

A method of securing and transferring a load between a vessel and an offshore installation and an apparatus therefor

5 The present invention relates to a method of securing and transferring a load between a vessel and an offshore installation and an apparatus therefor. In particular, the present invention relates to transferring a load between a vessel and an offshore jack-up installation.

10 In the offshore industry operations are performed from specialised platforms or vessels, known colloquially as “rigs”. Multiple types of rig exist, such as fixed platforms, jack-ups, semi-submersibles, ships, barges and the like. The particular type of rig used can depend on a number of factors, such as water depth, rig availability, operational requirements and the like.

15 Offshore jack-up rigs can be used for different purposes. Some offshore jack-up rigs are used to drill and extract oil and gas. However, in order to reduce the dependence on limited fossil fuel resources around the world, there has been an increasing demand for renewable energy generation. One such source of renewable energy that has become increasingly reliable is wind energy
20 generation.

Typically, electricity is generated from the wind with wind turbine generators (WTG) installed in locations with a reliable prevailing wind. Some wind turbine generators have been installed on land in windy areas such as on hilltops. Wind
25 turbine generators installed on land are also known as “onshore” wind turbine generators. However, larger wind turbine generators can be installed in coastal waters. Wind turbine generators installed in coastal waters, the sea or deep ocean are also known as “offshore” wind turbine generators.

30 Accordingly, offshore jack-up rigs can be used for other offshore installations such as offshore WTGs. Offshore wind turbine generator installation is typically carried out in separate stages. One current method of installation is to anchor a foundation to the seabed using a monopile foundation. This is a steel and / or concrete tube which is fixed to and protrudes from the seabed. A transition

piece (TP) is fixed to the monopile foundation and the transition piece projects out of the water. The offshore wind turbine generator is then fixed to the transition piece.

- 5 One such jack-up rig for installing WTGs is disclosed in EP 2 886 722. This discloses a plurality of WTG components stored on the deck of the jack-up rig ready for installation at a designated offshore area. A problem with the jack-up rig is that the WTG components are loaded on the deck of the jack-up rig in port. When all the WTG components are installed, the jack-up rig must sail
10 back to port to be replenished with more WTG components. This reduces the amount of time that the jack-up rig can be used to install offshore WTGs in the designated offshore area.

- KR20170109094 shows a jack-up vessel with a detachable deck comprising
15 the WTG components. Once the jack-up vessel is in the designated offshore area, the legs extend and lift up a platform from the vessel using a rail system. A problem with this is that legs and platform require the jack-up vessel to move the legs and platforms between installation sites. Furthermore, when the vessel sails away from the legs, the vessel requires very calm weather in order not to
20 collide with the legs (e.g. due to heave, roll or sway of the vessel due to the waves).

- Alternatively, a jack-up rig can be supplied with WTG components via a supply vessel. One such supply vessel is shown in KR20180003214. A problem with
25 the supply vessel is that the transfer of the WTG components to the jack-up vessel can be difficult especially in bad weather. This means that the jack-up vessel cannot be resupplied until there is a suitably long calm weather window.

- Examples described hereinafter aim to address the aforementioned problems.
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According to an aspect of the present invention there is a method of securing a vessel with an offshore jack-up having a hull and a plurality of moveable legs engageable with the seafloor and the offshore jack-up is arranged to move the legs with respect to the hull to position the hull out of the water, wherein the

method comprises: moving at least a portion of the vessel underneath the hull of the offshore jack-up or within a cut-out of the hull when the hull is positioned out of the water and the legs engage the seafloor; engaging a stabilizing mechanism mounted on the offshore jack-up against the vessel; pushing the
5 stabilizing mechanism down on the vessel to increase the buoyant force acting on the vessel; and lifting a cargo from the vessel with a plurality of lifting arms mounted on the offshore jack-up after the stabilizing mechanism pushes down on the vessel.

10 Optionally, the stabilizing mechanism pushes against a deck of the vessel.

Optionally, the stabilizing mechanism includes a plurality of stabilizing arms.

Optionally, the vessel is substantially fixed with respect to the hull when
15 stabilizing mechanism pushes down on the vessel.

Optionally, the vessel is accessible from above when the vessel is within the cut-out.

20 Optionally, the offshore jack-up comprises a crane with a working area extending over the cut-out portion of the hull.

Optionally, the hull comprises at least one guide structure for laterally positioning the vessel underneath the hull or within the cut-out.
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Optionally, the at least one guide structure is a first guide structure and a second guide structure and the plurality of stabilizing arms are mounted along the first guide structure and the second guide structure.

30 Optionally, the hull comprises at least one stop structure for limiting an extent the vessel moves forward underneath the hull.

Optionally, the stabilizing mechanism is extendible underneath the hull.

Optionally, each of the stabilizing arms comprise a self-seating head for engaging in a reciprocal hole in a deck of the vessel.

5 Optionally, at least one pair of stabilizing arms engage the vessel on opposites sides of the centre of buoyancy of the vessel.

Optionally, the plurality of the stabilizing arms engage the vessel at substantially the same time.

10 Optionally, the cargo includes one or more of a wind turbine tower, a nacelle, wind turbine blades, a wind turbine generator component, equipment, personnel, supplies, a transition piece, a monopile, a jacket and / or any other components of an offshore wind turbine generator or wind turbine generator farm.

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Optionally, the method comprises placing the cargo on a deck of the vessel whilst the stabilizing mechanism pushes down on the vessel.

20 Optionally, the method comprises engaging a bow of the vessel with a moveable coupling mechanism mounted on the hull.

Optionally, the vessel is pivotable about the moveable coupling mechanism before the stabilizing mechanism engages the vessel.

25 Optionally, the vessel comprises a plurality of hulls.

30 In another aspect of the invention there is provided an offshore jack-up comprising: a hull; a plurality of moveable legs engageable with the seafloor, wherein the offshore jack-up is arranged to move the legs with respect to the hull to position the hull out of the water when the legs engage the seafloor; a stabilizing mechanism mounted on the offshore jack-up engageable with a vessel positioned underneath the hull of the offshore jack-up or within a cut-out in the hull when the hull is positioned out of the water; wherein when the stabilizing mechanism push down on the vessel, the buoyant force acting on

the vessel increases; and a plurality of lifting arms mounted on the offshore jack-up arranged to lift a cargo on the vessel after the stabilizing mechanism pushes down on the vessel.

