

**TITLE: System for loading and unloading fluid, related installation and method**

The present invention relates to a system for loading and/or unloading fluid between a transport structure floating in a body of water and a fluid receiving structure comprising at least one fluid tank, the loading and/or unloading system comprising:

- a reference structure, anchored on the bottom of the body of water, the reference structure being distinct from the floating transport structure;
- a fluid transfer pipe for extending from the fluid receiving structure to the reference structure;
- an intermediate floating connection unit comprising a pontoon, a flexible pipe for connecting to a loading and/or unloading port on the floating transport structure, and a transfer connector between the flexible connection pipe and the fluid transfer pipe.

The present invention is particularly applicable to the transfer of fluid, for loading or unloading the fluid. The fluid is a gas or a liquid, for example, in particular liquefied natural gas (LNG), liquefied petroleum gas (LPG) or liquid hydrogen. The fluid is transported between a fluid transport vessel and a storage and/or regasification terminal, with this terminal capable of being on land or also floating, moored and permanently connected to land.

Given the constraints on vessel safety and movement, it is preferable to carry out transfer operations, particularly of gas or liquid hydrocarbons, while keeping the vessel out of a port or in deeper waters, a few hundred meters from the coast, for example.

In this case, a fluid transfer pipe is usually deployed between the terminal and the loading and/or unloading point at sea. The connection is made between a flange of the loading and unloading manifold of the transport vessel and the end of the transfer pipe of the present invention.

However, in order to allow easy handling of the free end of the transfer pipe when connecting to a vessel, or when disconnecting it, it is known, for example, from EP 3 097 008 to use an intermediate unit comprising a pontoon, a flexible pipe designed to connect to the manifold on the vessel, and a connector connecting the flexible pipe to the transfer pipe.

Such a transfer system is not entirely satisfactory. Indeed, it requires the secure mooring of the intermediate unit to the transport vessel by means of a suction cup system or a mechanical system. This mooring mechanically links the pontoon of the intermediate unit with the vessel. Such a connection is acceptable in very calm waters.

However, when the swell and/or wind increases, the transport vessel, which has a high mass, can undergo significant displacement, with substantial inertia. The pontoon of the intermediate unit is much lighter, and thus at least partially follows the inertia of the vessel, causing undesired movements of the transfer pipe in some cases.

Furthermore, in an emergency, it is necessary to disconnect the intermediate unit from the vessel very quickly, which is not easy to achieve and may pose safety risks.

One purpose of the invention is thus to provide a system for loading and unloading fluid that is simple and reliable to implement, while being extremely safe in an emergency.

To this end, the object of the invention is a system of the aforementioned type, characterized in that the loading and/or unloading system comprises at least one rigid link for mounting the intermediate floating unit on the reference structure, allowing at least one degree of freedom between the intermediate floating unit and the reference structure, with the intermediate floating unit designed to be permanently uncoupled from the floating transport structure.

The system according to the invention may comprise one or more of the following features, taken alone or in any technically possible combination:

- the intermediate floating unit is movable between an operational loading and/or unloading position, in which the or each rigid link connects the intermediate floating unit to the reference structure, and an inactive securing position in which the intermediate floating unit is away from the reference structure, the or each rigid link being disconnected on the side of the intermediate floating unit and/or on the side of the reference structure;
- the system comprises a mooring structure of the floating transport structure, with the reference structure separate from the mooring structure or formed by part of the mooring structure;
- the rigid link comprises a bar, hinged at a first end to the reference structure and at a second end to the intermediate floating unit;
- the reference structure comprises at least one bollard or pillar, the or each rigid link comprising a member engaged around the bollard or pillar, movable in translation along the bollard or pillar, the member engaged around the bollard or pillar advantageously being a cuff;
- the system comprises at least two rigid links each independently connecting the reference structure to the intermediate floating unit;
- the reference structure comprises at least one reference bollard anchored at the bottom of the body of water, the rigid link connecting the reference bollard to the intermediate

floating unit with at least one degree of freedom between the reference bollard and the intermediate floating unit;

- the reference structure comprises an open-worked mesh, partially submerged in the body of water, with the open-worked mesh being anchored on the bottom of the body of water;
- the open-worked mesh delimits at least one housing for receiving the intermediate floating unit, the intermediate floating unit being able to be inserted into the housing in an operational loading and/or unloading position;
- the connector of the intermediate floating unit comprises a quick disconnection and isolation device and,
- the intermediate floating unit comprises a storage assembly for the connecting hose suitable for deploying the connecting hose from a storage configuration received or coiled in the storage assembly to a connection configuration connected to the unloading port on the floating transport structure.

