A test specification (standard) for OWS systems

with a residual oil content of <5 ppm.

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1. Introduction

A resolution passed by the International Maritime Organization (IMO), is usually a (written) statement based on a resolution in which specific demands are formulated.

A standard or a norm is a standardised, widely accepted and commonly applied (or at least targeted) process or method of producing or doing something that has proved to be superior to other processes. In this regard, the term standard is widely used in technology and methodology with regard to human rights, standards of living or environmental protection. The term is used both to describe generally accepted targets as well as in reference to commonly recognised forms of implementation. However, a standard is not a "basic specification" as to how something should be built or how it functions. A standard defines the requirements a technology is expected to fulfil.

The German DIN standards can do more than simply act as "guidelines" when designing and developing new systems. For enterprises, the standards play a key role in a wide range of different technical aspects, from the standardisation of individual components, specifications for an entire unit or line right through to the definition of testing specifications and procedures. And, equally importantly, they set clear rules for machinery and plant manufacturers and their customers.

The standardisation; ISO, EN or DIN standards can be more than simple recommendations when designing or developing a new system or device. The standards play a key role in a wide range of different technical aspects, from the standardisation of individual components, specifications for an entire unit or line right through to the definition of testing specifications and procedures. And, equally importantly, they set clear rules for machinery and plant manufacturers, systems inspectors and users/customers.

Standards also have more far-reaching implications. They are frequently used to define binding international standards that, in turn, are used to establish to IMO resolutions (International Maritime Organization) that specify standardised, globally applicable test procedures. These regulations lead to tougher, better environmental protection (e.g., preventing marine contamination) which, in our increasingly globalised world, is an issue that is crucial for our future.

The work of a standards committee can, even if it does not define a concrete standard or norm, lead to the revision and improvement of test procedures in international standards and specifications.

Using the example of the IMO Resolution MEPC 107 (49) the following paper describes what the impact of working on and heading a standards committee is.

The author headed the working group NA 132-02-11-01 AK / ISO TC 8/ SC 2/ WG 2 – Oil-Water Separators. This working group is part of the DIN Standards Committee Shipbuilding and Marine Technology (NSMT).

The NSMT is responsible for national standardization in the area of shipbuilding and marine technology and for the German involvement in the respective European and international committees. In addition the committee defines necessary defence technology standards (VG) in this field. The NSMT is also in charge of coordinating the German contribution to the CEN/TC 15 "Inland Navigation Vessels", ISO/TC 8 "Ships and Marine Technology", ISO/TC 188 "Small Craft", IEC/TC 18 "Electrical installations of ships and of mobile and fixed offshore units" and IEC/TC 18/SC 18A "Electric cables and for ships and mobile and fixed offshore units".

The committee is also responsible for defining the necessary standards and specifications for defence technology (VG Standards and WL Material Property Specifications) in shipbuilding and marine technology and, if required, is entrusted with representing the interests of the German Navy in civil standardisation work.

The activities of the working group led to a revision of the international MEPC 60 (33) Resolution. The new resolution, MEPC 107 (49) contains stricter testing standards and specifications. The close cooperation in the working group enabled the enterprises involved to respond to these changes at a very early point in the proceedings.

As a result, NFV (Norddeutsche – Filter – Vertriebs GmbH) was the first enterprise worldwide to present an OWS that complied with these new, stricter test specifications.

The new OWS became an important component for new developments in the field of oil/water separation.

2. Terminology and Technology

2.1 What is bilge water?

The bilge is the bottommost compartment in a ship, making it the lowest point within the vessel. Any water that enters the hull and all condensation drains down to this lowest point. This water is called bilge water, and it can be pumped out with the aid of bilge pumps.

Bilge water can be a mixture of water, diesel oil, gas oil, hydraulic oil, detergents, oil additives, chemicals, dirt, soot and other substances. This mixture is usually collected in the bilge water tank.

