

AN OFFSHORE STORAGE FACILITY

Field of Invention

The present invention relates to a system and method for storing
5 matter in an offshore storage facility. In particular, this system and method
is suitable for, but not limited to, storing liquid such as crude oil in an
offshore environment.

Background Art

The following discussion of the background to the invention is
10 intended to facilitate an understanding of the present invention only. It
should be appreciated that the discussion is not an acknowledgement or
admission that any of the material referred to was published, known or
part of the common general knowledge of the person skilled in the art in
any jurisdiction as at the priority date of the invention.

15 Storing crude oil after production in an offshore environment is
typically a time-consuming, risky, complex and costly affair. The difficulties
in the storage process and/or operation is further exacerbated by the
unpredictable environmental conditions, giving rise to additional
operational and safety concerns. Floating facilities such as Floating
20 Storage and Offloading vessels (FSOs) are prominently used worldwide
for oil storage during production. While FSOs are widely used as a reliable
solution for storing crude oil in offshore fields, they are associated with
several issues which include but are not limited to:

- The design and construction of an FSO is complex, costly and
25 a time-consuming affair.
- FSOs use expensive and complex mooring system to
maintain its position under varying environmental conditions.
- The tanks of FSOs to store oil are complex.

- FSOs being a manned facilities, involve heavy maintenance costs and high operating expenses.
- FSOs are exposed to high fatigue rates because they are not specifically built for frequent loading and unloading of oil which results in frequently changing bending moments and shear force.
- Unequal loading of the tanks in FSOs exposes the structures of FSOs to unequal hydraulic pressure, thereby exacerbating the fatigue experienced by FSOs.
- Unpredictable environmental loads further aggravate the problem and increases the likelihood of high fatigue and associated failure.

Other than FSOs, subsea storage facilities are also used to store crude oil in offshore fields. Examples of such facilities include the MOPUstor tank and the Subsea Storage Tank of Atkins Engineering. Generally, they are installable on the sea-bed and due to developments in the design of such facilities, they can be built, installed and operated successfully. However, such subsea storage facilities also have some significant limitations which include but are not limited to:

- They have a very complex design, especially due to the high pressure differential acting on the structure near the sea-bed.
- Such complexities lead to a time-consuming construction process and high cost.
- Installation of such facilities requires construction vessels and involves huge cost.
- Such facilities have not only high design and construction cost but also high maintenance cost.

- Usually such facilities require piling to provide the additional grounding support to the facility, where such piling can create fatigue problems.
- The decommissioning process of such facilities is complex and expensive.
- Such facilities are difficult to inspect and repair because of the subsea environment.

Therefore, there exists a need for a better solution to ameliorate the aforementioned problems.

10 Summary of the Invention

The present invention seeks to address and/or ameliorate the problems in the prior art by providing a solution for storing matter in an offshore facility, which may be adapted for use with gas, liquid or solid. In particular, the offshore facility is suitable for storage of crude oil.

- 15 The offshore facility of the present invention is robust, easy to fabricate and install, safe and economical to build and operate. It is also easy to relocate and has a longer operational life with less maintenance because the structure of the offshore storage facility of the present invention experiences minimal fatigue rates. Further, the offshore facility
- 20 is easier to mobilize and operate as compared to other existing offshore storage facilities. It can be operated unmanned. Hence, its affordability and safety are drastically improved.

- 25 In accordance with a first aspect of the present invention, there is an offshore storage facility having an elongate structure having at least one storage compartment; a buoyant first portion; and a second portion comprising an end portion, the second portion operable to be submerged in a water body, where in operation, the end portion rests on a natural surface in the water body and the offshore storage facility pivots about the natural surface on which the end portion rests. The offshore storage

30 facility of the present invention will act like a roly-poly toy in water which restores its original position when pushed over. The roly-poly nature of the offshore storage facility offers lesser resistance to the environmental load and experiences substantially reduced fatigue.

Preferably, the elongate structure comprises an inner wall and an
35 outer wall. Preferably, the inner wall and outer wall define at least one chamber therebetween for containing at the buoyant first portion, a first matter which has lower density compared to the water body. More preferably, the inner wall and outer wall define at least one chamber for containing at the second portion, a second matter which has substantially
40 equal or higher density compared to the water body.

Preferably, the buoyant first portion comprises at least one buoyancy means around a portion of the periphery of the elongate structure. More preferably, the buoyancy means is movable along the longitudinal axis of the elongate structure.

45 Preferably, the end portion is tapered. More preferably, the second portion comprises a flange extending radially with respect to an exterior circumferential surface of the end portion. Even more preferably, the end portion is rounded.

Preferably, the second portion comprises a positioning system
50 adapted to minimize movement of the offshore storage facility along the surface. More preferably, the positioning system comprises one or more of the following: a suction pile, an anchor and a ballast.

Preferably, the offshore storage facility comprises an anti-rotation means for engaging the surface to minimize rotation of the elongate
55 structure. More preferably, the anti-rotation means comprises at least one protrusion extending from the end portion. Even more preferably, the protrusion comprises at least one plate wherein the normal of the plate is aligned substantially perpendicular to the longitudinal axis of the elongate structure.

60 Preferably, the offshore storage facility comprising a helical strake on the outer surface of the elongate structure.

 Preferably, the buoyant first portion comprises at least one attachment adapted to moor at least one floatable structure.

 In accordance with a second aspect of the present invention, there
65 is a method for installing an offshore storage facility in a water body, the method comprising the steps of: providing an offshore storage facility according to the first aspect of the present invention at an offshore installation site; weighting the second portion of the elongate structure to cause the end portion to rest on a surface in the water body; and pivoting
70 the offshore storage facility about the surface on which the end portion rests.

 Preferably, the method further comprises the step of providing at least one buoyancy means around a portion of the periphery of the elongate structure.

75 Preferably, the step of weighting the end portion comprises ballasting said portion with a ballast which has a higher density compared to the water surrounding the offshore storage facility.

 Preferably, the method further comprises the step of positioning the end portion on the surface to minimize movement of the offshore storage
80 facility along the surface.

 Preferably, the method further comprises engaging the end portion to the surface to minimize rotation of the elongate structure.

 Preferably, the method further comprises the step of mooring at least one floatable structure to the buoyant first portion.

