Sikafloor® Marine UL FF
EXPERIENCE A REVOLUTIONARY MARINE FLOORING SOLUTION

White Paper

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BUILDING TRUST

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INTRODUCTION

There's always a compromise between environmental considerations and costs when developing or working with products created for maritime and shipping markets. Unfortunately, for a very long time, sustainability has not been prioritized over durability and cost-effectiveness. This approach, however, has been changing due to recent global sustainability initiatives.

As Sika is a specialty chemical company with a leading position in development and production of aesthetic deck coverings, acoustic flooring solutions, bonding, sealing, and reinforcing products for many market segments including the maritime industry, we feel it is our obligation to the world to help the market step into a sustainable future by developing and implementing new technologies, which include our environmental principles, from the very beginning of the development phase. Sika's mission is to convert the environmental compromise into a balance, where sustainability and durability are paramount and there is no need to sacrifice the quality or eco-friendliness.

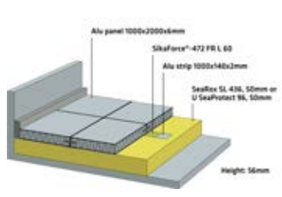
To help the shipbuilding industry to reduce CO_2 emissions, Sika has developed an ultra-light weight floating floor solutions that will reduce the weight by at least 24 kg/m² compared to a traditional floating floor construction used nowadays in the shipbuilding industry.

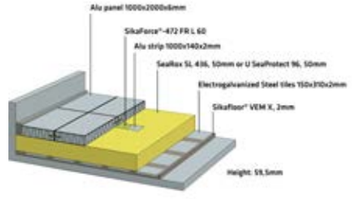
Different types of ships all have floating floors installed for acoustic comfort or as A-60 fire rated floor. Floating floors in larger areas are used onboard cruise ships, expedition ships, RoRo car ferries, passenger ferries, supply vessels, mega yachts, and research vessels, just to mention some ships where floating floors are used. By reducing the weight of the ship construction, we can help by minimizing the fuel and energy consumption and reducing the emission of CO_2 in the building and supply chain.

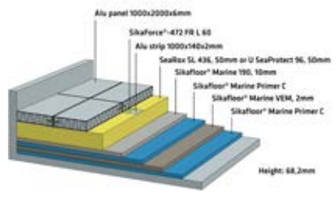
SIKAFLOOR® MARINE ULTRA-LIGHT FLOATING FLOOR SYSTEM

A "Floating Floor" is a floor which is applied on top of an insulation with no solid connection to the super-structure of a ship, which means pipe penetrations, columns, foundations for machinery etc. must be disconnected from the floor system. The acoustic performance comes from the mass and spring concept, where the insulation is the spring and the top layer is the mass.

The Sikafloor®Marine Ultra-Light floating floor system comes in two different versions where the only difference is the type of insulation sheet used underneath the floating floor. Both versions have an A60 certificate when applied in a thickness of 50 mm or more and can both be applied including Sika's special visco elastic solutions.







Product Description: Sikafloor® Marine UL FF-1 (System)

- Layer 1: Mineral wool Isover Ultimate U SeaProtect 96, density 96 kg/m3, min 50mm, mounted tightly together (compressed)
- Layer 2: Aluminum strip 140 x 2000 x 2 mm were placed on top of the mineral wool in all plate intersections
- Layer 3: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 (max. 400 g/m2)

Total thickness approximately: 56 mm

Alternative 1
Sikafloor® Marine UL FF-1 including visco elastic system which uses steel tiles

- Layer 1: Sikafloor® Marine VEM X, max. 2 mm
- Layer 2: Steel tiles, 150 x 310 x 1.5 mm, 90% coverage
- Layer 3: Isover Ultimate U SeaProtect 96, density 96 kg/m³, min 50mm, mounted tightly together (compressed)
- Layer 4: Alu strips, 2 x 140 x 2000 mm bonded with SikaForce®-472 FR L 60
- Layer 5: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 max. 400 g/m2

Total thickness approximately: 60 mm

SIKAFLOOR® MARINE ULTRA-LIGHT FLOATING FLOOR SYSTEM

Alternative 2
Sikafloor® Marine UL FF-1 including visco elastic system which uses a cement based constrained layer

