
AQUA POWER
Technologies
MANTA Installation & Removal
MK1.0

Summary

S.Etherington | 05/06/2024 | MK1.0

Overview

This deployment procedure relates to the installation and removal of the MANTA converter.

Version

MK1.0 05/06/2024 Initial release of procedure.

Notes

When lifting the MANTA converter into the water or out of the water, unloaded lengths of chain will also be being lifted and lowered from the workboat deck to the crane hook. To avoid entaglement, excess chain will be placed inside a cable drum and attached to the crane hook. When required chain will be unloaded from the drum until all the chain is furled out.

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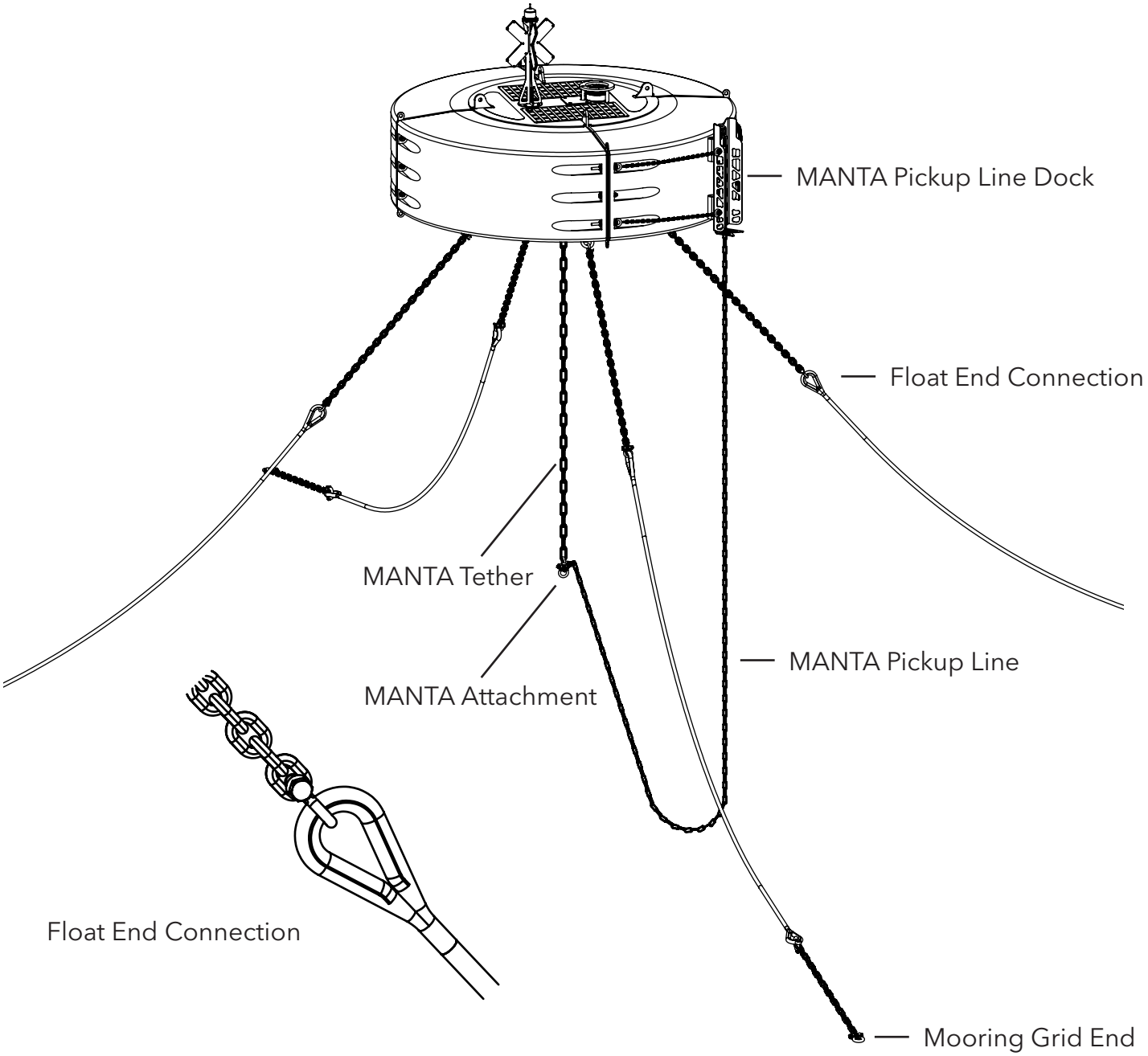
Float & Bridle Assembly Detail

S.Etherington | 05/06/2024 | MK1.0

Shown below is the deployment assembly of the MANTA float and the bridle lines. For the purposes of this document, the bridle line attachment to the grids mooring plates is not shown.



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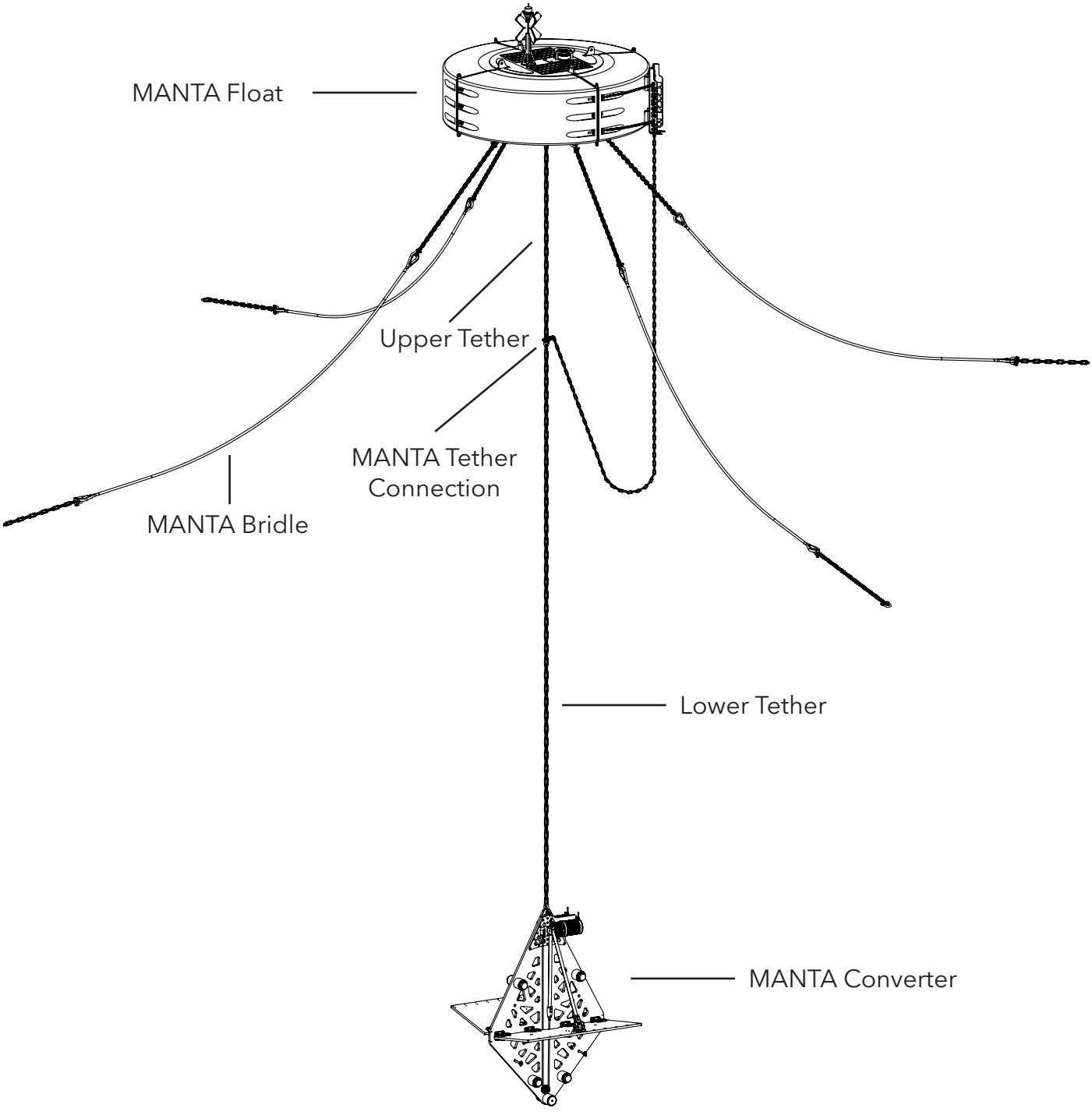
MANTA System Detail

S.Etherington | 05/06/2024 | MK1.0

Shown below is the complete MANTA system comprising the MANTA float, the bridle lines, and the MANTA converter. For the purpose of this document, the mooring end plates of the grid are not shown. After the completion of the MANTA converter installation, the deployed assembly should look as follows.



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MANTA System Detail

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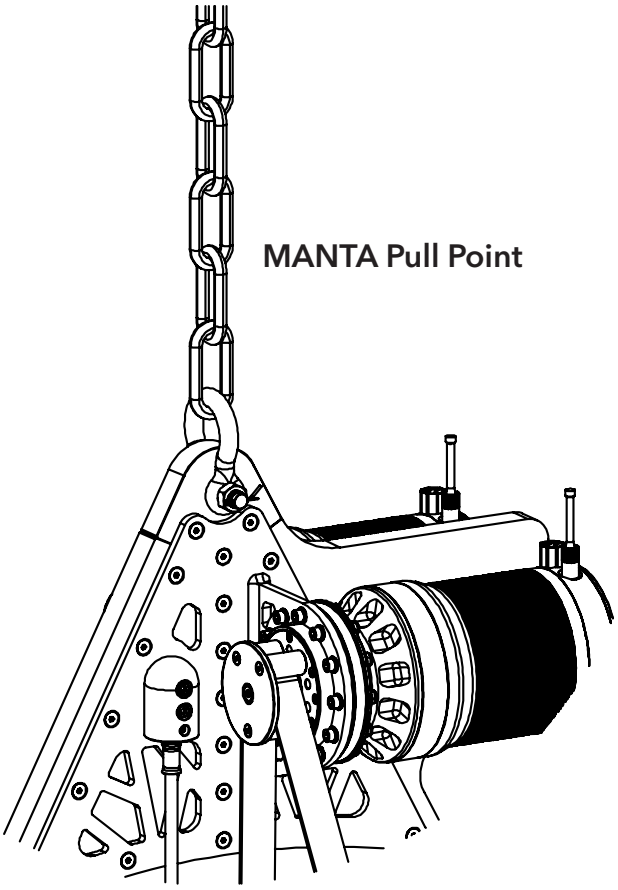
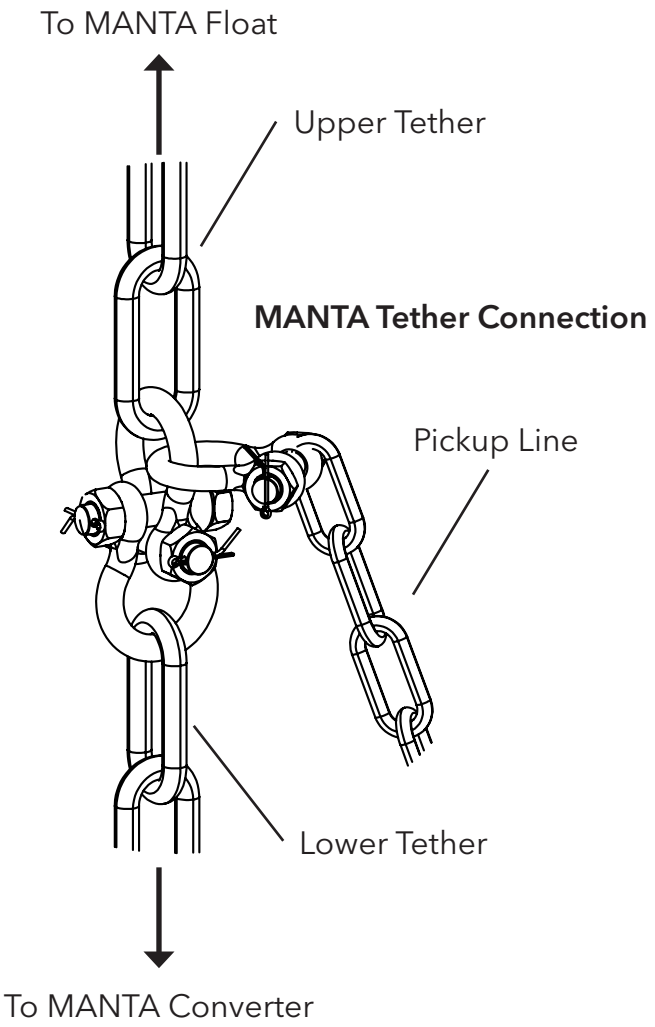
For reference, detail views of critical components of the assembly are shown below. Within this procedure document, the below items are referenced extensively.