85 In accordance with a third aspect of the present invention, there is a method for loading and unloading oil in an offshore storage facility according to the first aspect of the present invention located in a water body, the method comprising the steps of: filling the storage compartment of the elongate structure with water, the storage compartment adapted to

90 be in fluid communication with the water surrounding the offshore storage facility via an outlet; loading the storage compartment with oil to cause the water in the storage compartment to be displaced out to the water body surrounding the offshore storage facility via the outlet; and unloading the oil from the storage compartment to cause water surrounding the offshore storage facility to enter the storage compartment via the outlet.

Preferably, the method further comprises the step of separating the oil and water with an intermediate membrane in the storage compartment.

Preferably, the method further comprises the step of separating oil from an oil-water mixture with a coalescer.

100 Other aspects of the invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

Brief Description of the Drawings

105 The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates an embodiment of an offshore storage facility of the present invention.

110 Figures 2a provides a side view of an embodiment of an offshore storage facility of the present invention. Figure 2b provides a perspective view of an embodiment of an offshore storage facility of the present invention. Figure 2c provides a view from A in Figure 2a of an embodiment of an offshore storage facility of the present invention. Figure 2d provides a view from B in Figure 2a of an embodiment of an offshore storage facility of the present invention.

115 Figure 3 illustrates another embodiment of an offshore storage facility of the present invention.

Figures 4a and 4b show the installation phases of another embodiment of an offshore storage facility of the present invention.

Figure 5 illustrates an embodiment of another embodiment of an offshore storage facility of the present invention.

5 Figures 6a to 6c show illustration phases of another embodiment of an offshore storage facility of the present invention.

Figure 7 provides a cross-sectional view of another embodiment of an offshore storage facility of the present invention.

10 Figure 8 provides a perspective view of another embodiment of an offshore storage facility of the present invention.

Figure 9 provides a side view of an embodiment of an offshore storage facility of the present invention.

Figure 10 provides a sectional view of an embodiment of an offshore storage facility of the present invention.

15 **Description of Embodiments of the Invention**

Particular embodiments of the present invention will now be described with reference to the accompany drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Other
20 definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one or ordinary skill in the art to which this invention belongs. Where possible,
25 the same reference numerals are used throughout the figures for clarity and consistency.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising, will

be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Furthermore, throughout the specification, unless the context requires otherwise, the word "include" or variations such as "includes" or
5 "including" will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers. Additionally, the "longitudinal" direction is defined as the direction that is substantially parallel to the length of the elongated structure 10.

The terms "vertical" and "horizontal" used throughout the
10 specification will have ordinary meaning in the art and will be understood by a skilled person to refer to the orientation of the longitudinal axis of an elongate object or structure with respect to the vector direction of gravity. For example, vertical means that the longitudinal axis of the elongate object or structure is parallel to the vector direction of gravity and
15 horizontal means that the longitudinal axis of the elongated object is perpendicular to the direction of gravity. For the avoidance of doubt, Figure 4b shows that the elongate structure 11 is substantially vertical.

The terms "pressure" used throughout the specification will have ordinary meaning in the art and includes, but not limited to, hydrostatic
20 pressure.

The terms "top" and "bottom" used throughout the specification will have ordinary meaning in the art and will be understood by a skilled person to refer to how far an article is placed with respect to a ground level, for example, an article is located at the bottom if it is closer to a
25 ground level compared to an article located at the top. For the avoidance of doubt, Figure 4b shows the first portion 12 being located on top of the second portion 13.

In accordance with an embodiment of the invention as shown in Figures 1 and 2, there is an offshore storage facility 10 for storage of

matter, in particular crude oil or other liquids that may or may not mix with water. The term "matter" used throughout the specification refers to fluids and solids, where "fluids" used throughout the specification refers to liquids and gases. The offshore storage facility 10 comprises an elongate structure 11 having a buoyant first portion 12 and a second portion 13 adaptable to be submerged into a water body such as the sea or ocean. The elongate structure 11 may be constructed from material known in the art, which include but is not limited to steel. The elongate structure 11 is preferably a unitary structure. The elongate structure 11 is adapted to buoy in water 50 (e.g. sea water) with its second portion 13 having an end portion 13a adapted to rest on and pivotable/pivotal about a surface 70 in the water body. It will be appreciated that when the end portion 13a rests on a surface 70 in the water body, part of the second portion 13 may sink into the surface 70 due to the weight of the offshore storage facility 10, such that the end portion 13a is located below the surface level of surface 70 when in operation. Preferably, the end portion 13a does not engage the surface 70 when it rests on the surface 70, such that the resting on surface 70 will allow the end portion 13a to be pivotable about the surface 70. The surface 70 is preferably a ground surface. More preferably, the surface 70 is a sea floor. The first and/or second portions 12, 13 are preferably sealed.

The elongate structure 11 comprises an outer wall (hull) 15a and an inner wall (hull) 15b. The outer wall 15a gives the elongate structure 11 its general shape, where the elongate structure 11 can have a general circular (i.e. cylindrical structure) or general polygonal cross section. The inner wall 15b can have the same or a different cross sectional shape compared to the outer wall 15a. The outer and inner walls 15a, 15b may be concentric to one another. The outer and inner walls 15a, 15b may be stiffened to bear any necessary environmental and structural loads. The

inner wall 15b defines a storage compartment 14 for storing any liquids, gases and/or solids. Preferably, storage compartment 14 is adapted to store hydrocarbons and more preferably oil. The storage compartment 14 is preferably an enclosed structure where liquid, gas and/or solid can only enter and/or exit the storage compartment 14 via at least one suitable inlet and/or outlet 19a. The storage compartment 14 may be further stiffened from within to bear the necessary environmental and structural load. Depending on the application, there may be one or more storage compartments 14. Preferably, the storage compartment 14 is a single compartment. As a single compartment, the storage compartment 14 can store two liquids which are immiscible to one another. In Figure 1, the storage compartment 14 can store oil 60 and water 52. Storage compartment 14 can comprise an intermediate membrane (now shown) that is operable to separate two liquids. The intermediate membrane can slide up and down a longitudinal axis of the elongate structure 11, depending on the quantity of the liquids stored in the storage compartment 14. Such an arrangement or configuration is suitable for the storage of liquids which should not be mixed together, for example diesel and water. It will be appreciated that the intermediate membrane may be made from any suitable material in the art, which include but are not limited to metals and polymers. Depending on application, the intermediate membrane may or may not be flexible.