As bilge water is commonly contaminated with traces of oil and fuel, it cannot simply be discharged overboard into the sea. Before the bilge water can be discharged, it has to be treated in a OWS where the water and oil are separated.

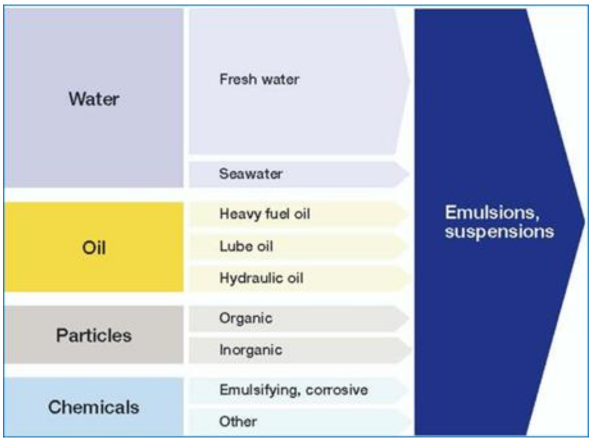


Figure 1 (E. Runge)

2.2 What is an emulsion?

Two liquids that under ordinary circumstances will not blend may form an emulsion when vigorously mixed. This emulsion is a mixture of liquids that looks like homogenous liquid, as the droplets of each substance are microscopically small. In fact, it is a heterogeneous mixture consisting of very small droplets with a diameter of between 0.1 and 100 µm. Due to this small size, gravity cannot force the two liquids in the emulsion to separate. An emulsion consists of the main liquid, which is called the continuous phase, and the secondary liquid, the dispersed phase, which is present in the first phase as fine droplets.

Figure 2 (E. Runge)

2.3 What is a dispersion?

A dispersion is a heterogeneous system that consists of at least two phases that will not blend or dissolve in each other or only up to a certain point. A dispersion can occur in all physical states. The term dispersion is also used to describe a liquid-liquid system which contains droplets that are larger in size than those in an emulsion and which contains a lower concentration of interface active substances than an emulsion.

Dispersions are instable and will separate into homogenous phases due the different densities of the substances.

A OWS must be able to separate both these types of mixtures, i.e., emulsions and dispersions.

Figure 3 (E. Runge)

2.4 The basic principles of dual-phase bilge water cleansing

The “multiphases” (oil, water, solids) are roughly separated in the first phase (MPS). In the second phase the fine oil droplets (< 1 µm (1/1000 mm) are permanently separated (emulsions/dispersions).

First step: Multiphase Separation (MPS)

The bilge water is pumped into the first chamber of an OWS that is designed to separate larger proportions of oil (up to 100% oil). The separated oils are pumped into an oil tank. All solids or other heavier substances slide down into the sludge holding tank; this tank must be fitted with an outlet.

Second step: Mechanical fine droplet separation

The oily water is then pumped into a chamber for fine droplet separation. The fine oil droplets (>0.5 µm) coalesce to form large drops, which are fed into the oil tank. This permanent separation must deliver complete operational safety.

Regrettably, the word separator gives the impression that mechanical separators are meant; however, these are not capable of mechanically separating the fine oil droplets!

The abbreviation OWS (Oil Water Separator) refers to the SEPARATION process!

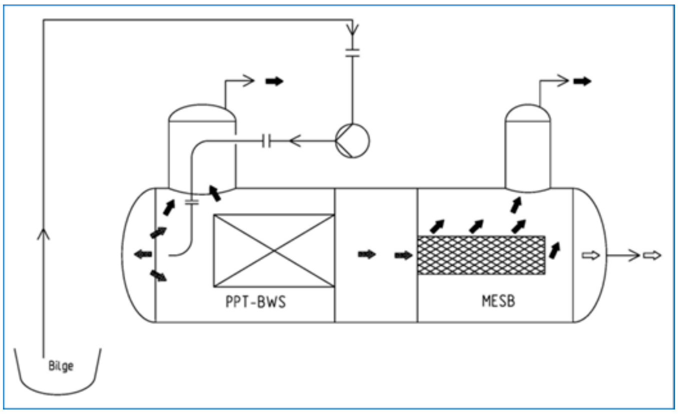
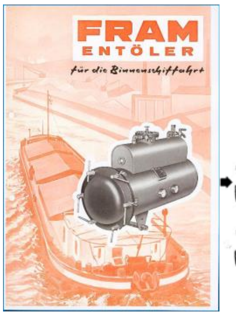
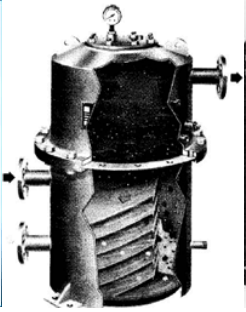