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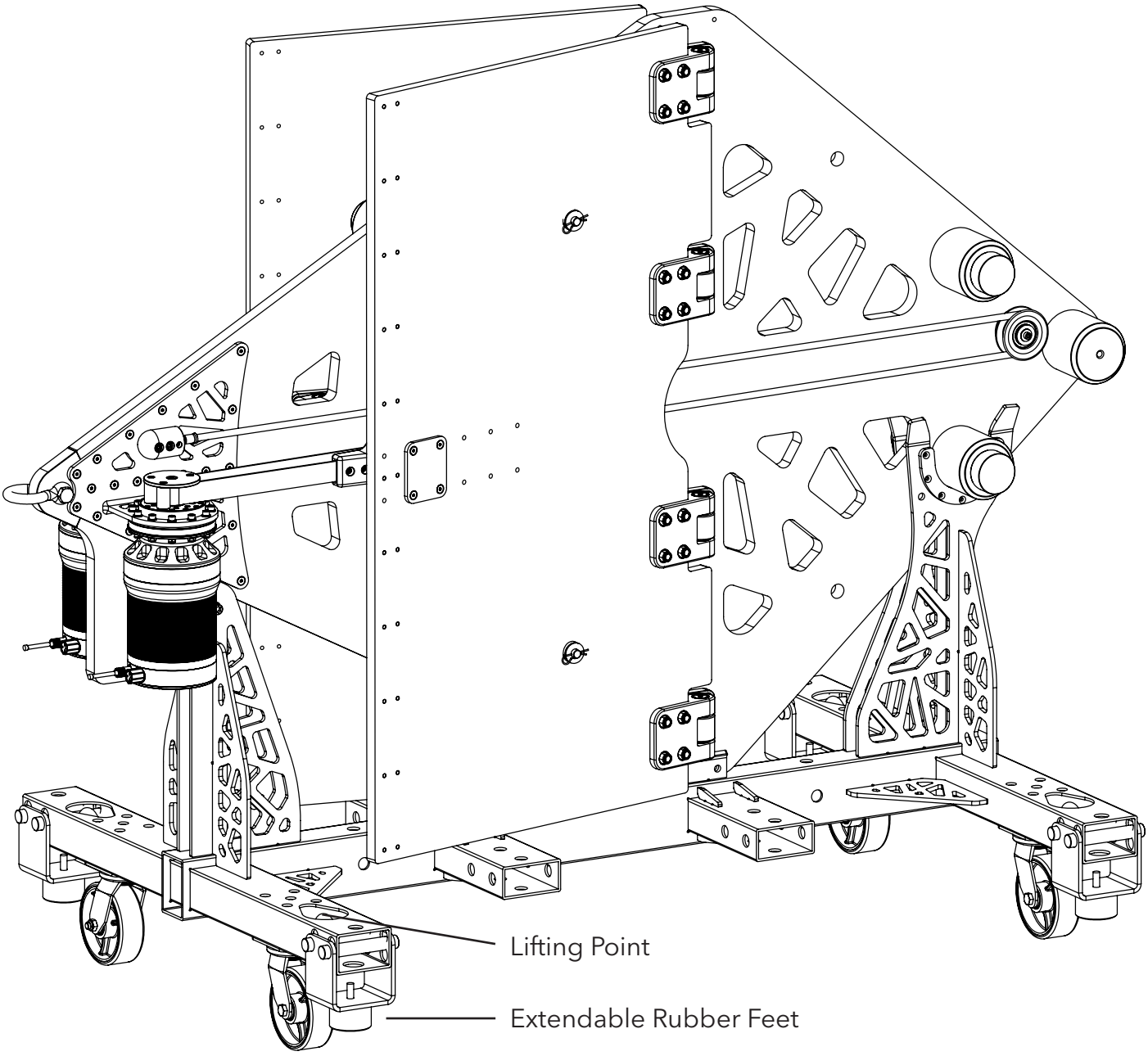
MANTA Trolley

S.Etherington | 05/06/2024 | MK1.0

Below shows the MANTA converter cradled in its transportation trolley. The trolley is used to safely locate the MANTA converter when not deployed. When deploying the MANTA converter, the trolley is designed to sit on the workboat deck.



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MANTA Trolley

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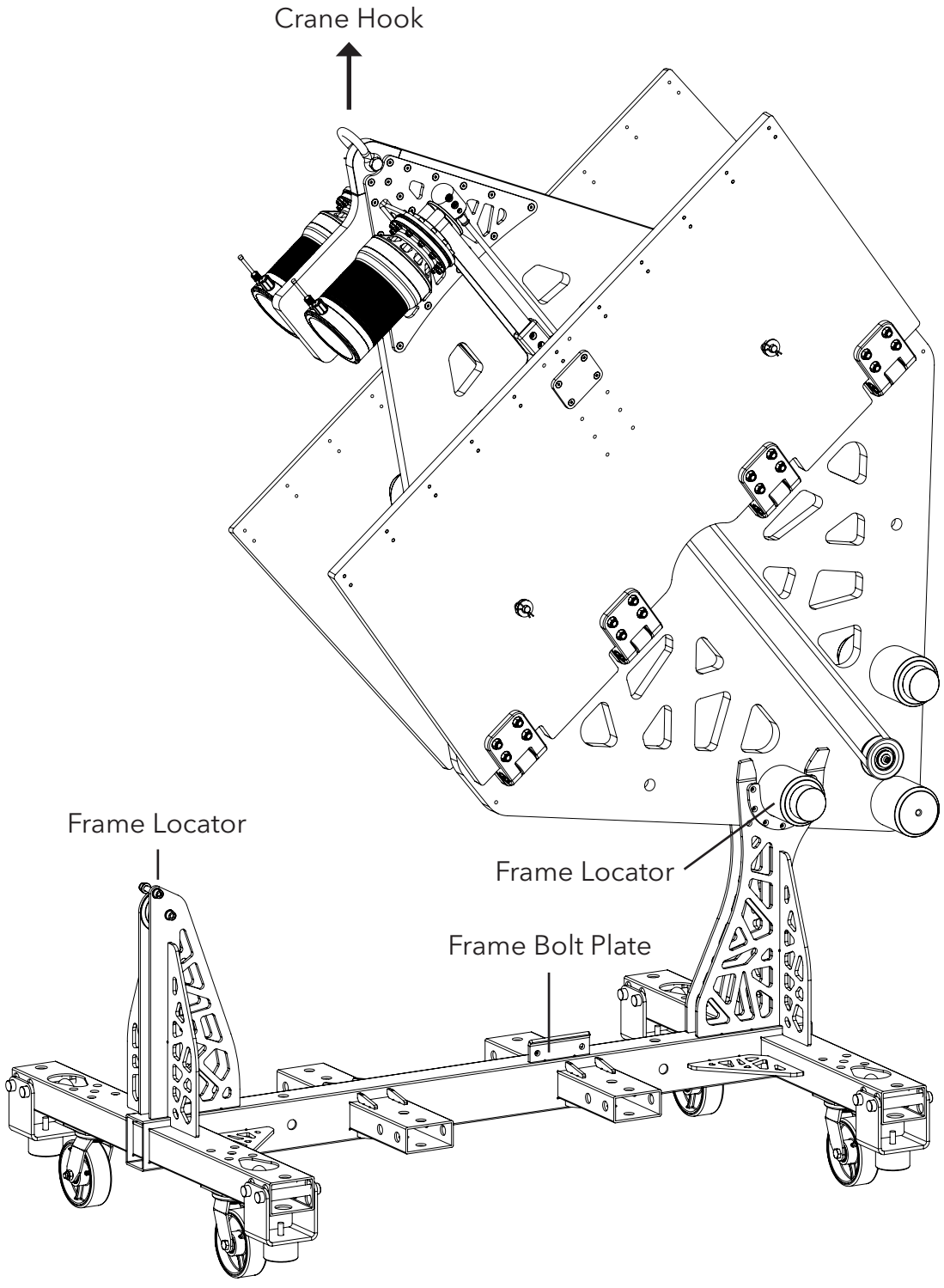
Below shows the converter being raised/lowered from/into the trolley. Note the frame locators and the bolt plate, which are used to guide the MATNA converter into place, and secure the converter.



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MANTA Trolley & Lily Mae Reference