The invention also relates to a fluid transfer installation comprising:

- a fluid transport structure floating in the body of water;
- a fluid receiving structure, comprising at least one fluid tank;
- a loading and/or unloading system as defined above, the fluid transfer pipe connecting the fluid tank to the intermediate floating unit connector, the flexible pipe connecting an unloading port on the floating transport structure to the intermediate connector.

The installation according to the invention may comprise one or more of the following features, taken alone or in any technically possible combination:

- the intermediate floating unit is movable between an operational loading and/or unloading position, with the or each rigid link connecting the reference structure to the intermediate floating unit and an inactive securing position in which the intermediate floating unit is away from the reference structure, the or each rigid link being disconnected on the side of the intermediate floating unit and/or on the side of the reference structure, the fluid transfer pipe being a flexible pipe, the receiving structure comprising at least one return assembly of the fluid transfer pipe for jointly returning the fluid transfer pipe and the intermediate floating unit to the vicinity of the receiving structure and
- the receiving structure is a floating unit or is a land-based unit.

The invention also relates to a method for loading or/and unloading fluid comprising the following steps:

- providing a loading or/and unloading system as defined above in a body of water;
- bringing a floating transport structure into the vicinity of the reference structure;
- advantageously mooring the floating transport structure;
- connecting the flexible connection pipe to a unloading port on the floating transport structure;
- loading or unloading fluid through the flexible connection pipe, the transfer connector and the fluid transfer pipe from the floating transport structure to the fluid tank;
- during loading or unloading, relative movement of the intermediate floating unit in relation to the reference structure and in relation to the floating transport structure.

The method according to the invention may comprise one or more of the following features, taken alone or in any technically possible combination:

- dismounting the or each rigid mounting link of the intermediate floating unit on the reference structure; and
- moving the intermediate floating unit to an inactive position away from the reference structure.

The invention will be better understood from the following description, given only by way of example, and made with reference to the appended drawings, in which:

[Fig 1] Figure 1 is a top view of a transfer installation comprising a first loading and unloading system according to the invention;

[Fig 2] Figure 2 is a side view of the loading and unloading system of Figure 1;

[Fig 3] Figure 3 is a rear view of the loading and unloading system of Figure 1;

[Fig 4] Figure 4 is a top view of the loading and unloading system detail of of Figure 2;

[Fig 5] Figure 5 is a view analogous to Figure 1, in an inactive position;

[Fig 6] Figure 6 is a view analogous to Figure 1 of a second transfer installation according to the invention comprising another fluid loading and unloading system;

[Fig. 7] Figure 7 is a view analogous to Figure 1 of a third transfer installation according to the invention comprising another fluid loading and unloading system;

[Fig. 8] Figure 8 is a view analogous to Figure 1 of a fourth transfer installation according to the invention comprising another fluid loading and unloading system;

[Fig. 9] is a view similar to Figure 1 of a fifth transfer installation according to the invention comprising another fluid loading and unloading system;

[Fig 10] Figure 10 is a view analogous to Figure 3 of the fifth transfer installation according to the invention;

[Fig 11] Figure 11 is a view analogous to Figure 5 of the fifth transfer installation according to the invention;

5 [Fig 12] Figure 12 is a view analogous to Figure 1, of a variant of Figure 1.

A first installation 10 for transferring fluid into a body of water 12 is illustrated schematically in Figures 1 to 5.

The fluid consists of liquefied hydrocarbons, for example, such as liquefied natural gas (LNG), liquefied petroleum gas (LPG). The fluid here has a temperature below 0° C, in particular between -163° C and -30° C.

The installation 10 is designed to be operated in a shallow body of water 12, with a depth of between 5 m and 70 m for example. Variants, including the one shown in Figures 9 and 10, can accommodate depths of up to 500 m and beyond.