- Layer 1: Sikafloor® Marine Primer C
- Layer 2: Sikafloor® Marine VEM max. 2 mm
- Layer 3: Sikafloor® Marine Primer C
- Layer 4: Sikafloor® Marine 190 min 10 mm
- Layer 5: Isover Ultimate U SeaProtect 96, density 96 kg/m^3, min 50 mm, mounted tightly together (compressed)
- Layer 6: Alu strips, 2 x 140 x 2000 mm bonded with SikaForce®-472 FR L 60
- Layer 7: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing.
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 max. 400 g/m2

Total thickness approximately: 68 mm

Product Description: Sikafloor® Marine UL FF-2 (System)

- Layer 1: Mineral wool SeaRox SL 436, density 140 kg/m^3, min 50mm, mounted tightly together (compressed)
- Layer 2: Aluminum strip 140 x 2000 x 2 mm were placed on top of the mineral wool in all plate intersections
- Layer 3: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 (max. 400 g/m2).

Total thickness approximately: 56 mm

Alternative 1
Sikafloor® Marine UL FF-2 including visco elastic system which uses steel tiles

- Layer 1: Sikafloor® Marine VEM X, max. 2 mm
- Layer 2: Steel tiles, 150 x 310 x 1.5 mm, 90% coverage
- Layer 3: Mineral wool SeaRox SL 436, density 140 kg/m^3, min 50mm, mounted tightly together (compressed)
- Layer 4: Alu strips, 2 x 140 x 2000 mm bonded with SikaForce®-472 FR L 60
- Layer 5: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 max. 400 g/m2

Total thickness approximately: 60 mm

Alternative 2
Sikafloor® Marine UL FF-2 including visco elastic system which uses a cement based constrained layer

- Layer 1: Sikafloor® Marine Primer C
- Layer 2: Sikafloor® Marine VEM max. 2 mm
- Layer 3: Sikafloor® Marine Primer C
- Layer 4: Sikafloor® Marine 190 min 10 mm
- Layer 5: Mineral wool SeaRox SL 436, density 140 kg/m^3, min 50mm, mounted tightly together (compressed)
- Layer 6: Alu strips, 2 x 140 x 2000 mm bonded with SikaForce®-472 FR L 60
- Layer 7: Alu panel, 1000 x 2000 mm with grove and flat tongue profile for jointing
- Adhesive: For bonding Aluminum strips and tongue profile, SikaForce®-472 FR L 60 max. 400 g/m2

Total thickness approximately: 68 mm

REDUCED FUEL CONSUMPTION AND CO_2-FOOTPRINT

Sika engineers conducted an internal study to calculate the CO_2 emission reduction level for a large, diesel-fueled cruise vessel. In the internal study, no new energy and fuel sources or hybrid engines are taken into consideration.

According to input data for a specific cruise ship with 17,023 m² floating floors installed, the data has been used for calculating fuel savings and related carbon footprint. The weight of an existing Litosilo Steel floating floors is 48.1 kg/m². The new Sikafloor® Marine UL FF, ultra-light weight floating floor is only 14.85 kg/m2!

A COMPARISON OF THE DIFFERENT SYSTEMS REVEALS THAT A SIGNIFICANT WEIGHT SAVING OF 33.25 KG CAN BE ACHIEVED PER M^2

THE INDEPENDENT STUDY SHOWS A WEIGHT SAVING OF 566 TONS FOR A 17,023 M^2 AREA

SUMMARIZED SAVINGS FROM THE GSR SERVICE STUDY

In order to substantiate the above business case on weight savings, reduced fuel consumption and CO_2-footprint, Sika has ordered an **independent study from GSR Services** on this data. The study compares two different Sikafloor Marine floating floor systems when used in a large cruise ship newbuilt construction. GSR Services GmbH compared the Sikafloor Marine Litosilo Steel, which has a total weight of 48.1 kg, to the Sikafloor Marine UL-FF 2.

1. FUEL SAVINGS MGO (MARINE GAS OIL) (GSR STUDY)
Comparing the installed power with related fuel consumption per sailing day results in a daily MGO consumption of approximately 257 tons with the conventional floating floor system. With the new floating floor system UL FF-2, a reduction of 0.41% equals savings of **approximately 1.05 to of MGO fuel per day** (or **383 tons/year** – depending on sailing days).

With a view on MGO prices of 1.100 $/t at the time of data collection, this corresponds to a **daily saving of 1.158 $** (up to **422.670$/year** – depending on sailing days).

Savings of
1.05 TONS
MGO fuel per day

2. FUEL SAVINGS LNG (GSR STUDY)
The specific fuel consumption including operational pumps for one full sailing day results in a daily LNG-consumption of approximately 194, a reduction of 0.41% of installed power saves approx. **0.8 to of LNG per day** (approx. **292 t/year** – depending on sailing days).