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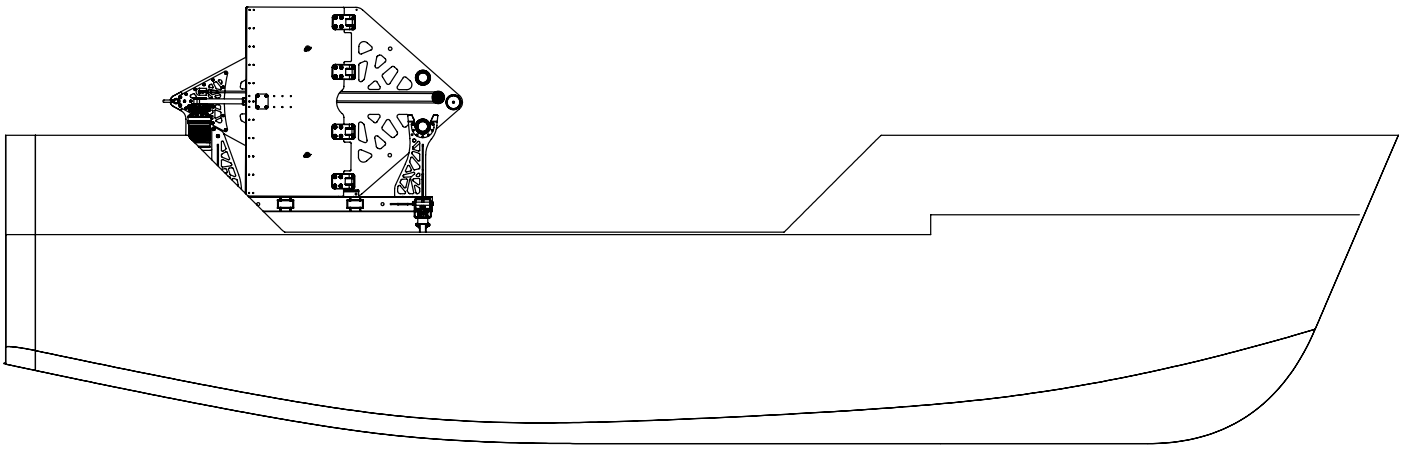
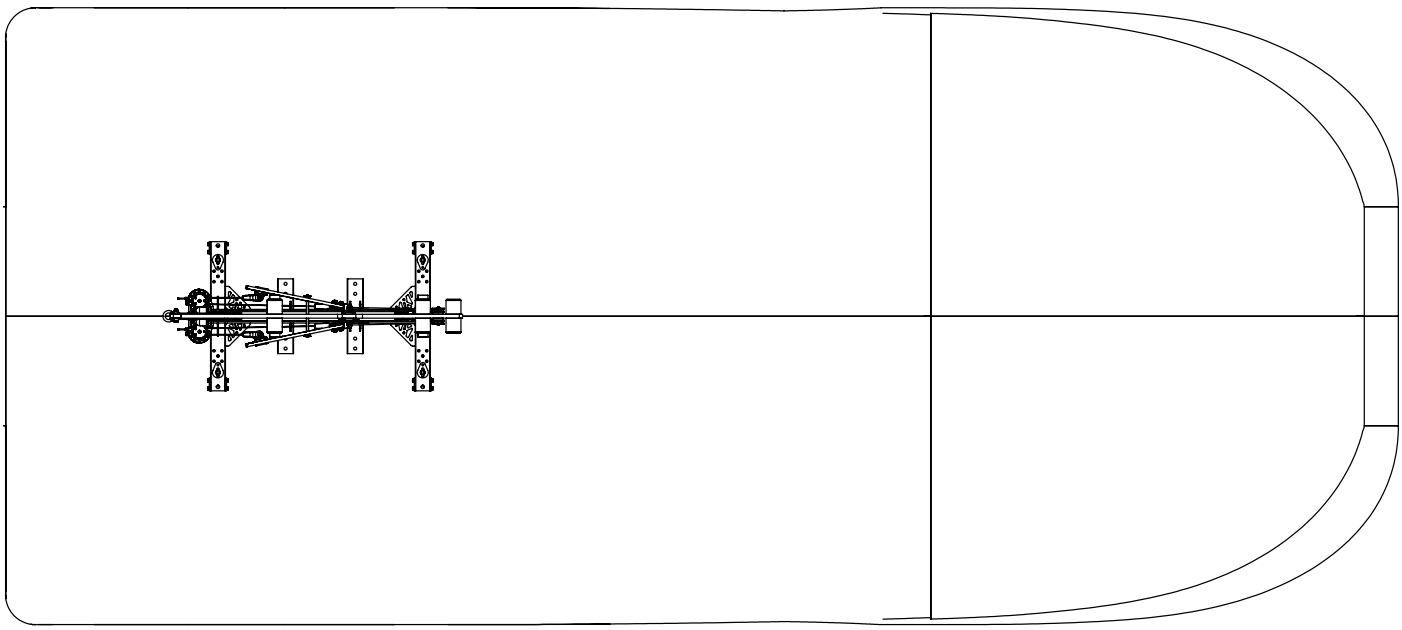
Below shows the MANTA converter on its trolley mounted on the deck of the Lily Mae. The CAD drawing for Lily Mae has been provided by MacDuff Ship Design and is an accurate representation of the workboat's hull.





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MANTA Trolley & Lily Mae Reference

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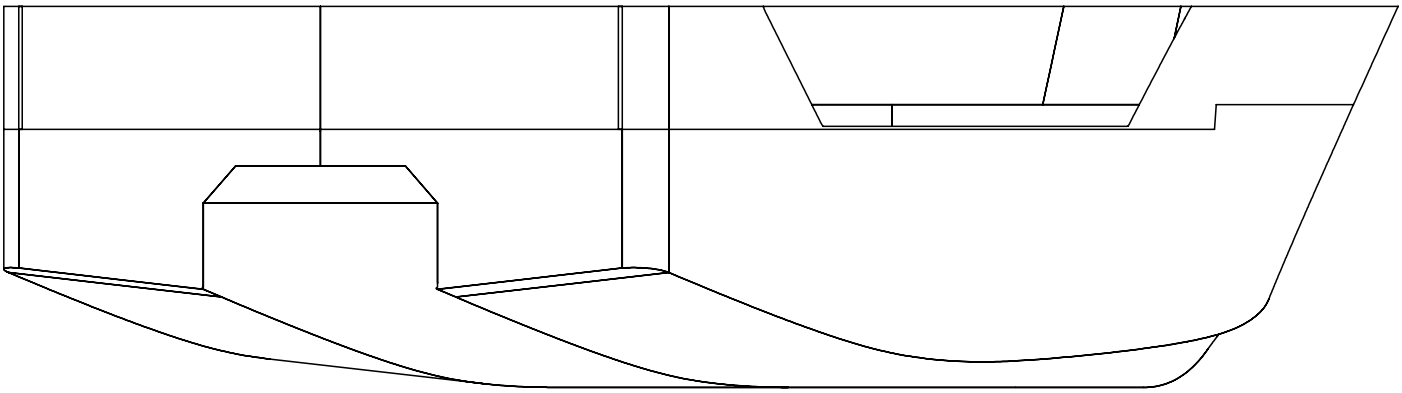
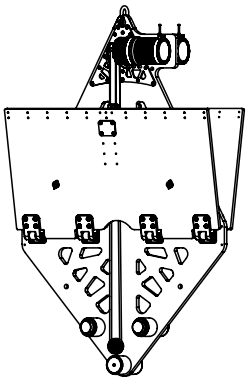
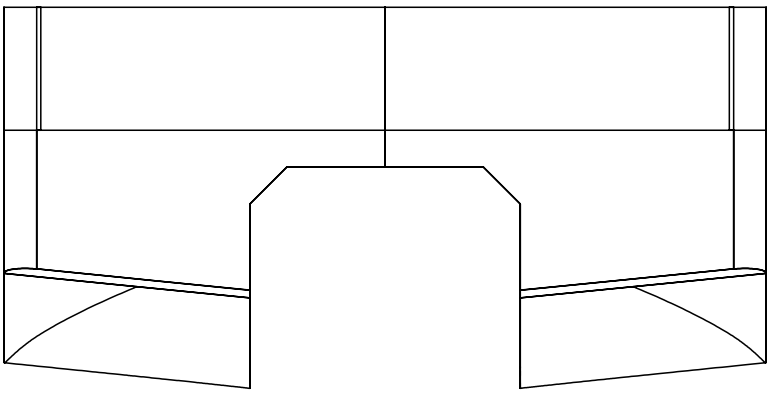
Below shows the MANTA converter at a critical stage of either the installation or recover. The final lift out of the water has to be undertaken in one movement, not separate individual lifts. This is due to the potential of swell induced collisions between the hull of Lily Mae and the MANTA converter. This is explained in detail in both procedures.

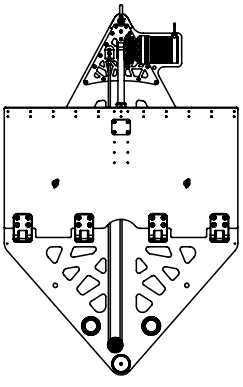
Ortho View





Rear View





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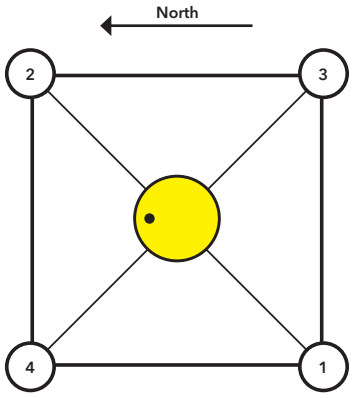
Step 1

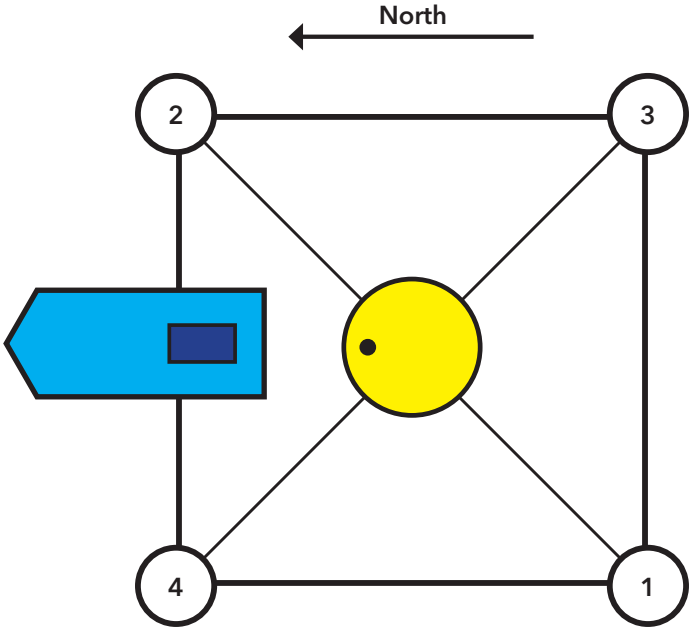
Prior to deploying the MANTA converter, the bridles and the float both need to have been installed. If both requirements have been installed, the deployed assembly will look like the following. MANTA's float is represented by the yellow circle (note the orientation), and the bridles are represented by the lines between the grid plates and the float.



Step 2

Prior to the deployment of the MANTA converter at the site, the converter and trolley need to be loaded onto the workboat deck. Use the handed lifting strops alongside a forklift/telehandler to lift the converter and trolley assembly off the dockside and onto the workboat deck. Once on the workboat deck, securely fasten the assembly in place so as not to move in transit.

At the deployment site, the workboat needs to position itself with the rear of the boat facing the buoy, so that the MANTA Pickup Line is closest to the boat.



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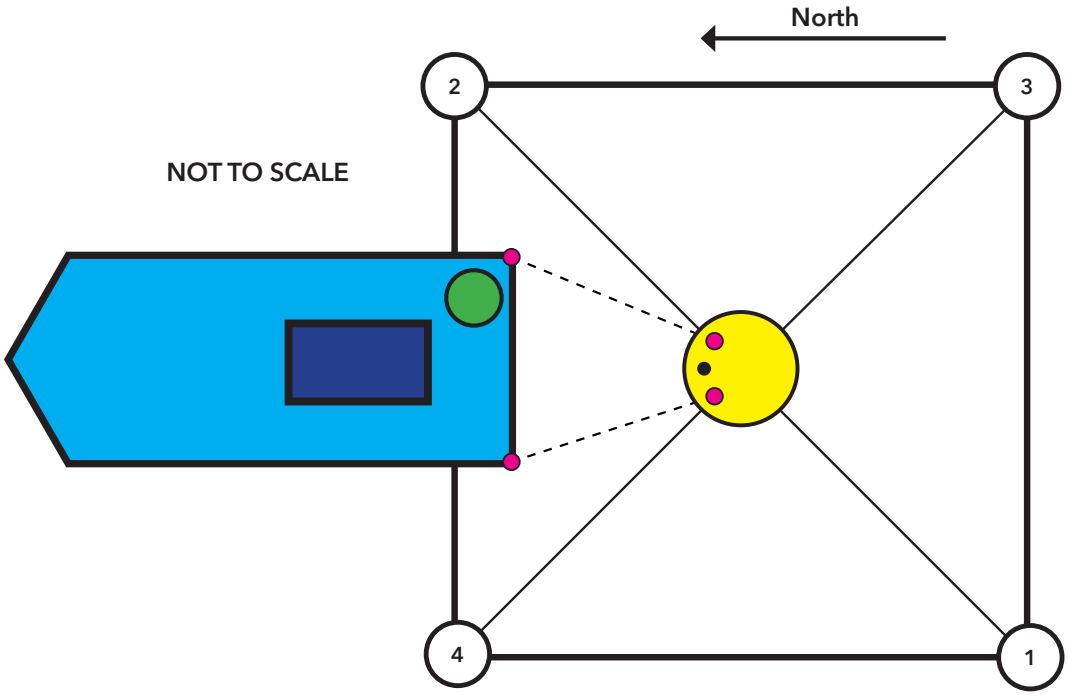
Step 3

To provide a stable reference between the MANTA float (yellow circle) and the workboat (light blue), two temporary hold lines should be used (dashed lines). It may be beneficial to install the temporary hold lines using a small rib so that the boat can work alongside the float. However, if health and safety regulations allow, the temporary hold lines can also be installed by a person boarding the float and attaching the temporary hold lines.