With reference to Figure 1, the installation 10 comprises a fluid transport structure 14, floating on the body of water 12, a fluid receiving structure 16, located on land or floating, and a fluid transfer system 18 according to the invention, designed to connect the floating transport structure 14 on the body of water 12 to the fluid receiving structure 16.

The floating transport structure 14 is a fluid transport vessel, for example, in particular for cryogenic fluid.

20 It comprises a hull 20, at least one fluid tank 22 carried by the hull 20, a manifold 24 for transferring fluid, and a plurality of unloading ports 26 projecting from the manifold 24.

The floating transport structure 14 further comprises at least one pipe handling device 27, preferably a crane or jib.

In this example, the manifold 24 is located laterally along an edge of the hull 20. The unloading ports 26 extend transversely in relation to a longitudinal axis of the hull 20, and each port 26 here has a flange 28 for connecting to a flexible connection pipe, which will be described further below.

With reference to Figure 2, each unloading port 26 is mounted on a deck 29, for example, that extends to the lateral edge of the hull 20. The deck 29 is provided on its lateral edge with a transverse saddle 29A for guiding the connecting flexible pipe.

30 As seen in Figure 1, the fluid receiving structure 16 is located onshore here, in the vicinity of the shore 30. It comprises at least one downstream fluid tank 32, possibly a regasification unit (not shown), and a repatriation assembly 34 of a transfer pipe, which will be described below. The repatriation assembly 34 is a drum or basket, for example.

In this example, the fluid transfer system 18 comprises a mooring structure 40 of the floating transport structure 14, such as a dolphin assembly, a reference and holding structure 42, located adjacent to the mooring structure 40, a transfer pipe 44 deployable from the fluid receiving structure 16 to the reference structure 42, and an intermediate floating unit 46 removably mounted on the reference structure 42, between the reference structure 42 and the mooring structure 40.

The fluid transfer system 18 further comprises disconnectable rigid links 48 hinged between the intermediate floating unit 46 and the reference structure 42.

With reference to Figures 1 and 3, the mooring structure 40 comprises a plurality of mooring bollards 50, advantageously a buffer 52 mounted on each mooring bollard 50, and mooring lines 54 designed for connecting the hull 20 of the floating transport structure 14 to at least one mooring bollard 50.

The mooring bollards 50 are anchored here to the bottom of the water body 12. They project vertically above the surface of the water body 12. In this example, a plurality of mooring bollards 50 are aligned along a horizontal direction D to receive a lateral edge of the hull 20.

The buffers 52 are each suitable for being interposed between the edge of the hull 20 and the bollard 50. They are arranged at least partially above the surface of the body of water. The bollards 50 and the buffers 52 taken together form mooring and berthing dolphins, for example.

The lines 54 are able to put the hull 20 into contact with the buffers 52 of the bollards 50, transversely to the mooring direction D ("breast lines"). The mooring lines 54 are suitable for extending between the hull 20 and an end bollard 50 located beyond an axial end of the hull 20, for example, and thus immobilize the hull 20 longitudinally in relation to the mooring bollards 50 ("spring lines").

Thus, the floating transport structure 14 is suitable for navigating between a free position, located away from the mooring structure 40, and a moored position on the mooring structure 40, in which its lateral edge is arranged and is held supported against the buffers 52 of the bollards 50 by the mooring lines 54 and is held longitudinally in position by the mooring lines 54 located at its axial ends, for example.

In this example, the reference structure 42 comprises at least one reference bollard 60, preferably two reference bollards 60.

The reference bollards 60 are each anchored at the bottom of the body of water 14. They extend vertically to project partially beyond the surface of the body of water 12.

The reference bollards 60 are located between the mooring bollards 50 and the receiving structure 16, adjacent to the mooring structure 40.

In the example shown in Figures 1-5, the reference structure 42 has two reference bollards 60 located between two mooring bollards 50 parallel to the mooring direction D.

5        The transfer pipe 44 here is a cryogenic flexible pipe. It is floating or submerged. The transfer pipe 44 can be maneuvered between a retracted configuration in the repatriation assembly 34, visible in Figure 5, in which its free end 70 is located away from the reference structure 42 and in the vicinity of the receiving structure 16, and a deployed configuration across the body of water 12 between the receiving structure 16 and the  
10       reference structure 42, visible in Figure 1, in which the free end 70 is located in the vicinity of the reference structure 42.