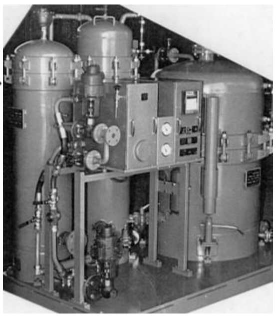
Figure 4 (E. Runge)

3. A brief history of OWS technology

3.1 The history of OWS (oil water separator) in shipping







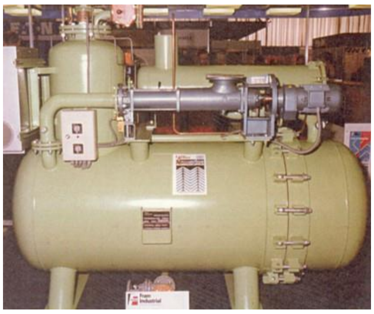


Figure 5 (E. Runge) *Figure 6 (E.Runge)* *Figure 7 (E.Runge)* *Figure 9 (E.Runge)*

Figure 9 (E.Runge)

In Germany and Europe, the licensee of the US company FRAM introduced an OWS with a residual oil content of < 20 mg/l for inland and coastal shipping. (Fig.5) As many OWS systems failed to achieved the specified residual oil levels and large quantities of (oily) bilge water were pumped into the rivers of Europe, the use of OWS systems was prohibited; instead, an on-board collection tank became compulsory, a so-called “Duisburg Pot” which was emptied either on land or using special OWS vessels.

The first OWS for marine shipping failed to find a market as there were no specifications and the idea of environmental protection was still very much in its infancy in those days.

Later, safety concerns (fire hazards) led to increased demands to make OWS with a residual oil content of <100 ppm mandatory for marine shipping, and systems with a performance of up to 100m³/h came onto the market (Fig.6). These systems could also be used as a bilge water evacuation system. Introduced by the IMCO (later IMO), MARPOL 73/78 is the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978.

IMCO Resolution A-233 (VII) = 100 ppm

At the SMM 1972, US developers presented to industry experts an OWS (oil water separator) that was capable of achieving residual oil values of as low as <15 ppm and which became the basis for the MARPOL Convention 73/78; however, these still had a residual oil content of <100 ppm! (Fig. 7)

The system had three stages and also included a residual oil monitor with a recorder.

The four-stage variant even managed to comply with residual oil values of >5 ppm; this was the US Navy version.

German experts expressed doubts as to whether the OWS was effective and commissioned a rigorous test.

The results of the tests performed at HDW, Hamburg (Howaltdswerke Deutsche Werft), later Blohm&Voss, corroborated the tests conducted by the USCG (US Coast Guard), the US Navy and their certification agencies, and resulted in this system being copied by the competition.

Then the resolution was introduced: IMCO Resolution A-393 (XX) = 15 ppm

The first resolutions had only tested with diesel, i.e. gas oil and lubricating oil. (Fig. 8)

At the beginning of 1980, a German company caused an industry sensation with the launch of a single-phase OWS that needed no filter and coalescer elements and which even produced better deoiling results. Further advantages of the new system were simple operation and much lower operating costs.

In 1992 the IMO MARPOL Resolution MEPC 60 (33) was passed, which was scheduled to come into effect on 1 April 1994. For the first time, heavy oil was also tested.