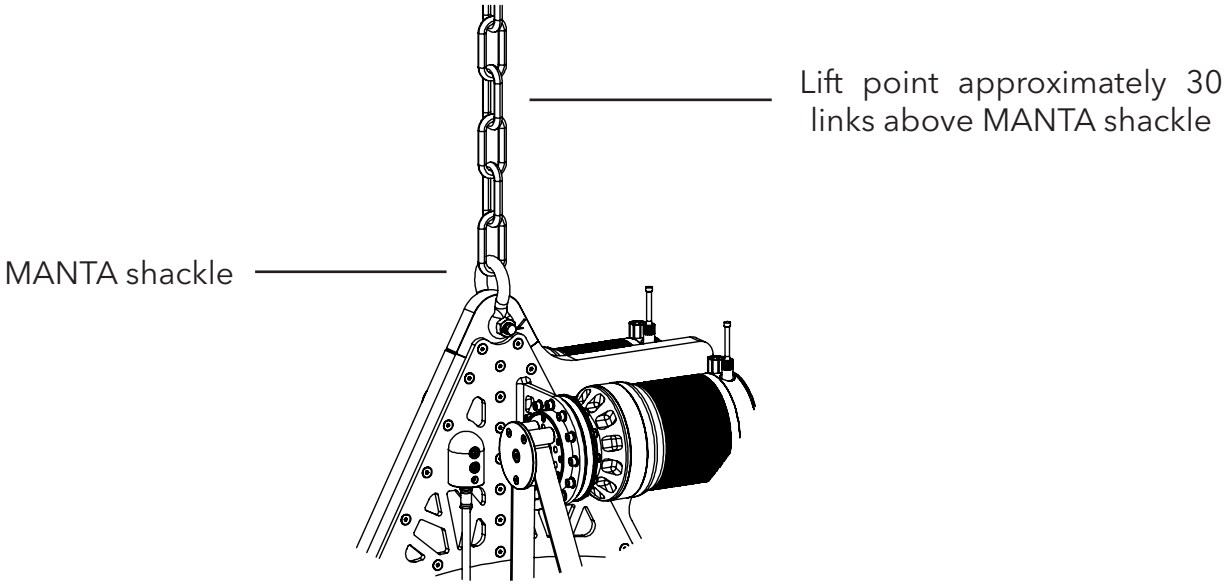
The temporary hold lines should be positioned on the float (yellow circle) either side of the MANTA Pickup line (black dot) and tethered to the workboat's cleats (pink circles). When complete the orientation of components should look as follows. The temporary hold lines should be no less than 5 meters long.



Step 4

Using the supplied chain hook (compatible with 16mm long link chain), the converter should be lifted by the chain, not the shackle. A lift point approximately 30 links above the MANTA converter shackle will suffice.

The reason for lifting the converter by the chain with a preset link height is due to the electrical cables bend restrictions. If the converter is lifted by the shackle, the cables will be bent beyond their designed limited as the cable is supported by the chain, and the chain will be hanging down.

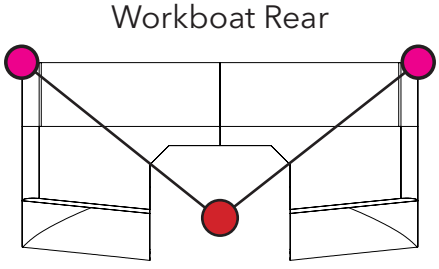


Step 5

With the workboat crane coupled to MANTA's tether chain, the lifting load sling can be attached to the rear of the workboat. The lifting load sling should be attached to cleats eitherside of the workboat, but not the same cleats as the floats temporary hold lines.

The lifting load sling is used when lowering and raising the MANTA converter. The MANTA converter will be lifted and lowered in stages, and the lifting load sling is used to temporarily hold the MANTA converter whilst the crane hooks onto a new section of the chain.

It is imporant that the lifting load sling shackle (red circle) is not resting on the workboat hull as this may squash electrical cables and damage them.



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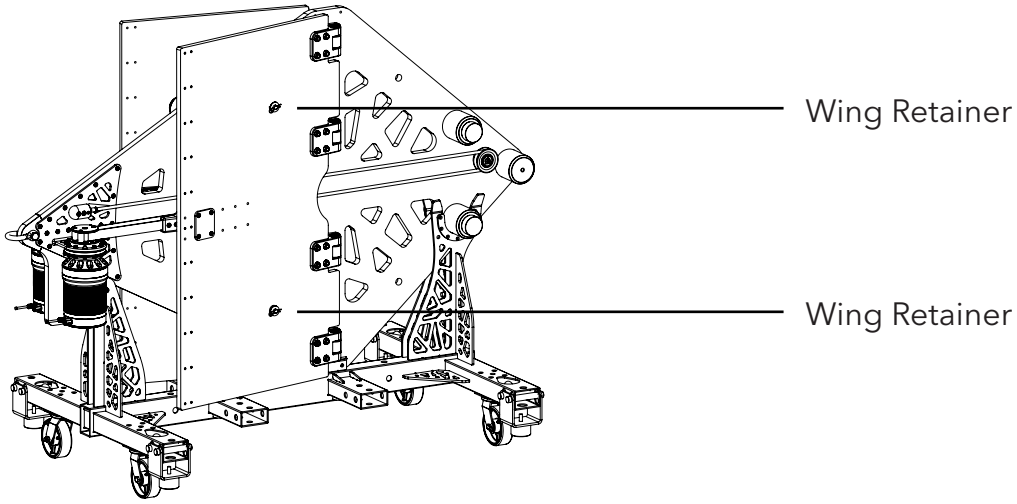
Step 6

With the crane coupled to the chain at the present link distance, and the lifting load sling securely in place, MANTA's wing retainer rods can be removed. The wing retainer rods are used to secure MANTA's wings when in transit.

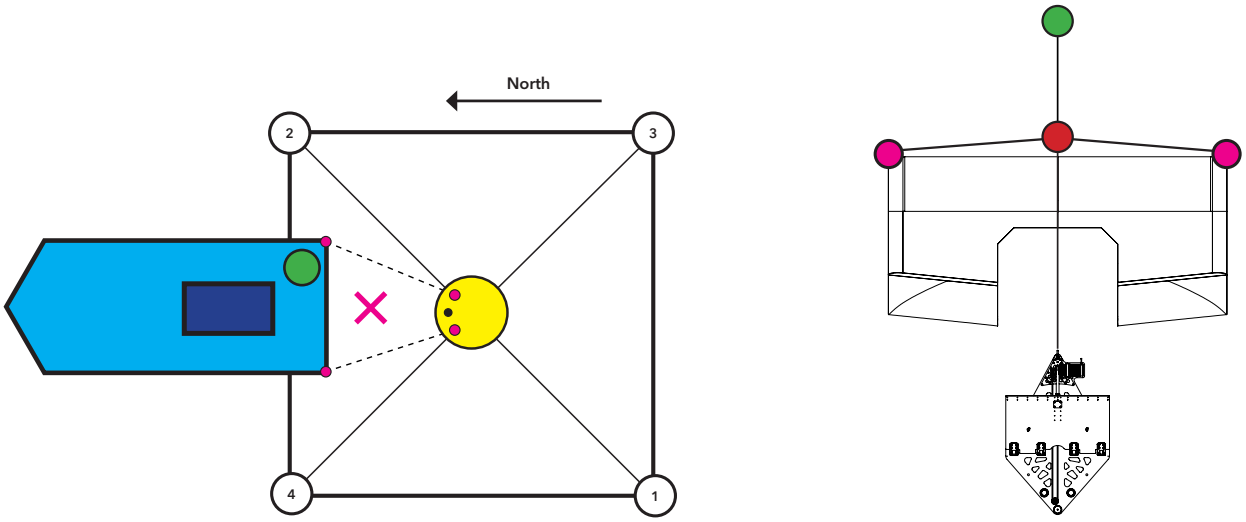


Step 7

The MANTA converter is now ready to be lifted out of its trolley and into the water. Take care when lifting the converter to guide the flaps, as they will naturally fold down in air. Once the MANTA converter is vertical and clear of the trolley, move the trolley to the workboat bulkhead, so it is clear for continued deck operations.

As the workboat crane lowers the MANTA converter into the water, when the crane hook (green circle) is 2 meters above the workboat deck, attach the lifting load sling shackle (red circle) to the MANTA tether chain.

The orientation of the deployment assembly is as follows. The pink cross denotes where the MANTA converter should be in relation of the bridle lines and the float.



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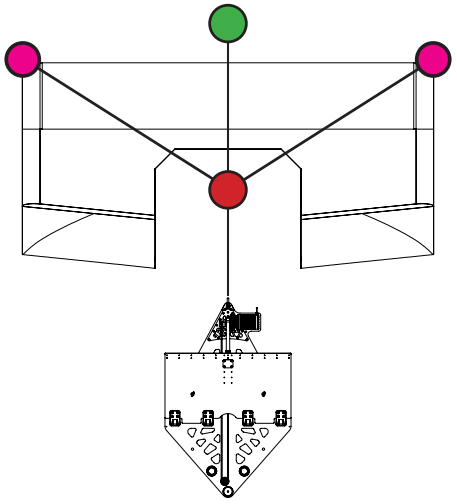
Step 8

With the weight of MANTA still hanging on the crane and the lifting load sling shackle coupled to MANTA's tether chain (red circle), continue to lower the MANTA converter into the water. When the complete weight of the MANTA converter is resting on the lifting load sling and the crane hook (red circle) is slack, unhook the crane hook from the tether chain. The orientation of components should look as follows.

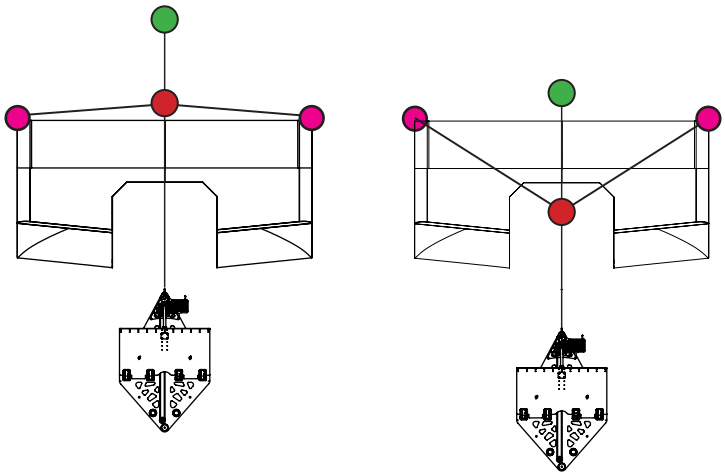


Step 9

Reattach the crane hook (green circle) to a point further along the MANTA converter tether chain and lift the MANTA converter until the lifting load sling becomes slack. Uncouple the lifting load sling shackle (red circle) and continue to lower the MANTA converter.

As the workboat crane lowers the MANTA converter into the water, when the crane hook (green circle) is 2 meters above the workboat deck, attach the lifting load sling shackle (red circle) to the MANTA tether chain.

Repeat steps 8 and 9 until there is only 5 links of MANTA tether chain left to lower.



