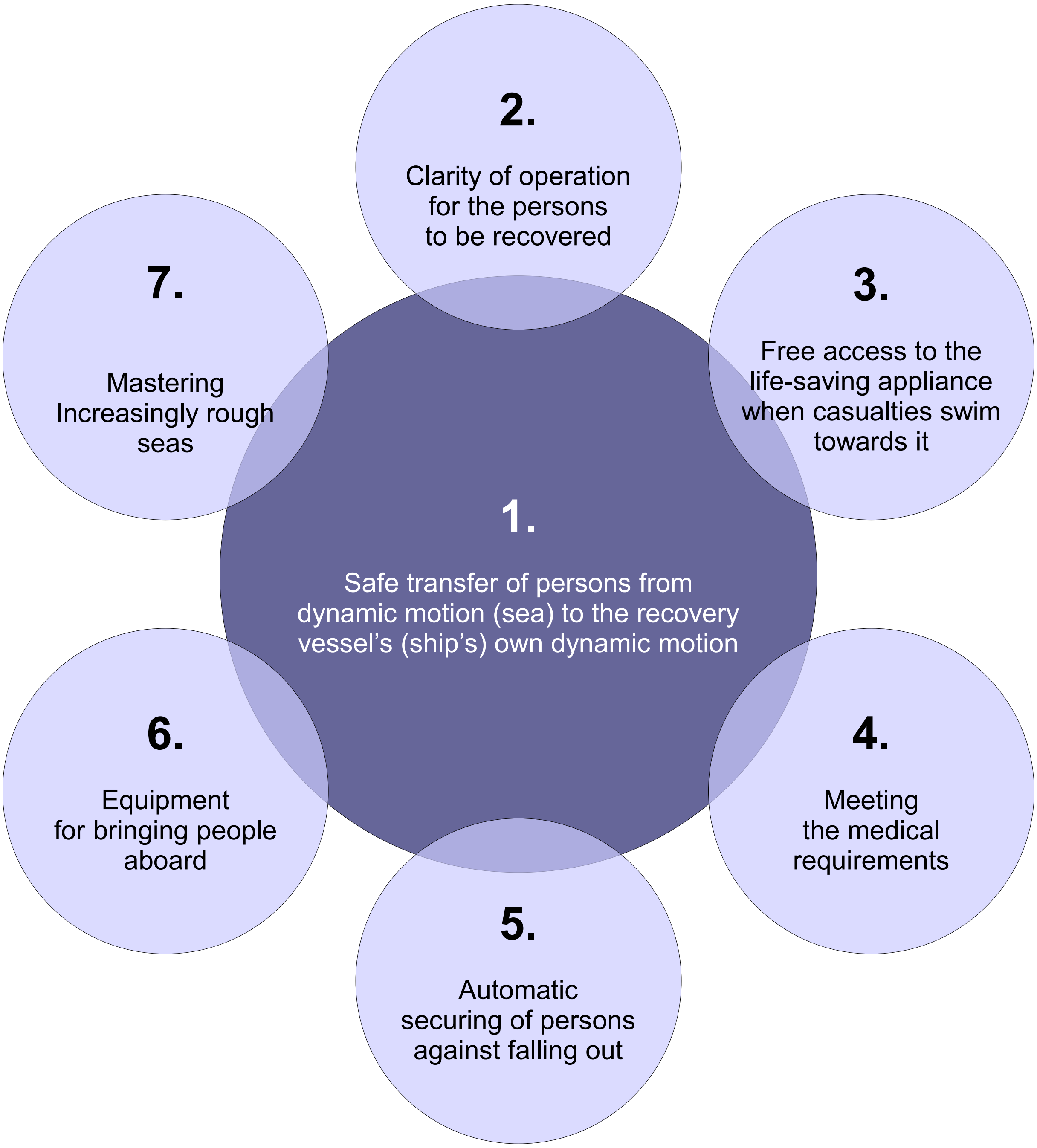

Figure 3: Relationship between evaluated main problem areas

The following points explain in detail the main problem areas and their solutions.

3.1 Safe transfer of persons from dynamic motion (sea) to the recovery vessel's (ship's) own dynamic motion

Five diagrams illustrate the impacts in an unregulated and a regulated transfer.

3.1.1 Impacts of ship roll and seaway

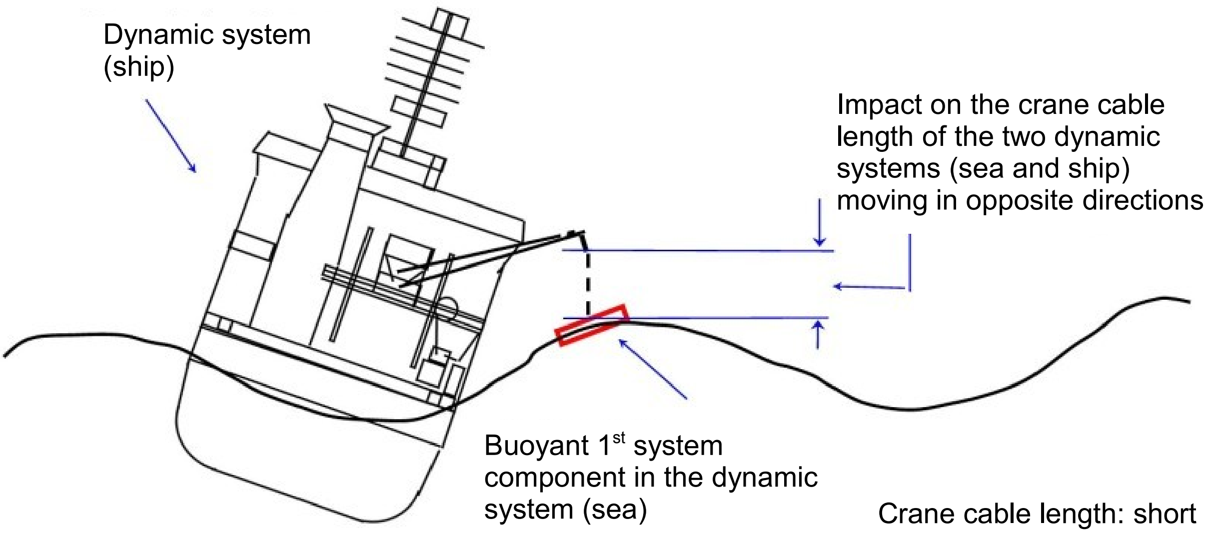

Figure 4: Impacts of ship roll and seaway

The diagram shows the impacts of ship roll and seaway on the distance (length of crane cable) between the head of the crane boom and a recovery device floating on a wave.

This determines the length of the crane cable between the boom head and the recovery device which is necessary in this position.

3.1.2 Impacts of ship roll and seaway moving in opposite directions

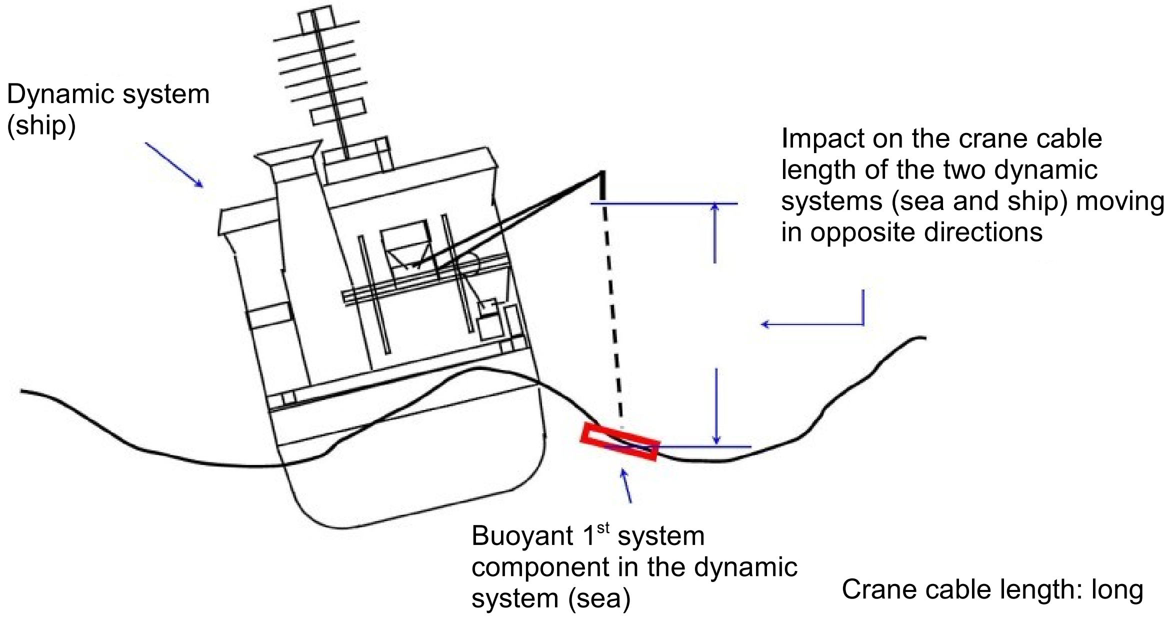

Figure 5: Impacts of ship roll and seaway moving in opposite directions

The diagram shows the impacts of **ship roll and seaway moving in opposite directions** on the distance (length of crane cable) between the head of the crane boom and a recovery device floating in the trough of the waves.

This requires a significantly greater length of the crane cable between the boom head and the recovery device compared with Figure 1.

3.1.3 Negative impacts of ship roll and seaway

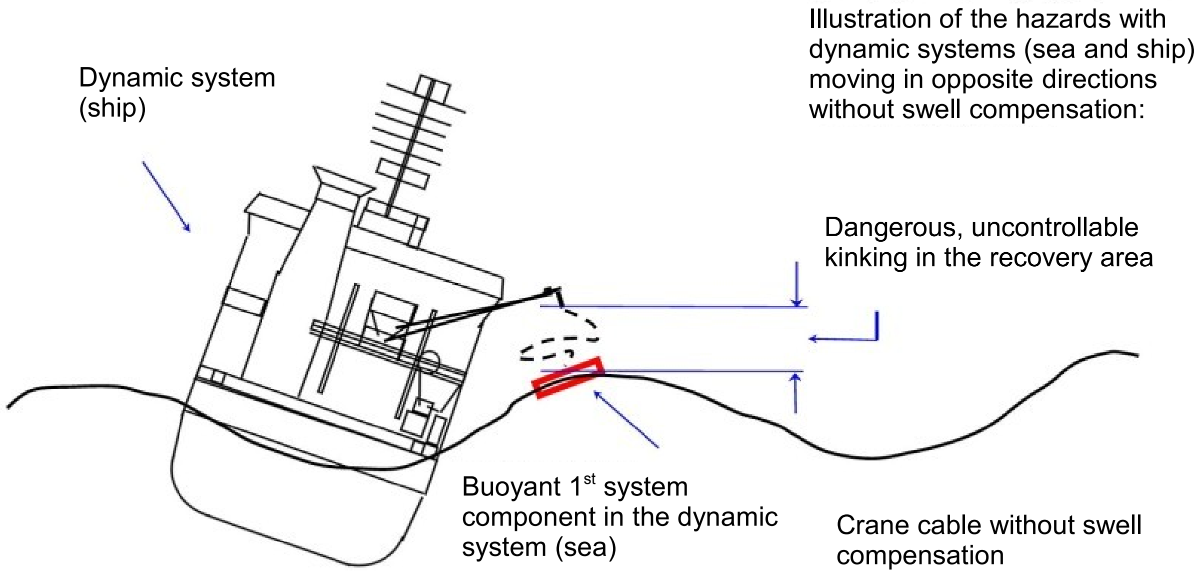

Figure 6: Negative impacts of dynamic systems moving in opposite directions

The diagram shows how the **dynamic systems moving in opposite directions** have a negative impact on the length of the crane cable and how, as a result, the controllability of the recovery operation from the deck of the ship is prevented by turbulence in the recovery area.

