



**Ir. D.F. Woudagemaal** (D.F. Wouda Steam Pumping-Station) (Municipality of Lemsterland, the Province of Friesland)

The Ir. D.F. Woudagemaal is the largest steam-driven pumping-station ever built as regards capacity and is still in running order today. It has a capacity of approximately 2,500 hp – enough to pump 4,000 m<sup>3</sup> of water per minute up to a one-metre-higher level. The pumping-station was placed on the World Heritage List in 1998. The austere, functional building constructed mainly of brick, was built over a watercourse, the Stroomkanaal, which flows into the IJsselmeer. The longest part of the building contains four tandem compound type steam engines, each driving two centrifugal pumps. Standing with your back towards the IJsselmeer, the boiler house is set at right angles next to the chimney stack on the left-hand side of the building. Running along the side walls are jetties, between which are four outflow openings and four sets of two floodgates. These doors are reminiscent of the days prior to 1932, when the present-day IJsselmeer was still the Zuyder Zee, and the rising tide was a force to reckon with. Jetties on the north side of the pumping-station have duckweed barriers and grooves into which stop logs can be inserted. The jetties are connected by a bridge resting on arches in front of the wall. Stop logs are wooden or possibly steel beams which can be stacked in the grooves to form an emergency dam. The pumping-station is connected with the Friesland 'Boezem' (or Reservoir) via the 'Stroomkanaal' and Groote Brekken Lake. The Stroomkanaal is 4 kilometres long and was dug in 1925. Friesland Boezem is filled with water from virtually all the lakes and watercourses in the province. Together they form the storage capacity for surplus water in the province. Friesland Boezem is by far the largest uninterrupted reservoir in the Netherlands.

The pumping-station was put into operation in 1920 and was coal-fired up to 1967. In that same year the original boilers were replaced and the pumping-station switched to oil, but the pumps continued to be driven by steam. Also in that same year the electrically driven J.L. Hoogland pumping-station (with a capacity of 6,000 m<sup>3</sup> per minute) took over the task of the Woudagemaal. Since then, the Woudagemaal has been used only as a back-up pumping-station and is deployed when extra capacity is required.

The Ir. D.F. Woudagemaal was named after its designer, Dirk Frederik Wouda (1880-1961), in 1947. D.F. Wouda was chief engineer of the Public Works Department of the Province of Friesland. His name is inscribed on a slightly protruding wall section on the landward side of the pumping-station as a permanent tribute.

The rise of steam-driven drainage – in the course of the 19th century – was a great leap forward with respect to water management in the Netherlands. For centuries the only way to drain and discharge water was by means of windmills and sluices. So one was dependent on wind and on water levels outside the polder. The first steam engines used for this purpose were built at the end of the eighteenth century. However, they were not very reliable and perhaps even just as unpredictable as the wind. Both too little and too much wind prohibited drainage by means of mills, and sluices had to remain closed during storms. During the 18th century, only limited use was made of steam engines due to technical flaws, restricted capacity and lack of confidence with respect to safety. Not one of the oldest pumping-stations – so the entire generation up to around 1850 – remains today, because although steam engines became more reliable during the first few decades of the 19th century, they were rarely installed in pumping-stations. Steam-driven drainage did not really become popular until the end of the second quarter and especially in the third quarter of the 19th century and they did not become a common feature until approximately 1875.



The transition to other fuels and energy sources commenced around 1900, as from which time gas and oil were used, and soon afterwards electricity as well. In that sense the Woudagemaal was an exceptionally late steam-driven pumping-station. Steam was used mainly because of the enormous capacity that was required and because by then the reliability of steam was considered thoroughly tried and tested.

The Woudagemaal is not only the largest pumping-station in the world; it is also the largest one still operating today and it is one of the last steam-driven specimens to have been built on this scale. This pumping-station represents and is the height of over one hundred years of steam-driven drainage in the Netherlands. It is also a symbol of the end of the steam era in draining technology.