The outer wall 15a and inner wall 15b defines at least one chamber 16 therebetween. The inner wall 15b and accordingly the chamber 16 extend substantially along the entire length of the elongate structure 11. The chamber 16 is preferably sealable and can contain matter (i.e. liquids, gases or solids). The liquids, gases or solids may enter and exit chamber 16 via a suitable inlet and outlet 19a and pipings (not shown). An upper portion of the chamber 16 around the first portion 12 is suitable to

comprise matter (for example air) having a lower density compared to matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation. A lower portion of chamber 16 around the second portion 13 is suitable to comprise matter

5 having a substantially equal or higher density compared to the matter (for example water and concrete) surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation. In Figure 1, the upper portion of chamber 16 preferably comprises air 16a and the lower portion of chamber 16 preferably

10 comprises water 16b. It would be appreciated that chamber 16 may be a plurality of chambers where the lower chambers can comprise matter having substantially equal or higher density compared to the matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation and upper chambers can

15 comprise matter having lower density compared to the matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation. The fact that the lower portion of chamber 16 or the lower chambers comprise matter having substantially equal or higher density compared to the matter surrounding the offshore

20 storage facility and in which the offshore storage facility 10 is submerged during operation, allows the second portion 13 and end portion 13a to easily sink and settle on surface 70. The fact that the upper portion of chamber 16 or the upper chambers comprise matter having lower density compared to the matter surrounding the offshore storage facility and in

25 which the offshore storage facility 10 is submerged during operation, allows the elongate structure 11, particularly buoyant first portion 12 to buoy up in for example water 50. Due to the buoying up of the first portion 12 and the sinking/settling of the second portion 13 and end portion 13a on a surface in a water body, the offshore storage facility 10 acts like a

roly-poly toy in the water body which restores its original position when pushed over. The first portion 12 offers minimal resistance to environmental loads. Accordingly, the roly-poly nature of the offshore storage facility 10 offers lesser resistance to the environmental load (for example from water currents 51) and the facility 10 does not need to be structurally heavy.

Depending on application and requirements, the elongate structure 11 may only comprise a chamber or chambers 16 at the first portion 12 and no chamber or chambers 16 at the second portion 13. In other words, the elongate structure 11 may have an outer wall 15a and inner wall 15b only at the first portion 12, and not at the second portion 13, where the walls 15a, 15b extend substantially from the end of the first portion 12 to a mid portion of the elongate structure. Vice versa, the elongate structure 11 may only comprise a chamber or chambers 16 at the second portion 13 and no chamber or chambers 16 at the first portion 12. Arrangement of the chamber 16 within the elongate structure 11 will be explained in more detail with reference to Figure 7.

In various embodiments, the elongate structure 11 does not comprise chambers 16. Depending on the application and requirements, the storage compartment 16 can comprise at the first portion 12, matter having lower density (for example air) compared to the matter surrounding the offshore storage facility and in which the offshore storage facility 10 is submerged during operation. Further the storage compartment 16 can comprise at the second portion 13, matter having substantially equal or higher density (for example water and oil) compared to the matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation. In various embodiments, the elongate structure 11 can be constructed such that the material at the first portion 12 of the elongate structure has a lower density

compared to the matter surrounding the offshore storage facility and in which the offshore storage facility 10 is submerged during operation, while the material at the second portion 13 of the elongate structure has substantially equal or higher density compared to the matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation. In such various embodiments, the first portion 12 buoys up while the second portion 13 sinks and submerges in, for example a water body, during operation. Due to the buoying up of the first portion 12 and the sinking/settling of the second portion 13 and end portion 13a on a surface in a water body, the offshore storage facility 10 acts like a roly-poly toy in the water body which restores its original position when pushed over.

The offshore storage facility 10 stores matter, particularly fluids, in a way that the pressure differential acting against the outer surface of the elongate structure 11 is low all along its length from the bottom to the top. Due to lower pressure differential, the need of heavy structural reinforcements is eliminated and hence the offshore storage facility 10 is lighter as compared to the existing subsea storage facilities.

When in operation, the offshore storage facility 10 stores matter, preferably oil in a storage compartment 14 that spans from the bottom (high pressure) to the top (low pressure) of the elongate structure 11. Therefore the "effective" or integrated pressure differential acting against the outer surface of the elongate structure 11 along the longitudinal axis is comparatively lower for an equivalent storage volume. Further, as the stored matter (e.g. oil) is removed from the first portion 12 where the pressure differential is the smallest, frequent loading and unloading of stored matter would induce smaller cyclical change in bending moment and shear force. Accordingly, the offshore storage facility 10 experiences substantially reduced fatigue or practically no fatigue, and can be

structurally lighter than existing subsea storage facilities, e.g. the MOPUstor tank. Experiencing substantially reduced fatigue or practically no fatigue allows reduced maintenance and increases ease of operation of the offshore storage facility 10. The offshore storage facility 10 may be
5 operated unmanned.

The offshore storage facility 10 comprises a weight 18 located at the second portion 13 of the elongate structure 11. Weight 18 may be a solid or liquid ballast. Weight 18 may be separate from or be integral with elongate structure 11. The weight 18 aids in the settling of the second
10 portion 13 and end portion 13a onto surface 70 by providing a suitable downward force, and contributes to the roly-poly nature of the offshore facility 10 when in operation. Depending on application, the weight 18 will function as the main ballasting component to cause the submerging of the end portion 13a into the water 50 and resting of the end portion 13a on
15 the surface 70. The elongate structure 11 may have suitable pipings (not shown) that load the weight 18 with a solid (for example concrete, and iron ore pellets) or a liquid (for example water) that is substantially equal or higher density compared to the matter surrounding the offshore storage facility and in which the offshore storage facility 10 is submerged during
20 operation. In some embodiments, the weight 18 may be pre-loaded before installation of the offshore storage facility 10. The end portion 13a can be flat or shaped. A shaped end, such as a tapered or rounded end, is advantageous over a flat end because a high cyclical overturning moment generated by environmental load may result in fatigue on one or more
25 edges of a flat end. Preferably, the end portion 13a is tapered and more preferably, substantially rounded. A substantially rounded end portion 13a reduces the likelihood of one or more edges of the end portion 13a getting fatigued. Additionally, a substantially rounded end permits free movement of the elongate structure 11 about a pivot point on the surface 70, to which

the end portion 13a rests. The free movement of the elongate structure 11 refers to lateral movement along a principal axis (not shown) of the elongate structure 11, i.e. the two perpendicular axes passing through the pivot point and parallel to the sea floor chosen arbitrarily (also known as
5 Pitch and Roll axes). The free movement can also be any lateral movement that can be described vectorially by the two principal axes. Such movements are analogous to that of a joystick in which the fixed bottom end of the joystick acts as a pivot point for the free movement of the top end.

