Construction of Wellhead Protection Glory Holes for White Rose

Trailing Suction Hopper Dredger Vasco da Gama - August 2003

Courtesy of Husky Energy
**Introduction**

Late June 2003, Vasco S.A., a member of the Jan De Nul Group, was approached and engaged by the Canadian Oil Company Husky Energy to take over the excavation of the large central glory hole on the White Rose Project from another Contractor. This Project was located approximately 200 nautical miles south east of Newfoundland on the Grand Banks in the Atlantic Ocean. The Glory Hole serves as wellhead protection against iceberg scouring.

Jan De Nul immediately mobilized its dredger the TSHD Vasco da Gama from Singapore to execute this work. This vessel is the largest trailing suction hopper dredger in the world and is equipped with a deep dredging suction pipe with a 6,500 kW underwater pump, enabling dredging to be carried out down to 135 m water depth (dredging extension up to a depth of 165 m is possible).

With a 9 m depth and bottom dimensions of 50 x 60 m, the central glory hole was the largest of the three to be excavated. The TSHD Vasco da Gama rushed through the excavation in a record time of just over one month. This was nearly six times the production rate of the grab dredging system used for the other glory holes.

Despite the presence of a boulder field containing rocks weighing up to 4.8 tons and stiff clay to be dredged, a remarkably flat level floor of the glory hole was achieved to a designed accuracy of 25 cm. This was the result of trailing the 8 m wide and 50 ton draghead as a sweepbeam over the seabed, which proved to be another significant advantage over the grab dredging method which left an irregular bottom level after excavation and then required additional levelling by rock dumping at a significant additional cost.

During the dredging operations a number of specific environmental precautions were taken into account, including the presence of whales. Furthermore two crew members had been trained as ornithological observers to monitor sea birds.

The TSHD Vasco da Gama completed its work within the anticipated working days and with no weather standby costs, which ultimately resulted in a lower final cost than was originally anticipated by the Operator.
Glory Hole Excavation Works

The work comprised the excavation of the central White Rose Glory Hole, with the following requirements for the floor, ramp and stable slope angles:

- Width 45.7 m, Length 58.3 m.
- Sidewalls had to be stable under all environmental conditions.
- White Rose Glory Hole bottom had to be at least nine meters below the original surrounding seabed.
- The flowline exit corridor had to be on a 5 horizontal to 1 vertical slope.
- The corridor base could not have rocks or sharp protuberances likely to cause damage or wear to any flexible flowline or umbilical.
- Bottom floor tolerances had to be to the requirements of the subsea production system including levelling the hole base and flowline access corridors; bridging of flowline spans and backfilling the hole and flowline access corridors with rock as necessary.
- The Contractor had to ensure that all White Rose Glory Hole survey dimensions were accurate to within one percent and that the White Rose Glory Hole base centres were located to within one meter of the exact co-ordinates specified by the Operator.
- Dredged spoil had to be disposed of at an approved location as stated in the Ocean Dumping Permit.

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[Map of White Rose field location]

[Image of TSHD Vasco da Gama entering the narrows at the port of St John’s]
Surveys

Surveys and Reports on the ‘as excavated’ White Rose Glory Hole had to include both the raw data taken from the multi-beam device installed in the moonpool of the TSHD Vasco da Gama and the preparation of an AutoCad 3D model.

The Contractor also provided a flying eyeball camera ROV on board of the TSHD Vaso da Gama. The ROV was used for inspection of the completed Glory Hole and to confirm the condition of the hole visually with respect to its flatness and the presence of boulders.
Working conditions

In view of the required dredging depth up to 128 m, the harsh sea state conditions and the challenging soil conditions, the works were executed by means of the very large trailing hopper dredger “Vasco da Gama”.

The diagram shows the distribution of the wave directions from June to October. It also indicates that the prevailing wave direction during the summer and the beginning of autumn is about 210 degrees (wind blowing from the SE). A substantial percentage of the waves also have a NW direction. This sailing direction was adopted for excavating the flowline ramps.