3.1.4 Uncontrolled change in the length of the crane cable

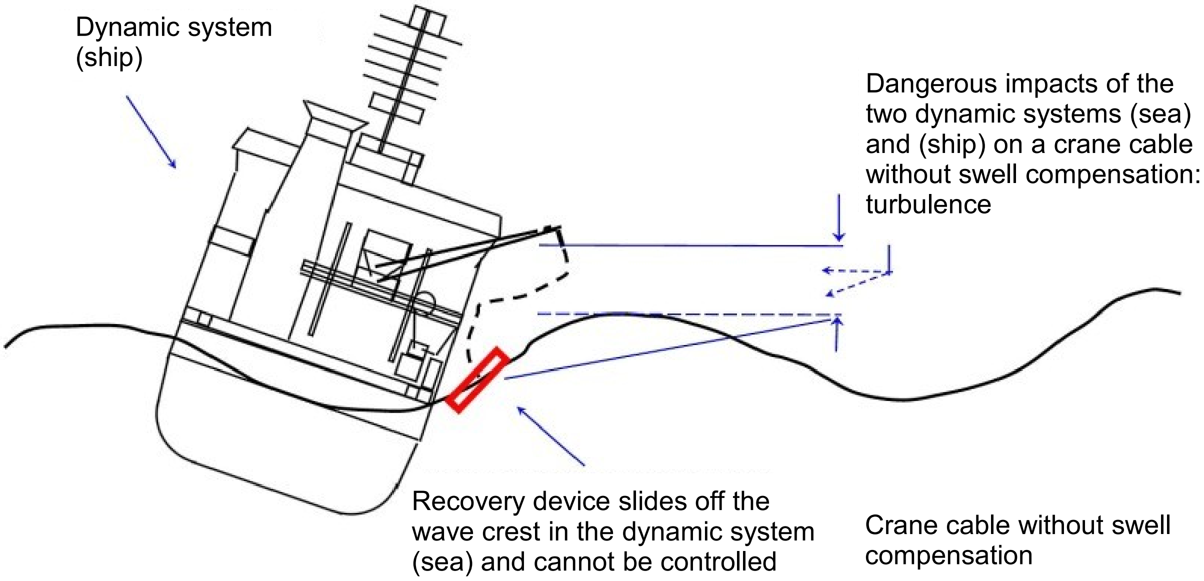

Figure 7: Uncontrolled change in the length of the crane cable

The diagram shows the uncontrolled change in the length of the crane cable as a result of the influence of the dynamic systems (sea and ship) and their negative impacts on the life-saving appliance as a result of hazardous kinking and **hazardous changes in the position of the recovery device** in the area of the ship's side.

3.1.5 Advantage of the counterweight function

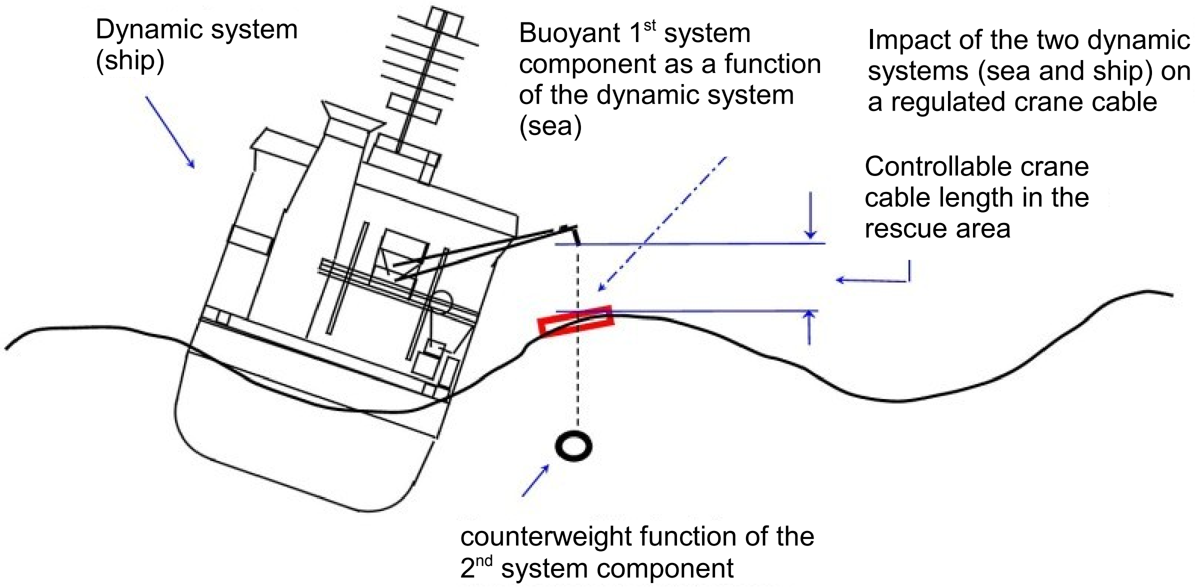

Figure 8: Advantage of the counterweight function of a second recovery system component

The diagram shows the advantage of the counterweight function of a **second recovery system component** that has been combined with the buoyant **first recovery system component**.

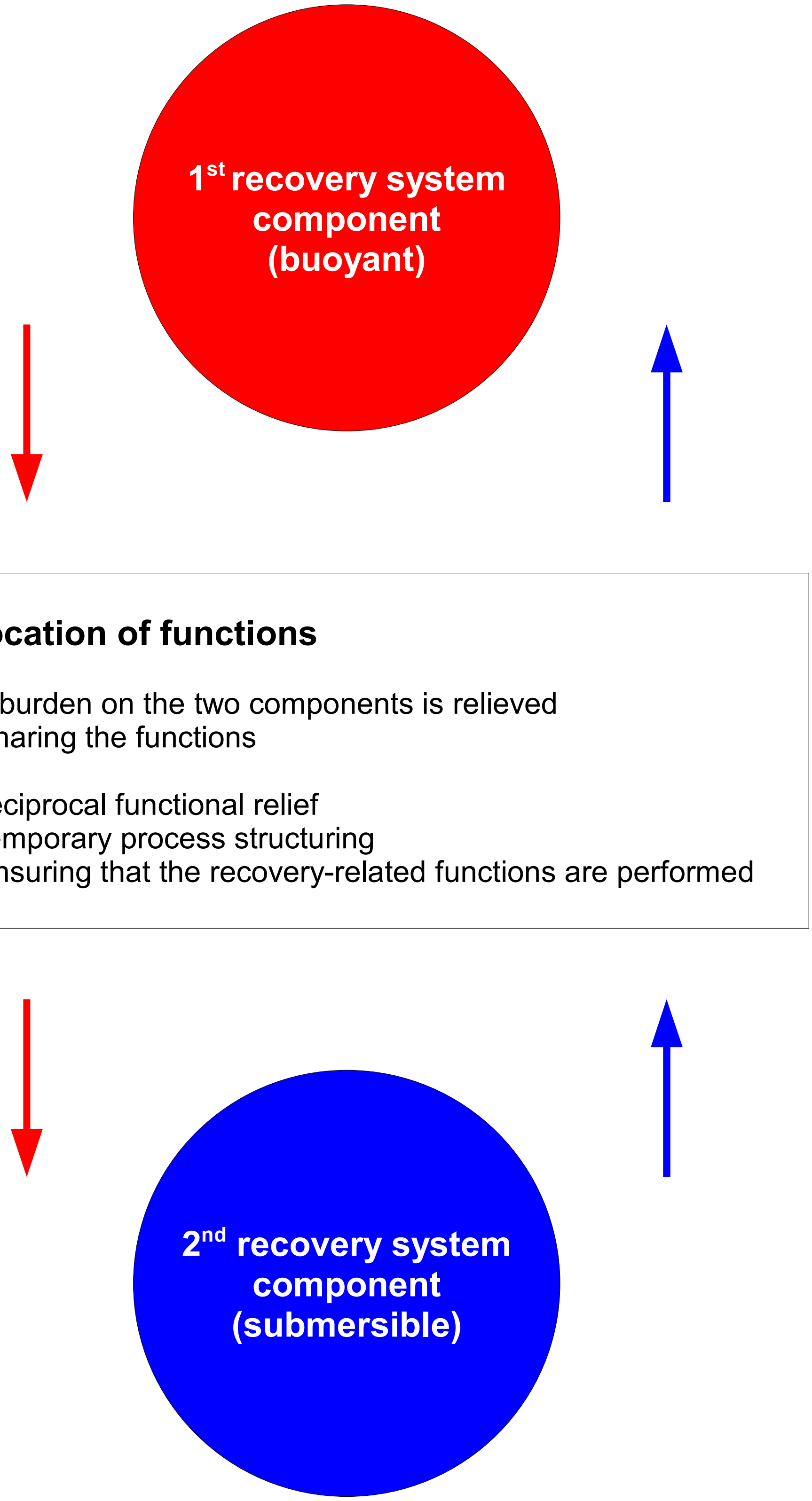

Figure 9: Functional interrelationships when the recovery-related system functions are divided between two recovery system components

By means of its **counterweight function**, the s**econd recovery system component** ensures that the crane cable remains vertical, adapting it to the dynamic motion in opposite directions, and means that there is no need a for a costly electronically controlled swell compensator. Thus, in one of the design variants derived from this, the crane cable can serve as a **guide cable** for the **first recovery system component** sliding up and down on the cable in the seaway.

In other variants, the slack of the crane cable caused by the seaway is deflected behind the float of the life-saving appliance by means of a counterweight (see Figures 23 and 24).

Experimental evidence proving the feasibility of the counterweight function on the crane cable and the buoyant first recovery system component is available from:

- the Large Wave Channel at the Coastal Research Centre in Hannover (max. 2 metre wave) and
- practical trials at sea with **wave heights of up to 4 metres** in the North Atlantic and further
- trials at sea with different sizes of ship and **wave heights up to 3 metres**, as described in Section 3.7

3.2 Clarity of operation for the persons to be recovered

If the counterweight function of the second recovery system component is combined with further recovery system components, the buoyant first recovery system component can be designed as a rescue disc, like a lifebuoy, which slides up and down **freely and automatically** on the crane cable or crane cable forerunner and adapts to the seaway.

The following diagram shows which functions each of the two recovery system components performs.