With a view on LNG fuel prices of 3000$/t at the time of data collection[1], this corresponds to a **daily saving of 2.389 $** (up to **871.985$/year** – depending on sailing days). It is to be noted that LNG bunkers are available in different qualities mirrored in 'lower heating value' which has been taken into consideration for the calculation.

Savings of
0.8 TONS
LNG fuel per day

REDUCING
transportation costs

3. DAILY CO_2 EMISSION REDUCTION MGO (GSR STUDY)
According to data from Helmholtz (Gemeinschaft deutscher Forschungszentren)[2], burning 1 liter of diesel produces 2.65 kg CO_2. Taking MGO density into account (890 kg/m³), the reduced installed power corresponds to a **daily emission reduction of approximately 3.1 to CO_2** (or **1.132 to CO_2/year** – depending on sailing days).

Emission reduction of
3.1 TONS CO_2
per day (MGO)

4. DAILY CO_2 EMISSION REDUCTION LNG (GSR STUDY)
The converter tool[3] of the ICBE (International Carbon Bank & Exchange) has been chosen to calculate the carbon dioxide emission saving for LNG used as fuel.

The daily fuel saving of around 0.8 tons LNG and a density of 450 kg/m³ corresponds to a **daily emission saving of approximately 1,14 to CO_2** (or **416 to/year** – depending on sailing days).

Generally, it should be noted that using LNG as fuel results in an NOx reduction of approximately 80% whereas carbon dioxide emissions remain relatively similar for the different types of fuel as per the available literature on this subject.

Emission reduction of
1.14 TONS CO_2
per day (LNG)

[1] www.shipandbunker.com, link called on 05.08.2022
[2] www.helmholtz.de, visited on 12.08.2022, comparable values are provided in regard to CO_2 emissions for various types of fuel
[3] www.icbe.com, link called on 05.08.2022

APPLICATION AREAS AND ADVANTAGES

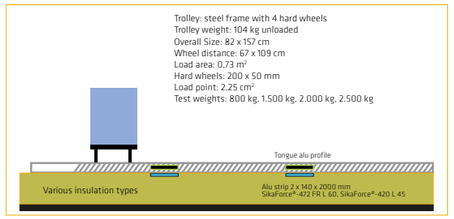
Sikafloor® Marine ULFF is suitable **for all interior installations in passenger, crew cabin areas and public areas**. Only for areas where an extremely heavy load is expected, the ship designers could consider traditional Sikafloor® Marine floating floor systems.

ADVANTAGES FOR THE OWNERS, DESIGNERS, SHIPBUILDERS, WORKERS, AND ENVIRONMENT

- Extreme / Significant weight savings
- Fast ROI
- High savings in energy and fuel consumption during operations
- Savings in the structural construction
- A60 fire rated floor
- Acoustic performance fully documented
- Including documented Visco Elastic solution
- Good dynamic behavior
- No VOC
- No EH&S issues
- Easy processing and fast to install, reducing labor costs and time on site
- Reduced transportation costs
- 98% recyclable flooring panels
- Good corrosion resistance
- Waterproof, flexible membrane layer
- Certification according to IMO/SOLAS, EC-Type examination Certificate, Wheelmark MED-B and -D
- US Coast Guard approved

LOAD TESTS

Pioneering a first-of-its-kind ultra light weight floating floor has been a challenge. In particular, it has been challenging to obtain a floor construction with sufficient strength and rigidity and being able to withstand the point loads and maximum weight of the total construction installed on the floor. Comprehensive load tests have been carried out with a special trolley and test weights as illustrated.



TEST METHOD
Loaded trolley rolled manually around as shown:

- 10 Circles with a load of approx. 800Kg and control of floor
- 10 Circles with a load of approx. 1.500Kg and control of floor
- 10 Circles with a load of approx. 2.000Kg and control of floor
- 10 Circles with a load of approx. 2.500Kg and control of floor

CRITERIA TO PASS THE TEST
Full 10 circles with 3 first loads:

- No visible cracks
- No deep wheel marks
- No permanent local deformation of alu panels
- No noise when rolling the trolley over the floor

The installation process of the cabin areas onboard a cruise ship begins with the prefabrication of all passenger and crew cabins with bulkheads, fixed furniture, and bathroom module pre-assembled by the supplier at their warehouses. These readymade cabins are transported to the ship, hoisted to the entree area of the vessel, where the prefab cabins are then rolled out on the floating floor to their final position.