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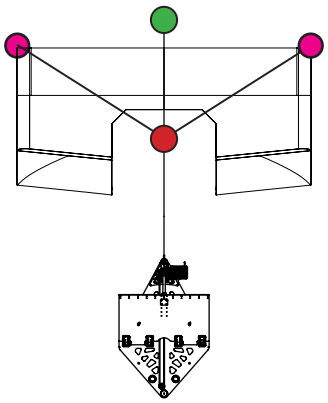
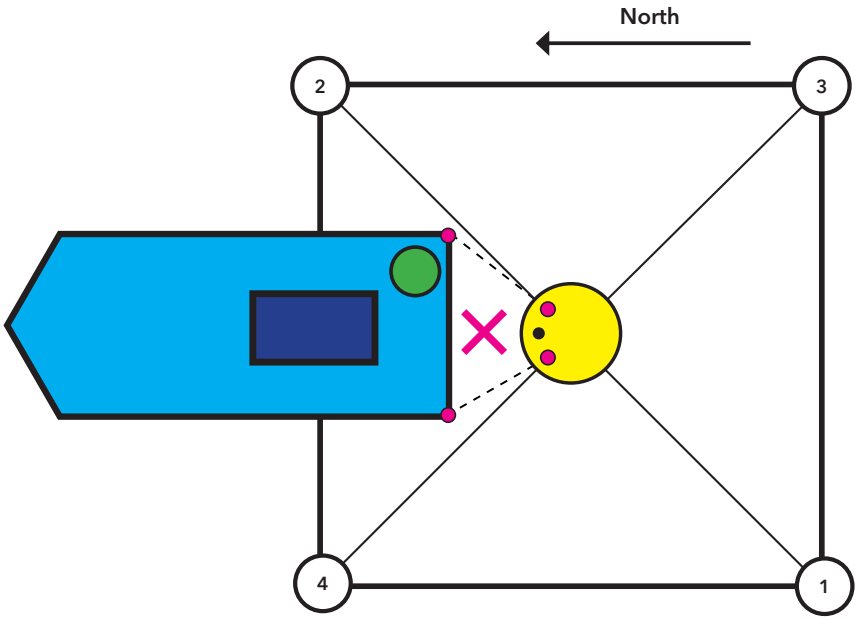
Step 10

With approximately 5 links reamining on the MANTA tether to be lowered, attach the lifting load sling shacke (red circle) to MANTA's tether chain. Lower the converter once again until the weight of MANTA is hanging solely on the lifting load sling.



Step 11

MANTA's chain tether now needs to be shackled to the floats tether, and the electrical connections need to be mated. The MANTA Pickup Line is required to raise the MANTA attachment shackle above the surface in order to make the connections. In order to achieve the connection, the workboat needs to be pulled closer to the float so that the pickup line can be reached. The orientation of components now looks as follows.



Be aware of MANTA's position underwater in relation to the MANTA Pickup Line.

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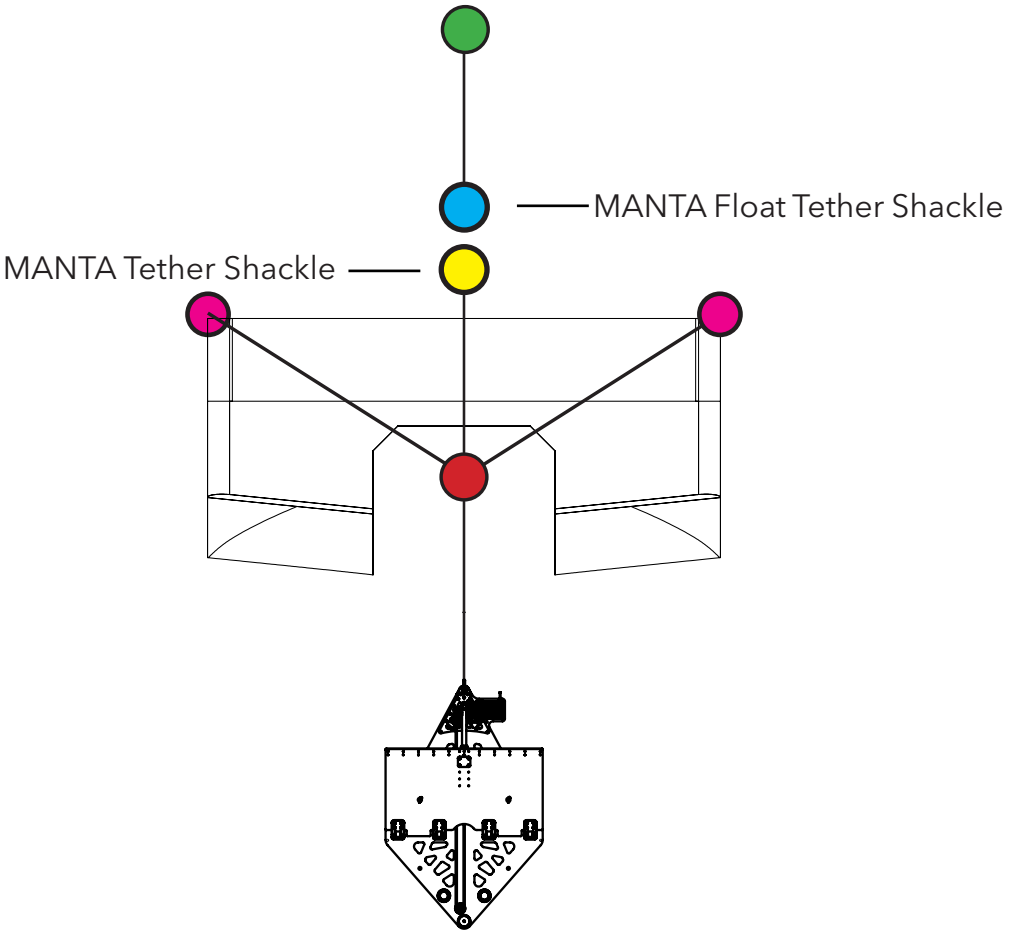
Step 12

With MANTA's float closer, the MANTA Pickup Line can now be reached. It is advised to attach a safety line to the Pickup Line as it will sink if dropped. Pull up on the MANTA Pickup Line to bring the MANTA Attachment shackle (Yellow circle) clear of the waterline and near to the workboat deck.

Be mindful that the MANTA tether chain attached to the underside of the float and the MANTA Pickup Line is not long. Therefore be careful not to let the tether chain be the main method of coupling between the float and the workboat. Ensure the tether chain is always slack, and ensure the temporary hold lines take the strain.

Attach the MANTA Pickup line to the crane hook (green circle) and ensure the MANTA float tether is hanging below. Allow approximately 5 links before hooking into the MANTA float tether chain.



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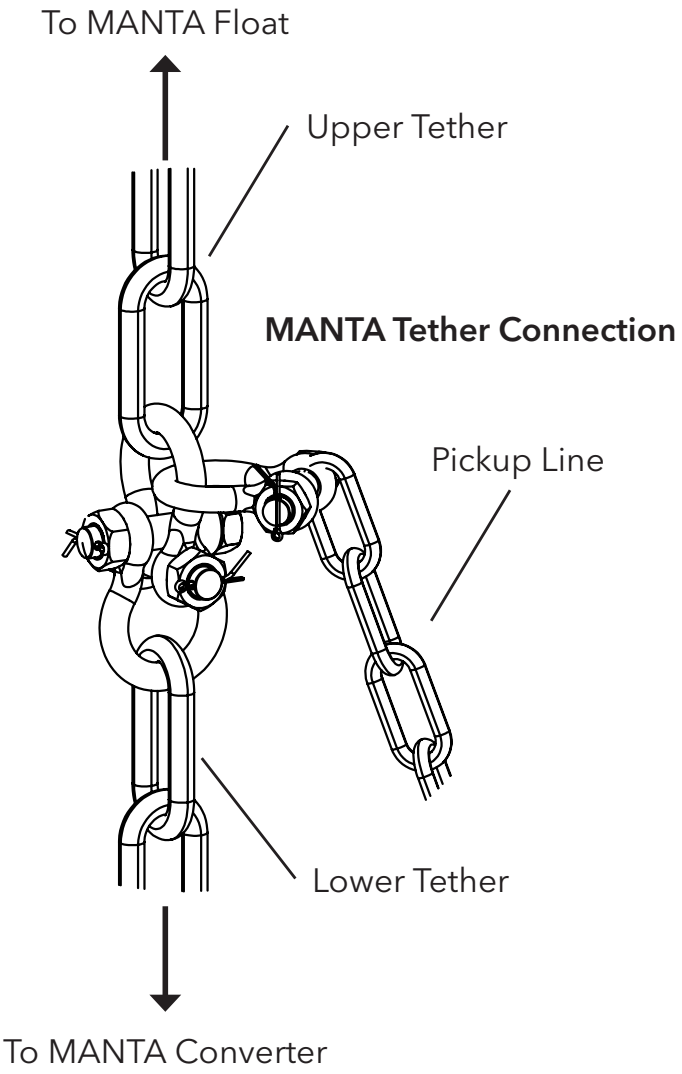
Step 13

With both the MANTA tether chain and the float tether chain at the surface, make the shackled connection and ensure the safety pins are installed. The shackled connections should look as follows.

Ensure the pickup line is attached to the crane hook and begin to lift the MANTA converter, which is hanging circa 10 meters underwater, until the lifting load sling become slack.

Unshackle the lifting load sling shackle and begin to lower the MANTA converter back down. As the workboat crane lowers the MANTA converter into the water, when the crane hook is 2 meters above the workboat deck, attach the lifting load sling shackle to the MANTA Pickup Line.

Repeat this process until the complete weight of the MANTA converter is hanging from the float. Be mindful not to let the MANTA tether chain and electrical cables fall over the edge of the workboat, guide them by hand into the water so that abrasions with the workboat are avoided.



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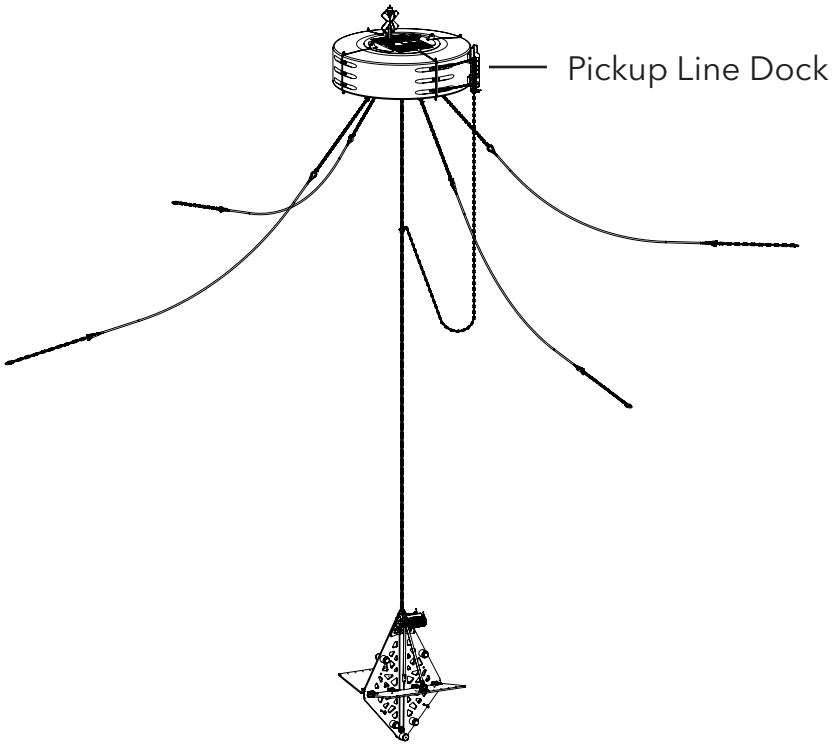
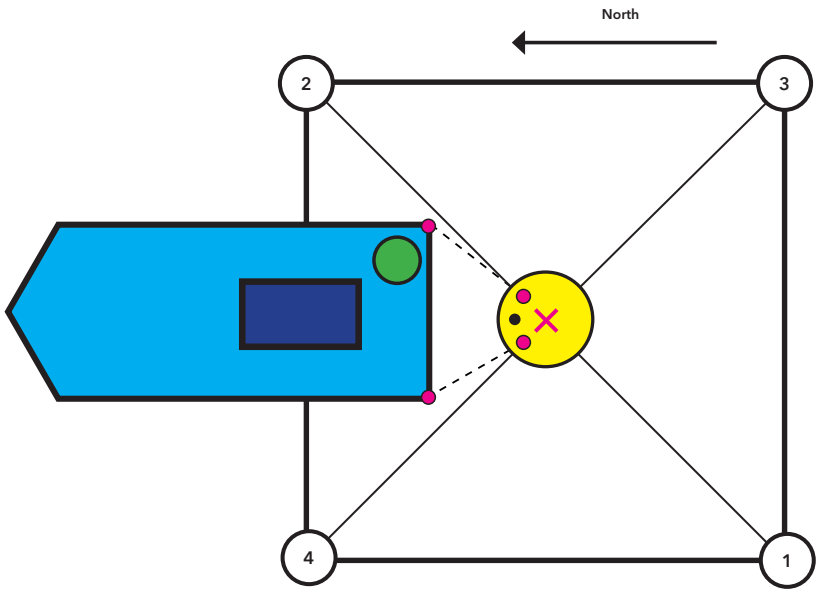
Step 14