- 5 In yet another aspect of the invention there is provided a method of securing a vessel with an offshore installation fixed to the seabed having an above-water structure, the method comprising: moving at least a portion of a vessel underneath the above-water structure of the offshore installation or within a cut-out of the above-water structure; engaging a stabilizing mechanism mounted
10 on the above-water structure on the vessel; and pushing the stabilizing mechanism down on the vessel to increase a buoyant force acting against the vessel lifting a cargo from the vessel with a plurality of lifting arms mounted on the offshore installation after the stabilizing mechanism pushes down on the vessel.

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Various other aspects and further examples are also described in the following detailed description and in the attached claims with reference to the accompanying drawings, in which:

- 20 Figure 1 shows a perspective view of an offshore jack-up according to an example;

Figure 2 shows a side view of an offshore jack-up with an unsecured vessel according to an example;

- 25 Figure 3 shows a side view of an offshore jack-up with a secured vessel according to an example;

Figure 4 shows a plan view of an offshore jack-up according to an example;

Figure 5 shows an underneath plan view of an offshore jack-up according to an example;

- 30 Figure 6 shows a plan view of an offshore jack-up with a secured vessel according to an example;

Figure 7 shows a front side view of an offshore jack-up with an unsecured vessel adjacent to the offshore jack-up according to an example;

Figure 8 shows a front side view of an offshore jack-up with a secured vessel according to an example;

Figure 9 shows another front side view of an offshore jack-up with a secured vessel according to an example;

Figure 10 shows a perspective view of a load carrying platform according to an example;

5 Figures 11a, 11b and 11c show a schematic side cross sectional view of part of a vessel and an offshore jack-up according to an example;

Figures 12 and 13 show a flow diagram of methods according to an example;

Figure 14 shows an underneath plan view of an offshore jack-up according to an example; and

10 Figure 15 shows a plan view of an offshore jack-up with a secured vessel according to an example.

Examples of the present disclosure relate to methods and apparatus for securing and transferring a load between a vessel and an offshore jack-up. In
15 some examples, any form of offshore installation and any form of vessel may be utilised. However, for the illustrative purposes only, the following description is provided with reference to an offshore jack-up such as a jack-up rig, a jack-up barge, a lifting vessel or a jack-up vessel.

20 Figure 1 shows a perspective view of an offshore jack-up 100 according to an example. The offshore jack-up 100 is a jack-up rig 100 and the term “jack-up” 100 will be used hereinafter. However, the methods and apparatus discussed below can be used with other offshore installations and other forms of jack-up equipment such as jack-up vessels or jack-up barges.

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The jack-up 100 comprises a hull 102 and a plurality of moveable legs 104a, 104b, 104c, 104d. In the example as shown in Figure 1, there are four moveable legs 104a, 104b, 104c, 104d, but in other examples there can be three moveable legs or more than four moveable legs. In some examples as
30 shown in Figure 1, the moveable legs 104a, 104b, 104c, 104d, are open truss legs, but in other examples the moveable legs 104a, 104b, 104c, 104d, are solid cylindrical legs.

The moveable legs 104a, 104b, 104c, 104d extend downwardly through the hull 102 via respective jacking mechanisms 106a, 106b, 106c, 106d. The jacking mechanisms 106a, 106b, 106c, 106d comprise a casing for protecting the jacking mechanisms 106a, 106b, 106c, 106d. The jacking mechanisms 106a, 106b, 106c, 106d, in some examples, are hydraulically operated rack and pinion mechanisms. The operation of a jack-up 100 is known and will not be discussed in further detail.

In Figure 1 the jack-up 100 is illustrated with the moveable 104a, 104b, 104c, 104d 14 in an extended position. When the moveable legs 104a, 104b, 104c, 104d are in the extended position, the moveable legs 104a, 104b, 104c, 104d extend down to and engage the seafloor 200. For the purposes of clarity, the seafloor 200 is not shown in Figure 1 and the moveable legs 104a, 104b, 104c, 104d are partially shown. The engagement of the moveable legs 104a, 104b, 104c, 104d with the seafloor 200 is better shown in e.g. Figures 2 and 3.

The moveable legs 104a, 104b, 104c, 104d are moveable between the extended position and a retracted position, such that the hull 102 may float on the surface 202 of a body of water 204, and may be transported to a desired location. In some examples, the jack-up 100 comprises one or more propulsors 210 such as an azimuthing thruster (as shown in Figure 2) for moving the jack-up 100 between WTG installation sites. In an example, the jack-up 100 comprises four azimuthing thrusters 210 in each corner of the hull 102 as shown in Figure 5. Alternatively, in some examples, the jack-up 100 does not comprise propulsors 210 and is towed when the jack-up 100 is moved. In some examples, the jack-up 100 is towed with a vessel between the port and the WTG installation site whether or not the jack-up 100 comprises propulsors 210.

Figure 1 shows the jack-up 100 in an operational configuration where the hull 102 has been raised above the surface 202 of the water 204. During operation of the jack-up 100, a crane 108 can lift loads for offshore operations. In some examples, the crane 108 is configured to lift one or more components of a wind turbine generator (WTG). The jack-up 100 as shown in Figure 1 is arranged to

install WTGs. In other examples, the jack-up 100 is arranged to install or maintain other offshore structures.

5 The jack-up 100 as shown in Figure 1 is positioned adjacent to a (transition piece) TP 118 of a WTG. The TP 118 is ready to receive one or more WTG components 220 such as the WTG tower 222, the WTG nacelle 224, and the WTG blades 226.

10 The crane 108 comprises a boom 110 which is resting on a boom rest 112. The boom 110 of the crane 108 is positioned on the boom rest 112 when the jack-up 100 is sailing between locations. The boom rest 112 is mounted on an accommodation block 114. In examples, there are additional accommodation blocks (not show) arranged on a deck 116 of the hull 102. The boom 110 is moveable to an operational position as shown in e.g. Figures 2 and 3 in order
15 to hoist loads. The crane 108 and the operation thereof is known and will not be described in further detail.

The hull 102 comprises a deck 116 for storing equipment for the offshore installation operation. In some examples, one or more WTG components 220
20 are stored on the deck 116. For the purposes of clarity, no WTG components 220 have been shown in Figure 1.