The intermediate floating unit 46 is formed by a barge-type platform or by a semi-submersible platform or Single Point Anchor Reservoir (SPAR).

The intermediate floating unit 46 comprises a floating pontoon 80, a flexible pipe 82  
15       for connection to a unloading port 26 on the floating transport structure 14, and a pipe 84 for connecting the free end 70 of the transfer pipe 44 to a first end of the flexible pipe 82.

Advantageously, the floating unit 46 further comprises a support turret 88 for the connector 84 and a storage assembly 86 for the flexible pipe 82 when the flexible pipe 82 is not connected to the unloading port 26.

20       The floating pontoon 80 is small in size. For example, it has a horizontal surface, when projected in a horizontal plane, less than the surface of the hull 20. The horizontal surface of the floating pontoon 80 is generally less than 100 m<sup>2</sup>, comprised of between 36 m<sup>2</sup> (e.g. 7 m x 5.2 m) and 60 m<sup>2</sup> (e.g. 10 m x 6 m), for example. The pontoon 80 has no tank for the transferred fluid; it also has no ballast device.

25       With reference to Figure 2, the flexible connection pipe 82 is connected at a first end 90 to a downstream end of the connector 84. It has a second end 92 designed to be connected to the unloading port 26. The second end 92 here is provided with a flange 94 for connecting to the connection flange 28 of the unloading port 26.

The flexible connection pipe 82 is deployable between a resting configuration, received or coiled in the storage assembly 86, by means of the handling device 27, for  
30       example, and a connecting configuration, in which it extends advantageously in a chain-like manner between the intermediate floating unit 46 and a unloading port 26 on the hull 20.

Advantageously, the turret 88 sets the height for connecting the flexible connection pipe 82 on the side of the floating unit 46 so that it forms a catenary of suitable shape and  
35       length between the end connections 90 and 92, on the side of the floating transport structure

14. In particular, the support turret 88 is preferably of sufficient height so that the end 90 of the flexible connection pipe 82 does not touch the water during an emergency disconnection operation.

5 The connector 84 comprises a rigid section 96 extending in this example between the upper surface of the floating pontoon 80 and the top of the turret 88.

At its downstream end, the rigid section 96 is provided with a flange for connecting a quick disconnect and isolation device 98, of the Emergency Release System - Double Ball Valves + Emergency Release Coupler type (ERS - DBV + ERC), for example.

10 The quick disconnect and isolation device 98 enables the quick closure of the flexible pipe 82 and the rigid pipe 84 as well as the quick disconnection thereof, to allow for release of the floating transport structure 14, in complete safety and without significant dispersion of transfer fluid in the case of an emergency.

The free end 70 of the transfer pipe 44 is furthermore connected permanently to the upstream end flange 100 of the rigid section 96.

15 Thus, upon retraction of the transfer pipe 44, from the deployed configuration to the retracted configuration, the intermediate floating unit 46 is movable together with the free end 70 toward the receiving structure 16, from an operative position, suitable for loading or unloading when connected to the reference bollards 60, to an inoperative position, free from the reference bollards 60, in which it is located adjacent to the receiving structure 16.

20 In this example, the fluid transfer system 18 comprises at least one movable and disconnectable rigid link 48, preferably at least two movable and disconnectable rigid links 48 connecting each reference bollard 60 to the intermediate floating unit 46, in particular to the floating pontoon 80 of the floating unit 46.

25 Each rigid link 48 here is formed by a bar 102, hinged at a first end 104 to the reference bollard 60, and hinged at a second end 106 to the floating unit 46.

The bar 102 is rigid and non-deformable. It has a constant length between the floating unit 46 and each reference bollard 60.

30 The joint at each end 104, 106, allows at least one degree of rotational freedom between the end 104, 106, and the reference bollard 60 and the floating unit 46, respectively. Preferably, each joint allows two degrees of rotational freedom and is of the gimbal or ball joint or staggered-pin gimbal type.

Cross-linking structures 49 ensure the diagonalization of the assembly formed by the two links 48, in order to maintain the position of the assembly 42 in the horizontal plane.