10 The offshore storage facility 10 can include suitable pipings for pumping fluids into and out of storage compartment 14 and/or chamber 16. The pipings for moving fluids into and out of storage compartment 14 are shown in Figure 10. The offshore storage facility 10 can comprise a deck 19 at the end of the first portion 12 of the elongate structure 11. Deck
15 19 can comprise the one or more inlet 19a, outlets 19a and pipes for pumping fluids into and out of storage compartment 14 and/or chamber 16. The deck 19 may be modular in nature which allows it to be used for different purposes depending on application, for example, it can be used as a drilling platform or support an accommodation facility. Preferably,
20 there will not be any production, accommodation or drilling facilities on deck 19. Deck 19 may have suitable attachments for securing of floatable structures to offshore storage facility 10.

At least one anti-rotation means may be attached to the end portion 13a to minimize and/or prevent rotation of the elongate structure 11,
25 particularly about its longitudinal axis. In some embodiments, the anti-rotation means may be in the form of plates 20a, 20b extending from the end portion 13a (Figure 3). Plates 20a, 20b facilitate temporary anchorage of the elongate structure 11 to surface 70. The surfaces of plates 20a, 20b are arranged substantially perpendicular to one another to form a cross-

plate structure when viewed from a top or plan view. The cross-plate structure 20a, 20b may be attachable to (via for example suitable grooves and attachments) or be integrally moulded with the second portion 13 and end portion 13a. The cross-plate structure 20a, 20b may conform to a substantially rounded shape of the end portion 13a. In operation, the cross-plate structure 20a, 20b embeds into surface 70. The cross-plate structure 20a, 20b is shaped and sized to minimize and/or prevent rotational motion of the elongate structure 11, preferably about its longitudinal axis when the cross-plate structure 20a, 20b is embedded, or partially embedded in surface 70. Minimizing and/or preventing rotational motion is important to protect the integrity of external piping connections, i.e. risers as shown in Figure 10, between the production point and the elongate structure 11 and from the elongate structure 11 to the offloading point. Further, the cross-plate structure 20a, 20b helps to secure the position of the offshore storage facility 10 on surface 70 to minimize and/or prevent movement of the offshore storage facility 10 along the surface 70. The cross-plate structure 20a, 20b is also operable to function as a pivot point for the storage facility 10 to pivot therefrom, enabling the offshore storage facility 10 to move in a variety of directions about the pivot point when the cross-plate structure 20a, 20b is embedded, or partially embedded in surface 70. The overall shape of the cross-plate structure 20a, 20b is preferably round and when attached to the end portion 13a, preferably has a greater diameter than the end portion 13a and hence cover over the end portion 13a. It will be appreciated that the cross-plate structure 20a, 20b can be any other anti-rotation structure or mechanism so long as said structure or mechanism prevents the elongate structure from rotating, for example, the anti-rotation structure or mechanism can be protrusions extending from the end portion 13a which penetrate the surface 70, or the plates 20a, 20b may be arranged substantially parallel

to one another rather than form a cross-plate structure. It will also be appreciated that depending on application, end portion 13a may have more than one cross-plate structure 20a, 20b to facilitate temporary anchorage of the elongate structure 11 to surface 70.

5 In some embodiments, a positioning system (not shown) can be installed near the second portion 13 of the elongate structure 11 to secure the position of the offshore storage facility 10 at a particular site and minimize and/or prevent it from drifting and/or moving along the surface 70 due to forces from for example the water currents 51. Non-limiting
10 examples of a positioning system include but are not limited to the use of a gravity system or by self-weight, a ballast, e.g. an added heavy solid ballast, a suction pile, an anchor or an anchoring system. Such positioning system may be attachable via suitable attachment means to the second portion 13, end portion 13a and/or to the plates 20a, 20b.

15 In another embodiment in Figure 5, additional buoyancy means 122 (i.e. a float) may be attached to or integrated with the elongate structure 111 to aid in buoying the structure 111 in water 150, provide stability and to maintain it in a desired substantially vertical position. In an embodiment where the elongate structure 111 has no chamber, i.e. no inner wall, the
20 buoyancy means 122 will work as the main buoyancy means to cause the buoying of the structure, in particular the first portion 112, in water 150. Such buoyancy means 122 can be used in extreme environmental conditions. The buoyancy means 122 may be in the form of an incomplete annular structure of buoyancy chambers attachable to or integratable with
25 the elongate structure 11 around a portion of the periphery proximate the first portion 112. Depending on application, the buoyancy means 122 may be a complete annular ring of at least one buoyancy chamber or may comprise ballast tanks suitable for storing for example, air. Depending on application, the buoyancy means 112 may be pre-loaded with matter

having lower density compared to the matter surrounding the offshore storage facility before installation or may be loaded with such matter during installation. Depending on application, the buoyancy means 122 may be made to actuate along the longitudinal axis of the elongate structure 111 by a suitable mechanism.

The elongate structure 111 has one or more helical strakes 121 which are fitted at the outer surface of the elongate structure 111. The helical strake 121 runs from the bottom of the elongate structure 111 to the height close to the water-level. The objective of this structure is to reduce vortex induced vibrations due to the water currents.

In another embodiment as shown in Figure 7, the offshore storage facility 210 comprises an elongate structure 211 comprising an elongate structure 211 having a buoyant first portion 212 and a second portion 213 adaptable to be submerged into a water body such as the sea or ocean. The elongate structure 211 is adapted to buoy in water 250 (e.g. sea water) with its second portion 213 having an end portion 213a adapted to rest on and be pivotable about a surface 270 in the water body.