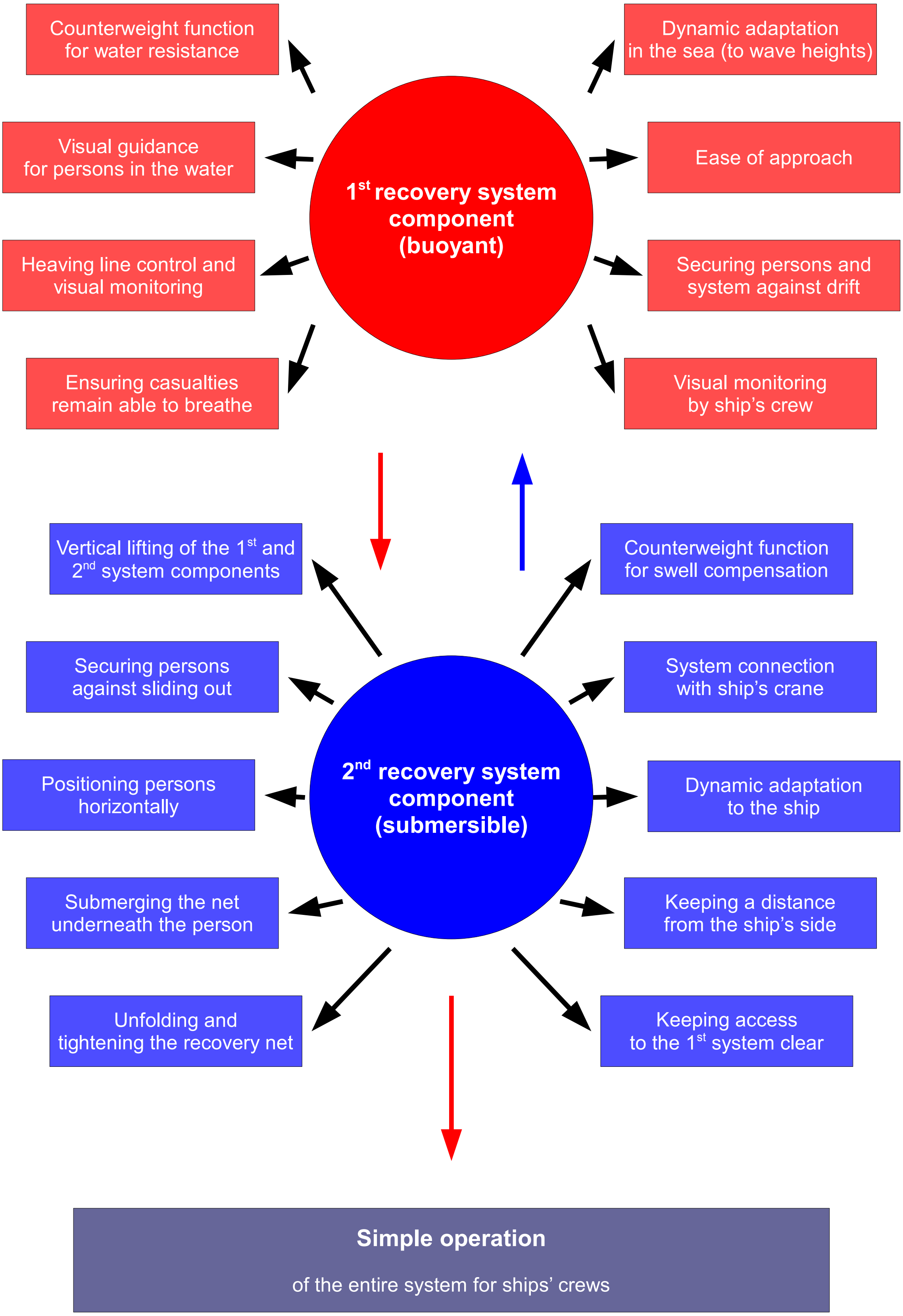

Figure 10: Functions performed by the two recovery system components

3.2.1 Clarity of operation of the first recovery system component

By combining the counterweight function of the second recovery system component with further functions, the buoyant first recovery system is relieved of other functions, and its operation is thus **clear** to a person adrift in the sea.

Figure 11: Swimming towards and gripping one of the yellow loops

In keeping with the principle of a **lifebuoy**, the circular shape of the buoyant first recovery system component ensures access over an **arc of 360 degrees**. **Access area = 100 %** when the second recovery system component is submerged.

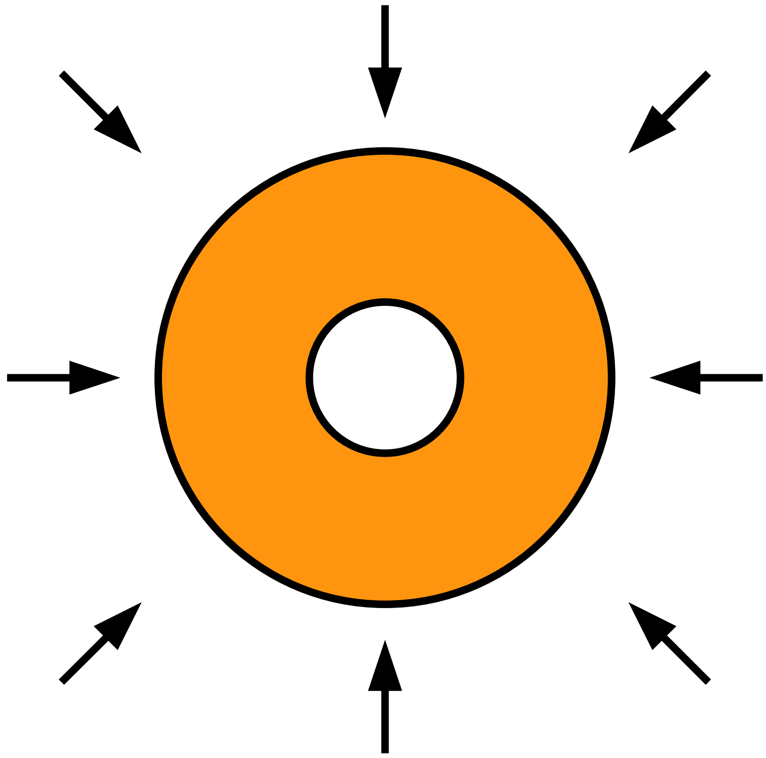

Figure 12: Principle of a lifebuoy with circular shape

Its operation is clear to persons to be recovered.

3.2.2 Clarity of operation of the second recovery system component

The second recovery system component combines the counterweight function with the function of **picking up a person under water** by submerging a stretched net below the trough of the waves.

The second recovery system component is not visible to the person to be recovered as they swim towards its and thus does not result in any confusion about how to operate the life-saving appliance. This guarantees **clarity** of operation.

If the second recovery system component is designed such that it exhibits a collapsible frame for a net stretched across it, the persons are secured and positioned horizontally, as medically required, by **lifting the second recovery system component** with the crane.

The persons to be recovered do not have to assist in their rescue.

Figure 13: Lifting the second recovery system with the crane to position the persons in the net. The buoyant first recovery system component is also lifted at the same time.

Ratio of dimensions in percent between the first recovery system component (buoyant) and the second recovery system component (submersible)

1. Area of the first recovery system component (buoyant)

$\boldsymbol{Given}\textbf{:}\, \textit{radius of the rescue disc}\,(r_{RD}) = 33.0\,cm$

$\boldsymbol{Calculation\ with\ formula: A_{RD} = r^2 \cdot \pi\,(where\ \pi = 3.14159)}$
$A_{RD} = 33.0^2 \cdot 3.14159 = \underline{3{,}421.1944\,cm^2 \approx 3{,}421.2\,cm^2}$

The area of the first recovery system component is $3{,}421.2\,cm^2$.

2. Area of the second recovery system component (submersible)

   $\boldsymbol{Given}: radius\ of\ the\ net\ support\ surface(r_{SS}) = 138.0\,cm\,;$
   $Apex\ angle\,(\alpha)\,in\ degrees = 30\,;\ reference\ surfaces\,(RS_{SS}) = 6$

   $\boldsymbol{Calculation\ with\ formula: A_{SS} = ((\cos(\alpha)\cdot r)\cdot(\sin(\alpha)\cdot r))\cdot RS_{SS}}$
   $A_{SS} = ((\cos(30)\cdot 138.0)\cdot(\sin(30)\cdot 138.0))\cdot 6 = (119.5 \approx 120)\cdot 69\cdot 6 = \underline{49{,}680\,cm^2}$

   $The\ area\ of\ the\ second\ recovery\ system\ component\ is\ 49{,}680\,cm^2.$

3. Calculation of the support surface during the lifting operation

   $\boldsymbol{Given}: Area\ of\ the\ first\ recovery\ system\ component\,(A_{RD}) = 3{,}421.2\,cm^2\,;$
   $Area\ of\ the\ second\ recovery\ system\ component\,(A_{SS}) = 49{,}680\ cm^2$

   $\boldsymbol{Calculation\ with\ formula: A_{LO} = A_{SS} - A_{RD}}$
   $A_{LO} = 100 - (3{,}421.2\cdot 100/49{,}680) = 100 - (6.88 \approx 6.9) = \underline{93{,}1}$

   $The\ support\ surface\ during\ the\ lifting\ operation\ is\ 93{,}1\ percent.$

To keep the net support surface free, the construction has a plastic bearing on which the first recovery system component rests when it is lifted out of the water. As a result, the first recovery system component is lifted together with the second recovery system component and the support surface is kept free.

The following diagram shows how the first recovery system component is automatically supported when the second recovery system component is lifted.

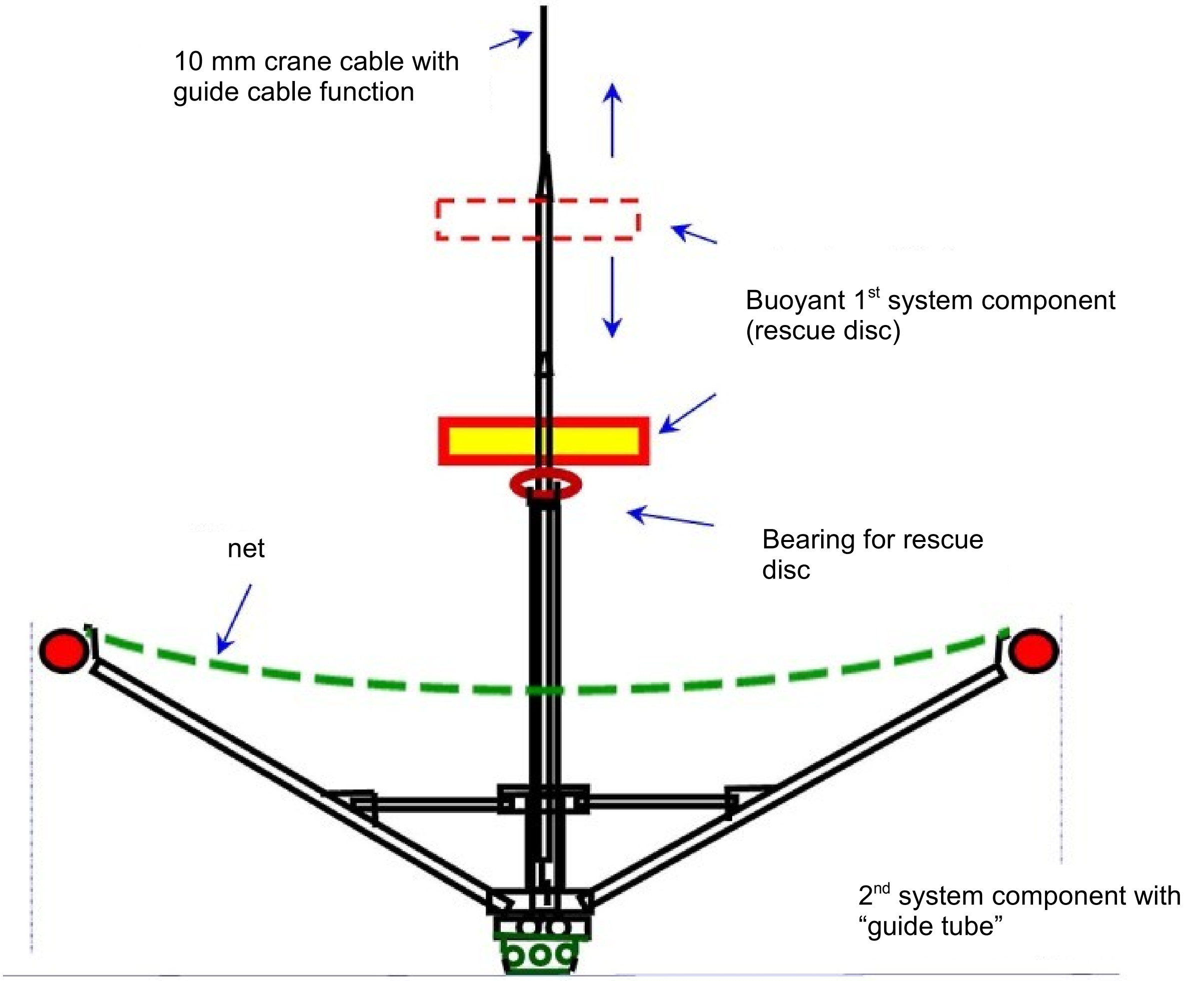

Figure 14: The first recovery system component is supported as the second recovery system component is lifted