Today, the turnkey companies are installing heavy floating floors with 4 mm steel plates, to avoid deflections and deformations in the floor. The weight of most of the prefab cabins are in the range of 2,000 – 2,500 kg, which have in general a size of approximately 24 m^2. Few luxury cabins can even weigh up to 4,000 kg in total, and are bigger in size as compared to the standard cabins.

By conducting the rolling load test with a maximum weight of 2.500 kg, installed on a rolling device of 0,73 m^2 and with 4 hard wheels, it is concluded that the Sikafloor® Marine ULFF, despite having only a weight of 14.85 kg/m^2 and installed on insulation material, can easily handle the rolling installations of the majority of prefabricated cabins used in cruise ship building today. It is always recommended to protect the floating floor when rolling in the cabins.

LOAD TESTS

Using the new Sikafloor® Marine UL FF, may require the protection of the floor during the rolling in of the prefab cabins where the floating floor is covered with plates that will absorb the point loads from the small hard wheels of the lifting trolleys used to roll-out the prefab cabins. When the prefab cabins are in place, the ultra-light weight floor has sufficient compressive strength to carry the load of the accommodation.

Besides the prefabricated cabin installations, there is also a big potential of installations where lining and partition walls, ceilings and furnitures are installed onboard directly on the floating floors, where the Sikafloor® Marine UL FF ultra-light weight floating floor has sufficient strength to carry the load of installations and the traffic that the floor will be exposed to.

PASSED THE CABIN ROLL LOAD TEST WITH MORE THAN 2.500 KG WITHOUT DEFORMATION

NOISE REDUCTION PERFORMANCE

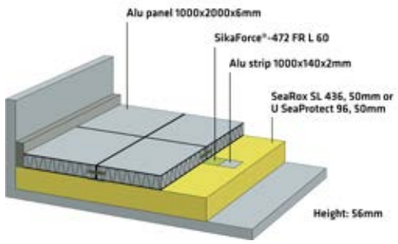
In noise and vibration control, the most important tasks are the minimization of the excitation and of the propagation of sound in structures. Furthermore, the transfer from structure-borne sound into airborne sound – the vibration-induced radiation of sound – should be kept as low as possible.

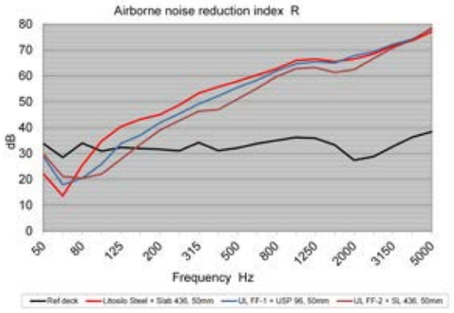
Therefore, at Denmark's Tekniske Universitet (DTU), Sika has also performed sound tests with the combination of visco-elastic and the Sikafloor® Marine UL FF floating floor systems.

The Sikafloor® Marine VEM190 and Sikafloor® Marine VEM-X visco-elastic systems are damping the structure-borne noise by transfer of vibration energy into heat caused by the friction between the constrained layer and steel deck with the visco-elastic layer causing that effect. The Sikafloor® Marine UL FF floating floor system which is installed reduces the propagation of airborne and impact noise to the adjacent compartments and decks above.

The following Sound reduction Index R according to ISO standards are measured:

- FF-1, Rw 55 dB (U SeaProtect)
- FF-2, Rw 51 dB (SeaRox)
- FF-2 + SFM 590, Rw 53 dB (SeaRox + synthetic watertight levelling membrane)
- FF-1 + VEM 190, Rw 57 dB (U SeaProtect)
- FF-2 + VEM 190, Rw 55 dB (SeaRox)
- FF-1 + VEM Steel, Rw 58 dB (U SeaProtect)
- FF-2 + VEM Steel, Rw 55 dB (SeaRox)