With the weight of MANTA hanging solely from the float, detach the cranes hook from the Pickup Line and reattach the Pickup Line to the floats Pickup Line Dock. The orientation of components should look like the following.



Looking down on the deployment, the orientation of components should look as follows. The pink cross represents the MANTA converter and is now directly under the float.

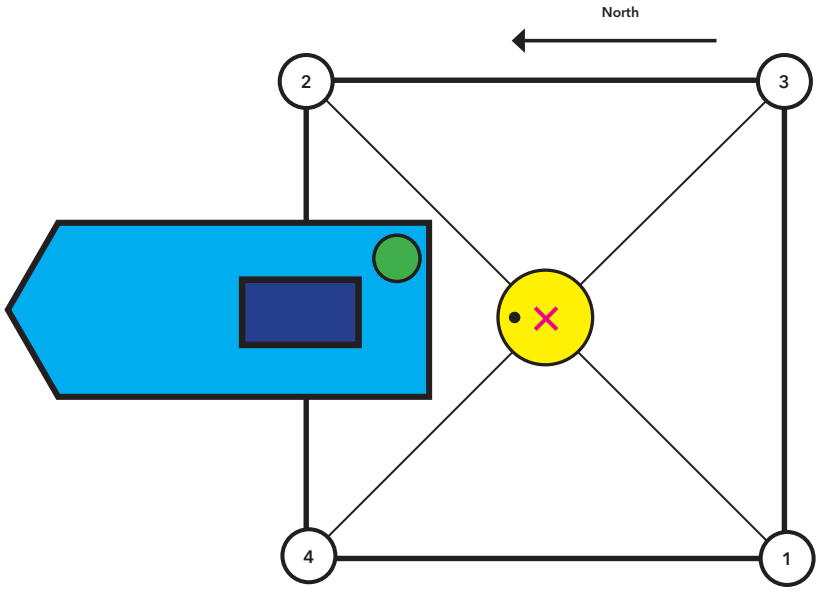


Step 15

The workboat is till connected to the MANTA system by the temporary hold lines with MANTA's float. Remove the temporary hold lines from the workboat cleats, and from the MANTA float shackle points.

It may be easier for a person to board the float to unshackle the temporary hold lines from the float. However, if health and safety regulations do not permit this, a small craft such as a rib could be used to work alongisde the float to remove the temporary hold lines.

Once the hold lines have been removed, the installation of the MANTA converter is complete - the MANTA system is now installed. The orientation of components should look as follows.



It is advised that an ROV inspection of the MANTA system is undertaken immediately after the deployment of the MANTA converter. This is to ensure that none of the bridles, tethers or electrical connections are twisted, in the wrong position, or damaged.

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MANTA Removal Procedure

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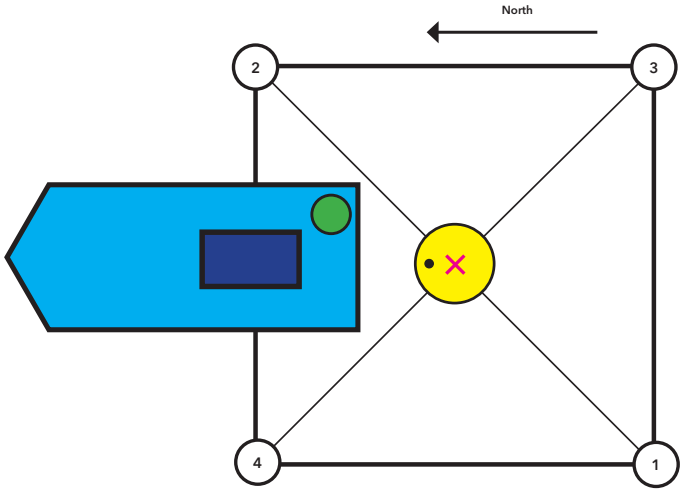
Step 1

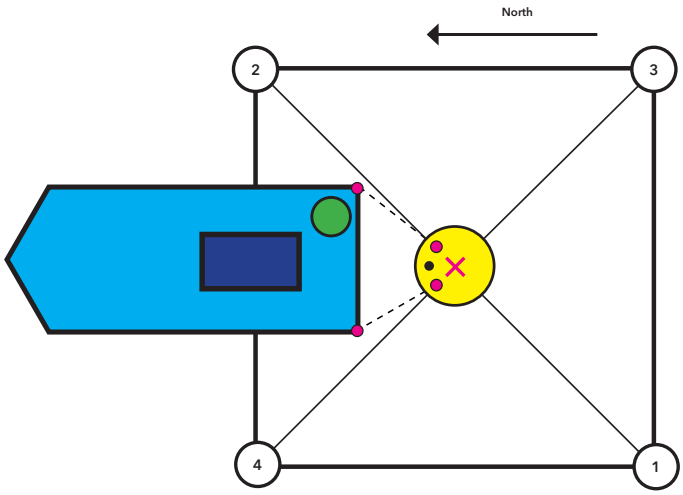
For the removal of the MANTA converter the workboat needs to be aligned as follows. The rear of the workboat needs to be closest to the MANTA Pickup Line



Step 2

To provide a stable reference between the MANTA float (yellow circle) and the workboat (light blue), two temporary hold lines should be used (dashed lines). It may be beneficial to install the temporary hold lines using a small rib so that the boat can work alongside the float. However, if health and safety regulations allow, the temporary hold lines can also be installed by a person boarding the float and attaching the temporary hold lines.

The temporary hold lines should be positioned on the float (yellow circle) either side of the MANTA Pickup line (black dot) and tethered to the workboat's cleats (pink circles). When complete the orientation of components should look as follows. The temporary hold lines should be no less than 5 meters long.



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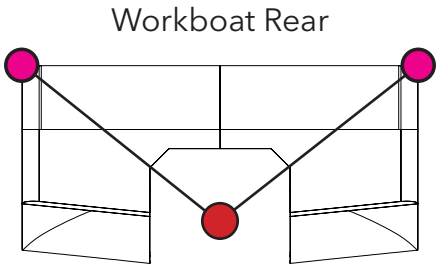
Step 3

The lifting load sling needs to be attached to the rear of the workboat. The lifting load sling should be attached to cleats either side of the workboat, but not the same cleats as the floats temporary hold lines.

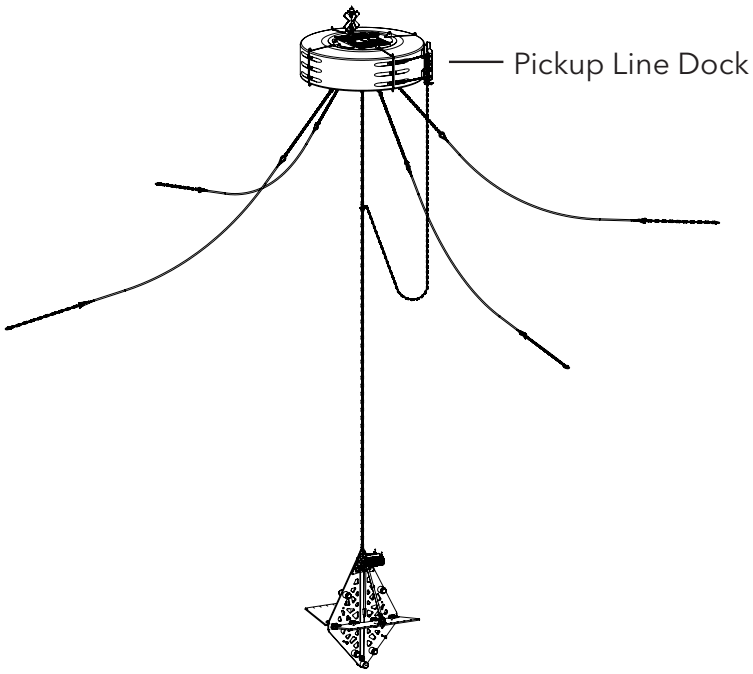
The lifting load sling is used when lowering and raising the MANTA converter. The MANTA converter will be lifted and lowered in stages, and the lifting load sling is used to temporarily hold the MANTA converter whilst the crane hooks onto a new section of the chain.

It is important that the lifting load sling shackle (red circle) is not resting on the workboat hull as this may squash electrical cables and damage them.



Step 4

To lift the MANTA converter clear of the water, the Pickup Line is required. To access the Pickup Line, manually move the workboat towards the float by pulling on the temporary hold lines. Without hitting the float with the rear of the workboat, unshackle the Pickup Line from the Pickup Line Dock and shackle the Pickup Line directly to the crane's hook. It is advised to attach a safety line to the Pickup Line as it will sink if dropped.



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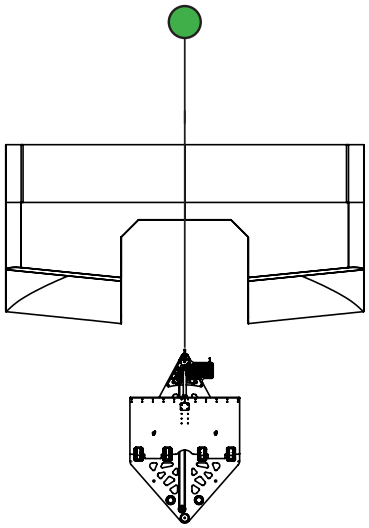
Step 5

To lift the MANTA converter clear of the water, the Pickup Line is required. To access the Pickup Line, manually move the workboat towards the float by pulling on the temporary hold lines. Without hitting the float with the rear of the workboat, unshackle the Pickup Line from the Pickup Line Dock and shackle the Pickup Line directly to the crane's hook (green circle). It is advised to attach a safety line to the Pickup Line as it will sink if dropped.

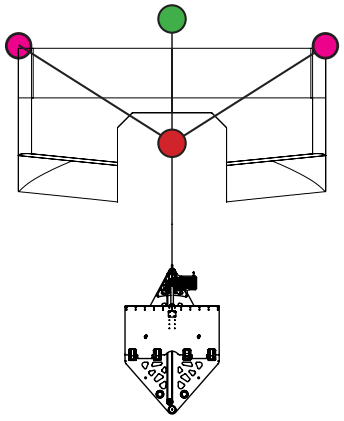
The orientation of components should look like the following.