Available support surface after the first recovery system component (buoyant) has been supported by lifting the second recovery system component (submersible) out of the water:

Given : *Support surface during the lifting operation* (A_{LO}) *in percent* $=93.1$;
Central area under the rescue disc (A_{RD}) *in percent* $=6.8$

Calculation with formula : $\boldsymbol{A_{SS}=A_{LO}+A_{RD}}$
$A_{SS}=93.1+6.8=\underline{99.9}$

The available support surface is 99.9 *percent.*

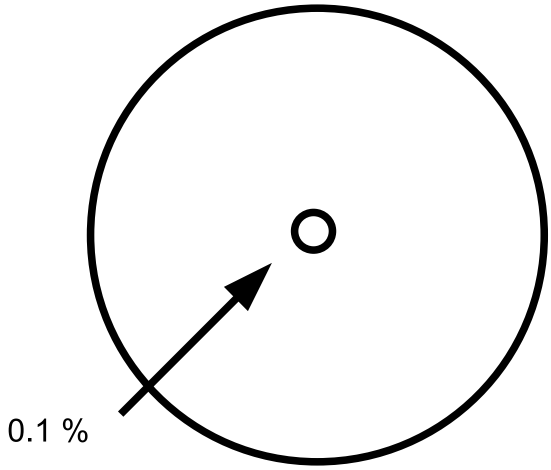

Figure 15: Available support surface after the first component has been supported

Experiments to prove the clarity of operation were carried out

- at the Coastal Research Centre, Large Wave Channel
- in practical trials at sea with different sizes of ship and wave heights
- and at a seafarers' school with numerous test persons.

3.3 Free access to the life-saving appliance when casualties swim towards it

The following are necessary

- **Ease of use and accessibility** for a person adrift in the water without seafaring knowledge and experience.
- **Securing** persons to and/or in the life-saving appliance.
- **Protection against injuries**.

Experimental trials have demonstrated the drawbacks of a limited access area for an exhausted person in the seaway. In an emergency, this can result in failure of the recovery operation.

The recovery-related importance of free access – **a fundamental requirement** – is thus of crucial design relevance for the **general requirements** that have to be met by life-saving appliances (see Figures 11 and 16).

Approximate figures based on reports and trials

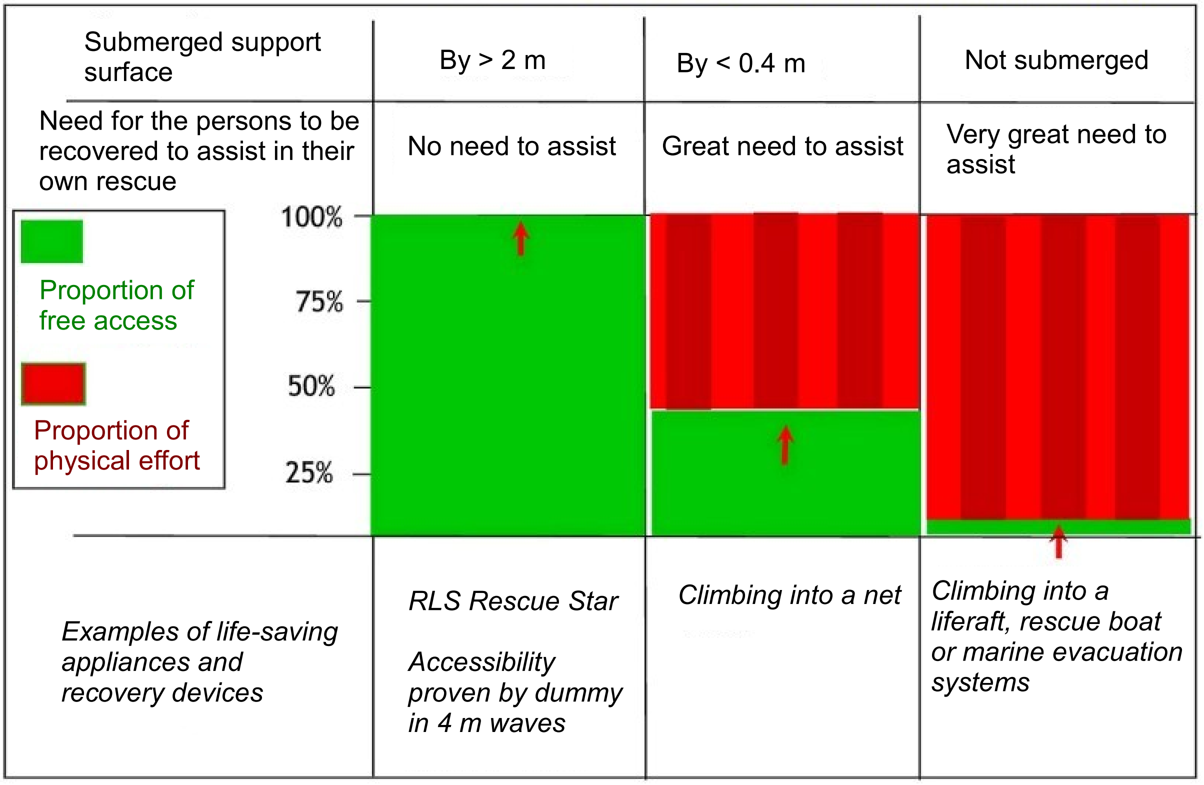

Figure 16: Free access to the support surface as a function of submersion and impacts on the need for the person to be recovered to assist in their rescue

The diagram shows the impact of **submerging the support surface** below the surface of the water on free access for the persons to be recovered as they swim towards it. This is the support surface on which the persons are to be gently positioned, secured and lifted out of the water.

In practical trials in the North Atlantic, with rough seas and waves up to four metres high, it was possible to demonstrate that free access on all sides to the buoyant first recovery system component in combination with the second recovery system component (support surface for the persons) submerged around two metres under water and the resultant ease of access is of

crucial recovery-related importance in terms of being able to secure persons on and/or in the life-saving appliance in rough seas.

The **recovery situation to be mastered** was as follows:

The following diagram shows the position of the container ship *MV LT Cortesia* during the high sea trials of the aforementioned functions of the two recovery system components:

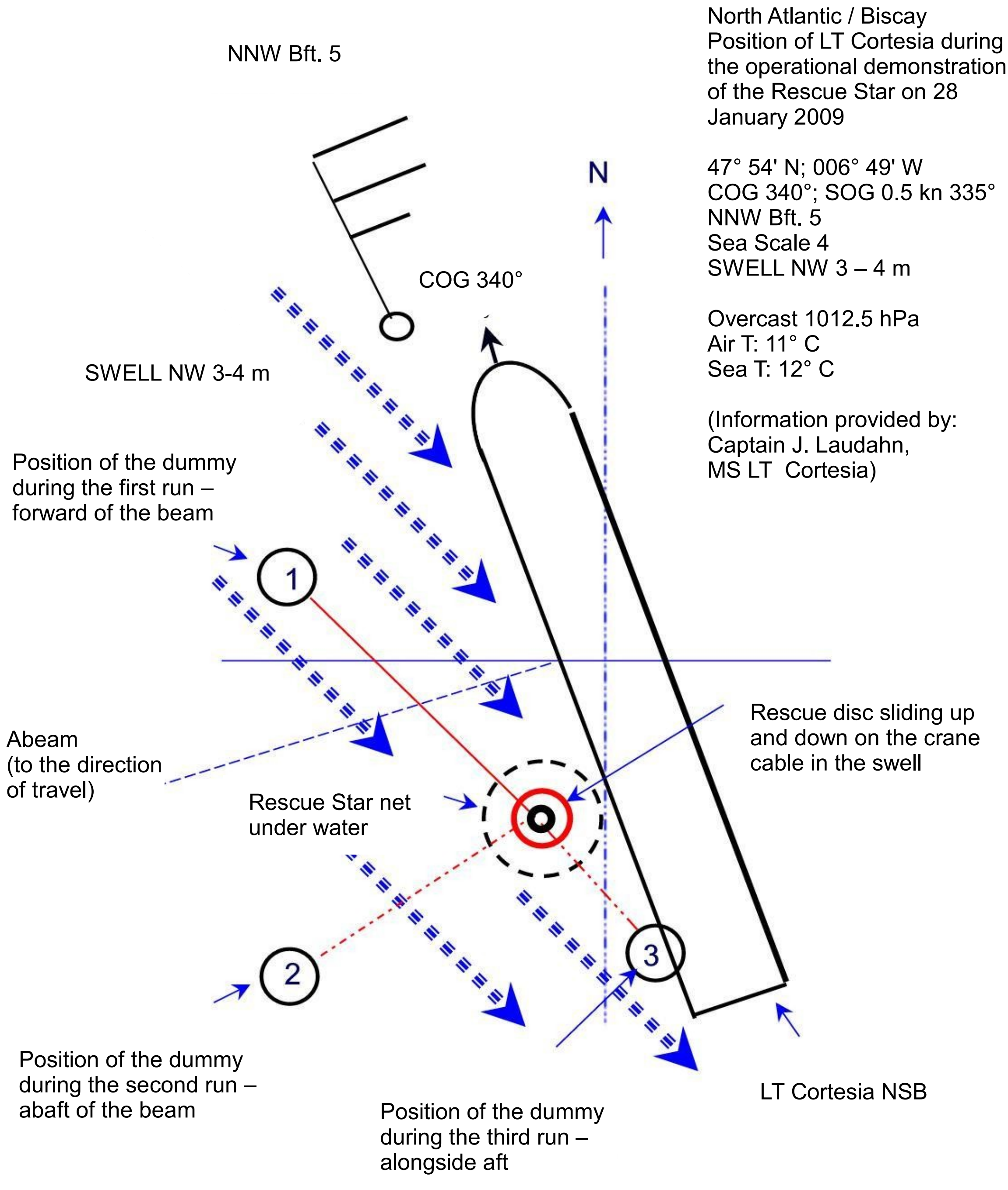

Figure 17: Position of the container ship MV LT Cortesia during the high sea trials

The dummy was lowered into the water three times, and each time it was positioned accurately and securely on the net of the Rescue Star in a horizontal position – thereby minimizing the risk of shock – and swiftly taken on board.

Under such rough sea conditions, free access to the buoyant first recovery system component is just as essential as the submersion of the second recovery system component.

This is especially true if, in an emergency, several persons have to simultaneously reach the buoyant first recovery system component from different sides in rough seas.

Free access is absolutely essential if an incapacitated person secured to a lifeline has to be towed to the buoyant first recovery system component from on deck in rough seas. Here, free access is a prerequisite for hauling in a line from the casualty to the deck of the ship. Only if there is free access can the person be guided to the buoyant first recovery system component from on deck.

The following diagram shows how it is **basically possible to master rough seas** and secure persons to a rescue disc and the impact of a line stopper function for incapacitated persons (green lines) (see also Section 3.7).