A problem with existing jack-up rigs which are used to install multiple WTGs in a designated area is that the jack-up rigs must sail back to port to be resupplied.
25 This means that the jack-up rig spends time sailing to port which could be used installing more WTGs. Examples described in this disclosure provide methods and apparatuses for resupplying the jack-up 100 without requiring the jack-up 100 to sail back to port.

30 Turning to Figure 2, the jack-up 100 will be described in further detail. Figure 2 shows a side view of the jack-up 100 with an unsecured vessel 206 according to an example.

The jack-up 100 as shown in Figure 2 is in an operational configuration. The moveable legs 104a, 104b are extended and feet 208a, 208b mounted on the moveable legs 104a, 104b are partially embedded in the soft seafloor 200. This means that the jack-up 100 is stable and able to lift heavy loads with the crane
5 108.

The vessel 206 comprises a barge 212 tethered to an anchor handling vessel 214. The anchor handling vessel 214 is arranged to transport the barge 212 into the vicinity of the jack-up 100. In some examples, the vessel 206 is a barge
10 212 which comprises propulsors (not shown) for moving the barge 212 under its own power and no anchor handling vessel 214 is required. In some examples the anchor handling vessel 214 is instead another powered vessel such as platform supply vessel (PSV), multipurpose support vessel (MSV) tug boats, ice breaker, patrol boat, coast guard vessel, navy vessel, fire-fighting
15 vessel, or any other suitable vessel for managing the movement the barge 212. The term "vessel" 206 is a powered barge 212, an unpowered barge 212, or a combination of a barge 212 and another powered vessel 214 such as an anchor handling vessel 214.

The barge 212 comprises a deck 216 for securing and transporting loads to the jack-up 100. As shown in Figure 2, a cargo load 218 is positioned on the deck 216. The cargo load 218 is one or more WTG components 220 for installing on the TP 118. Specifically, the WTG components 220 comprise one or more
20 towers 222, one or more nacelles 224 and one or more blades 226. In other examples, the cargo load 218 can be additionally or alternatively one or more
25 of equipment, personnel, and / or supplies for the jack-up 100. In other examples, the cargo load 218 can be additionally or alternatively one or more of a transition piece, a monopile, a jacket and / or any other components of an offshore wind turbine generator or wind turbine generator farm.

30 Optionally, the WTG components 220 are securely mounted to a cargo carrying platform 228 comprises a frame 230 for surrounding the cargo load 218. The cargo carrying platform 228 and the frame 230 will be discussed in further detail below. Figure 2 also shows another cargo carrying platform 232 with a similar

frame 230 which is empty and positioned on the deck 116 of the jack-up 100. In some examples, the deck 116 of the jack-up 100 has clear space for receiving one or more full or empty load carrying platforms 228, 232 on the deck 116 of the jack-up 100. In some examples, the load carrying platforms 228, 232 are received on the deck 116 between two of the moveable legs 104b, 104c.

In an example (not shown), the WTG components 220 are mounted directly on the barge deck 216. However, as shown in Figure 2, the cargo carrying platform 228 is secured to the deck 216 of the barge 212 with at least one securing mechanism (not shown). In some examples, the at least one securing mechanism can be a twistlock mechanism or a quick release clamp for selectively securing and releasing the cargo carrying platform 228 to the deck 216 of the barge 212. The at least one securing mechanism in some examples can be mounted on the cargo carrying platform 228.

As shown in Figure 2, the anchor handling vessel 214 is guiding the barge 212 towards the jack-up 100. In Figure 2, the barge 212 is not coupled to the jack-up 100. This means that the barge 212 and the anchor handling vessel 214 will move relative to the jack-up 100 due to the motion of the sea (e.g. heave, sway, surge, roll, pitch and / or yaw of the barge 212 and / or the anchor handling vessel 214).

This means that if the weather conditions are too rough, the barge 212 and the anchor handling vessel 214 cannot approach the jack-up 100. Once there is a suitably calm weather window, the barge 212 and the anchor handling vessel 214 move towards the jack-up 100.

Turning to Figure 3, the method of securing the barge 212 will be described in further detail. Figure 3 shows a side view of an offshore jack-up 100 with a secured vessel 206 e.g. the barge 212 according to an example.

At least a portion 300 of the barge 212 is moved underneath the hull 102 of the offshore jack-up 100 when the hull 102 is positioned out of the water 204 and

the moveable legs 104a, 104b engage the seafloor 200. The jack-up 100 is in the operational configuration and the hull 102 is above the surface 202 of the water 204. In this way, there is clearance between the bottom 302 of the hull 102 and the surface 202 of the water 204 for receiving the portion 300 of the
5 barge 212.

The hull 102 of the jack-up 100 may comprise at least one guide structure 304 for laterally positioning the portion 300 of the barge 212 underneath the hull 102 or within a cut-out 400 of the hull 102. The cut-out 400 is described in further
10 detail below. In some examples, there is a first lateral guide structure 304a and a second lateral guide structure 304b for limiting the lateral movement of the barge 212 with respect to the hull 102 or with respect to the cut-out 400. The first and second lateral guide structures 304a, 304b are best shown in Figure 5. In other examples, there is a single guide structure 304 mounted on the
15 underside of the hull 102 for guiding the barge 212.

This means that if the barge 212 is moving sideways with respect to the hull 102, for example due to currents, the first and second lateral guide structures 304a, 304b will prevent the barge 212 from colliding with the moveable legs
20 104a, 104b, 104c, 104d when the barge 212 is underneath the hull 102. In addition, the first and second lateral guide structures 304a, 304b limit the movement of the barge 212 with respect to the hull 102 and therefore this prevents the frame 230 and the WTG components 220 from colliding with the jack-up 100. The first and second lateral guide structures 304a, 304b extend
25 downwardly from the hull 102 and project towards the surface 202 of the water 204.

In an example, optionally the hull 102 of the jack-up 100 comprises at least one stop structure 306 for limiting the extent the barge 212 moves forward
30 underneath the hull 102. In another example, there are several stop structures 306 for limiting the extent the barge 212 moves forward underneath the hull 102. In another example, there is not a stop structure 306 and the anchor handling vessel 214 maintains the position of the barge 212 with respect to the jack-up 100 before the barge 212 is secured to the jack-up 100. Similarly, in

another example, there are no first and second lateral guide structures 304a, 304b and the anchor handling vessel 214 maintains the position of the barge 212 with respect to the jack-up 100.