As early as 1993 the German OWS system (PPT-BWS) was successfully tested under the supervision of GL (Germanischer Lloyd) and was the first OWS on the (world) market to receive certification. (Fig. 9)

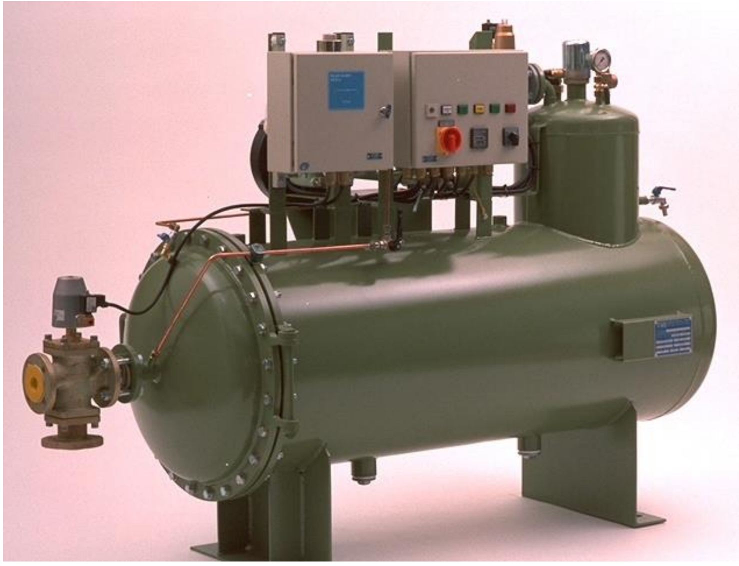


Figure 9 (E. Runge)

OWS model “PPT-BWS” (complies with MEPC. 60 (33))

There was widespread criticism from experts (including the author) that MEPC 60 (33) neither improved environmental protection nor ensured the necessary level of safety for the crew on board the vessels.

The test specifications were too theoretical and the testing mixtures did not reproduce real, on-board conditions. Incorrect testing also produced “certified” OWS systems that did not comply with the test specifications.

The German Navy was the only body to require OWS that were capable of handling and cleaning wastewater on board their vessels. They also had to be easy to operate and work fully automatically, i.e. in complete compliance with the IMO resolutions; in addition, the tests were conducted with real bilge water.

The author and his company also met these challenges and in most cases delivered optimum solutions.

The resulting OWS systems are so sophisticated that they are used in NSA and PSSA areas (national special areas and particularly sensitive sea areas) where a residual oil content of <5 ppm (parts per million) is stipulated. (Fig. 10)

Figure 10 (E. Runge)

OWS model “Deoiler-2000“ (< 5 ppm)

3.2 The foundation of the working group NA 132-02-11-01 AK / ISO TC 8/SC 2/WG2 – Oil-Water Separators in the NSMT (German Shipbuilding and Marine Technology Standards Committee)

The author, who is presently Senior Consultant of the firm ER – Consulting, Hamburg, has over 50 years of expertise in the field of processing oily shipping wastewater. He has developed and successfully marketed numerous innovative oil-water separation solutions.

An increased awareness of the importance of environmental protection and the rising acknowledgement that the existing resolutions, **which are not standards**, were inadequate led to the formation of the working group NA 132-02-11-01 AK / ISO TC 8/SC 2/WG2 – Oil-Water Separators at the German Shipbuilding and Marine Technology Standards Committee (NSMT) under the leadership of the author.

The urgent demand for a new set of standards or a new resolution also arose from the recognition that the test specifications detailed in the “old” MEPC 60 (33) were not an adequate reflection of the conditions encountered on board; this was in line with the criticism levelled at the IMO resolution.