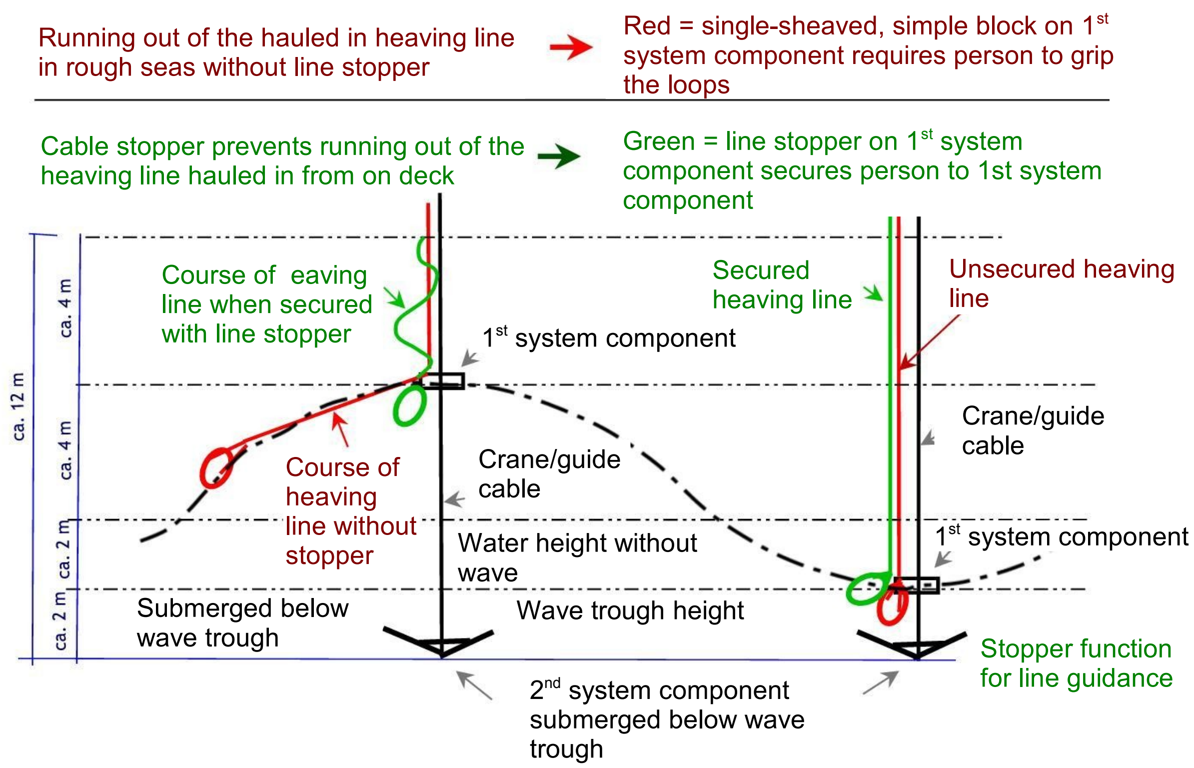

Figure 18: Possibilities for mastering rough seas

The **requirement for free access thus takes precedence** over stability-related extreme stress requirements to be met by the life-saving appliance, which do not become relevant until the appliance **is actually accessible under extreme conditions**.

It must be possible for persons to swim to the appliance without obstruction, and this must be made a requirement. This may entail design constraints on stability-related extreme stress requirements.

3.4 Meeting the medical requirements

Today's generally accepted and scientifically proven medical requirements to be met by maritime recovery systems have been substantiated and demonstrated by Dr Wolfgang Baumeier in the *SARRRAH project of the Department of Anesthesiology, University Medical Center Schleswig-Holstein (UK S-H), Campus Lübeck*.

Physicians are in unanimous agreement that the basic principle for recovering weakened and hypothermic persons from the water is a **gentle and horizontal recovery** to avoid circulatory failure.

The casualty should be **moved as little as possible** to prevent cold peripheral blood from entering the weakened minimum circulation, which is just about keeping the casualty alive. It is also important that the casualty avoids physical exertions, stress and any constriction of the respiratory muscles.

The fear among maritime rescue services is that persons they have recovered from the water alive will suffer a circum-rescue collapse, which is frequently fatal.

Any shipwrecked person will very quickly become hypothermic to a greater or lesser extent. Initially, their muscle functions will be increasingly impaired. If the core of the body also cools down, the diuresis caused by the cold and the weakening of myocardial activity will result in a critical lability of the circulation.

It is a proven fact that recovery from the water leads to a drop in blood pressure in the central veins and destabilizes the circulation. The effects of this become increasingly drastic the more the casualty is moved from a horizontal to a vertical position. This has been proven beyond all doubt by Surgeon Rear Admiral Frank Golden at the Institute of Naval Medicine in Hampshire (UK). Circulatory collapse can have various causes:

- the main cause is a reduction in hydrostatic pressure support on the venous return;
- the influence of gravity;
- increased viscosity of the blood;
- reduced output of the cooled myocardium;
- the reduced time interval for filling the coronary arteries;
- weakened baroreceptor reflexes.

As early as 1991, Golden showed in a study that, during a winching operation with a single helicopter sling, the central venous pressure fell by around 12 millimeter of mercury after 30 minutes in 15 centigrade cold water.

If ventricular fibrillation then occurs, the shipwrecked person can only be saved by means of sustained resuscitation measures, which have to be continued without interruption until they reach a suitable medical facility.

A rescuer at a distance from the casualty can never judge the actual degree of hypothermia or the circulatory situation. The prime objective must therefore be, wherever possible, to recover a person from the water in a horizontal or semi-horizontal position and without any unnecessary change in position. Under no circumstances should the person be forced to climb out of the water into the dry themselves.

Only in a horizontal rescue position can a potentially fatal collapse of the person suffering from extreme hypothermia be effectively prevented.

In May 2006, IMO included this very requirement in its regulations and called for technical solutions.

Figure 19: Horizontal positioning to minimize the risk of shock

With the submerged net, persons can be **automatically positioned horizontally** as the crane lifts the second recovery system component out of the water.

Together with the second recovery system component, which acts as a counterweight under the water, a net that is stretched horizontally over a collapsible frame or similar can be submerged to a sufficient depth (around two metres) below the wave trough to pick up a person from below.

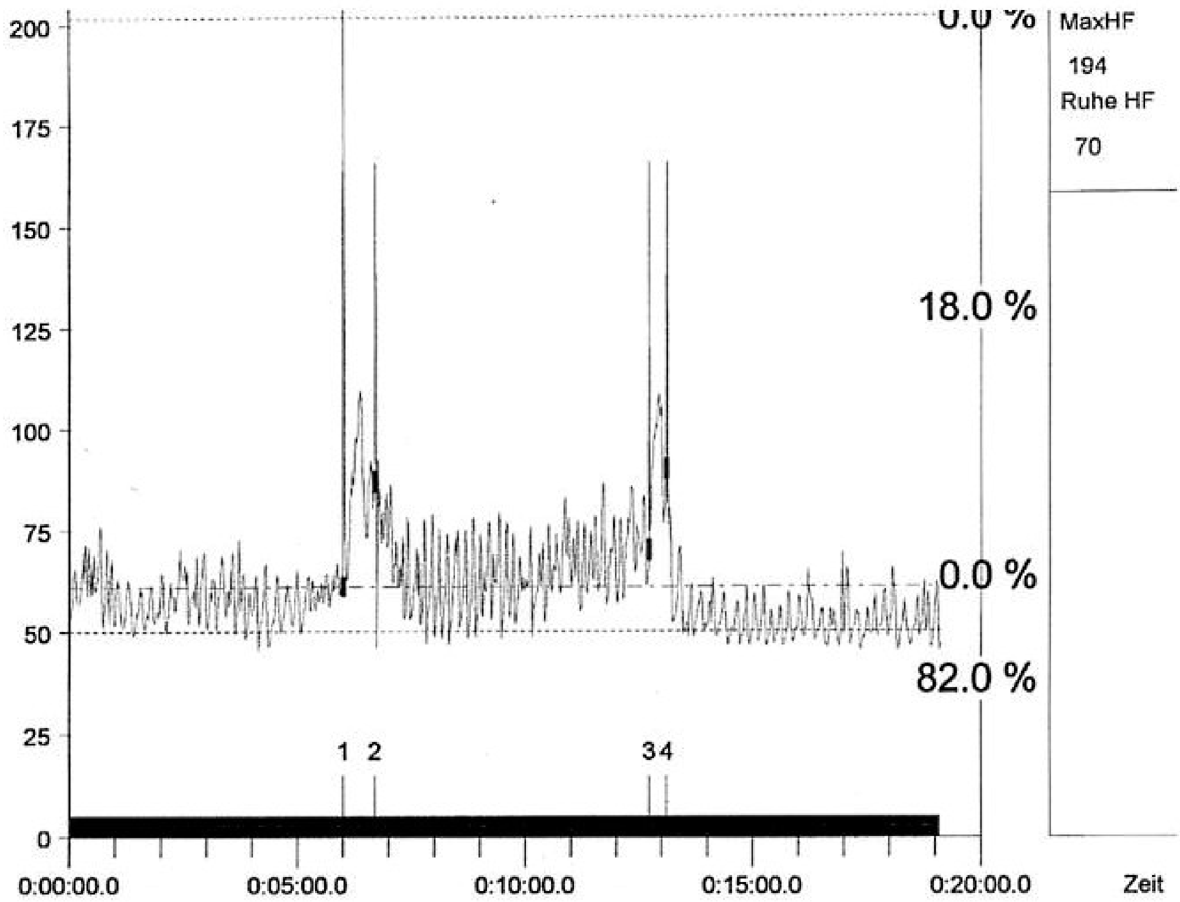

Figure 20: Heart rate in the semi-horizontal position

Impact of circulation-friendly positioning on heart rate

- Phase 1 (left): Rest phase before the test, lying on a mat
- Phase 2 (centre): Semi-horizontal position in the *RLS - double strops*
- Phase 3 (right): Rest phase, measuring the impact

3.5 Automatically securing the casualty against falling out

If the recovery-related advantage of a two recovery system component solution is used in the design of the life-saving appliance, the submersible second recovery system component can be provided with a net or another stable, horizontally arranged surface which, when a load is imposed on it by supporting one or more persons, can **automatically expand to form a**

trough in which the persons are protected against falling out, even if it is flung against the ship's side (see Figures 13 and 19).

If use is made of the crane cable length regulation as described in section 3.1.5 (… in other variants, the slack of the crane cable that arises in the seaway is deflected behind the float of the life-saving appliance by a counterweight), the casualty can be automatically secured against falling out of a rescue basket by, for instance, automatic swivelling of the front half of the floor as it is lifted, so that the persons who have swum into the basket cannot be flung out.