- 5 The at least one stop structure 306 extends downwardly from the hull 102 and projects towards the surface 202 of the water 204. In some examples, the at least one stop structure 306 and the first and second lateral guide structures 304a, 304b comprise an open lattice structure. This allows the water 204 to flow through the at least one stop structure 306 and the first and second lateral
10 guide structures 304a, 304b and reduce the drag on the jack-up 100 when the jack-up 100 is being moved.

As shown in Figure 3, the crane 108 has hoisted the empty cargo carrying platform 232 and lowered the empty cargo carrying platform 232 on to the deck
15 216 of the barge 212. This means that the barge 212 can be used to supply loads 218 and retrieve empty load carrying platform 232. Accordingly, the jack-up 100 can be replenished more efficiently if the load carrying platforms 228, 232 are reused.

- 20 The jack-up 100 will now be described in further detail with respect to Figures 4 and 5. Figure 4 shows a plan view of an offshore jack-up 100 according to an example. Figure 5 shows an underneath plan view of an offshore jack-up 100 according to an example. For the purposes of clarity, Figures 4 and 5 are shown without the frame 230 or the WTG components 220.

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The hull 102 comprises a cut-out 400 at one end of the jack-up 100. In this way, a portion of the hull 102 comprises first arm 402 and a second arm 404 which project out and define the cut-out 400. The cut-out 400 is arranged to receive a portion of the barge 212 or the cargo carrying platform 228.

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This means the hull 102 comprises a cut-out portion 400 whereby the deck 216 of the barge 212 is accessible from above when at least a portion 300 of the barge 212 is underneath the hull 102 of the offshore jack-up 100. This means that the cargo load 218, for example the cargo carrying platform 228 comprising

the WTG components 220 can be lifting vertically off the deck 216 of the barge 212. In some examples, the cargo carrying platform 228 is lifted through the cut-out 400 in the hull 102.

- 5 In the example shown in Figures 4 and 5, the cut-out 400 is in the periphery of the hull 102 of the jack-up 100. In another example (not shown) which is less preferred, the cut-out 400 is located in the centre of the deck 116 of the jack-up 100. This means that the deck 116 of the jack-up 100 comprises a hole for receiving the cargo carrying platform 228.

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In an example, the crane 108 comprises a working area A extending over the cut-out 400 of the hull 102. Accordingly, the crane 108 can hoist objects from the deck 216 of the barge 212 and lower them on to the deck 116 of the jack-up 100. The working area A covers most of the deck 116 of the jack-up 100 and the location of the TP 118. In other examples, the working area A of the crane 108 covers the entire deck 116 of the jack-up 100. This means that the crane 108 can hoist WTG components 220 from the deck 116 of the jack-up 100 and / or the deck 216 of the barge 212. The crane 108 can then lower the WTG components 220 onto the deck 116 of the jack-up 100 or the TP 118.

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Figure 4 shows the hull 102 comprising a lifting mechanism 406 mounted on hull 102. In an example the lifting mechanism 406 is mounted around the periphery 408 of the cut-out 400. The lifting mechanism 406 is configured to lift the cargo carrying platform 228 between a first position on the deck 216 of the barge 212 and a second position wherein the cargo carrying platform 228 is clear of the deck 216 of the barge 212. When the lifting mechanism 406 lifts the cargo carrying platform 228 into the second position, the cargo carrying platform 228 is no longer in physical contact with the barge 212. In this respect, the cargo carrying platform 228 is fixed with respect to the lifting mechanism 406 when in the second position. This means that the movement of the barge 212 due to the water 204 does not move the load carrying platform 406.

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In an example, the lifting mechanism 406 lifts the cargo carrying platform 228 in a vertical distance D1 (as shown in Figure 9). In some examples, the

distance D1 is 3m. In some examples, the vertical distance D1 is 1m to 5m. In some examples, the lifting mechanism 406 lifts the cargo carrying platform 228 to a height above the deck 216 of the barge 212 where the deck 216 of the barge 212 cannot impact the underside of the cargo carrying platform 228. The vertical distance D1 can be varied depending on the weather conditions and the size of the waves. In some examples, the vertical distance D1 is greater than the vertical displacement of the barge 212 experiences due to the waves e.g. heave. For example, if the barge 212 experiences a heave of plus or minus 2m, then the lifting mechanism 406 lifts the cargo carrying platform 228 a vertical distance D1 of greater than 2m.

Accordingly, as soon as the lifting mechanism 406 lifts the cargo carrying platform 228 off the barge 212, the barge 212 can be moved out from underneath the hull 102. This means that there can be a quick transfer of the cargo load 218 and the WTG components 220 to the jack-up 100 from the barge 212. This means that the barge 212 and the anchor handling vessel 214 can wait near the jack-up 100 and transfer the cargo load 218 to the jack-up 100 in a small calm weather window.

Figure 4 shows the lifting mechanism 406 is a plurality of lifting arms 406. For the purposes of clarity only one lifting arm 406 has been labelled in Figure 4. In an example, the lifting arms 406 are spaced along the first arm 402 and the second arm 404. This means that the plurality of lifting arms 406 each lift the cargo carrying platform 228. Figure 4 shows that there are eight lifting arms 406, however, in other examples there can be any other number of suitable lifting arms 406. In one example, there can be two lifting arms 406 which are positioned either side of the centre of gravity of the cargo carrying platform 228. In other examples, there can be any other number of lifting arms 406 e.g. three, four, six, ten etc.

Turning to Figure 5, the underside of the jack-up 100 will now be described. Figure 5 shows a dotted outline of the barge 212 position with respect to the jack-up 100.