At the Glory Hole excavation sites, the swell consists of a primary swell component, a secondary swell component (bi-directional waves) and a wind sea component.

Weather Sensitivity

Due to the size of the vessel (200 m long and 36 m wide), operational environmental conditions up to 8 sec waves and 2.5 m significant wave height were possible.

A significant wave height of 2.5 m corresponds with maximum waves of approximately 5m in accordance with a Jonswap wave distribution spectrum, which provides a sufficient safety margin at both ends of the 8m stroke of the swell compensator device installed on the deep dredging installation.

Although statistically there is a 10% excess of these working conditions in August, the TSHD Vasco da Gama completed the work without any significant weather standby time.

Soil Conditions

The soil conditions at the White Rose Glory Hole can be summarized as follows:
- Scattered hard layers over the total excavation depth with characteristics comparable to caprock.
- The sandy/gravely layers contained clay and numerous boulders with a very high density of 2.8 ton/m³ and dimensions up to 1.4 m long, 1.2 m wide and 1.1 m high, and with a total weight of 4.8 tons.
- This boulder field was present between 3 m and 7 m in the excavation depth.
- The clay layer was very stiff to hard with a shear strength of 250 to 300 kPa.

The TSHD Vasco da Gama successfully dredged these soils, and the bottom of the glory hole was levelled in hard clay within a bottom tolerance of 25 cm.
Trailing Suction Hopper Dredger Vasco da Gama

Due to the seastate conditions, type of soils and large water depths, the Trailing Suction Hopper Dredger “Vasco da Gama” was equipped with a deep dredging suction pipe with underwater pump for a dredging depth of 135 m.

The deep dredging suction pipe was fitted out with a draghead of 8 m wide and 50 tons in weight in order to limit the number of runs and to obtain a smooth bottom profile.

For excavation of the glory hole up to 9 m below seabed, the dredger sailed parallel lines 5 m apart at a speed of approximately 2 knots in order to take into account some overlapping for dealing with the horizontal positioning and tracking tolerances.

The layer thickness removed by the draghead during each track varied between 15 cm for loose granular sand, to less than 5 cm for stiff clay. Slopes of around 1 to 5 in the upper layers and 1 to 2 below were achieved by defining consecutive boxcuts in the dredge computers for each layer thickness to be removed.

For safety reasons, the dredger traversed around the glory hole during the dredging cycle instead of moving backwards to reach the start point of the next dredging cycle.

Approximately two vessel lengths were needed for the dredging approach. The suction pipe was raised to at least 15 m above the seabed when sailing away from the glory hole.

The dredged materials were loaded into the hopper and discharged by dumping through the bottom doors at the agreed dumping location. In order to limit disturbance of the seabed, all the loads were dumped at the same location.

During the process of the glory hole excavation, progress was monitored on board of the dredger by means of the dredging control systems, more particularly by the suction tube monitoring system. The actual draghead depth and the target depth per layer were compared on-line and any difference displayed. The position of the draghead was visualised on screen on a background of bathymetric data by means of a plan view with a differential colour chart showing the amount still to be dredged together with a longitudinal and cross profile of the Glory Hole, marking seabed level and target level. At regular intervals, the progress was checked by means of the multibeam bathymetric survey system installed in the moon pool of the dredger which avoided the use of a separate survey vessel. The system provided immediate on-line seabed information for the project team on board and was interlinked with the dredge computers in order to continuously update the dredge level achieved.
**Conclusion**

Despite the presence of a boulder field containing rocks weighing up to 4.8 ton and very stiff to hard clay to be dredged, a remarkably levelled floor of the Glory Hole was achieved by the trailing suction hopper dredger method within tolerances of 25 cm. This was the result of trailing the 8 m wide and 50 ton draghead as a sweepbeam over the seabed, and which could be executed without any additional cost for levelling by rock dumping.

The TSHD Vasco da Gama completed its work within the anticipated working period with no weather standby costs, resulting in a total cost for the Operator which was lower than originally anticipated.