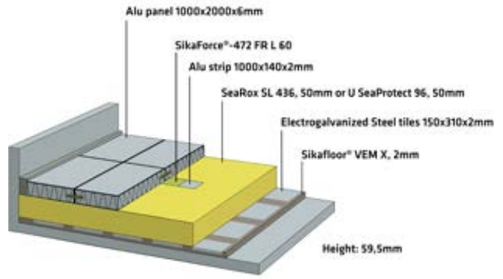


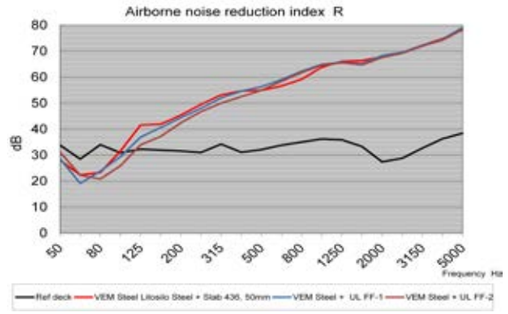


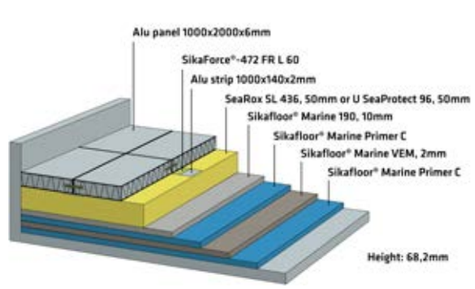
The vibration induced radiation of noise in the low frequency range up to 250 Hz will not be reduced/damped by the floating floor. Therefore, in specific areas, e.g., over the propulsion/propeller areas it's necessary to apply the visco-elastic floor to dampen the propagation of structure borne noise.

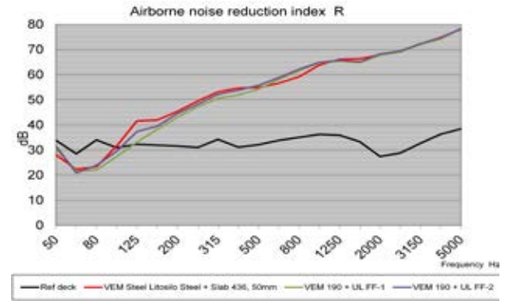
Other areas e.g., over the engine room, thruster compartments, HVAC, etc., the noise sources are transmitting noise into both structure-borne as well as airborne noise in the adjacent compartments and decks above. Here it's necessary to install a combination visco-elastic and floating floor solution, shown below.

NOISE REDUCTION PERFORMANCE

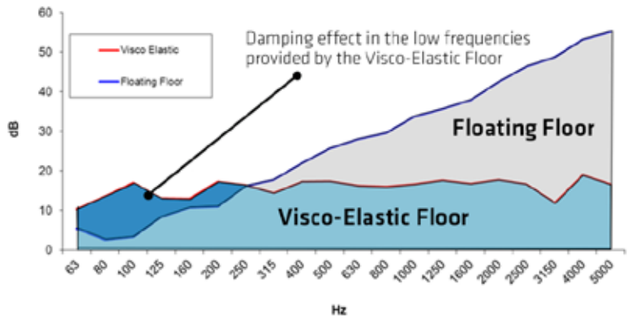








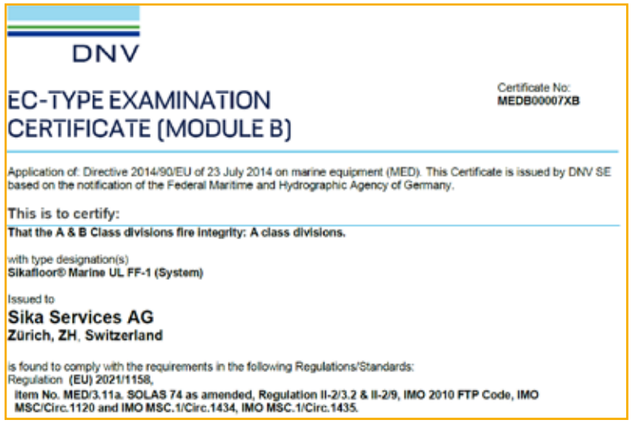
Below figure shows the damping effect in the low frequencies provided by the visco-elastic floor.



A-60 FIRE APPROVED

Sikafloor® Marine UL FF is approved for use as a horizontal fire retarding division of class A-60. The approval includes combinations with visco-elastic mortar systems, using either steel tiles or a constrained layer of mortar.

The test has been subject to the standard fire test complying with the international Code for Application of Fire Test Procedures, 2010. Resolution MSC.307(88), 2010 FTP Code, Annex 1 Part 3, Test for “A”, “B” and “F” Class Divisions. Maximum allowed average temperature is 140° C.