Step 6

Begin to lift the MANTA converter using the crane (green circle) and the Pickup Line chain. When the crane lift height is reached, couple the lifting load sling to either the Pickup Line chain. Once the MANTA converter's Pickup Line chain is coupled to the lifting load sling shackle (red circle), the crane should lower its height so as to transfer the load of MANTA to the lifting load sling. The orientation of components should look like the following.

As the crane lowers the load onto the lifting load sling, the slack chain and cables shall be placed into their corresponding containers. The containers will be shackled to the crane hook to ensure no chain and cable it loose throughout the remaining lifting operations.



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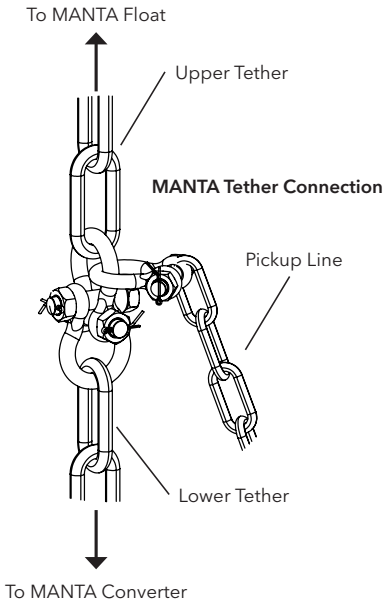
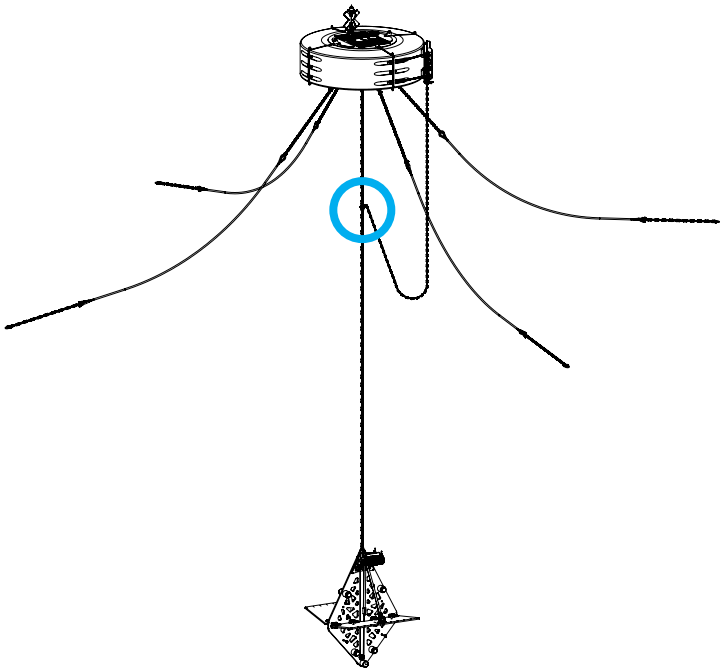
Step 7

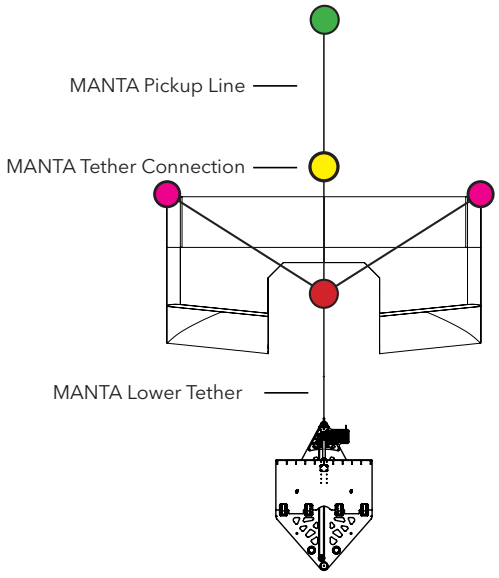
Repeat Step 6 until the MANTA Tether connection is pulled clear of the water and is accessible. Below, the MANTA Tether connection is highlighted with a blue circle, and a detailed view is shown.





Step 8

Before separating the MANTA converter from the float, ensure that the Lower Tether of MANTA's chain is securely fastened to the lifting load sling. Once securely connected, lower the MANTA converter to transfer the load to the lifting load sling. The orientation of components should look as follows.



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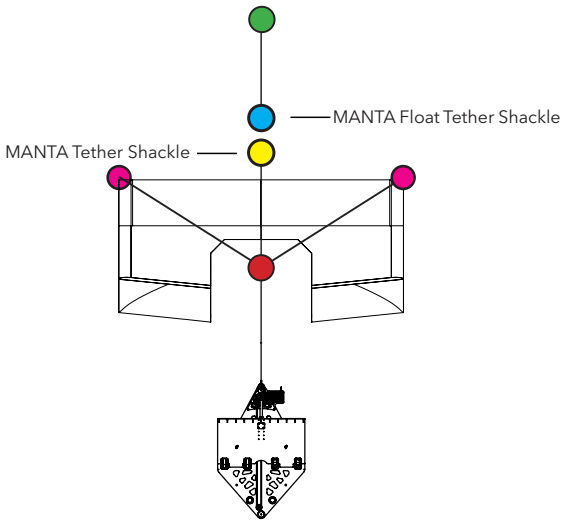
Step 9

With the MANTA Tether connection accessible and the weight of the MANTA converter transferred to the lifting load sling, unshackle the upper tether from the lower tether. Do not unshackle the pickup line from the upper tether shackle. In addition to unshackling the chain, the electrical connections need to be unmated.

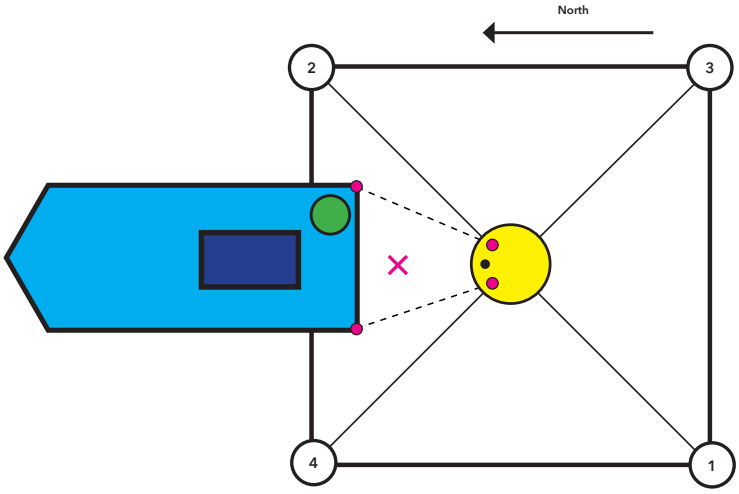
After unmating the electrical connections, make sure that the dummy connections are installed, so as not to leave bare electrical contacts in contact with seawater. The orientation of components should look like the following.



Step 10

With the MANTA converter completely separated from the MANTA float, the Pickup Line should be reattached to the Pickup Line Dock. Once the Pickup Line is securely fastened to the Pickup Line Dock, the remaining Pickup Line and MANTA Tether chain can be gently lowered back into the water and left hanging under the float.

The temporary hold lines can be extended to their full length, which should be at least greater than 5 meters. The orientation of components should look like the following.



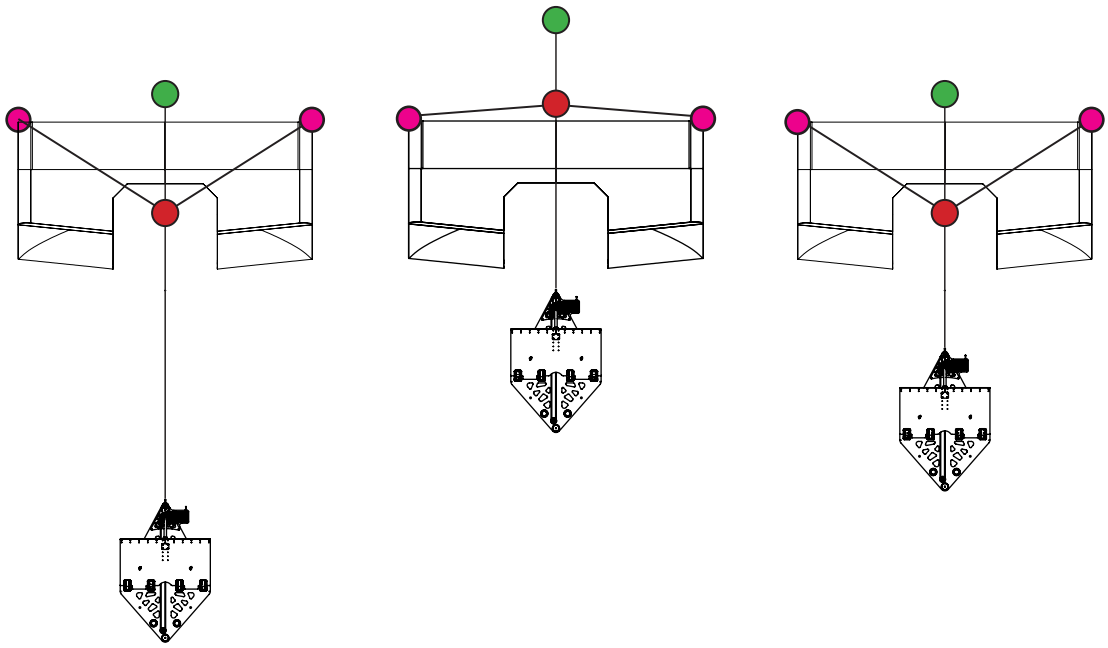
Step 11

MANTA is now suspended from the lifting load sling and a safe distance away from becoming tangled with MANTA's float.

Lift the MANTA crane hook, which is coupled to the MANTA Tether chain, to transfer the load from the lifting load sling onto the crane's hook. Once the lifting load sling is slack, uncouple the lifting load shackle and continue to lift the MANTA converter.

When the maximum height of the crane is reached, couple MANTA's chain tether to the lifting load sling. Once securely fastened, begin to lower the MANTA converter until the load is transferred back to the lifting load sling.

Repeat this process until the MANTA converter is approximately 3 meters below the workboat hull.



Step 12

It is important to conduct the last lift in one continuous movement. The MANTA converter cannot be left hanging on the lifting load sling if it can be in contact with the workboat hull.

For the final lift, ensure that the crane hook is coupled to the MANTA tether chain, approximately 30 links above the converter. This is to ensure that the electrical cables are supported.

Prepare the MANTA trolley for the MANTA converter by ensuring that the trolley is firmly fixed in placed on the workboat deck.

