The Arctic region is a particularly harsh and challenging environment. Apart from a short period during the summer months, it is subject to very low air temperatures with large amounts of snow and at times rapidly accreted ice cover in open water. Some areas can be covered by sea ice and experience icebergs for prolonged periods. This limits the choice of suitable installation vessels and the restricted operating windows can place significant constraints on the project schedule.

Risk Reduction
All the individual aspects of the SDS are developed from very basic principles and existing technology, both when it comes to the equipment and method.

The complete Submerged Deployment Vehicle (SDV) and structure is transported to site using a submerged tow, which largely eliminates the effects of the surface environment. Upon arrival in field it is parked above the seabed within reach of final target and consequently the weather window for lowering the structure to the seabed is short.

In addition, the lowering operation can be suspended at any time without risk to the structure or personnel. The control chains are simply withdrawn from the towers and the structure and SDV is safely anchored by the tow chain clump weight. Using a submerged tow also avoids the often critical phases of offshore over boarding and lowering through the splash zone.

Once the over boarding has started for a conventional lifted installation, it is generally not practical to suspend the operation before the structure has been landed on the seabed. If delays do occur during the installation in deteriorating weather conditions there is a risk of overloading the hoist wires and/or structure due to increased dynamic loading. This could result in failure of the wire and catastrophic loss.

Therefore a suitable and substantial weather window is required to cover the entire installation. When using the SDS the structure and SDV are parked close to the seabed at the end of the tow so the final lowering period is short with less risk of delays. Even if adverse weather does occur during lowering, the system largely eliminates the dynamic loading on control chains, the structure and its components.
No Tension Change
During the final set down with a conventional installation there is a rapid change of tension in the hoist wire as the structure lands on the seabed. This can result in snatch loads in adverse sea states and consequently it is desirable to fully release the load as soon as the structure lands. This largely precludes the option to reposition the structure if it has been landed off target.

The SDS differs from a conventional installation in that there is no significant change of tension in the control chains when the structure touches the seabed. This is possible to land the structure and reposition it if required.

The only hoist wires used in the SDS are associated with the control chains. These are subject to relatively low dynamic loading which reduces the likelihood of failure and even if failure did occur it would not result in loss of the structure.

Arctic Advantages
The reduced weather sensitivity of the SDS increases the operating window for hostile regions, reduces weather downtime, and increases the available installation season. Extending the typical summer installation periods by a month on either end could significantly decrease the field development time. The installation capacity of the SDS also permits the use of larger structures with fewer subsea tie-ins resulting in further schedule savings.

Ice accretions will significantly affect a vessel with a lot of deck equipment such as an HLV reducing the summer working period.

Year-Round Installation and Retrieval
Future developments of large fields may involve subsea processing units for separation, gas compression or pumping. These may require individual modules to be recovered and replaced during the field life for maintenance. This would only be possible during the summer season with conventional lifted installations necessitating additional redundancy in the process system. An alternative based on the SDS could allow almost year round installation or retrieval by virtually any AHT suited to the Arctic conditions.

The concept is for a large foundation structure housing several modules with parking bays for ballast weights. Standardising on the interface geometry of the modules and the ballast weights would permit a single-sized SDV to be used for all modules. Using parking bays for ballast weights eliminates the requirement to deploy ballast weight to replace the structure weight significantly reducing the required installation window.

This variant of the SDV differs slightly from the function of the square mode described in “How it Works” below as it does not require integral ballast chain lockers. However, it could still be used to install structures other than the designated modules if required by incorporating ballast lockers into the interface frame.

How It Works
The system uses a buoyant SDV to support the subsea structure during transportation, positioning and
installation. The vessel consists of solid buoyancy modules supported on steel frame/hull. The amount of buoyancy is sufficient to render the combined SDV and payload slightly positively buoyant.

The complete assembly is transported to site using a submerged tow thereby avoiding the effects of the surface environment and also avoiding the need for an offshore lift.

During final installation the position of the assembly can be controlled horizontally, vertically and rotationally by means of chains lowered into the SDV control chain towers which behave as soft springs and minimise dynamic loading.

Once the structure is landed on the seabed, ballast is added to the SDV to compensate for the weight of the structure prior to disconnection. The ballast is deployed in batches to suit the capacity of the surface vessel.

The structure may be loaded-out into the Subsea Deployment Vehicle (SDV) by a variety of methods depending on the available equipment and draught including a direct lift, a submersible barge or a dry dock.

Towing
When there is limited water depth at the load-out location, the SDV and structure will be towed in shallow draft surface tow mode until reaching a suitable location for flooding the hulls.

In deep draught mode, the SDV and structure will be towed with only the castles and control chain towers breaking surface. When the water depth is suitable for submerged tow, the tow vessel will pay out the tow wire and tow chain clump weight. The tow chain clump weight will cause the SDV to submerge.

The tow vessel can adjust its speed and the length of the tow wire to maintain the SDV at a suitable depth. The SDV may be lowered as the water depth increases by paying out on the tow wire.

On approaching the field, the vessel slows down and adjusts the tow wire while keeping the chain clump weight on the seabed until it is landed by lowering the control chain towers. The position and orientation of the SDV will be adjusted by moving the installation vessel and/or the crane.

The control chains are then removed completely from the towers allowing the SDV to float above the seabed while remaining safely anchored by the clump weight before being towed back to shore.

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