The elongate structure 211 comprises an outer wall (hull) 215a which gives the elongate structure 211 its general shape. The elongate structure 211 also comprises an inner wall (hull) 215b located at the first portion 212 and which extends substantially from the top end (i.e. near the deck 219) to a mid portion of the elongate structure 211. The inner wall 215b can have the same or a different cross sectional shape compared to the outer wall 215a. The outer and inner walls 215a, 215b may be concentric to one another. The outer and inner walls 215a, 215b may be stiffened to bear any necessary environmental and structural loads. The elongate structure 211 further comprises a storage compartment 214, defined by the inner and outer walls 215a, 215b, for storing any liquids, gases and/or solids. Preferably, storage compartment 214 is adapted to

store oil. The storage compartment 214 is preferably an enclosed structure where liquid, gas and/or solid can only enter and/or exit the storage compartment 214 via at least one suitable inlet and/or outlet 219a. The storage compartment 214 may be further stiffened from within to bear the necessary environmental and structural load. Depending on the application, there may be one or more storage compartments 214. Preferably, the storage compartment 214 is a single compartment. As a single compartment, the storage compartment 214 can store two liquids which are immiscible to one another.

10 The outer wall 215a and inner wall 215b defines at least one chamber 216 therebetween. The chamber 16 is preferably sealable and can contain matter (i.e. liquids, gases or solids). The liquids, gases or solids may enter and exit chamber 216 via a suitable inlet and outlet 219a and pipings (not shown). The chamber 216 located at the first portion 212, is suitable to comprise matter (for example air) having a lower density compared to matter surrounding the offshore storage facility 210 and in which the offshore storage facility 210 is submerged during operation. It would be appreciated that chamber 216 may be a plurality of chambers. The chamber 216 being located at the first portion 212 and operable to contain matter having lower density compared to the matter surrounding the offshore storage facility and in which the offshore storage facility 210 is submerged during operation, allows the elongate structure 211, particularly buoyant first portion 212 to buoy up in for example water 250. Filling (e.g. by pumping via inlets 219a and the pipes) the storage compartment 214 with a matter that is substantially equal or higher density compared to the matter surrounding the offshore storage facility and in which the offshore storage facility 10 is submerged during operation, will cause the second portion 213 to sink/settle into the water 250 and cause the end portion 213a to rest on and be pivotable about a surface 270. Due

to the buoying up of the first portion 212 and the sinking/settling of the second portion 213 and end portion 213a on a surface in a water body, the offshore storage facility 210 acts like a roly-poly toy in the water body which restores its original position when pushed over. The first portion 212
5 offers minimal resistance to environmental loads. Accordingly, the roly-poly nature of the offshore storage facility 210 offers lesser resistance to the environmental load and the facility 210 does not need to be structurally heavy.

It will be appreciated that in another embodiment, the chamber 216
10 can be located at the second portion 213 instead of the first portion 212, i.e. the elongate structure 211 comprises inner and outer walls 215a, 215b only at the second portion 213. In such embodiment, the chamber 216 is operable to be filled with a matter that is substantially equal or higher density compared to the matter surrounding the offshore storage facility
15 and in which the offshore storage facility 10 is submerged during operation. This will cause the second portion 213 to sink/settle into the water 250 and cause the end portion 213a to rest on and be pivotable about a surface 270. Matter having lower density compared to the matter surrounding the offshore storage facility and in which the offshore storage
20 facility 210 is submerged during operation, may be used to fill up the storage compartment 214 which would accumulate at the first portion 212 and cause the buoyant first portion 212 to buoy up in water 250.

The offshore storage facility 210 comprises a weight 218 located at the second portion 213 of the elongate structure 211. The weight 218 is
25 operable to contain solid or liquid ballast. The weight 218 aids in the settling of the second portion 213 and end portion 213a onto surface 270 by providing a suitable downward force, and contributes to the roly-poly nature of the offshore facility 210 when in operation. Depending on application, the weight 218 will function as the main ballasting component

to cause the submerging of the end portion 213a into the water 250 and resting of the end portion 213a on the surface 270.

The end portion 213a is substantially rounded to permit free movement of the elongate structure 211 about a pivot point on the surface 270, to which the end portion 213a rests. The end portion 213 further comprises a cross-plate structure 220 that provide temporary anchorage of the elongate structure 211 to the surface 270, to minimize and/or prevent rotation of the elongate structure 211, particularly about its longitudinal axis. The cross-plate structure 220 may be wholly embedded, or partially embedded in surface 270. The cross-plate structure 220 is also operable to function as a pivot point for the storage facility 210 to pivot therefrom, enabling the offshore storage facility 210 to move in a variety of directions about the pivot point when the cross-plate structure 220 is wholly embedded, or partially embedded in surface 70.

The offshore storage facility 210 has a deck 219 located at the end of the first portion 212. The deck 219 includes one or more inlet 219a, outlets 219a and pipes for pumping fluids into and out of storage compartment 14 and/or chamber 16. The elongate structure 211 further comprises at the first end portion 212 and about the exterior circumferential surface of the outer wall 215a. Scaffolding 219b can include suitable attachments for securing floatable structures (e.g. vessels) to offshore storage facility 210. Scaffolding 219b also provides for access to machinery and equipment for maintenance and/or regular operation, where such machinery and equipment are onboard deck 219. While scaffolding 219b is shown in Figure 7 to locate above the water level, it will be appreciated that scaffolding 219b can extend below the water level in operation, and can also extend substantially along the length of the elongate structure 211.

Figures 8 to 10 illustrate another embodiment of the present invention, where there is an offshore storage facility 310 comprising an elongate structure 311 comprising a buoyant first portion 312 and a second portion 313. In this embodiment, the buoyant first portion 312 is substantially submerged in the water body 350 when the offshore storage facility 310 is in operation, such that the end of the first portion 312 stays close to the water level 353, where the end of the first portion 312 may be above or below the water level 353. The end of the first portion 312 comprises suitable attachments 319c for securing and mooring floatable structures 380 (e.g. vessels) to offshore storage facility 310. The end of the first portion 312 also comprises a lattice structure 319d to provide a mounting and to locate a deck (platform) 319 above and a distance away from the water level 353. The deck 319 is provided with machinery and equipment, (e.g. pumps) located in a building 319e, for the operation of the offshore storage facility 310. The deck 319 also includes inlets and outlets (not shown) and pipes 319a' for moving/pumping fluids (e.g. water and oil) into and out of the storage chamber 314. Such inlets and outlets may also be used to move/pump matter, such as ballast, into and out of chambers 316. Building 319e protects the machinery, equipment, etc. from weather conditions. The lattice structure 319d keeps the machinery and equipment away from the water 350, so as to stay clear of waves, even in extreme conditions. The height of the lattice structure is preferably 15m to 20m. The offshore storage facility 311 also includes risers 323 for the collection of oil and/or gas from an offshore oil and/or gas field. The risers 323 may be fitted with suitable weights 324 for preventing the risers 323 from buoying up and being pulled away by currents.