Thus, the intermediate floating unit 46 is suitable for moving freely in height in relation to the reference bollard 60, independently of the height of the body of water 12 during tides, or for following the movements of the swell.

The intermediate floating unit 46 is also permanently devoid of any physical or mechanical connection with the floating transport structure 14 other than the flexible connection pipe 82. It thus evolves independently and completely uncoupled from the floating transport structure 14, even when the flexible pipe 82 connects the intermediate floating unit 46 to an unloading port 26 on the floating transport structure 14, given the flexibility of the pipe 82.

In an advantageous variant, the first end 104 of the bar 102 is further suitable for sliding vertically along the reference bollard 60, further providing a large amount of vertical deflection, particularly during tides.

In this case, the first end 104 comprises a ring engaged around the reference bollard 60, for example, the ring advantageously floating and provided with rollers for rolling on the reference bollard 60.

In the example shown in Figure 1, each bar 102 extends substantially perpendicular to the mooring direction D between a reference bollard 60 and the pontoon 80 of the intermediate floating unit 46.

In the variant shown in Figure 12, each bar 102 extends substantially parallel to the mooring direction D between a reference bollard 60 and the pontoon 80 of the intermediate floating unit 46. This alternative geometric arrangement facilitates the passage of the pontoon on its repatriation path towards the fluid receiving structure 16.

The intermediate floating unit 46 is thus held in position between the reference bollards 60 and the mooring bollards 50, in the vicinity of and facing the lateral edge of the hull 20, without connection to the hull 20.

As seen in particular in Figure 4, the support turret 88 is also provided with a saddle 108 for guiding the first end 90 of the flexible pipe 82. The flexible pipe 82 is thus guided at its ends 90, 92 by the respective saddles 29A and 108.

The operation of the installation 10 for unloading a fluid contained in the floating transport structure 14 will now be described, in the knowledge that the installation 10 may also be operated for loading the unit 14.

Initially, prior to the arrival of the floating transport structure 14, as shown in Figure 5, the intermediate floating unit 46 is stored adjacent to the receiving structure 16.

The fluid transport pipe 44 is partially retracted in the repatriation assembly 34. This keeps the transfer system 18 safe, especially in poor weather conditions.

When a floating transport structure 14 arrives, it moves into the docking position with its longitudinal axis parallel to the docking direction D. Its lateral edge rests against the buffers 52 of the mooring bollards 50 located along direction D.

5 The mooring lines 54 are put in place to keep the hull 20 supported laterally against the buffers 52 of the bollards 50 and correctly positioned, longitudinally to the direction D.

Alternatively, or in addition to the mooring lines 54, the floating unit may be held in position by a self-contained dynamic positioning system.

10 Simultaneously, before or after this docking operation, the intermediate floating unit 46 is moved toward the reference structure 42. The hinged disconnectable rigid links 48 are placed between the pontoon 80 of the intermediate floating unit 46 and the reference bollards 60.

15 The intermediate floating unit 46 is thus held in a horizontal position between the reference structure 42 and the mooring structure 50 in the vicinity of and facing the lateral edge of the hull 20 of the floating transport structure 14, without mechanical connection to the hull 20.

20 With the disconnectable rigid links 48 being hinged at the floating unit 46 and at the reference bollards 60, the intermediate floating unit 46 follows the movements of the body of water, resulting from swell and tide, for example, independently of the movements of the hull 20, while remaining indexed in a horizontal position, longitudinally and transversely, in relation to the reference structure 42.

Then, as shown in Figure 4, the handling device 27 grasps the second end 92 of the flexible pipe 82, and unwinds it away from the storage assembly 86 to lift it and bring it into the vicinity of the unloading port 26.

25 The flange 94 of the flexible pipe 82 is then connected to the connection flange 28 of the unloading port 26. Advantageously, the pipe 44 is permanently connected to the pipe 84 and this pipe 84 has been connected to the flexible pipe 82.

30 The unloading of fluid from a fluid tank 22 on the floating transport structure 14 to a downstream fluid tank 32 located in the receiving structure 16, on or near land, is then performed. The fluid flows through the flexible connection pipe 82, the quick disconnect and isolation device 98, the rigid section 96 of the connector 84, and then through the fluid transfer pipe 44.