In an example, a stabilizing mechanism 502, 504, 506, 508, 510, 512 is mounted on the jack-up 100. In an example, the stabilizing mechanism 502, 504, 506, 508, 510, 512 comprises a plurality of stabilizing mechanisms 502, 504, 506, 508, 510, 512. In an example, the stabilizing mechanism 502, 504, 506, 508, 510, 512 is a plurality of stabilizing arms 502, 504, 506, 508, 510, 512. In an example, a plurality of stabilizing arms 502, 504, 506, 508, 510, 512 are mounted on the hull 102. The stabilizing arms 502, 504, 506, 508, 510, 512 are engageable with the barge 212. In an example, the stabilizing arms 502, 504, 506, 508, 510, 512 are engageable with the structure of the barge 212 such as the deck 216 or any other suitable portion of the barge 212. The stabilizing arms 502, 504, 506, 508, 510, 512 are engageable with the deck 216 of the barge 212 positioned underneath the hull 102 or within the cut-out 400. The stabilizing arms 502, 504, 506, 508, 510, 512 push down on the deck 216 of the barge 212 and this reduces the relative movement of the barge 212 with respect to the jack-up 100. When the stabilizing arms 502, 504, 506, 508, 510, 512 push down on the deck 216 of the barge 212, the buoyant force acting on the barge 212 increases. This results in the barge 212 being engaged with the jack-up 100 stops or limits the relative movement therebetween. In other words, the waves and current of the water 204 acting on the barge 212 do not cause the barge 212 to move relative to the jack-up 100 when the stabilizing arms 502, 504, 506, 508, 510, 512 engage the deck 216 of the barge 212.

In an example, when the stabilizing arms 502, 504, 506, 508, 510, 512 engage with the deck 216, the stabilizing arms 502, 504, 506, 508, 510, 512 dampen the movement of the barge 212. The stabilizing arms 502, 504, 506, 508, 510, 512 comprise a dampener such as a hydraulic piston 700, 704 (described in further detail below). In some examples, the dampener 700, 704 is coupled to the stabilizing mechanism and can be one or more of a spring, a resilient material, or an electro-mechanical dampener, cables and a winch or any other suitable means for dampening the movement of the barge 212.

In an example, the stabilizing mechanism 502 is a single pad (not shown) that engages the deck 216 of the barge 212. The single pad is a substantially flat planar surface that engages a substantial area of the deck 216. Since the single

pad is of a large area, the pad can push down on the deck 216 of the barge 212 along most of the barge 212. In this way, the stabilizing mechanism 502 comprises a single engaging element for stabilizing the barge 212.

5 In some examples, the stabilizing arms 502, 504, 506, 508, 510, 512 are mounted on the underside of the hull 102. Each of the stabilizing arms 502, 504, 506, 508, 510, 512 are extendible underneath the hull 102 towards the surface 202 of the water 204.

10 In an example, the stabilizing arms 502, 504, 506, 508, 510, 512 are spaced along the hull 102. The stabilizing arms 502, 504, 506, 508, 510, 512 are arranged to engage both sides of the barge 212 along the longitudinal length of the barge 212. As shown in Figure 5 there are six stabilizing arms 502, 504, 506, 508, 510, 512. However, in other examples, there can be three or more stabilizing arms 502, 504, 506, 508, 510, 512. In the less preferred example
15 with only three stabilizing arms, there are a first and second stabilising arm 502, 504 at the sides of the barge 212. A third stabilizing arm 514 (shown in dotted lines) is positioned at the bow of the barge 212 aligned with the centreline of the barge 212. In other examples, there can be any number of stabilizing arms 502, 504, 506, 508, 510, 512.

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In an example, the jack-up 100 comprises a moveable coupling mechanism (not shown) mounted on cut-out 400. The moveable coupling mechanism is configured to releasably engage with the bow of the barge 212 when the barge 212 abuts the stop structure 306. In some examples, the coupling mechanism
25 is mounted to the stop structure 306. In some examples, a first part of the coupling mechanism is mounted on the stop structure 306 and a second part of the coupling mechanism is mounted on the bow of the barge 212. In some examples, the first part of the coupling mechanism and the second part of the coupling mechanism are a latch and catch mechanism. In some examples, the
30 barge 212 is pivotable about the moveable coupling mechanism before the plurality of stabilizing arms 502, 504, 506, 508, 510, 512 engage the deck 216 of the barge 212.

In an example, at least one pair of stabilizing arms 502, 504, 506, 508, 510, 512 engages the deck 216 on opposites sides of the centre of buoyancy B of the barge 212. In an example, there are at least two pairs of stabilizing arms 502, 504, 506, 508, 510, 512 engages the deck 216 on opposites sides of the centre of buoyancy B of the barge 212. In an example, one stabilizing arm 514 can be part of two pairs 514, 502 and 514, 504 of stabilizing arms on opposites sides of the centre of buoyancy B of the barge 212. This means that when the stabilizing arms 502, 504, 506, 508, 510, 512 push down on the deck 216 of the barge 212, the turning moments about the centre of buoyancy B are balanced. Accordingly, the barge 212 is not subjected to a rolling or a pitching motion due to the force of the stabilizing arms 502, 504, 506, 508, 510, 512 acting on the deck 216 of the barge 212.

In an example, the plurality of stabilizing arms 502, 504, 506, 508, 510, 512 are mounted adjacent to the first lateral guide structure 304a and the second lateral guide structure 304b. This means that when the barge 212 is aligned between the first lateral guide structure 304a and the second lateral guide structure 304b, the stabilizing arms 502, 504, 506, 508, 510, 512 are aligned correctly for engaging with the deck 216 of the barge 212. In some examples, the stabilizing arms 502, 504, 506, 508, 510, 512 are mounted to the first lateral guide structure 304a and the second lateral guide structure 304b. The stabilizing arms 502, 504, 506, 508, 510, 512 each comprise an engagement head 516 projecting inwardly towards the barge 212. For the purposes of clarity only one engagement head 516 has been labelled in Figure 5.

As can be seen from Figure 6, when the barge 212 is in position, the frame 230 can be lifted off from the deck 216 of the barge 212. Figure 6 shows a plan view of an offshore jack-up 100 with the barge 212 secured to the jack-up 100 according to an example.

Figure 6 shows the anchor handling vessel 214 pushing the barge 212 into position with respect to the jack-up 100. The barge 212 comprises a stern cut-out 600 for receiving and engaging with the bow 602 of the anchor handling vessel 214. The stern cut-out 600 engaging with the bow 602 provides for a

stable connection between the anchor handling vessel 214 and the barge 212 when the anchor handling vessel 214 pushes the barge 212.

The barge 212 has been pushed into position and abuts the stop structure 306 (not shown in Figure 6) and is aligned between the first lateral guide structure 304a and the second lateral guide structure 304b (again not shown in Figure 6). The frame 230 is ready to be lifted off the deck 216 of the barge 212 once the barge 212 has been secured with respect to the jack-up 100.