3.3 The group’s work and the implications for marine environmental protection

In 1999 the working group for Oil-Water Separators was founded at the NSMT; this formed the basis for the working group NA 132-02-11-01 AK – Oil-Water Separators which was subsequently set up in 2002. In the following years, a new test resolution was formulated by manufacturers, operators, classification societies and the German Navy after an intense debate, and partially also in the face of considerable opposition. The biggest advocate of stricter testing conditions was the German Navy.

At the ISO Conference in Hamburg, which took place from 24-26 June 2003, the new test specifications for the new generation of OWS were ratified and passed on to the ISO and from there on to the IMO which ratified the specifications that same year at the organisation's 49th meeting as Resolution MEPC 107 (49).

All pictures by (E. Runge)

ISO Conference in Hamburg

From the very outset, the author wished to see test specifications for OWS established that actually complied with the conditions found on board the vessels.

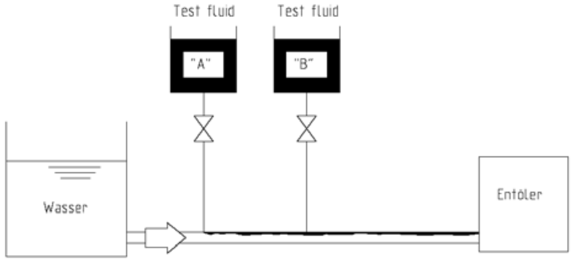
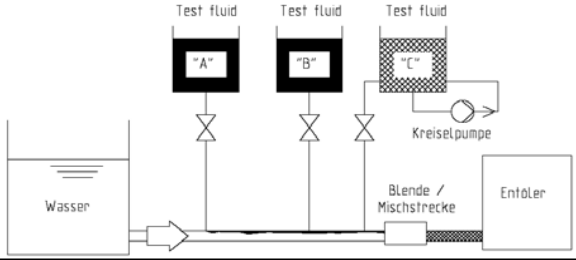
These included ship's wastewater containing heavily emulsified oil and fuel phases, such as the water from fuel oil separators, cold cleaning solvents and dirt.

The test specifications developed by the working group formed the backbone of the new IMO guidelines and Resolution MEPC 107 (49) – and particularly the fluids used for testing – which came into effect in January 2005.

What major changes did MEPC 107 (49) bring?

A new factor was the use of the test fluid C, a mixture containing a surfactant which chemically emulsifies the oils and the dirt in order to more accurately reproduce the wastewater found on board.

The following table illustrates the difference between MEPC 60 (33) and MEPC 107 (49):

IMO - MARPOL - Resolution MEPC 60 (33)	IMO - MARPOL - Resolution MEPC 107 (49), valid from 1 Jan 2005
Test fluids: • A (fuel oil RMF) • B (diesel oil DMA)	Test fluids: • A (fuel oil RMF) • B (diesel oil DMA) • C (emulsion*) • Dirt
Test procedure: The test fluids A and B are added directly to the water phase in the pipe. During the testing process for suction deoilers the media flowed into the device with no application of energy, i.e. the separation of the phases took place in the pipes. This in no way complies with onboard conditions. 	Test procedure: The test fluids A, B and C are added to the water phase in the pipe. In the conditioning pipe, a mixing section, energy is applied to the medium to simulate the pipelines, taps, values etc. on board. 
No specifications!	The deoiling must be conducted in such a way that it is possible to verify clearly that the device will function properly on board.
 <- Test fluid A  <- Test fluid B	 <- Test fluid A, B & C
Residual oil content: ≤ 15 ppm	Residual oil content: ≤ 15 ppm

Tables by E. Runge

What is test fluid C?

- 94.78% water
- 2.50% fuel oil (RMF)
- 2.50% diesel oil (DMA)
- 0.05% surfactant (sodium salt of dodecylbenzene sulfonic acid)
- 0.17% iron oxide in a mixture of particle sizes ranging from 10µm to 100µm

This mixture is blended in a tank with a centrifugal pump running at 3000 rev/min and a flow rate of approx. 100 m^3/h and then 6% is continuously added to the water being deoiled.