In the event of an emergency, the emergency disconnect and isolation device 98 closes the flexible pipe 82 and the pipe 96 and disconnects the first end 90 of the flexible pipe 82, allowing rapid evacuation of the floating transport structure 14 away from the

reference structure 42, due to the lack of any connection between the hull 20 and the intermediate floating unit 46.

Upon completion of unloading, the flange 94 at the second end 92 of the flexible pipe 82 is disconnected from the connection flange 28 of the floating transport structure 14.

5 The handling device 27 returns the second end 92 to the storage assembly 86, enabling storage by coiling or winding the flexible pipe 82 in the storage assembly 86. In particular, the storage position facilitates access and handling of the flange 94.

The mooring lines 54 are released, and the floating transport structure 14 moves away from the mooring structure 40.

10 The disconnectable rigid links 48 are then released, and the intermediate floating unit 46 is returned to its inactive position toward the receiving structure 16, together with the winding of the fluid transfer pipe 44, without necessarily having to disconnect the free end 70 of the fluid transfer pipe 44.

With the transfer system 18 according to the invention, the intermediate floating unit 15 46 is very simple to handle and to install, and is held in position on a reference structure 42 that is completely independent of the floating transport structure 14, providing greater safety and simplicity of operation.

In addition, the fluid transfer system 18 can be made safe easily, particularly in the event of adverse weather conditions, by retracting the fluid transfer pipe 44 and bringing the 20 intermediate floating unit 46 into the vicinity of the receiving structure 16.

Because the intermediate floating unit 46 is lightweight and small in size, it is easily movable, while providing a very secure connection between each fluid tank 22 present on the floating transport structure 14 and the fluid transfer pipe 44 to a downstream fluid tank 32 on land.

25 A second installation 120 according to the invention is illustrated in Figure 6. The installation 120 differs from the installation 10 in that the reference bollards 60 are arranged on either side of the intermediate floating unit 46, parallel to the mooring direction D.

The bars 102 forming the hinged disconnectable rigid links 48 are arranged parallel to the mooring direction D. As before, they are hinged at their first end 104 to the reference 30 bollard 60 and at their second end 106 to an edge of the floating pontoon 80.

The operation of the second installation 120 is identical to that of the installation 10.

A third installation 130 according to the invention is illustrated in Figure 7. Unlike the installation 10 shown in Figure 1, the disconnectable rigid links 48 are formed here by cuffs 132 located on the sides of the intermediate floating unit 46. Each cuff 132 internally defines 35 a passage 134 for sliding the reference bollard 60.

Each cuff 132 comprises a bracket capable of moving between an open configuration, for inserting the reference bollard 60 into the passage 134 (see bottom left in Figure 7), and a closed configuration, for holding the intermediate floating unit 46 in a horizontal position in relation to the bollard 60.

5           Advantageously, rolling elements such as rollers are provided in the cuffs 132, to promote the cuff 132 sliding on the reference bollard 60. Sliding can also be provided by sliding materials.

          Thus, the floating pontoon 80 of the intermediate floating unit 46 is suitable for vertical sliding movement on the reference bollards 60 while being held in position by the  
10       cuffs 132.

          The operation of the third installation 130 is otherwise analogous to that of the second installation 120.

          A fourth installation 140 according to the invention is illustrated in Figure 8. Unlike the installation 10 shown in Figure 1 or the installation 120 shown in Figure 6, the reference  
15       structure 42 is formed here by certain elements of the mooring structure 40. Thus, two mooring bollards 50 located in the vicinity of the unloading ports 26 form reference bollards 60 for the attachment of the hinged disconnectable rigid links 48.

          Each bar 102 is thus attached at its first end 104 to a mooring bollard 50, forming a reference bollard 60 and, at its second end 106, to the floating pontoon 80 of the  
20       intermediate floating unit 46.

          In one advantageous embodiment, the first end 104 of the bar 102 is further suitable for sliding vertically along the reference bollard 60 to accommodate greater variations in the height of the body of water 12, due to tides, for example.

          The operation of the fourth installation 140 according to the invention is otherwise  
25       analogous to that of the first installation 10. In particular, the intermediate floating unit 46 remains attached exclusively to the reference bollards 60 without any mechanical connection to the floating transport structure 14 other than the flexible pipe 82.