The WTG components 220 are shown mounted on the frame 230. In particular, the blades 226 may extend out sideways beyond the footprint of the hull 102. Of course, the WTG components 220 can be orientated in any direction as required. If the WTG components 220 are oversized e.g. wider than the cut-out 400 width W (as shown in Figure 4), then the oversized WTG components 220 such as the blades 226 are positioned at a suitable height and orientation. For example, the oversized components e.g. blades 226 are positioned such that the blades 226 do not collide with the first arm 402 and / or the second arm 404 of the hull 102 when the cargo carrying platform 228 is lifted from the first position to the second position.

The steps of the securing and transferring method will now be described in further detail with respect to Figures 7 to 9, 10, 12 and 13. Figures 7 to 9 show a front side view of an offshore jack-up 100 with the barge 212 at different steps of securing the barge 212 and transferring the load 218. For the purposes of clarity, only the barge 212 (and not the anchor handling vessel 214) is shown in Figures 7 to 9.

Turning briefly to Figure 10, the cargo carrying platform 228 will be briefly described. Figure 10 shows a perspective view of a cargo carrying platform 228 according to an example. Figure 10 shows the cargo carrying platform 228 comprising a frame 230 which surrounds the periphery 1000 of the cargo carrying platform 228. The frame 230 surrounds the cargo load 218 and protects the supply load from being damaged during lifting and moving operations. This means that the frame 230 can be handled by the lifting

mechanism 406 and the crane 108. In this way, the frame 230 protects the cargo load 218 e.g. WTG components 220 from minor damage such as scratches, dents etc. This means that the WTG components 220 are less likely to need painting or repair after installation.

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The cargo carrying platform 228 is substantially planar and comprises a plurality of securing mechanisms 604 or lashing points. Figure 6 shows clamps 604 for clamping to the bottom of the WTG towers 222 to maintain the WTG towers 222 in an upright position. The securing mechanisms 604 can be clamps or other
10 suitable securing mechanisms 604. Further securing mechanisms 604 such as clamps can be used with the WTG nacelle 224 and the WTG blades 226. In some examples, the cargo carrying platform 228 receives WTG components 220 for two WTGs. In other examples, each cargo carrying platform 228 is configured to receive the WTG components 220 for a single WTG. In other
15 examples, each cargo carrying platform 228 is configured to receive the WTG components 220 for any number of WTGs e.g. three, four etc WTGs.

The frame 230 comprises an elevated fastening position 1002 for securing the blades 226. The elevated fastening position 1002 is adjacent to the footprint of
20 the cargo carrying platform 228. This can be seen in Figure 6 when viewing the empty load carrying platform 232. In an example, the frame 230 comprises a plurality of bracing struts for strengthening the frame 230.

The cargo carrying platform 228 comprises a plurality of vertical posts 1004.
25 Each of the vertical posts 1004 comprises a lateral projection 1006 each engageable with one of the lifting arms 406. In some examples, the lateral projections 1006 are optional. Indeed, the lifting arms 406 can lift the cargo carrying platform 228 from underneath the cargo carrying platform 228. Alternatively in other examples, the cargo carrying platform 228 comprises
30 holes for receiving reciprocal pegs mounted on the lifting arms 406.

In some examples, the frame 230 is optional. Indeed, the cargo carrying platform 228 is only a flat horizontal platform. In other examples, the cargo carrying platform 228 is a securely removeable top deck 216 of the barge 212.

Turning back to Figures 7 to 9, the method will now be described. The cargo load 218 e.g. the WTG components 220 are not shown in Figures 7 to 9 for the purposes of clarity. The supply carrying platform 228 is mounted on the deck
5 216 of the barge 212.

In Figure 7, the barge 212 has been moved such that at least a portion 300 of the barge 212 is underneath the hull 102 of the offshore or within a cut-out 400 of the hull 102 jack-up 100 as shown in step 1200 of Figure 12. Figures 12 and
10 13 show a flow diagram of methods according to an example. The barge 212 as shown in Figure 7 is not in engagement with the stabilizing arms 502, 504. Furthermore, the lifting arms 406a on the port side of the barge 212 and the lifting arms 406b on the starboard side of the barge 212 are not in engagement with the lateral projections 1006a, 1006b on the cargo carrying platform 228.

15

This means that the barge 212 can move relative to the jack-up 100. The position of the cargo carrying platform 228 is the same as shown in Figure 6. That is, the cargo carrying platform 228 is within the cut-out 400 of the hull 102.

20 In an example, the stabilizing arms 502, 504 and the lifting arms 406a, 406b are actuated with hydraulics. Each of the stabilizing arms 502, 504 and the lifting arms 406a, 406b are respectively coupled to a hydraulic actuator 700, 704, 702, 706. The hydraulic actuators 700, 702, 704, 706 are coupled to a hydraulic system (not shown) for controlling and actuating the hydraulic
25 actuators 700, 702, 704, 706. In an example, each of the stabilizing arms 502, 504 and the lifting arms 406a, 406b are coupled to another mechanism for actuating and extending the stabilizing arms 502, 504 and the lifting arms 406a, 406b. For example, the mechanism can be a rack and pinion mechanism, mechanical linkage, or any other suitable mechanism for extending and
30 retracting the stabilizing arms 502, 504 and the lifting arms 406a, 406b.

Whilst reference in Figures 7 to 9 is made to the stabilizing arms 502, 504 and the lifting arms 406a, 406b, the same mechanisms and methods of operation

are applicable to the other stabilizing arms 502, 504, 506, 508, 510, 512, 514 and the lifting arms 406 discussed in reference to the previous Figures 1 to 6.

Once the barge 212 is in position, the stabilizing arms 502, 504 are extended
5 to secure the barge 212 as shown in step 1300 in Figure 13. The plurality of stabilizing arms 502, 504 mounted on the hull 102 are extended and engage against the deck 216 of the barge 212 as shown in step 1202 of Figure 12. In an example, the stabilizing arms 502, 504 can dampen the movement of the barge 212 due to the water 204 and this allows for a soft engagement with the
10 deck 216 of the barge 212.