The second portion 313 comprises an end portion 313a and a curved flange 318a that is radial to the exterior circumferential surface of end portion 313. The end portion 313a is a tapered end portion that

provides for easy penetration into surface 370. The tapered end portion 313a also provides for more accurate positioning of the offshore storage facility 310 at an offshore site. The curved flange 318a is an extension and part of weight 318, as shown in Figure 10. The base of flange 318 rests
5 on and is in contact with the surface 370 during operation. Having a large surface area in contact with the surface 370 during operation stabilizes the offshore storage facility 310 during operation, especially at offshore sites where the soil of surface 370, is soft. Flange 318a may be a continuous or discontinuous annular ring around the exterior
10 circumferential surface of the end portion 313. The shape of flange 318a may be configured based on for example, the soil conditions at an offshore site. Structural ribs 318b (as shown more clearly in Figure 11) strengthen the structure of flange 318a.

The second portion 313 also comprises inlets and outlets 317 and
15 pipings 317a' for the movement of water 352 into and out of storage compartment 314. Inlets and outlets 317 and pipings 317a' are configured to allow for water 352 to be pushed/pumped out to the surrounding water body 350 during loading of oil into the storage chamber 314 and to be sucked/pumped in from the surrounding water body 350 during offloading
20 of oil from the storage chamber 314. Pipings 319a' and 317a' are not connected. However, depending on application and requirements, pipings 319a' and 317a' may be connected together and part of a unitary pipe system. The second portion 313 further comprises a coalescer 340, as shown in Figure 11. The coalescer 340 separates the oil from the water-
25 oil mixture, such that oil 360 will not or will minimally escape from the offshore storage facility 310 when water 352 is pushed/pumped out to the surrounding water body 350.

The elongate structure 311 comprises chambers 316 formed from outer wall 315a and inner wall 315a. Chambers 316 are located

substantially at the first end portion 312, such that the second portion 313 is single-walled. The inner and outer walls 315a, 315b may be stiffened to bear any necessary environmental and structural loads. The elongate structure 311 comprises suitable inlets, outlets and pipings (not shown) that are separate from inlets and outlets 317 and pipings 317a', 319a', which pump matter into or out of chambers 316.

Installation and In Operation

Figures 4 and 6 illustrate the methods of installation of the offshore storage facility of the present invention. Referring to Figure 4, the offshore storage facility 10 has a pre-installation state (Figure 4a) and an installed or operative state (Figure 4b). In the pre-installation state, the longitudinal axis of the elongate structure 11 is inclined at an angle with respect to the water level 53. In this state, the longitudinal axis of the elongate structure 11 may also be in a substantially horizontal position and parallel to the water level 53. In the installed or operative state, the longitudinal axis of the elongate structure 11 is substantially vertical and perpendicular to the water level 53 or surface 70.

The offshore storage facility 10 can be transported to an offshore installation site using either wet tow and/or dry tow as known in the art. When disposed offshore in an ocean for example, the storage compartment 14 and/or chambers 16 of the elongate structure 11 is substantially empty so that part of the elongate structure 11 of the offshore storage facility 10 floats on water. In an inclined position, the second portion 13 can be substantially submerged and nearer to a surface 70 than the first portion 12, and the first portion 12 of the elongate structure 11 remains substantially above the sea level 53.

To commence installation at an installation site, matter denser than that surrounding the offshore storage facility 10 and in which the offshore

storage facility 10 is submerged during operation, e.g. water and/or ballast, is filled and/or pumped into the storage compartment 14 and/or chamber 16 via suitable inlets 19a and/or pipings. Where applicable and depending on application, weight 18 may at the same time be filled (if not
5 already filled) with a suitable solid or liquid ballast. Weight 18 and the filling of the storage compartment 14 and/or chamber 16 will weigh the second portion 13 and cause the elongate structure 11 to transit from an initial horizontal and/or substantially inclined position with respect to the sea level 53, to a more vertical position, where the second portion 13 and end
10 portion 13a sinks and descends towards the surface 70 and settles on it. As more water is pumped into the storage compartment 14 and/or chamber 16, the offshore storage facility 10 will cause the elongate structure 11 to descend further into surface 70 such that the plates 20a, 20b contacts, penetrates, cuts and embeds surface 70 (Figure 4b). Filling
15 of the storage compartment 14 and/or chamber 16 with a matter equal to or denser than that surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation, will cause the center of gravity of the elongate structure 11 to move substantially along its longitudinal axis towards the second portion 13,
20 such that when end portion 13a settles on surface 70, the elongate structure will be pivotable about end portion 13a. Chamber 16 may be partially left empty or matter, e.g. air, having a lower density compared to the matter surrounding the offshore storage facility 10 and in which the offshore storage facility 10 is submerged during operation, e.g. water 50,
25 may be pumped into chamber 16 to cause the first portion 12 to buoy up in water 50. Suitable positioning systems may be used to position the elongate structure 11 in position. Such positioning systems include but are not limited to the use of a gravity system or by self-weight, a ballast, e.g. an added heavy solid ballast, a suction pile, an anchor or an

anchoring system. Such positioning system may be attachable via suitable attachment means to the second portion 13, end portion 13a and/or to the plates 20a, 20b.

Figure 6 provides installation steps of another embodiment of the present invention, where a buoyancy means 122 may be used to assist the buoying of the first portion 112 in water 150.

In alternative embodiments, the installation may be performed during low tide or when the distance between the water level 153 and surface 170 is reduced. In such a situation, as the cross-plate structure 120a, 120b and end portion 113a approaches an area of the surface 170 from an angle with respect to the longitudinal axis where the elongate portion 111 is to be embedded to, the cross-plate structure 120a, 120b may start to cut into the surface 170 to facilitate embedment of the end portion 113a into the surface 170, and therefore the cross plate structure 120a, 120b touches the surface 170 before the longitudinal axis of the elongate structure 111 becomes substantially aligned with the vertical axis. In this case, the buoyancy means 122 may be moved along the substantial longitudinal axis of the elongate structure 111 towards the end portion 113a. Consequently, the longitudinal axis of the elongate structure 111 becomes substantially vertical by virtue of the turning moment exerted by the buoyant force from the buoyancy means 122 about the pivot near or at the end portion 113a of the elongate structure 111. Once installed in the configuration as shown in Figure 6c, the facility is ready for operation, in particular for the storage of crude oil.