Figure 21: RLS – Rescue Shuttle – buoyant rescue basket

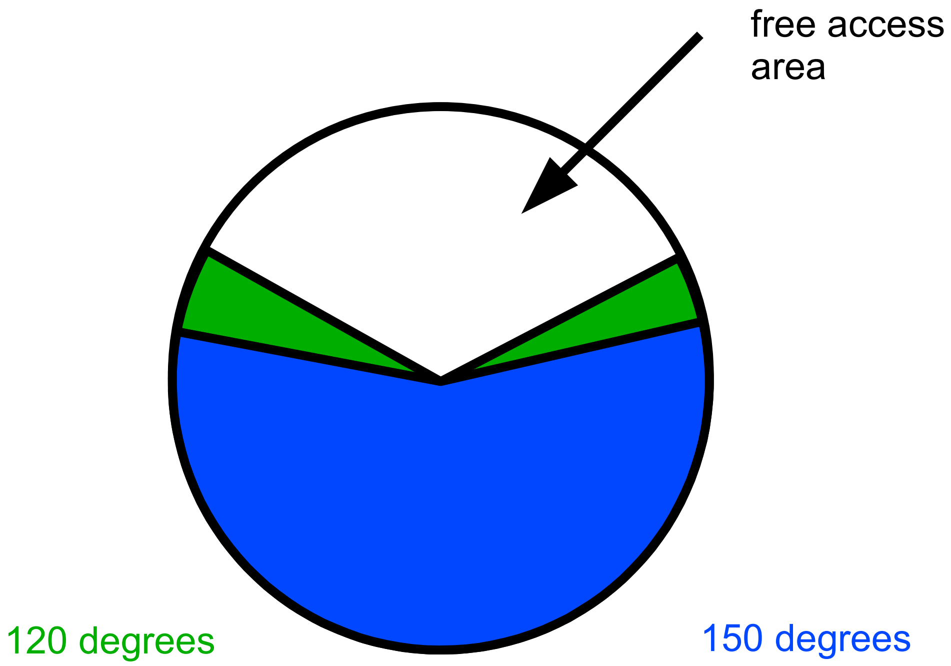

Figure 22: Free access area with an approx. 210 cm wide rescue basket and seaway of 1 metre or more – arc over 150 degrees. As wave height increases, further limitations down to 120 degrees.

This system, too, has the aforementioned second recovery system component for submersion under the surface of the water (with the help of the basket floor).

The counterweight required for regulating the length of the crane cable is arranged separately behind the basket and thus guides any crane cable slack to the rear of the basket, so that the entrance to the basket is kept open.

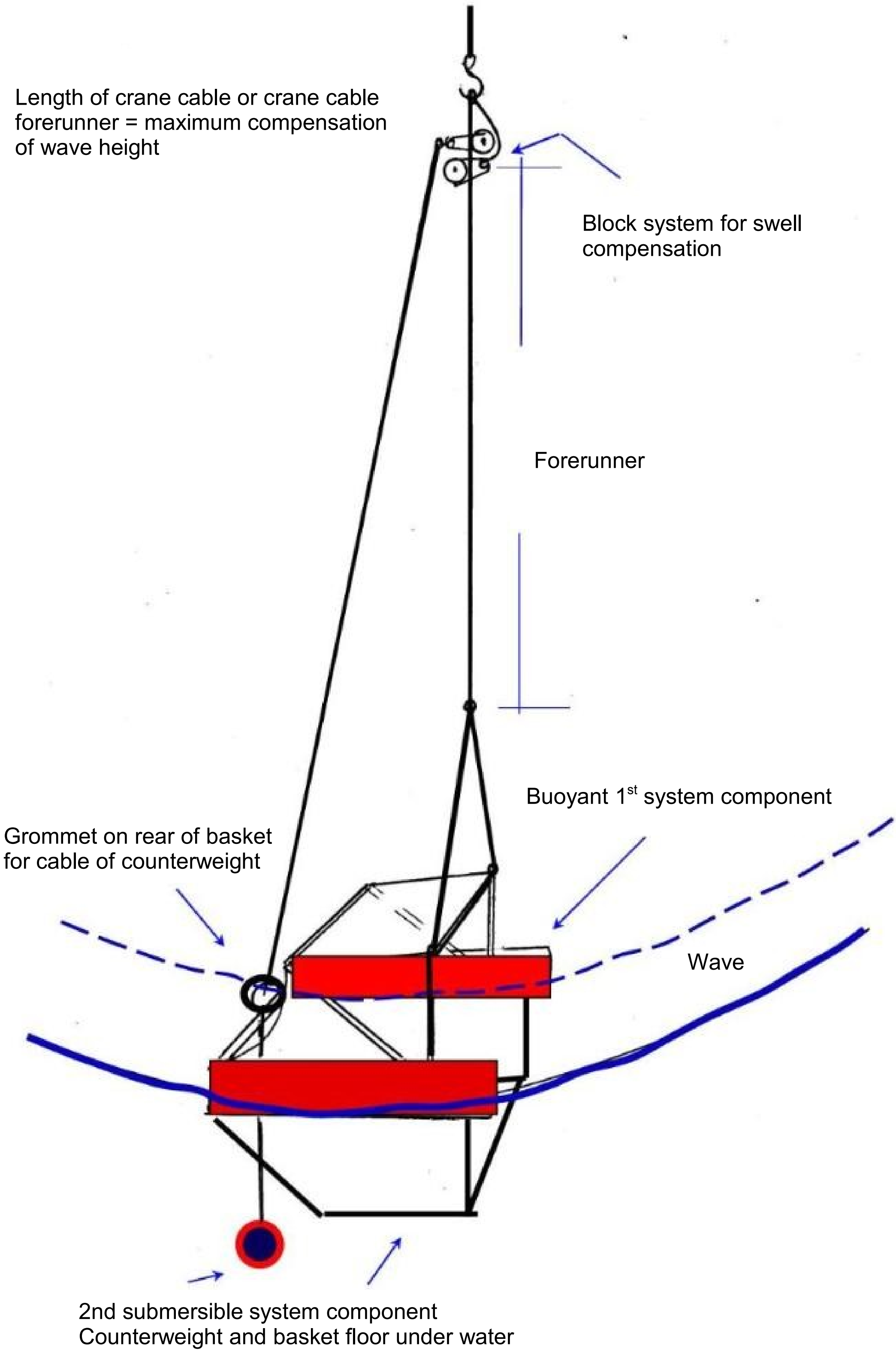

Figure 23: Swell compensation for buoyant rescue baskets (wave trough)

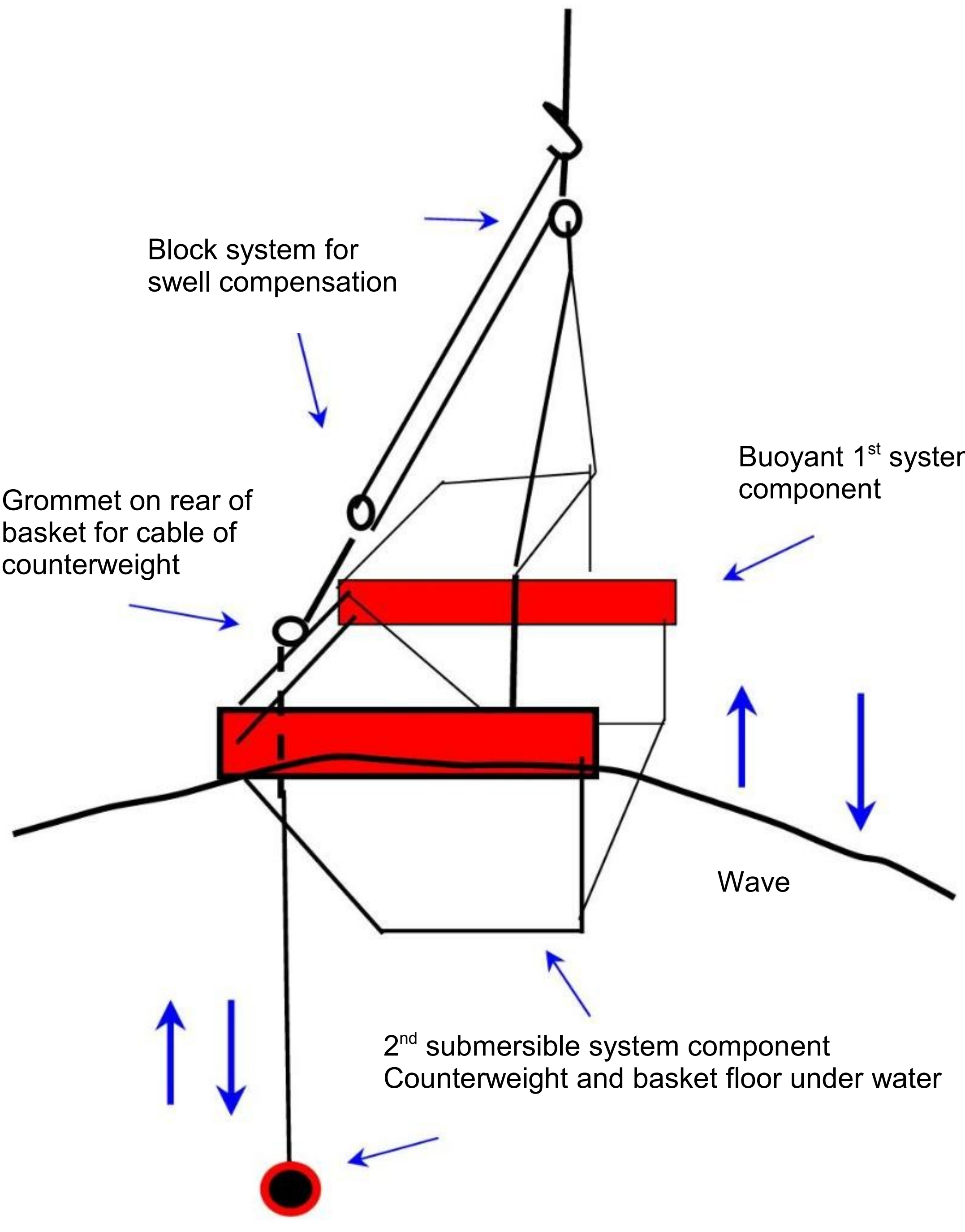

Figure 24: Swell compensation for buoyant rescue baskets (wave crest)

3.6 Equipment for bringing people aboard

This section refers to the launch and recovery equipment and the possibilities of connecting it to a crane or winch.

The speed requirement for launch and recovery equipment for systems for the recovery of persons is at least 0.3 metres per second in rough seas with waves up to 3 metres high. This concerns the suitability of cranes and winches.

If, on the submersible second recovery system component, the crane cable is used as a guide cable for the first recovery system component (rescue disc), this results in variants of the crane usage for a recovery device of this kind.