As can be seen from Figure 8, the hydraulic actuators 700, 704 have been actuated and extend the stabilizing arms 502, 504 until the engagement heads 516a, 516b are in physical engagement with the deck 216 of the barge 212.
15 Once the engagement heads 516a, 516b are seated correctly on the deck 216, then the hydraulic actuators 700, 704 continue to be actuated and extend the stabilizing arms 502, 504 further. Accordingly, the stabilizing arms 502, 504 are pushed against the deck 216 of the barge 212 to increase the buoyant force acting on the barge 212 as shown in step 1204 in Figure 12. In some examples,
20 the steps 1202 and 1204 can be one continuous movement. Alternatively, there can be a pause between steps 1202 and 1204 in order to check that the engagement heads 516a, 516b are seated correctly on the deck 216.

In some examples, the plurality of the stabilizing arms 502, 504 engage the
25 deck 216 at substantially the same time. This means that the barge 212 does not experience a turning moment about the centre of buoyancy as the stabilizing arms push down on the barge 212. In other examples, the stabilizing arms 502, 504 engage the deck 216 at slightly different times in order to accommodate different parts of the barge 212 moving at different rates.

30

This means that the stabilizing arms 502, 504 push the barge 212 into the water 204 by a vertical distance D2. This prevents the barge 212 from moving with respect to the jack-up 100. This means that the barge 212 is secured to the jack-up 100. In some examples, the vertical distance D2 is between 0.1 to 2m.

In some other examples, the vertical distance D2 is between 0.3 to 1.5m. In some other examples, the vertical distance D2 is between 0.5 to 1m.

5 In some examples the barge 212 is a monohulled vessel. In some examples, the barge 212 is a multihull vessel as shown in Figures 7 to 9. Figures 7 to 9 show the barge 212 have two hulls 800, 802, but in other examples the barge 212 can comprise any number of hulls. This means that the volume of water that is displaced when the stabilizing arms 502, 504 are pushed down in step 1204 is reduced. Accordingly, the force required to push the barge 212 down
10 with the stabilizing arms 502, 504 is reduced compared to pushing down on a monohulled barge 212

After the barge 212 is secured with respect to the jack-up 100, the Figure 9 shows that the hydraulic actuators 702, 706 have been actuated and extend
15 the lifting arms 406a, 406b so that they engage the lateral projections 1006a, 1006b of the cargo carrying platform 228. In this way, the lifting mechanism 406 mounted on the jack-up 100 is engaged with a cargo carrying platform 228 positioned on the barge 212 as shown in step 1302 in Figure 13. Once the lifting arms 406a, 406b have engaged the lateral projections 1006a, 1006b, the
20 lifting arms 406a, 406b lift the cargo carrying platform 228 between a first position on the barge 212 and a second position clear of the barge 212 as shown in step 1304 of Figure 13.

In some examples, the steps 1302 and 1304 can be one continuous movement.
25 Alternatively, there can be a pause between steps 1302 and 1304 in order to check that the lifting arms 406a, 406b are engaged correctly with the cargo carrying platform 228.

In some examples, the plurality of the lifting arms 406a, 406b engage the lateral
30 projections 1006a, 1006b at substantially the same time. This means that the cargo carrying platform 228 is lifted in a stable manner. In some examples, the lifting arms 406a, 406b move at different rates in order ensure that the cargo remains balanced on the cargo carrying platform 228.

As shown in Figure 9 and previously discussed above, the lifting arms 406a, 406b lift the cargo carrying platform 228 by a vertical distance D1. Once the cargo carrying platform 228 has disengaged from the barge 212, the cargo carrying platform 228 is fixed with respect to the lifting arms 406a, 406b. In other words, the motion of the water 204 will not affect the cargo carrying platform 228 once it is in the second position.

In some examples, once the cargo carrying platform 228 is in the second position, the crane 108 hoists the cargo carrying platform 228. The crane 108 may hoist the cargo carrying platform 228 to another part of the deck 116 of the jack-up 100 as shown in Figure 6. The crane 108 may hoist another cargo carrying platform 232 from the jack-up 100 to the barge 212 at this point as shown in Figure 3.

In some examples, when the barge 212 is secured to the jack-up 100 as described in step 1204, the crane 108 can place a load on the deck 216 of the barge 212. The load can be an empty cargo carrying platform 232 as described above.

In some examples, the engagement heads 516 on the stabilizing arms 502, 504, 506, 508, 510, 512, 514 comprise optional self-seating engagement heads. Figures 11a, 11b, 11c shown different example couplings between the stabilizing arms 502, 504, 506, 508, 510, 512, 514 and the deck 216 with different shapes of engagement heads 516. Figure 11a shows a semi-spherical engagement head 516 or elongated curved head configured to seat in a reciprocally curved hole 1100 in the deck 216 of the barge 212.

Figure 11b shows an upstanding peg 1102 mounted on the deck 216 configured to seat in a reciprocal hole 1106 in the engagement head 516.

Figure 11c shows a conical engagement head 516 configured to seat in a reciprocally conically curved hole 1104 in the deck 216 of the barge 212. In other examples, the lifting arms 406 and the lateral projections 1106 comprise

similar couplings to those shown in Figures 11a to 11c. In other examples, the surfaces on the engagement heads 516 and the deck 216 are flat.

Another example will now be described with respect to Figures 14 and 15.

5 Figure 14 shows an underneath plan view of an offshore jack-up 100 according to an example. Figure 15 shows a plan view of an offshore jack-up 100 with a secured vessel according to an example. Figures 14 and 15 show examples which are similar to the examples described in reference to Figures 1 to 13.

10 Figure 14 shows a barge 1400 which is smaller than the barge 212 described in the previous examples. In particular, the barge 1400 is aligned within the cut-out 400 of the hull 102. In this way, the barge 1400 does not have a portion of the barge 1400 which is underneath the hull 102. Instead, at portion of the barge 1400 is wholly contained within the cut-out 400. Some or all of the length of the barge 1400 can be aligned within the cut-out 400. In some examples,
15 the barge 1400 can project out from the cut-out 400 away from the jack-up 100. The cargo carrying platform 228 as shown in Figure 14 is lifted from the barge 212 by the lifting mechanism 406 in the same way as discussed above with respect to the previous examples.