During operation, oil or crude oil is pumped into the storage compartment, for example from inlet 119a at the first portion 112 of elongate structure 111. Any water in the storage compartment is displaced by the continuous pumping of oil into the storage compartment which can occur continuously and over a period of several days, whereby a

substantial volume of inner storage compartment becomes occupied by the oil. Preferably, oil 60 is stored above water 52. At any time, oil stored in the storage compartment can be offloaded to a shuttle tanker through a suitable offloading point. The offloading to the shuttle tanker (not shown) can be done on a periodic basis. Floatable structures such as shuttle tankers may be attached/moored to the offshore storage facility 10, 110, 210, 310 via suitable attachments (for example attachments 319c in Figure 8) located on the deck 19, 119, 219, 319 or at the first portion 12, 112, 212, 312. Therefore in operation, the offshore storage facility 10, 110, 210, 310 can act as a mooring facility for mooring floatable structures which include but are not limited to shuttle tankers. Depending on application, the floatable structures such as shuttle tankers can be moored or stationed at a separate mooring point during the offloading of oil 60 onto such floatable structures. Such mooring points include but are not limited to a Single-Point Mooring (SPM), which is a separate mooring buoy system that can be installed at a certain distance from the offshore storage facility 10, 110, 210, 310. Offloading of oil from the storage compartment will cause water from the surrounding water 50, 150, 250, 350 to enter the storage compartment. An intermediate membrane (not shown) may be provided in the storage compartment to separate two liquids which should not or cannot be mixed.

During operation, when the center of gravity of the elongate structure 11, 111, 211, 311 is displaced from a substantially vertical axis, the buoyant force exerted by the less dense matter in the chambers 16, 216 and/or the buoyancy means 122 is capable of exerting a restoring moment in the opposite direction of the displacement about the pivot at the end portion 13a, 113a, 213a. Analogously, the offshore storage facility 10, 110, 210, 310 acts like a roly-poly toy that restores its original position when pushed over. The roly-poly nature of the offshore storage facility 10,

110, 210, 310 offers lesser resistance to the environmental load (for example from currents 51). Further, it also prevents the elongate structure 11, 111, 211, 311 from extreme inclination under the influence of environmental loads or any kind of boat impact during accidents.

5 Plates 20a, 20b, 120a, 120b, 220 provide an anti-rotation mechanism when they penetrate surface 70, 170, 270. These plates are shaped and sized to minimize or prevent rotational motion of the elongate structure 11, 111, 211 particularly about its longitudinal axis when they are embedded, or partially embedded in surface 70, 170, 270. Minimizing
10 and/or preventing rotational motion is crucial to protect the integrity of external piping connections (not shown) between the production point and the elongate structure 11, 111, 211 and from the elongate structure 11, 111, 211 to the offloading point. Further, the plates 20a, 20b, 120a, 120b, 220 help to secure the position of the offshore storage facility 10, 110,
15 210 on surface 70, 170, 270 to minimize or prevent movement of the offshore storage facility 10, 110, 210 along the surface 70, 170, 270. The plates 20a, 20b, 120a, 120b, 220 are also operable to function as a pivot point for the storage facility 10, 110, 210 to pivot therefrom, enabling the offshore storage facility 10, 110, 210 to move in a variety of directions
20 about the pivot point when the plates 20a, 20b, 120a, 120b, 220 are embedded, or partially embedded in surface 70, 170, 270. It will be appreciated that the plates 20a, 20b, 120a, 120b, 220 can be any other anti-rotation structure or mechanism so long as said structure or mechanism prevents the elongate structure from rotating, for example, the
25 anti-rotation structure or mechanism can be protrusions extending from the second portion 13, 113, 213 and/or the end portion 13a, 113a, 213a, which penetrate the surface 70, 170, 270 or the plates 20a, 20b, 120a, 120b, 220 may be arranged substantially parallel to one another rather than form a cross-plate structure.

Buoyancy means 122 may be movable or actuatable in the substantial longitudinal direction during changing tidal conditions to provide the necessary buoyant force to keep the elongate structure 111 substantially vertical.

5 When in operation, offshore storage facility 10, 110, 210, 310 may be used to support any nearby offshore facilities, e.g. drilling platforms, production facilities and accommodation facilities, by providing storage capabilities.

During decommissioning, the steps in Figures 4 and 6 are reversed.

10 Firstly, the elongate structure 11, 111 is detached from the surface 70, 170 by any suitable means including, but not limiting to, water jets powered by compressed air located at the bottom of the elongate structure 11, 111. Subsequently, any matter in the storage compartment 14 and/or chamber 16 is removed or pumped out, preferably in a controlled manner.

15 The elongate structure 11, 111 will then start to float and the second portion 13, 113 and end portion 13a, 113a moves further away from the surface 70, 170. The elongate structure 11, 111 may at the same time become less vertical. As more matter is removed or gets pumped out of the storage compartment 14, the vertical inclination of the longitudinal axis

20 of the elongated structure 11, 111 reduces as the second portion 13, 113 and end portion 13a, 113a ascends towards the water level 53, 153 and away from the surface 70, 170 while the first portion 12, 112 remains substantially above the water level 53, 153. The first portion 12, 112 is kept substantially above the water level 53, 153 through the buoyant force

25 provided by the chamber 16 and/or buoyancy means 122. The longitudinal axis of the elongate structure 11, 111 may be inclined at an angle with respect to water level 153 with the second portion 13, 113 nearer to the surface 70, 170 than the first portion 12, 112. This inclination is a result of an unequal distribution of structural weight with the second portion 13, 113

heavier due to the additional weight of the weight 18 and/or cross-plate structure 20a, 20b, 120a, 120b.