MANTA Removal Procedure

S.Etherington | 05/06/2024 | MK1.0

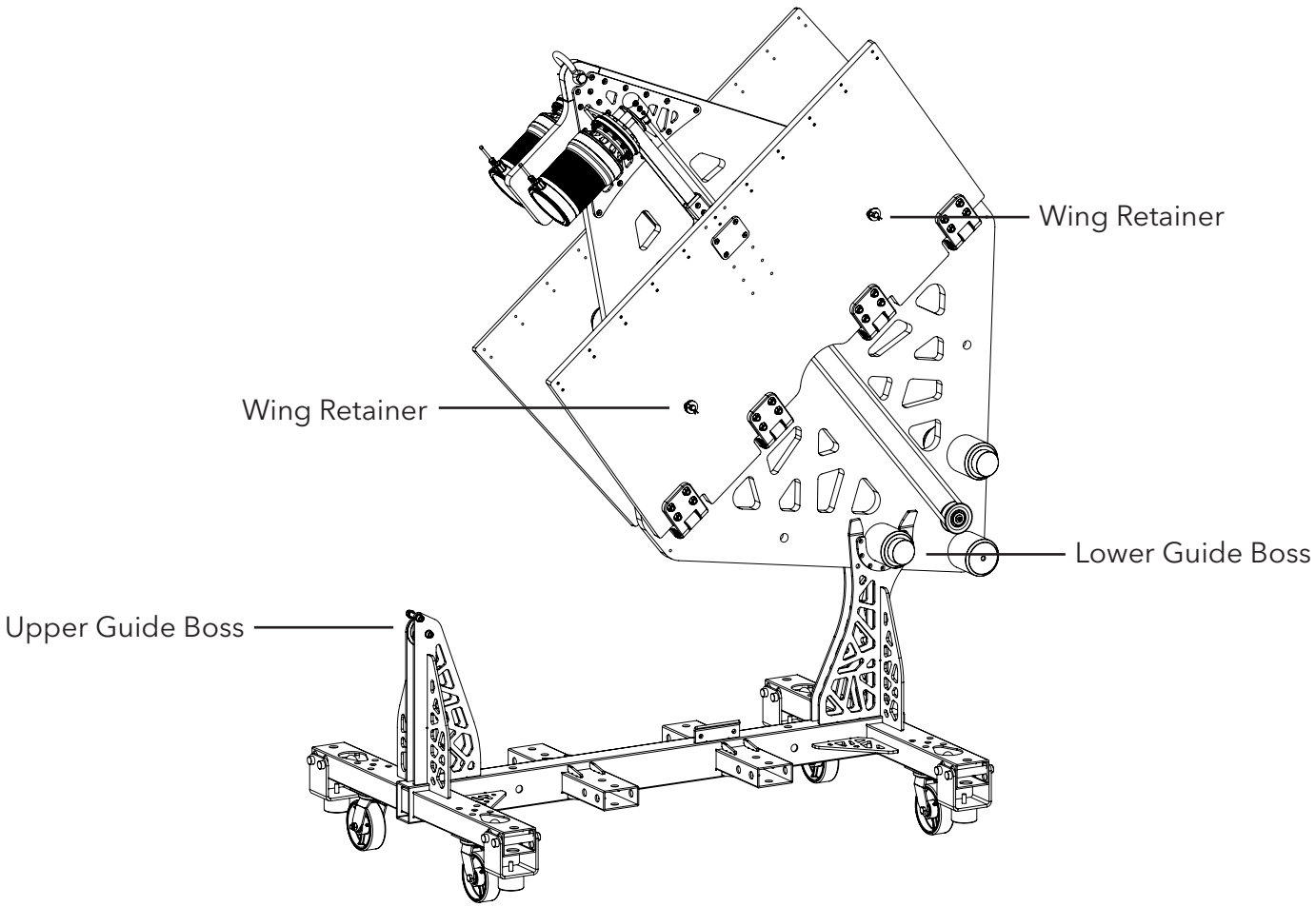
Step 13

Lift the MANTA converter clear of the water and hover above the trolley. When lifting the MANTA converter, be sure to lift slowly at the water line as MANTA's wings will fold down. This also means that the MANTA converter should be lifted with at least 3 meters clearance from the workboat hull.

Guide the MANTA converter into the trolley by locating the lower guide boss into the trolley u section. As the converter is being lowered, begin to fold the wings upwards (towards the generators), so that they do not foul on the trolley.

When the wings are folded up against their limit bumpers, post the wing retainers through the apertures of the wings and the frame. Insert the R clips to securely hold the wings in place.

With MANTA's wings contained, continue to lower the converter down into the trolley.



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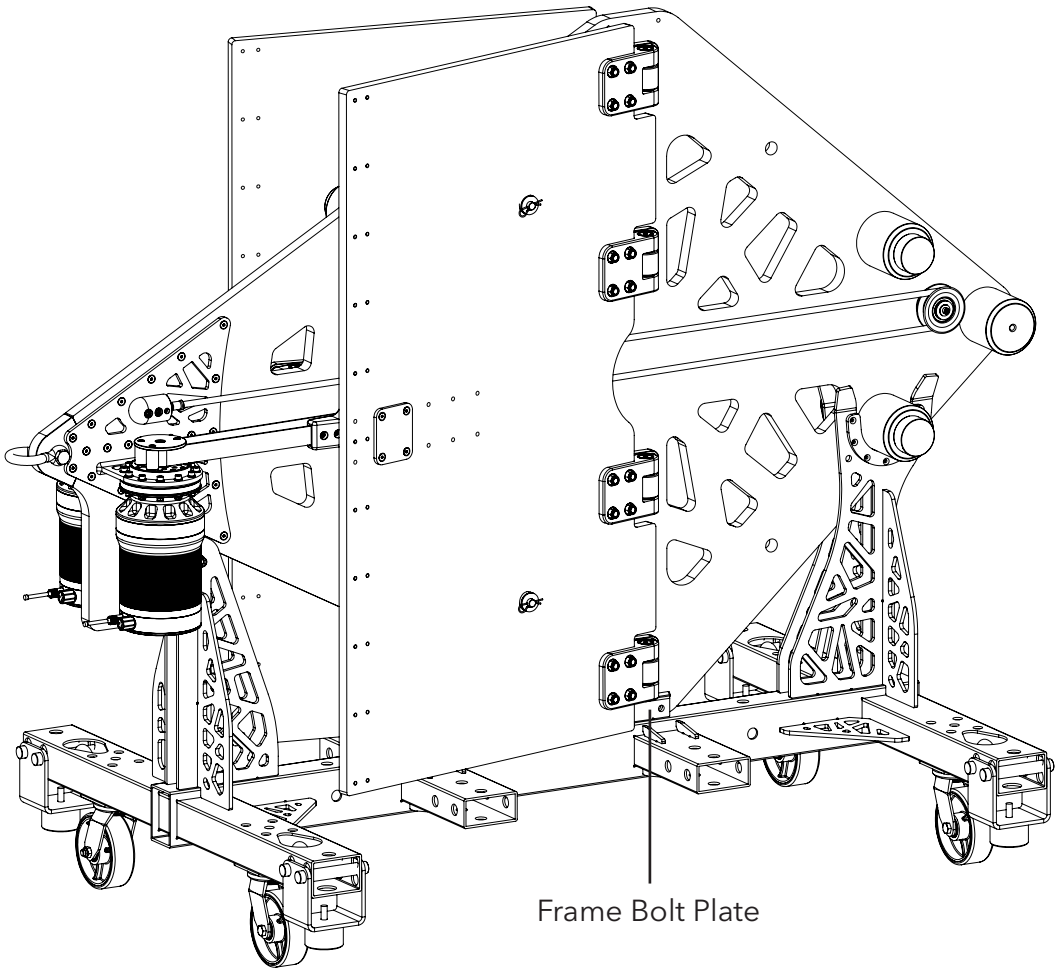
Step 14

Once the MANTA converter is seated in the trolley, fasten the converter to the trolley at the frame bolt plate. Uncouple the cranes hook from MANTA's Tether chain. The MANTA converter is now completely detached from the crane and is a standalone assembly on the workboat deck.



Step 15

The workboat crane can be returned to base and folded as it is no longer required. The lifting load sling can be removed from the workboats rear cleats and safely stored for MANTA's next removal/installation.

Finally, the temporary hold lines, which are connecting the workboat to the float, can be removed. Both hold lines need to be uncoupled from the workboats cleats, and from the floats shackle points. This may be achieved more easily by a smaller rib, which can work alongside the float. Alternatively, a person can board the float and unshackle the temporary float lines, but only if health and safety regulations allow.

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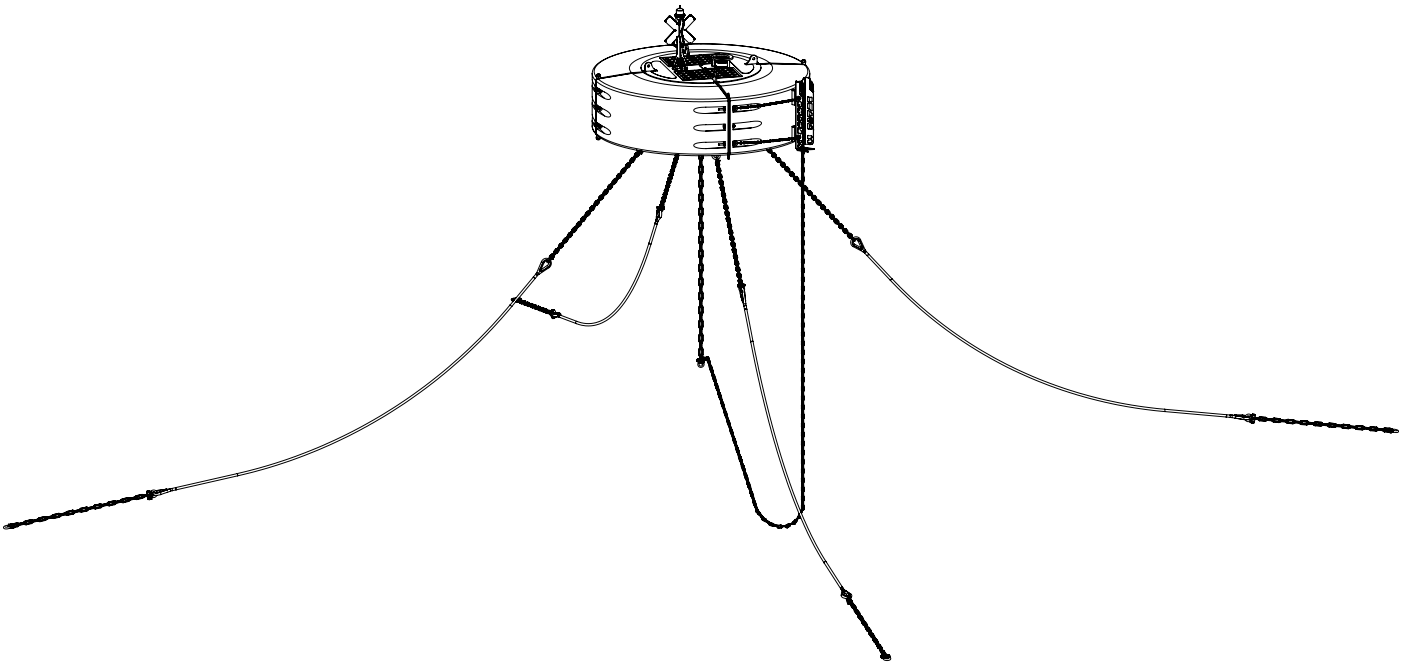
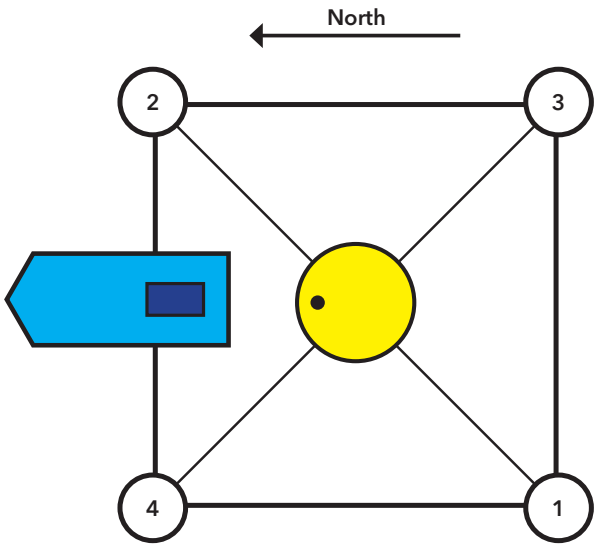
Step 16

The removal of the MANTA converter is now complete. The orientation of components left at the grid should look like the following.





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