20 Similarly, the stabilizing mechanism 1500 operates in the same way at the stabilizing mechanism 502, 504, 506, 508, 510, 512 as discussed in reference to the previous examples shown in Figures 1 to 13. However, the placement of the stabilizing arms 1502, 1504, 1506, 1508 has been adapted to the barge 1400. Since the barge 1400 is smaller, the centre of buoyancy B has moved
25 and the stabilizing arms 1502, 1504, 1506, 1508 are moved accordingly. In this way, there maintained four pairs 1) 1502, 1506 and 2) 1502, 1504 and 3) 1506, 1508 and 4) 1508, 1504 of stabilizing arms on opposites sides of the centre of buoyancy B of the barge 1400.

30 In another example, the shape, size, orientation, extension, and placement of the stabilizing mechanisms 502, 504, 506, 508, 510, 512, 1502, 1504, 1506, 1508 and the lifting mechanism 406 are configurable and adaptable to different vessels 212. For example, different barges 212 can have different shape, sizes and draft depending on the cargo and other factors.

In another embodiment two or more embodiments are combined. Features of one embodiment can be combined with features of other embodiments.

- 5 Embodiments of the present invention have been discussed with particular reference to the examples illustrated. However it will be appreciated that variations and modifications may be made to the examples described within the scope of the invention.

10

Claims

1. A method of securing a vessel with an offshore jack-up including a hull and a plurality of moveable legs engageable with the seafloor, the offshore jack-up having a stabilizing mechanism mounted thereon, and the offshore jack-up being arranged to move the plurality of moveable legs with respect to the hull to position the hull out of water, wherein the method comprises:
 - moving at least a portion of the vessel underneath the hull of the offshore jack-up or within a cut-out of the hull when the hull is positioned out of the water and the plurality of moveable legs engage the seafloor;
 - moving the stabilizing mechanism to contact the vessel;
 - pushing the stabilizing mechanism down on the vessel to increase a buoyant force acting on the vessel and to prevent the vessel from moving with respect to the hull; and
 - lifting a cargo from the vessel with a plurality of lifting arms mounted on the offshore jack-up after the stabilizing mechanism pushes down on the vessel.
2. The method according to claim 1, wherein the stabilizing mechanism pushes against a deck of the vessel.
3. The method according to claim 1, wherein the stabilizing mechanism includes a plurality of stabilizing arms.
4. The method according to claim 3, wherein each of the plurality of stabilizing arms comprise a self-seating head for engaging in a reciprocal hole in a deck of the vessel.
5. The method according to claim 3, wherein at least one pair of the plurality of stabilizing arms engage the vessel on opposites sides of the centre of buoyancy of the vessel.

6. The method according to claim 3, wherein the plurality of stabilizing arms engage the vessel at substantially the same time.

7. The method according to claim 1, wherein the vessel is accessible from
5 above when the vessel is within the cut-out.

8. The method according to claim 1, wherein the offshore jack-up comprises a crane with a working area extending over the cut-out of the hull.

10 9. The method according to claim 1, wherein the hull comprises at least one guide structure for laterally positioning the vessel underneath the hull or within the cut-out.

10. The method according to claim 9, wherein the at least one guide
15 structure includes a first guide structure and a second guide structure, the stabilizing mechanism includes a plurality of stabilizing arms, and the plurality of stabilizing arms are mounted along the first guide structure and the second guide structure.

20 11. The method according to claim 1, wherein the hull comprises at least one stop structure for limiting an extent the vessel moves forward underneath the hull.

12. The method according to claim 1, wherein the stabilizing mechanism is
25 extendible underneath the hull.

13. The method according to claim 1, wherein the cargo includes one or more of a wind turbine tower, a nacelle, wind turbine blades, a wind turbine generator component, equipment, personnel, supplies, a transition piece, a
30 monopile, a jacket or a component of an offshore wind turbine generator or wind turbine generator farm.

14. The method according to claim 1, further comprising: placing the cargo on a deck of the vessel whilst the stabilizing mechanism pushes down on the vessel.

5 15. The method according to claim 1, wherein the vessel comprises a plurality of hulls.

16. A method of securing a vessel with an offshore jack-up having a hull and a plurality of moveable legs engageable with the seafloor, the offshore jack-up arranged to move the plurality of moveable legs with respect to the hull to position the hull out of water, wherein the method comprises:
10 moving at least a portion of the vessel underneath the hull of the offshore jack-up or within a cut-out of the hull when the hull is positioned out of the water and the plurality of moveable legs engage the seafloor;
15 engaging a bow of the vessel with a moveable coupling mechanism mounted on the hull;
engaging a stabilizing mechanism mounted on the offshore jack-up against the vessel;
pushing the stabilizing mechanism down on the vessel to increase a buoyant
20 force acting on the vessel and to prevent the vessel from moving with respect to the hull; and lifting a cargo from the vessel with a plurality of lifting arms mounted on the offshore jack-up after the stabilizing mechanism pushes down on the vessel.

25 17. The method according to claim 16, wherein the vessel is pivotable about the moveable coupling mechanism before the stabilizing mechanism engages the vessel.

18. An offshore jack-up comprising:
30 a hull;
a plurality of moveable legs configured to engage with the seafloor, the offshore jack-up configured to move the plurality of moveable legs with respect to the hull to position the hull out of water when the plurality of moveable legs engage the seafloor;

a stabilizing mechanism mounted on the offshore jack-up, the stabilizing mechanism configured to move to contact a vessel positioned underneath the hull of the offshore jack-up or within a cut-out in the hull when the hull is positioned out of the water, wherein a buoyant force acting on the vessel increases when the stabilizing mechanism pushes down on the vessel, and wherein the vessel is prevented from moving with respect to the hull when the stabilizing mechanism pushes down on the vessel;
and

a plurality of lifting arms mounted on the offshore jack-up, the plurality of lifting arms configured to lift a cargo on the vessel after the stabilizing mechanism pushes down on the vessel.

19. A method of securing a vessel with an offshore installation fixed to the seabed and having an above-water structure, the above-water structure having a stabilizing mechanism mounted thereon, wherein the method comprises:

moving at least a portion of a vessel underneath the above-water structure of the offshore installation or within a cut-out of the above-water structure;

moving the stabilizing mechanism to contact the vessel;

pushing the stabilizing mechanism down on the vessel to increase a buoyant force acting against the vessel and to prevent the vessel from moving with respect to the above-water structure; and

lifting a cargo from the vessel with a plurality of lifting arms mounted on the offshore installation after the stabilizing mechanism pushes down on the vessel.