The present invention offers several improvements over existing offshore storage solutions, which include but are not limited to the following:

- low cost solution.
- ability to operate in shallow water (50 m to 400 m),
- easy to build.
- easy installation due to self-installation capability and thus rules out the requirement of heavy construction and support vessels such as huge floating cranes,
- easy towing to the desired offshore site even by small vessels.
- easy decommissioning which is done through dewatering mechanism which is simple and highly cost-effective.
- fatigue free structure which offers less resistance to environmental loads as structure is pivoted at the bottom and free to move around the water surface.
- ability to take impact from incoming vessels in case of accidental collisions and still remain safe by virtue of the structure's flexibility at the contact point on the surface 70, 170.
- Possibility of unmanned operation.
- Low maintenance due to the substantially reduced or practically no fatigue experienced by the elongate structure 11, 111.

It will be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further

embodiments falling within the intended scope of the invention. In particular,

- 5 • Suction mechanisms such as, but not limited to, suction anchors, suction piles or suction buckets can be used to secure the second portion and/or end portion to the surface during operation.
- 10 • Removal mechanisms such as, but not limited to, water jets powered by compressed air can be used to facilitate removal of the second portion and/or end portion from surface during decommissioning.
- 15 • The topography of the surface may not be flat and hence additional mechanisms such as, but not limited to, mooring lines, anchors, pillars and suction piles may be required to stabilize the elongated structure.
- 20 • The offshore storage facility can act as a mooring point for tankers. Further, the offshore storage facility can be fitted with a rotating turntable or ring at the deck to allow the moored vessel to weather-wane.
- 25 • Heating coils may be fitted at appropriate locations to maintain a minimum temperature of the matter, e.g. oil stored in the storage compartment.
- The inlets and outlets for moving fluids into and out of the offshore storage facility may be located at any position on the offshore storage facility depending on application and requirements. The inlets and outlets for moving water into and out of the offshore storage facility during loading and offloading of oil, are preferably located at the second portion of the elongate structure.

- The inlets, outlets and pipings that move matter into and out of the storage compartment(s) and/or the chamber(s) may be part of separate pump systems or may form a unitary pump system, depending on application and requirements.

Claims

1. An offshore storage facility comprising an elongate structure having:
 at least one storage compartment;
 5 a buoyant first portion; and
 a second portion comprising an end portion, the second
 portion operable to be submerged in a water body,
 where in operation, the end portion rests on a natural surface in the water
 body and the offshore storage facility pivots about the natural surface on
 10 which the end portion rests.
2. The offshore storage facility of claim 1, wherein the elongate
 structure comprises an inner wall and an outer wall.
- 15 3. The offshore storage facility of claim 2, wherein the inner wall and
 outer wall define at least one chamber therebetween for containing at the
 buoyant first portion, a first matter which has lower density compared to
 the water body.
- 20 4. The offshore storage facility of claim 2 or 3, wherein the inner wall
 and outer wall define at least one chamber for containing at the second
 portion, a second matter which has substantially equal or higher density
 compared to the water body.
- 25 5. The offshore storage facility according to any one of the preceding
 claims, the buoyant first portion comprising at least one buoyancy means
 around a portion of the periphery of the elongate structure.

6. The offshore storage facility of claim 5, wherein the buoyancy means is movable along the longitudinal axis of the elongate structure.
7. The offshore storage facility according to any one of the preceding
5 claims, wherein the end portion is tapered.
8. The offshore storage facility according to claim 7, wherein the second portion comprises a flange extending radially with respect to an exterior circumferential surface of the end portion.
- 10
9. The offshore storage facility according to any one of the preceding claims, wherein the end portion is rounded.
- 15
10. The offshore storage facility according to any one of the preceding claims, the second portion comprising a positioning system adapted to minimize movement of the offshore storage facility along the surface.
- 20
11. The offshore storage facility of claim 10, wherein the positioning system comprises one or more of the following: a suction pile, an anchor and a ballast.
- 25
12. The offshore storage facility according to any one of the preceding claims, the offshore storage facility comprising an anti-rotation means for engaging the surface to minimize rotation of the elongate structure.
13. The offshore storage facility of claim 12, wherein the anti-rotation means comprises at least one protrusion extending from the end portion.

14. The offshore storage facility of claim 13, wherein the protrusion comprises at least one plate wherein the normal of the plate is aligned substantially perpendicular to the longitudinal axis of the elongate structure.
- 5
15. The offshore storage facility according to any one of the preceding claims, the offshore storage facility comprising a helical strake on the outer surface of the elongate structure.
- 10
16. The offshore storage facility according to any one of the preceding claims, the buoyant first portion comprising at least one attachment adapted to moor at least one floatable structure.
17. A method for installing an offshore storage facility in a water body,
- 15 the method comprising the steps of:
- Providing an offshore storage facility according to any one of claims 1 to 16 at an offshore installation site;
- Weighting the second portion of the elongate structure to cause the end portion to rest on a surface in the water body; and
- 20
- Pivoting the offshore storage facility about the surface on which the end portion rests.
18. The method of claim 17, the method further comprising the step of providing at least one buoyancy means around a portion of the periphery
- 25 of the elongate structure.
19. The method according to claim 17 or 18, wherein the step of weighting the second portion comprises ballasting said portion with a

ballast which has a higher density compared to the water surrounding the offshore storage facility.

20. The method according to any one of claims 17 to 19, the method
5 further comprising the step of positioning the end portion on the surface to minimize movement of the offshore storage facility along the surface.

21. The method according to any one of claims 17 to 20, the method
further comprising engaging the end portion to the surface to minimize
10 rotation of the elongate structure.

22. The method according to any one of claims 17 to 21, the method
further comprising the step of mooring at least one floatable structure to
the buoyant first portion.

15

23. A method for loading and unloading oil in an offshore storage facility
according to any one of claims 1 to 16 located in a water body, the method
comprising the steps of:

Filling the storage compartment of the elongate structure with water,
20 the storage compartment adapted to be in fluid communication with the
water surrounding the offshore storage facility via an outlet;

Loading the storage compartment with oil to cause the water in the
storage compartment to be displaced out to the water body surrounding
the offshore storage facility via the outlet; and

25 Unloading the oil from the storage compartment to cause water
surrounding the offshore storage facility to enter the storage compartment
via the outlet.

24. The method of claim 23, the method further comprising the step of separating the oil and water with an intermediate membrane in the storage compartment.
- 5 25. The method of claim 23 or 24, the method further comprising the step of separating oil from an oil-water mixture with a coalescer.