As the test rig also features a conditioning pipe, even the diesel oil and fuel oil are very well mixed.

Figure (E. Runge)

An effective OWS system must be capable of separating this “mixture” permanently and continuously (which is a key IMO requirement) into clean water and oil.

The new test specifications defined in the IMO resolution are far more in line with actual, real-life conditions, and thus contribute substantially to better environmental protection. In tests conducted 100% in compliance with the resolution, the OWS provide better environmental protection.

By collaborating in the working group, the companies were able to develop a new system that was ready to market in time for the introduction of IMO Resolution MEPC 107 (49). Only one company successfully passed all tests in complete compliance with MEPC 107 (49) and received certification. Accordingly, only one German company was in a position to sell a unit certified according to MEPC 107 (49).

Figure 12 (E. Runge)

OWS model MPEB (complies with MEPC 107 (49))

Figure 13 (E. Runge)

OWS model “Future” < 3ppm

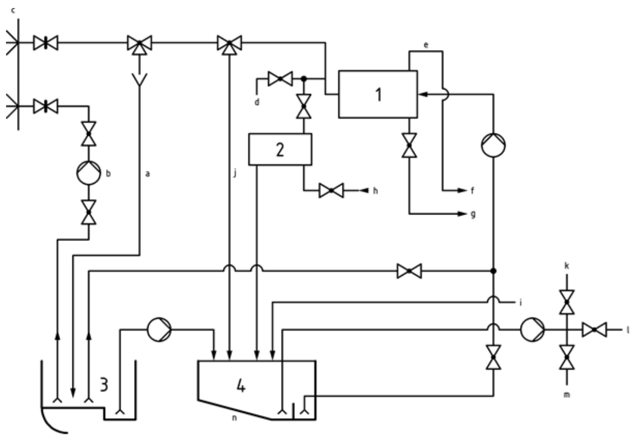
In the meantime, there have been numerous interpretations of the IMO Resolution MEPC 107(49), and many different testing approaches have been taken. New testers have been told: “…but that’s how we did it for MEPC 60 (33), isn’t it?”

OWS come onto the market that have not been fully tested in compliance with the MEPC 107 (49) testing procedures.

Working group NA 132–02–11–01-AK took action in response, convincing the IMO to issue a revised resolution, MEPC 54/6/1 Rev.1.

In order to improve the effectiveness of OWS that have not been correctly tested, the members of the working group jointly formulated a standard for the correct layout of the tanks and pipes.

DIN 86735: Tank system for bilge water systems on seagoing vessels



3.4 The present situation and the current MEPC 107 (49) testing resolution

Many national sea areas have been declared “5 ppm areas”, and Europe has agreed that from 2020, all sea areas, i.e. 70,000 km of coastline, are to be declared a “5 ppm Zone”. This standard can be achieved with OWS. However, it is not enough for specific classification societies to retrospectively “test” and then update the OWS certificates on paper in order to issue a new “5 ppm Certificate”. This holds all the more true as there is a severe error in the sampling and analysis specifications in

IMO MARPOL - Resolution MEPC 107 (49)!

Laboratory results that confirm a residual oil content of <5 ppm can, for example, have come from a back-flushing phase, which is not a correct procedure under the IMO resolution testing specifications. Other unintentional errors can lead to laboratory results that do not comply with the actual testing specifications.

In order to ensure standardised testing for all societies that test and certify OWS we need a standard – and not just a resolution.

The ISO demands a standard for the application of OWS on converter stations (offshore wind energy). This is a great opportunity to extend the standard to apply to shipping.

4. Summary

The success story of marine environmental protection has been decisively shaped by the collaboration in the working group NA 132-02-11-01 AK / ISO TC 8 – Oil-Water Separators at the German Shipbuilding and Marine Technology Standards Committee (NSMT).

The testing specifications of the international IMO Resolutions can be influenced at an early point in the proceedings through collaboration in the working group.

To ensure safety for everyone involved in this industry now and in the future we urgently need a globally binding testing and analysis standard.

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