## THE BRENT STORAGE SPAR

In July 1971, Shell/Esso discovered an oil reservoir in the British sector of the North Sea, which was named Brent. Shell had the habit to name its discoveries after birds, and a brent bird is a goose, looking like this:



But Brent also is an acronym of the five geological formations encountered at the discovery wells: Broom – Rannoch – Etive – Ness – Tarbert. What's in a name? Anyway, the Brent in this short story looks like this:



First oil was produced in 1976 on the Brent Bravo platform, a gravity structure, and the first tanker load of Brent crude was taken ashore to Sullom Voe on 13 December 1976. Four platforms were ultimately installed on the reservoir and remained there until the first one, Brent Delta, was dismantled by Allseas' Pioneering Spirit in April 2017. Delta had ceased producing in 2011. It was, however, not the first component of the Brent lay-out that was taken away. In 1995, the Brent storage spar was removed after its function had been suspended in September 1991. This function was intermediate storage of Brent production during the initial years, when a pipeline to shore was not yet available. The 36 inch oil pipeline to Sullom Voe (Shetlands) was commissioned in 1978 and ever since the prime function of the spar, which was storage of up to 300 000 bbls of oil, was less necessary. From that time on, the spar became a back-up facility and an alternative means of discharge of crude from the Brent field. Its certificate of fitness expired in 1991 and this made Shell decide to decommission the spar because of the costs to refurbish it and extend its operational life. Such costs were estimated to amount to  $\pm$  90 million which at the time was equivalent to Dfl 220 million. The original cost to build the Brent spar had been almost Dfl 60 million.

The name Brent spar was burned into the memory of the oil industry when in 1995 Greenpeace prevented Shell/Esso from sinking the decommissioned spar into the deep Atlantic Ocean. For Gusto, the Brent spar meant a lot more. It was the end result of a project that started in 1968, when Gerard Graaf (Shell) visited the Gusto



Product Development Department (Prodo) to discuss engineering support for a floating storage facility, denominated a spar. This term, spar, had been used already for slender bodies floating horizontally in transportation and flipped to vertical attitude for operation as a floating weather station. Gerard, who worked in BIPM's E&P department under Goldman or Starink, envisioned a similar principle applied to a not really slender body, which in vertical attitude would have a large draft and very limited wave-induced motions. To further this idea, Gerard needed assistance in determining feasibility, structural weight, upending procedures and so on. No comparable structure existed and therefore weight estimates and structural strength had to be determined from first principles. In 1968 the only calculating means of Prodo was a table-large Olivetti machine with magnetic cards, on which either a program or data could be stored. The number of program steps was very, very limited and the basic operators were +, -, \*, : and V. To program a sinus or cosine would take most of the memory, and for the round spar we needed plenty geometric functions. When in 1969 Prodo moved from the "Powerloods" to the main office of the yard, the Olivetti was taken along, but soon after Gusto installed its first (and only) computer terminal, working with the Univac computer in The Hague, at Shell. This made the Olivetti obsolete, but still no programs were available for the analysis of something like a spar.

Hans Sjouke convinced Gerard Graaf that his Prodo department could do the job and so George Lagers and later Karel de Werk were given the task to make a provisional design and figure out the feasibility of a storage spar with a nett content of 300 000 bbls of crude oil. The original project number was OW 67078. Soon Bart Groeneveld joined the team and jointly we were happily writing fortran programs to go through the steps of an upending procedure, which was at an early stage seen as a major factor of feasibility, because it was envisioned that the spar cylinder would have to be built in a drydock or on a slipway, in any case in a horizontal attitude. The reports written for Graaf have not been archived, unfortunately, but clearly they convinced Shell that a spar was a feasible storage instrument. Around 1970 Gerard Graaf went abroad for a number of years and Jan Vugts took his place as our Shell counterpart.

Then, in summer 1972, after discovery of the Brent field, Shell placed an order for the preparation of a final design and tender specifications of the spar, with Gusto project number 43209. Maas Wagenaar Hummelinck became the Gusto project manager and the Shell team consisted of Gerard Graaf, Stef Kapteijn and H. Barendregt. The tender specifications were ready on 2-10-1972. On 31 January 1973, a joint venture Gusto-Wilton Feyenoord contracted the construction of the spar for Shell UK. WF would build the storage cylinder and the neck, Gusto the topsides and, under a separate contract, the turntable needed for discharging crude into a tanker, very much alike the arrangement of an SBM. The respective contract prices were Dfl 36 188 000 for the spar and Dfl 2 990 000 for the turntable. The split between Gusto and WF was Dfl 9 271 000 and Dfl 26 917 000 and Gusto was the leading party in the joint venture.

When Shell ordered the spar, the Gusto yard was very busy already with the building and completion



of the Havdrill and the preparations for the Viking Piper. A special design team was taken out of the drafting offices and located in the Dukdalf, originally a chapel across the street from the main office. Maas Wagenaar Hummelinck was charged with leading this team and Karel de Werk at Prodo was his technical conscience. George Lagers was involved in the drillships, and on april 1, 1972, became head of Prodo, following Jan Suyderhoud, who had fulfilled this function for about a year and was then promoted to head of the

naval architectural drafting & design office. The oil related systems on board were designed by Constructors John Brown (CJB), a UK firm. One of their representatives was Hugh Shyver, with whom George had friendly contacts for many years after the spar delivery.