DNV

EC-TYPE EXAMINATION CERTIFICATE (MODULE B)

Certificate No: MEDB00007XB

Application of: Directive 2014/90/EU of 23 July 2014 on marine equipment (MED). This Certificate is issued by DNV SE based on the notification of the Federal Maritime and Hydrographic Agency of Germany.

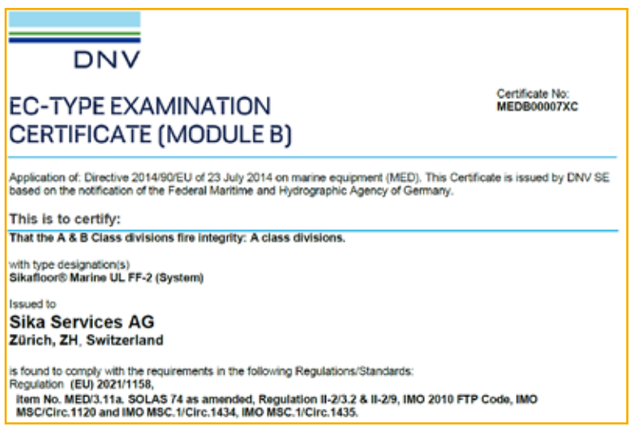
This is to certify:

That the A & B Class divisions fire integrity: A class divisions.

with type designation(s)
Sikafloor® Marine UL FF-1 (System)

Issued to
Sika Services AG
Zürich, ZH, Switzerland

is found to comply with the requirements in the following Regulations/Standards:
Regulation (EU) 2021/1158,
Item No. MED/3.11a. SOLAS 74 as amended, Regulation II-2/3.2 & II-2/9, IMO 2010 FTP Code, IMO MSC/Circ.1120 and IMO MSC.1/Circ.1434, IMO MSC.1/Circ.1435.



DNV

EC-TYPE EXAMINATION CERTIFICATE (MODULE B)

Certificate No: MEDB00007XC

Application of: Directive 2014/90/EU of 23 July 2014 on marine equipment (MED). This Certificate is issued by DNV SE based on the notification of the Federal Maritime and Hydrographic Agency of Germany.

This is to certify:

That the A & B Class divisions fire integrity: A class divisions.

with type designation(s)
Sikafloor® Marine UL FF-2 (System)

Issued to
Sika Services AG
Zürich, ZH, Switzerland

is found to comply with the requirements in the following Regulations/Standards:
Regulation (EU) 2021/1158,
Item No. MED/3.11a. SOLAS 74 as amended, Regulation II-2/3.2 & II-2/9, IMO 2010 FTP Code, IMO MSC/Circ.1120 and IMO MSC.1/Circ.1434, IMO MSC.1/Circ.1435.

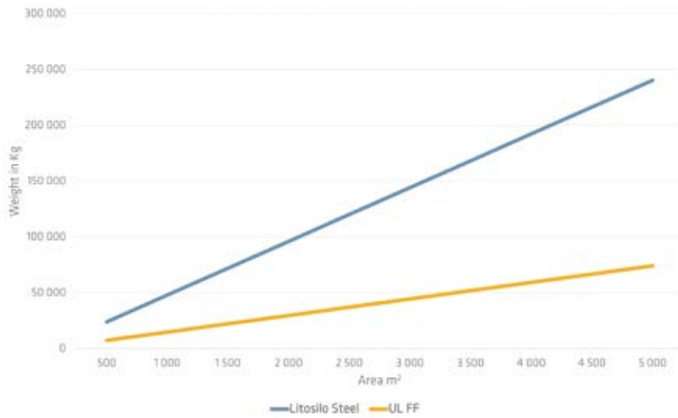
EC-TYPE EXAMINATION CERTIFICATE (MODULE B)

TRANSPORTATION SAVINGS FROM SIKA TO EUROPEAN YARDS

The weight of an existing floating steel floor is approximately 48.1 kg/m2. With the new developed ultra-light weight floating floor Sikafloor® Marine UL FF, the weight is only 14.85 kg/m²!