          A sixth installation 150 according to the invention is illustrated in Figure 9. Unlike the first installation 10 according to the invention, the mooring structure 40 is formed by a  
30       floating structure 151 comprising an open-worked mesh 152 delimiting interior spaces 154 for water circulation opening into the body of water 12 and flexible pipes 156 for anchoring the floating structure 151 to the bottom of the body of water 12. This arrangement with the floating structure 151 makes it possible for much greater water depths to be accommodated than when using the bollards 50 for mooring the unit 14.

The floating structure 151 further comprises an assembly 158 for attaching mooring lines 54 of the floating transport structure 14 to the mesh 152 of the supporting structure 151.

Preferably, the floating structure 151 is as described in EP 2 195 232. Advantageously, it comprises a ratio of the volume occupied by the interior spaces 154 to the volume occupied by the tubes forming the mesh 152, greater than 0.9 and preferably between 0.95 and 0.99.

With reference to Figures 9 and 10, the mesh 152 differs from that described in EP 2,195,232 in that it delimits an upper housing 160 for insertion of the intermediate removable floating unit 46.

The housing 160 opens laterally in relation to the docking direction D, at least on the side of the mesh 152 located opposite the receiving structure 16. The housing 160 further opens upwardly into the upper surface of the mesh 152.

As in the fourth installation 140 according to the invention, the reference structure 42 is located on the mooring structure 40. The mesh 152 thus delimits at least two vertical pillars 162 located on either side of the housing 160 on which the hinged disconnectable rigid links 48 are mounted.

In one embodiment, the vertical pillars are arranged on only one side of the intermediate removable floating unit 46, as in the installation 10.

Advantageously, the first end 104 of each bar 102 forming a link 48 is attached by being hinged on a pillar 162 and the second end 106 of the bar 102 is attached on one side of the floating pontoon 80 of the intermediate floating unit 46.

As before, due to the hinges present at the first end 104 and the second end 106, the movement of the intermediate floating unit 46 is independent of the movement of the floating transport structure 14 and that of the mesh 152.

The operation of the fifth installation 150 is otherwise similar to that of the first installation 10 except that the floating transport structure 14 is moored on the mesh 152 using the attachment assembly 158.

With reference to Figure 11, upon removal of the intermediate floating unit 46, the hinged disconnectable rigid links 48 are detached and the intermediate floating unit 46 is extracted from the housing 160 in the mesh 152 back to the receiving structure 16, as previously described.

## CLAIMS

1. A system (18) for loading and/or unloading fluid from a transport structure (14) floating in a body of water (12) to a fluid receiving structure (16) comprising at least one fluid tank (32), the loading and/or unloading system (18) comprising:

- a reference structure (42), anchored to the bottom of the body of water (12), the reference structure (42) being distinct from the floating transport structure (14);
- a fluid transfer pipe (44) for extending from the fluid receiving structure (16) towards the reference structure (42);
- an intermediate floating connection unit (46) comprising a pontoon (80), a flexible pipe (82) for connecting to a loading and/or unloading port on the floating transport structure (14), and a transfer connector (84) between the flexible connection pipe (82) and the fluid transfer pipe (44) characterized in that the loading and/or unloading system (18) comprises at least one rigid link (48) for mounting the intermediate floating unit (46) to the reference structure (42) allowing at least one degree of freedom between the intermediate floating unit (46) and the reference structure (42), the intermediate floating unit (46) being designed to be permanently uncoupled from the floating transport structure (14).

2. The system (18) according to claim 1, wherein the intermediate floating unit (46) is movable between a loading and/or unloading operational position, wherein the or each rigid link (48) connects the intermediate floating unit (46) to the reference structure (42) and an inactive securing position, in which the intermediate floating unit (46) is away from the reference structure (42), the or each rigid link being disconnected from the side of the intermediate floating unit (46) and/or the side of the reference structure (42).

3. The system (18) according to any of the preceding claims, comprising a mooring structure (40) of the floating transport structure (14), the reference structure (42) being separate from the mooring structure (40) or being formed by part of the mooring structure (40).

4. The system (18) according to any one of the preceding claims, wherein the rigid link (48) comprises a bar (102) hinged at a first end (104) on the reference structure (42) and at a second end (106) on the intermediate floating unit (46).