3.6.1 Fixed connection

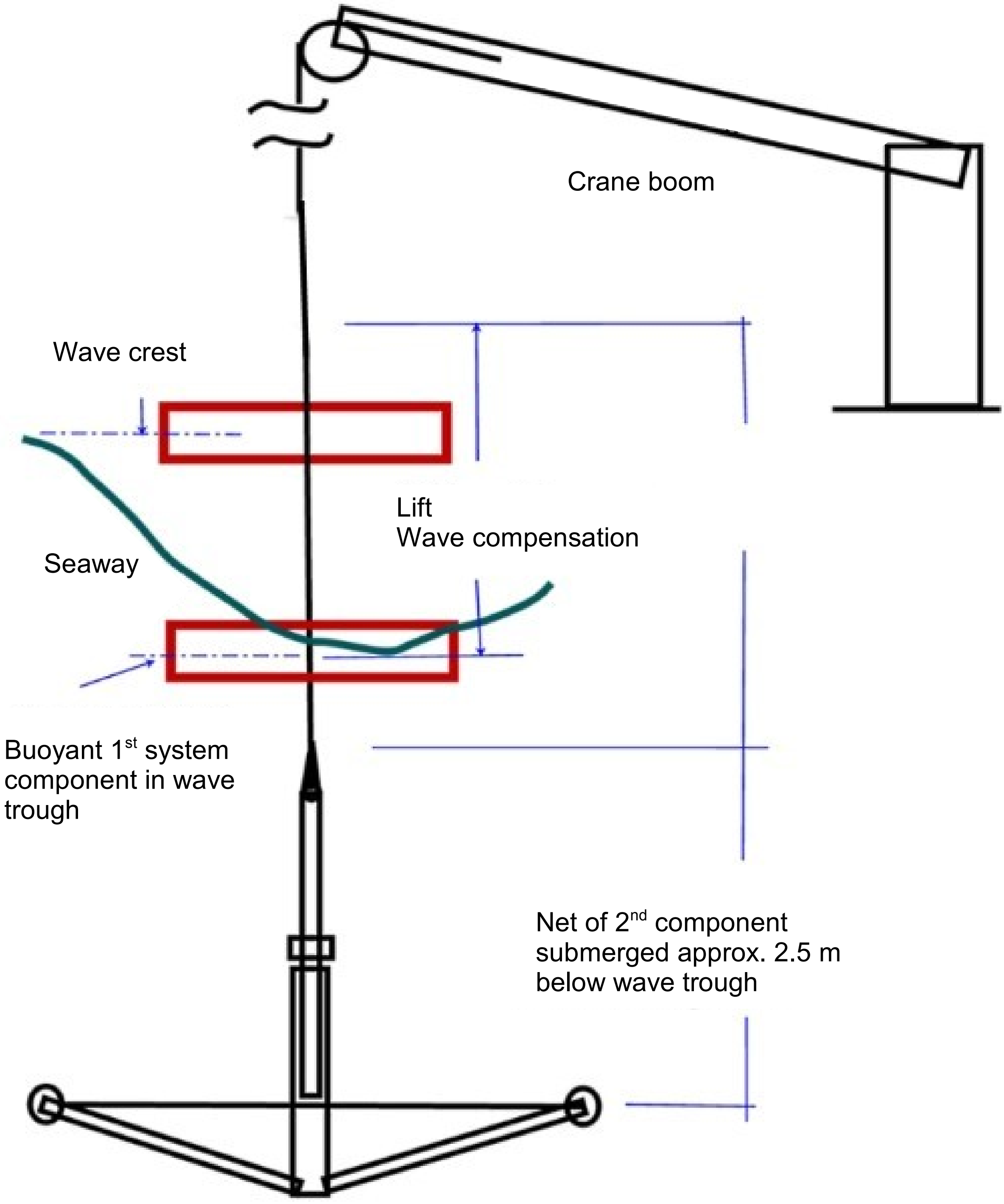

Figure 25: Fixed connection between the crane winch and the recovery device

Here, the 10 mm crane cable is fixed in a special coupling in the second recovery system component.

- Advantages:
  - The entire system is **immediately operational**.
  - The **unlimited lift** of the first recovery system component makes it possible to master **very high waves**.
  - A **fixed connection** between the recovery device and the crane cable can, with the help of the s**pecial coupling** located in the guide tube of the second recovery system component of the *RLS – Rescue Star*, be disconnected for the optional temporary mounting of a crane hook or other crane use.
  - The **crane cable can be disconnected** in the recovery device.
- Disadvantages:
  - None.

3.6.2 Flexible connection

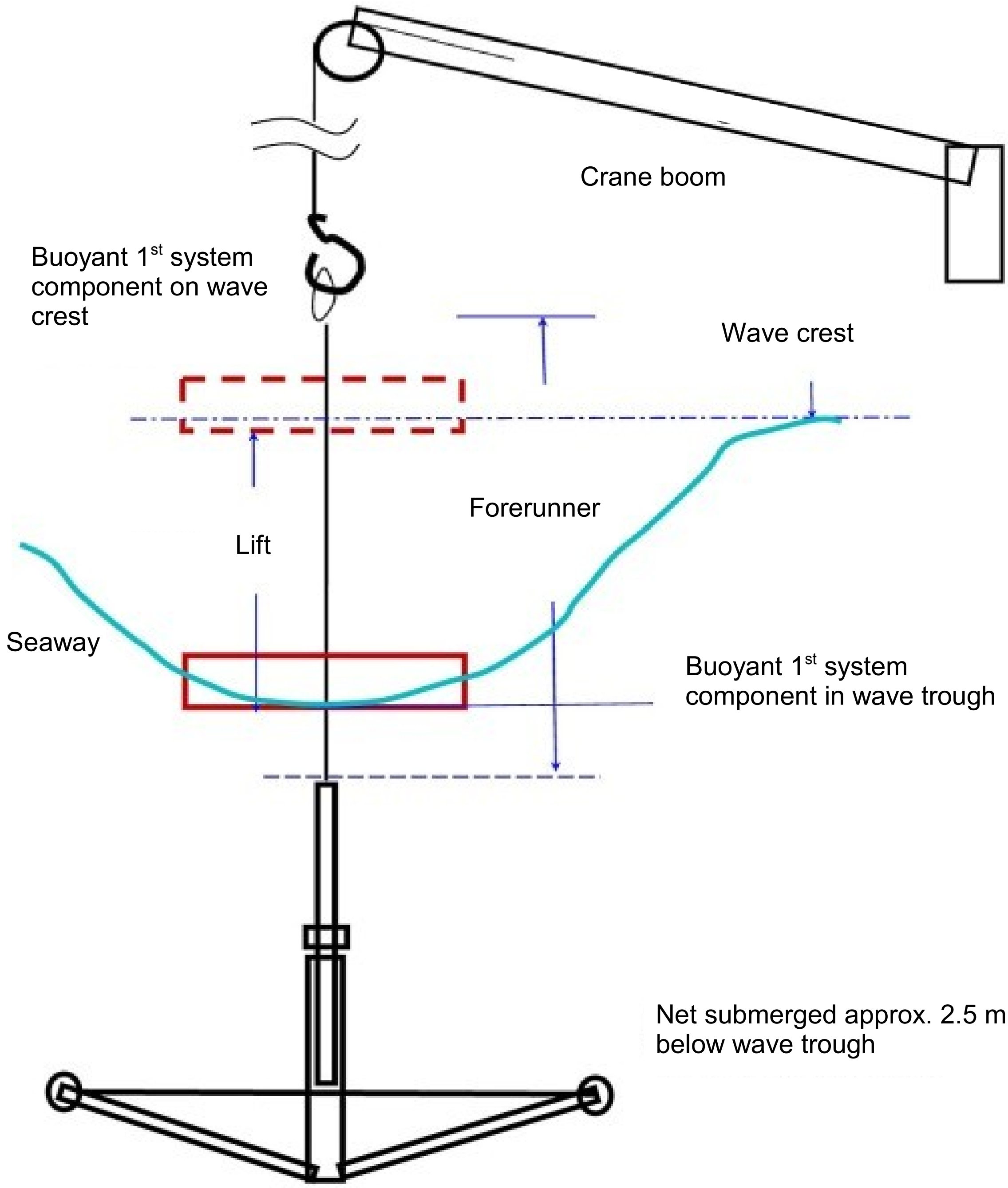

Figure 26: Flexible connection between the crane cable and the recovery device

The flexible connection is achieved with the help of a **crane cable forerunner** mounted in a special coupling in the second recovery system component.

- Advantages:
  - The entire system is **immediately operational**: by attaching the crane cable forerunner to a crane hook.
  - **The use of the crane can be quickly changed:** the crane cable is permanently available for other functions.
  - The permanent but detachable connection between the recovery device and the crane cable forerunner is ensured by a special coupling.
- Disadvantages:
  - The **restricted lift** of the first recovery system component limits the ability to master wave heights as a function of the length of the crane cable forerunner.
  - The maximum length of a crane cable forerunner is dependent on the ship's structure.

3.7 Mastering increasingly rough seas

The two recovery system component solution described above makes it possible to master rough seas.

The following diagram shows the first recovery system component on the crest of the waves and in the trough of the waves and the second recovery system component at a constant depth of around two metres below the trough of the waves.

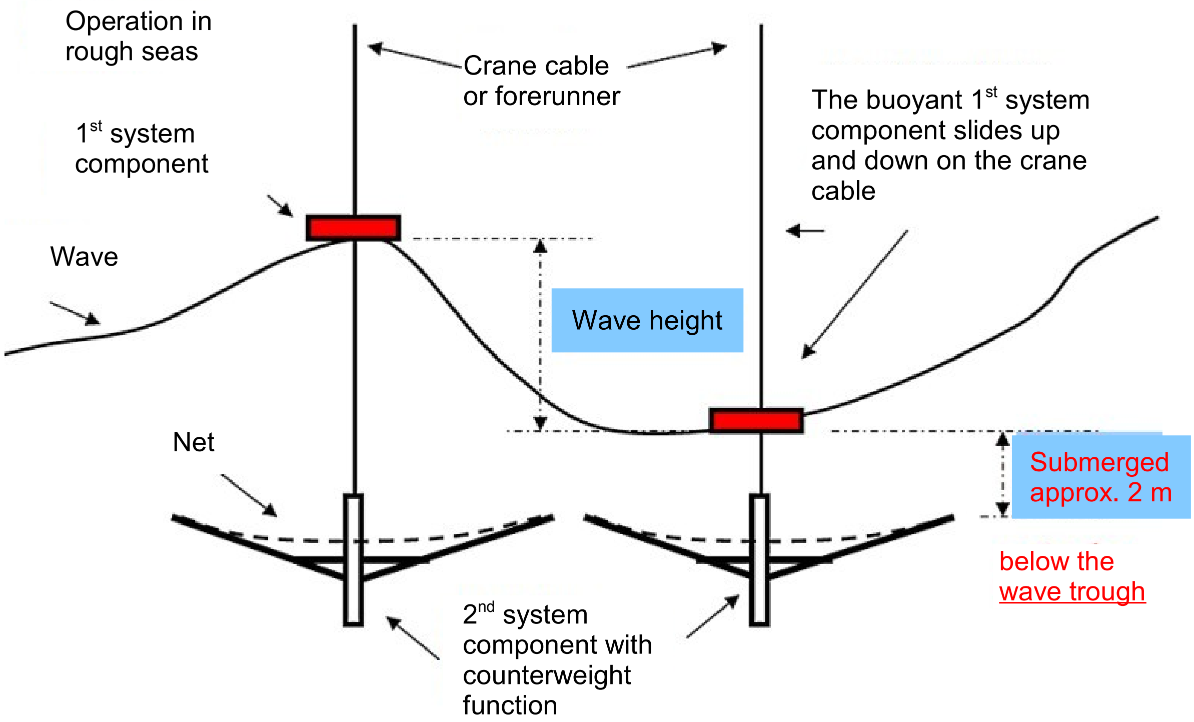

Figure 27: Operation of the two recovery system components in rough seas

Trials in the Large Wave Channel at the Coastal Research Centre, as well as practical trials on the high seas, have demonstrated the operational capability of the system in rough seas and on ships with high sides.

4 Findings

With the **analysis of the main problem areas** that can be observed and are likely to be encountered when rescuing persons in distress at sea, it was possible to gain evidence regarding general requirements which will inform the development of recovery methods and innovative life-saving appliances.

It was possible to show how, with the allocation of functions in a two recovery system component solution, the requirements described can be realized technically.

The results of the tests of the first recovery system component, the second recovery system component and the interaction between the two recovery system components in variable sea states are summarized in the following three tables.