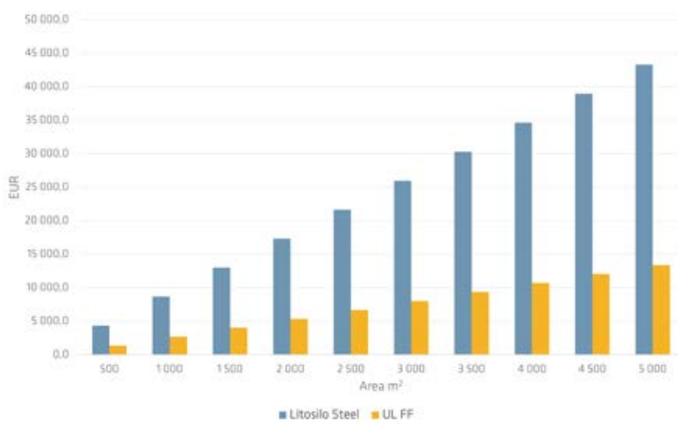
The difference in weight and transportation cost comparing the ultra-light weight UL FF system with Sikafloor® Marine Litosilo Steel.

For the comparison in transportation savings, we have used an estimated cost at 0.18 Eur/kg, for the transport from Sika factory to European shipyards.



Area m²	Weight kg	
	Litosilo Steel	UL FF
500	24 050	7 425
1 000	48 100	14 850
1 500	72 150	22 275
2 000	96 200	29 700
2 500	120 250	37 125
3 000	144 300	44 550
3 500	168 350	51 975
4 000	192 400	59 400
4 500	216 450	66 825
5 000	240 500	74 250

Estimated transportation costs in EUR; Transport to European Yards



Area m²	Transportation costs in EUR	
	Litosilo Steel	UL FF
500	4 329,0	1 336,5
1 000	8 658,0	2 673,0
1 500	12 987,0	4 009,5
2 000	17 316,0	5 346,0
2 500	21 645,0	6 682,5
3 000	25 974,0	8 019,0
3 500	30 303,0	9 355,5
4 000	34 632,0	10 692,0
4 500	38 961,0	12 028,5
5 000	43 290,0	13 365,0
About 0.18 EUR/Kg in EU		

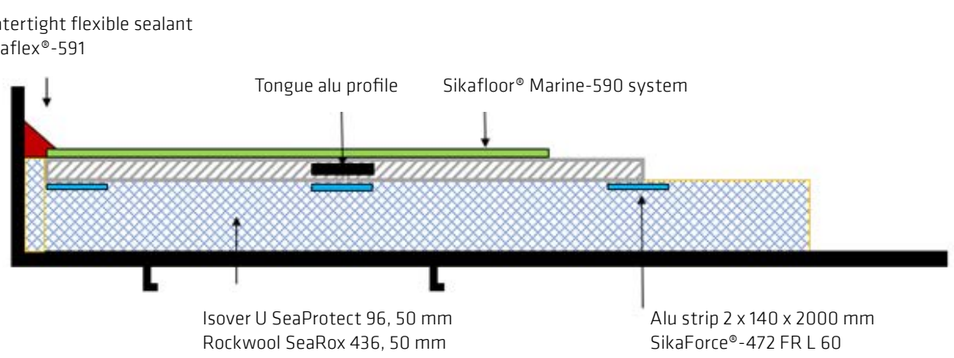
INSTALLATION

The Ultra-Light weight floating floor is built up by a layer of 50 mm mineral wool slaps. Strips are placed on top of the mineral wool in a pattern under the joints of the ultra-light weight panels and bonded with SikaForce®-420 adhesive.

The panels are assembled by a tongue and groove system and on top, a watertight levelling can be installed with Sikafloor® Marine-570 or -590.

The installation process will be easier compared to the installation process of a full steel floating floor system. As steel plates are heavy and come in a size of 1 x 2 mtr. the onboarding process and transportation to and on the ship takes a lot of time. With the light weight aluminum panels, multiple panels can be transported on the ship at the same time. In addition, a synthetic watertight and flexible levelling membrane can be applied with Sikafloor®Marine-570 and/or -590. See below the render for more information.

For addition application details please refer to the Additional Product Information of Sikafloor®Marine Ultra-light floating floor system.