The construction of the spar progressed reasonably well, but the costs ran out of hand completely. In November 1976 Gusto detailed the losses incurred: Dfl 7 160 000 on their part, the superstructure and the separate turntable contract, and Dfl 7 810 000 on the Wilton Feyenoord part. It was proposed that Shell UK should contribute part of these losses, because the spar was such a new animal. JD Bax negotiated and Shell finally agreed to pay an excess over and above the contract price (originally Dfl 39 178 240 but including variation orders amounting to Dfl 41 955 739) of Dfl 2.86 million. In the same settlement Shell also agreed to pay additionally for the ELSBM, which was in an equally bad loss situation for Gusto.

After launching, the spar body was towed to Norway early 1975 by Smit, for upending and assembly with the topsides in Erfjord. In March 1975, the topsides built by Gusto were loaded out and transported to Norway, where the body had already been upended. NOC had won the contract for the assembly, which they did with their crane vessel Blue Whale. Next year, the spar was towed to the Brent field while floating vertically. Gusto's Prodo department took the opportunity to try to measure (or better: estimate in an educated way) the drag of the body. Reason for this was the

suspicion, that under the high operational Reynolds number the drag coefficient might be higher than taken into account in the design. It was and is not possible to do model scale measurements at such high Reynolds numbers. Most unfortunately the full scale measurements in the fjord confirmed this suspicion (project OW 67340). Joop Mikx and Joost van Santen reported to Shell, where the staff was not amused because it was too late to change the anchoring scantlings. Shell demanded Gusto not to publish the results of the measurements.

In June 1976, Heerema performed the final installation in the Brent field, where NOC had placed the gravity anchor blocks in 1975. The first oil discharge from the spar took place in December 1976.

In 1977 misfortune struck: an incorrect operation caused underpressure in two of the six storage tanks which buckled inwardly and broke open to the sea. The crude entering the compartments is hot and shrinks while cooling; this needs to be compensated by admitting seawater, but at the time the crew had erroneously closed the seawater valves. The damage was partially repaired to reinstate the strength of the unit, but closing the large holes in the tanks was deemed impractical. This of course severely reduced the storage capacity, but the function of the spar as a floating unloading terminal was not affected and continued to exist also after the pipeline to Sullom Voe had come into operation.

As mentioned above, the spar ceased to operate as a discharge station in September 1991. In 1995

Shell made preparations to dispose of the spar by sinking it in the deep ocean, after lengthy studies had indicated that this was the safest option. Greenpeace protested heavily, because they feared that this would form a precedent for other oil companies to get rid of old platforms by dumping them into the sea. And indeed, practice in the Gulf of Mexico had already shown that abandoned platforms created artificial reefs, where fish life was abundant. But



Greenpeace would not have that and occupied the spar on 30 April 1975. European gouvernments and the general public started to protest against the Shell/Esso/British Gouvernment plans and Shell lost clients. For some reason Esso stayed out of the wind, maybe because Greenpeace feared being



sued in the United States (read Rob Glazer in Offshore Visie jan/feb 1997).

After the Greenpeace people had been removed from the spar, Shell continued the preparations for towing away and sinking the spar. On June 15, the last anchor line was severed and the tow started, but almost at the same time Shell gave in to the omnipresent public pressure and decided to abandon the idea of sinking. The spar was towed to Erfjord in Norway and cut into sections, which were then used to build a quay. Early June, I (George Lagers) received a phone call from Sjoerd Hengst, professor at the TUD. Did I know the Brent Spar? Yes, of course. The TUD had been approached by Greenpeace who requested somebody to come to the Shetlands and explain details of the Brent Spar to the Greenpeace staff. Sjoerd was planning to send Kees Dirkse, who was unaware of any details of the spar. So, could I travel with Kees? On Monday 12 June we flew to Lerwick. A representative of the Shetland Island Council toured us around the port, where local enterprises were hoping to disassemble the spar, if Shell decided ultimately not to sink it. In the evening we spoke with the Greenpeace people: Ulrich Jurgens and Rosy Young and a Dutch speaking lady called Mary. Their questions concerned mainly the feasibility of reversed upending and demolition of the spar. I explained that their assumptions on the amount of sludge and oil remaining in the spar were simply impossible. They seemed to accept this, but it did not at all affect their readiness for action. They were hoping that Greenpeace could still stop the towing away from site, which was about to get started. The next day Kees and I flew back to Scotland and on to the continent, not feeling that we had achieved anything. On the 20<sup>th</sup> Shell decided to abandon dumping, so the TUD had no further function. In November 1995 I sent a proposal to Eric Faulds, the Shell UK man in charge, regarding a method for reverse upending. I got an answer in January 1996, in which Shell acknowledged my suggestion as a novel one, but that was the end of the story. The spar was cut in pieces in the Norwegian Erfjord while in the process its draft was reduced all the time. The contract to do this was awarded to Wood-GMC in early 1998.



## POST SCRIPTUM

The Brent Spar was unique in several aspects. It was the first spar ever built for use in the offshore oilfields. It was the only storage spar so far. The events of 1995 were unique too and did not form an incentive for oil companies to copy the Brent Spar. In the mid seventies there have been some projects for other fields than Brent, but no one materialized. But around the time of the Brent Spar demise, the concept of a deep floating cylinder found a new application as a floating production platform. Contrary to the storage spar, the first production spar (Neptune, 1996) formed the

beginning of a series of similar platforms, originally all designed and built for the Gulf of Mexico, but later also applied in Malaysia. None of these was designed by Gusto Engineering, let alone built by IHC. Rauma Repola in Finland won several early spar building contracts and this had some spin off for the Dutch industry: from Finland to the GoM. The spar cylinders were usually transported by Dockwise.



A truss spar during transportation from Rauma to the Gulf of Mexico