Test zone	Wave height in cm up to max.	Location of trials	Criteria met
Zone A: Coast	50 to 200	Coastal Research Centre,Large Wave Channel	Yes
Zone B: Sea	100 to 300	North Sea and Baltic Sea	Yes
Zone C: High seas	200 to 400	North Atlantic / Bay of Biscay	Yes

Figure 28: Experimental evidence proving the feasibility of the counterweight function on the crane cable and the first recovery system component (buoyant)

Test zone	Wave height in cm up to max.	Location of trials	Criteria met
Zone A: Coast	50 to 200	Coastal Research Centre, Large Wave Channel	Yes
Zone B: Sea	100 to 300	North Sea and Baltic Sea	Yes
Zone C: High seas	200 to 400	North Atlantic / Bay of Biscay	Yes

Figure 29: Experimental evidence proving the feasibility of the counterweight function on the crane cable and the second recovery system component (submersible)

Test zone	Wave height in cm up to max.	Location of trials	Criteria met
Zone A: Coast	50 to 200	Coastal Research Centre, Large Wave Channel	Yes
Zone B: Sea	100 to 300	North Sea and Baltic Sea	Yes
Zone C: High seas	200 to 400	North Atlantic / Bay of Biscay	Yes

Figure 30: Experimental evidence proving the interaction between the two recovery system components (buoyant and submersible)

5 Practical use

5.1 Information on practical use

In addition to the **recovery-related main problem areas described above**, the requirement identified in section 3.2 for “simple operation of the entire system for ships’ crews” is of great importance, because a rescue action in an emergency is always an exceptional situation that is not part of the everyday routine of a ship's crew.

Operation requires only three steps:

1. Remove the tarpaulin

Figure 31: RLS – Rescue Star in stand-by position in a ring holder, protected by a tarpaulin

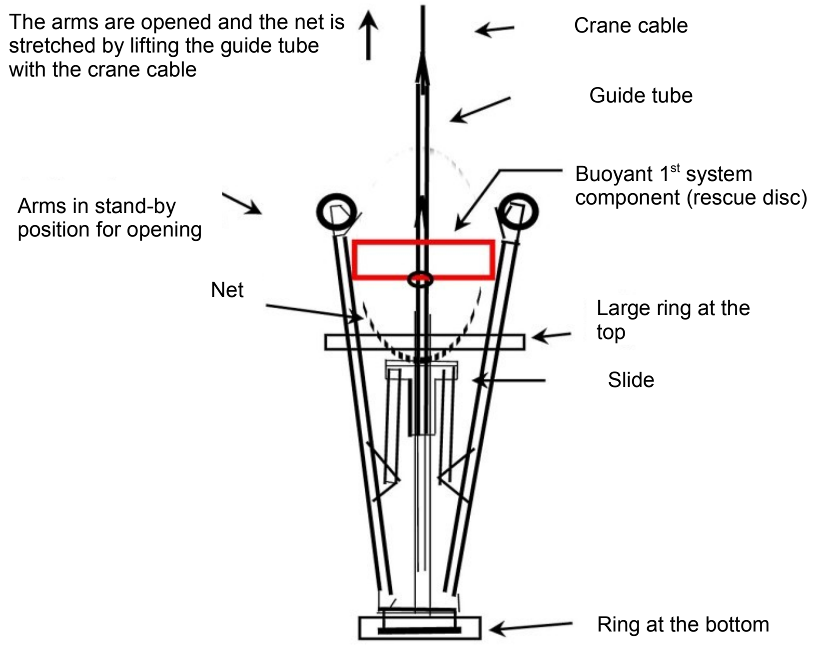

Figure 32: RLS – Rescue Star, lateral view after removal of the tarpaulin

2. Lift the V-shaped *RLS – Rescue Star* out of its holder

Figure 33: Automatically opening RLS – Rescue Star being lifted by the crane

The *RLS – Rescue Star* unfolds automatically and is fully operational.

3. Lower the opened *RLS – Rescue Star* into the water, controlled by two guide ropes.

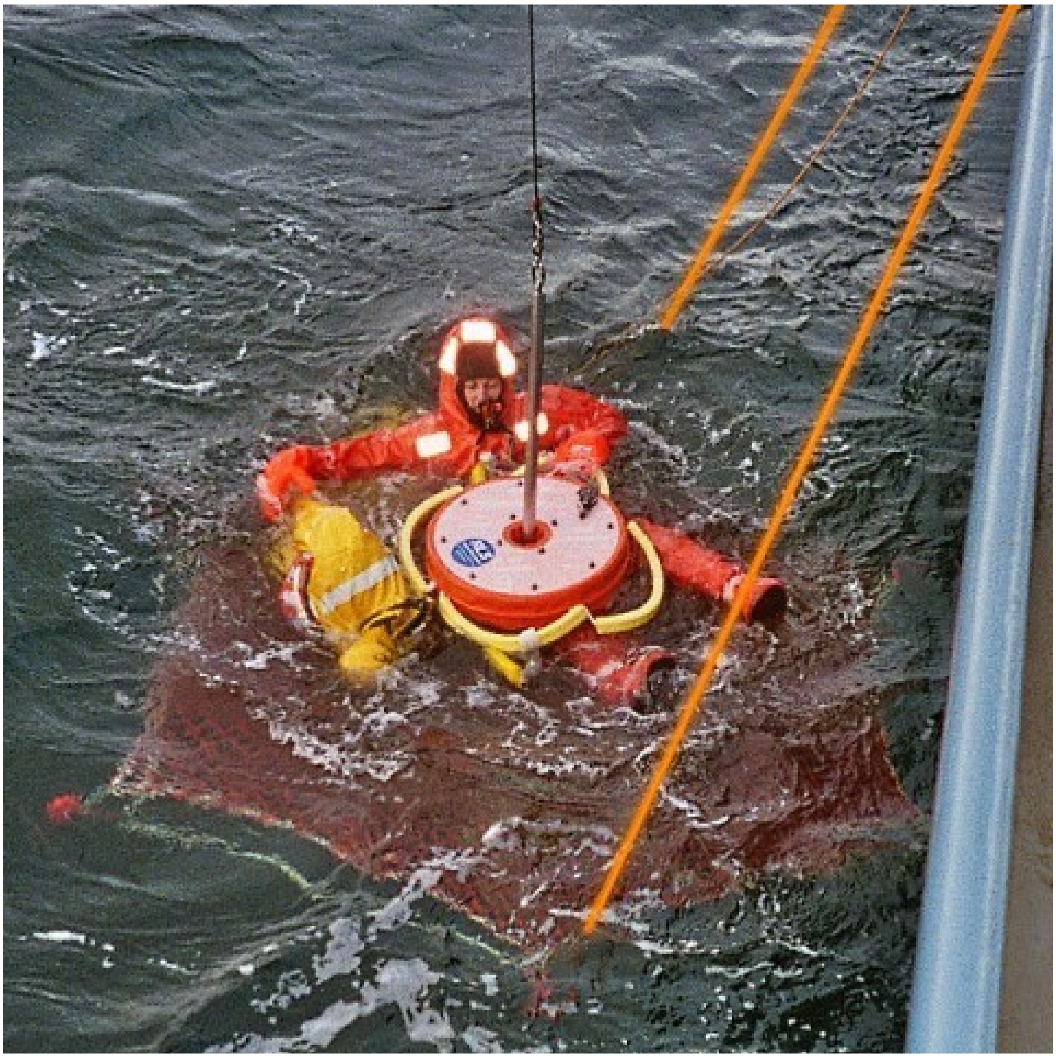

Figure 34: RLS – Rescue Star lowered into the water (guide ropes highlighted in orange)

Figure 35: Two guide ropes to prevent pendular motion (guide ropes highlighted in orange)

To prevent pendular motion, the two guide ropes are operated from on deck.

5.2 Information on operating the RLS – Rescue Star recovery device

The possibility of making technical use of the aforementioned advantages of a two recovery system component solution for particularly user-friendly and easy operation is described in detail in the following for practical use on board:

If the submersible second recovery system component is designed such that it is collapsible like an umbrella, with the arms of the collapsible frame being pushed upwards towards the crane cable with the help of a sliding member on the centre tube for the stand-by position, this produces a V-shaped arrangement that takes up very little space on deck (see Figures 31 and 32).

The V-shaped arrangement has the additional advantage that it can accommodate, in its top quarter, the buoyant first recovery system component, which is designed as a ring-shaped disc, thereby preventing a dead centre when the second recovery system component is opened.

For the stowage position, this results in a very simple and variable system comprising a small lower ring into which the collapsible frame of the second recovery system component, folded up like an umbrella, can be placed from above.

Protected against automatic unintentional opening, the arms of the second recovery system component (collapsible frame) are placed from above into a second, upper and larger ring which, together with the lower ring, exhibits a shape similar to an umbrella stand.

If the crane cable is permanently connected to the recovery device, the device is lifted vertically by the crane out of the ring holder for deployment. In the process, it opens automatically and stretches the net.

If the crane operator lowers the appliance with its opened frame (second recovery system component) and the rescue disc (the buoyant, first recovery system component) into the water, the first recovery system component automatically floats up and down on the crane cable or crane cable forerunner and is fully operational for picking up persons adrift in the water.

In practical use, the ship's crew should use the two guide ropes attached to the arms of the collapsible frame in order to prevent pendular motion on the ship's side.

5.3 Information on navigating and manoeuvring the ship

When the system is in practical use, those responsible for navigating the ship must avoid and reduce the remaining headway of the ship in order to ensure that the second recovery system component is submerged below the trough of the waves. Here, they must take care that the ship no longer makes any headway through the water. Practical trials have shown that it is important that the captain allows the ship to drift towards the recovery position, making use of wind and waves. Homing in on the object should be avoided wherever possible.

It is not absolutely imperative that a specific condition in relation to the waves (lee) be maintained for technical reasons related to the device, but it is recommended simply for reasons of drift and to ensure maximum protection for the person in the water. Drills should thus be regularly conducted, although there should be much greater focus on the captain and the success of the manoeuvre he is to perform than on the simple and safe launching of the *RLS - Rescue Star* by the crew on deck

With this technical design of the RLS – Rescue Star, the crew require only one briefing to become familiar with the entire system and understand how it works.

With this solution, none of the ship's crew has to leave the safety of the ship. There is no danger of the crew putting themselves at risk, as when launching a rescue boat. In addition, *dry runs* can be carried out to practise launching the recovery system when the ship is in dock and at sea in order to sufficiently familiarise the crew with its operation.

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7 Table of Figures

8 Appendix

Figures of the operational demonstration on *MV LT Cortesia* in the North Atlantic:

Figure 36: RLS – Rescue Star in a ring holder, view from below

Figure 37: RLS – Rescue Star in stand-by position in a ring holder, after removal of the tarpaulin

Figure 38: Lifted RLS – Rescue Star

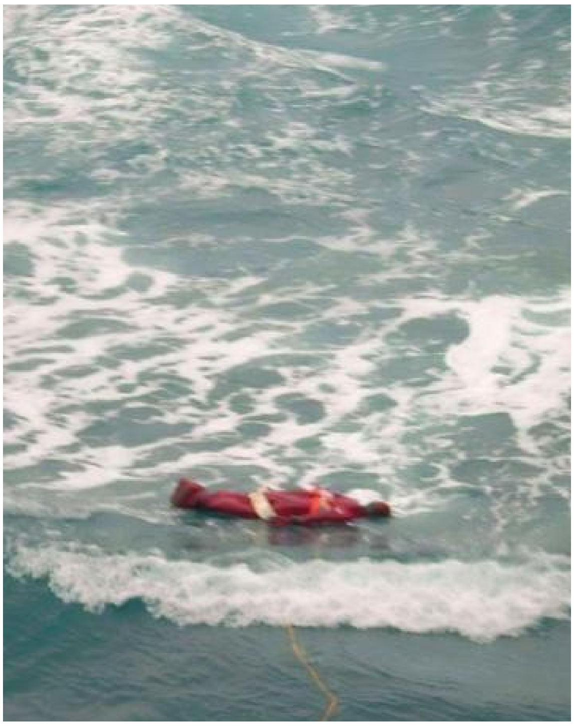

Figure 39: Dummy in rough sea during the recovery situation

Figure 40: Lifting the RLS – Rescue Star with the dummy in a horizontal position

Figure 41: The dummy taken swiftly on board