Sikafloor® Marine UL FF-1 & FF-2
System Built Up

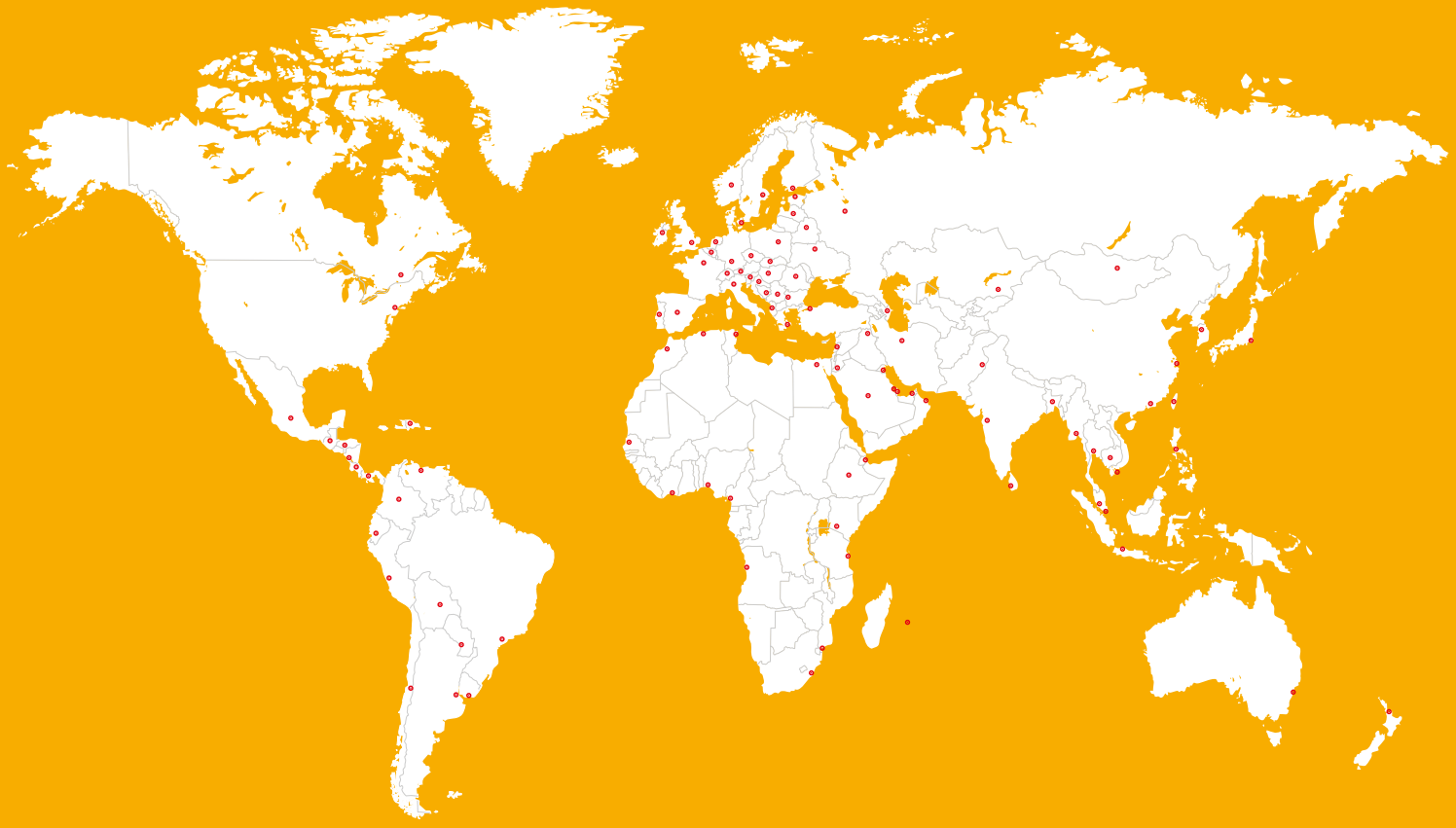
- Alu panel, 1000 x 2000 mm with tongue and groove all 4 sides of the panel
- Alu bottom profile 2 mm
- Flat tongue Alu profile matching the groove and butt jointing the panels
- Edge insulation
- Insulation U SeaProtect 96, 50 mm (UL FF1) or Insulation Rockwool USP 436, 50 mm (UL FF2)
- Alu strips 2 x 140 x 2000 mm
- Adhesive SikaForce®-472 FR L 60
- Watertight membrane: Sikafloor® Marine-590 system

SUMMARY

Sika's innovative new ultra-light weight floating floor solution paves the way for a sustainable future in the shipbuilding industry. Aimed at minimizing fuel and energy consumption and reducing CO_2 in the building and supply chain, our solutions offers several advantages over traditional flooring solutions.

We remain at the forefront of advanced flooring systems and continue to deliver on our customers' requirements.

GLOBAL BUT LOCAL PARTNERSHIP



CONTACT US FOR MORE INFORMATION:

www.sika.com/marine-floating-floors

Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika's product lines feature concrete admixtures, mortars, sealants and adhesives, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

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