5. The system (18) according to any one of claims 1 to 4, wherein the reference structure (42) comprises at least one bollard (60) or pillar (162), the or each rigid link (48) comprising a member engaged around the bollard (60) or pillar (162), movable along the

bollard (60) or pillar (162), the member engaged around the bollard (60) or pillar (162) advantageously being a cuff (132).

5       **6.**       The system (18) according to any one of the preceding claims, comprising at least two rigid links (48) each independently connecting the reference structure (42) to the intermediate floating unit (46).

10       **7.**       The system (18) according to any one of the preceding claims, characterized in that the reference structure (42) comprises at least one reference bollard (60) anchored at the bottom of the body of water (12), the rigid link (48) connecting the reference bollard (60) to the intermediate floating unit (46) with at least one degree of freedom between the reference bollard (60) and the intermediate floating unit (46).

**8.**       The system (18) according to any one of claims 1 to 6, wherein the reference structure (42) comprises an open-worked mesh (152) partially submerged in the body of water (12), the open-worked mesh (152) being anchored to the bottom of the body of water (12).

15       **9.**       The system (18) according to claim 8, wherein the open-worked mesh (152) defines at least one housing (160) for receiving the intermediate floating unit (46), the intermediate floating unit (46) being able to be inserted into the housing (160) in a loading and/or unloading operational position.

20       **10.**      The system (18) according to any one of the preceding claims, wherein the connector (84) of the intermediate floating unit (46) comprises a quick disconnect and isolation device (98).

25       **11.**      The system (18) according to any one of the preceding claims, wherein the intermediate floating unit (46) comprises a storage assembly (86) of the flexible connecting hose (82) suitable for allowing deployment of the flexible connecting hose (82) from a storage configuration, received or coiled within the storage assembly (86), to a connection configuration, connected to the unloading port (26) on the floating transport structure (14).

**12.**      An installation (10; 120; 130; 140; 150) for transferring fluid comprising:  
       - a fluid transport structure (14) floating in the body of water (12);  
       - a fluid receiving structure (16), comprising at least one fluid tank (32); and  
       - a loading and/or unloading system (18) according to any of the preceding claims, the fluid transfer pipe (44) connecting the fluid tank (32) to the connector of the intermediate floating unit (46), the flexible connection pipe (82) connecting an unloading port (26) on the floating transport structure (18) to the intermediate connector (84).

35       **13.**      The installation (10; 120; 130; 140; 150) according to claim 12, wherein the intermediate floating unit (46) is movable between a loading and/or unloading operational

position with the or each rigid link (48) connecting the reference structure (42) to the intermediate floating unit (46) and a securing inactive position, in which the intermediate floating unit (46) is away from the reference structure (42), the or each rigid link being disconnected on the side of the intermediate floating unit (46) and/or on the side of the reference structure (42), the fluid transfer pipe (44) being a flexible pipe, the receiving structure (16) comprising at least one assembly (34) for repatriation of the fluid transfer pipe (44), to jointly return the fluid transfer pipe (44) and the intermediate floating unit (46) to the vicinity of the receiving structure (16).

**14.** The installation (10; 120; 130; 140; 150) according to claim 12 or 13, wherein the receiving structure (16) is a floating unit or is on land.

**15.** A method for loading or/and unloading fluid comprising the following steps:

- providing a loading or/and unloading system (18) according to any of claims 1 to 11 in a body of water (12);
- bringing a floating transport structure (14) into the vicinity of the reference structure (42);
- advantageously mooring the floating transport structure (14);
- connecting the flexible connection pipe (82) to a unloading port (26) on the floating transport structure (14);
- loading or unloading fluid through the flexible pipe (82), the transfer connector (84) and the fluid transfer pipe (44) from the floating transport structure (14) to the fluid tank (32);
- upon loading or unloading, relative movement of the intermediate floating unit (46) in relation to the reference structure (42) and in relation to the floating transport structure (14).

**16.** The method according to claim 15 comprising:

- unmounting the or each rigid link (48) mounting the intermediate floating unit (46) on the reference structure (42); and
- moving the intermediate floating unit (46) to an inactive position away from the reference structure (42).