### **The Ir. D.F. Woudagemaal, a brief history**

The Province of Friesland has a long history of laborious drainage and increasing drainage issues. The difficulties were caused partly by the wind pushing up the water in the enormous boezem (reservoir). This boezem comprises the total storage capacity of the inland waterways in virtually the whole of the Province of Friesland. Furthermore, several lakes and pools were reclaimed, which reduced the storage capacity and therefore played a significant role in the issue. And peat extraction in the Province considerably reduced the 'sponge effect' and therefore the storage capacity of this type of soil and thus its ability to even out water levels. For centuries, water was discharged naturally into the Zuyder Zee and the Wadden Sea/Lauwerszee by opening sluices at low tide or when water levels outside the polder were low. During the course of the 19th century this became increasingly problematic as the surface levels of the peat and clay soil continued to drop, so mechanical ways were sought to discharge water in addition to natural discharge. Consequently, in 1913, it was decided to build two diesel-engine-driven pumping-stations along the southern coast. However, it soon became apparent that one large pumping-station would offer advantages over two separate diesel-engine-driven pumping-stations. Therefore, work commenced in 1915 on the construction of what at the time was still called the 'Provincial Steam-Driven Pumping-Station' west of Lemmer. World War I (1914-1918) caused considerable delays in its construction due to lack of materials. Also, material prices had risen beyond what had been budgeted. Instead of the budgeted 1.8 million guilders, construction costs eventually amounted to 2.8 million guilders – a colossal amount in those days. These problems were exacerbated on 16 June 1918, when lightning struck the just completed but not yet protected, 60-metre high chimney stack, only slightly increasing the costs but certainly slowing down the process of construction. The pumping-station had been put into service once before it was officially opened by Queen Wilhelmina on 7 October 1920.

The Ir. D.F. Woudagemaal has an engine room of over 62 m x 16 m under an elongated saddle roof with three lower-lying diagonal roofs on either side. A boiler house measuring 31m x 16 m is situated along the west side of the engine room and has a saddle roof with a skylight. These two buildings form an L-shape. The 60-metre high chimney stands on the west side of the boiler house.



D.F. Wouda was assisted by J.C. Dijkhoorn in the calculation of the installations. Construction was granted to Johan and Jacques Broersma, two brothers from Alkmaar, who were the main contractors, and to the 'Jaffa' machine factory (formerly L. Smulders & co.) in Utrecht for the technical aspects of the project. Upon completion, the pumping-station had four horizontal tandem compound type steam engines. In this type of engine the steam from one cylinder – a high-pressure cylinder – is sent to a second, low-pressure cylinder on the same piston rod. The four steam engines are fitted with large, impressive, vertically positioned fly wheels and horizontal cylinders and piston rods. They are still intact and run on superheated steam of 3100 C, at an overpressure of 10 atmosphere. The machines operate in parallel in opposite directions. Up until 1955 the required steam was provided by six coal-fired boilers. The boilers formed a 'combined system', with 'flame pipe boilers' above and Lancashire boilers below. In 1955, these combined boilers were replaced by four boilers built by Werkspoor, which were converted in 1967 into oil-burning boilers.

The eight 'Jaffa pumps' (named after the manufacturer) are constructed of sheet-iron segments and positioned in line with the flywheels, thus emanating enormous power. Together they are able to pump and discharge 4,000 m<sup>3</sup> (4,000,000 litres) of water per minute.

In 1967, a second pumping-station, the J.L. Hooglandgemaal, was put into operation to serve the Friesland Boezem. The reason for its construction was serious flooding due to insufficient capacity of the Woudagemaal and limited discharging via sluices between 1948 and 1951. The new pumping-station, operated by electrically driven Archimedean screws, was built at Stavoren. The Hooglandgemaal has a maximum capacity of 6,000 m<sup>3</sup>, but despite its considerably larger capacity, the Ir. D.F. Woudagemaal still needs to be deployed at times.

### **The Ir. D.F. Woudagemaal today**

The Ir. D.F. Woudagemaal was withdrawn from permanent service when the J.L. Hooglandgemaal, in Stavoren, became operational. But this was not the end of the steam giant. The pumping-station is constantly on stand-by and has a workforce of no less than eight men. They keep the installations and the building intact and can ensure that the pumping-station is 'steamed up' in 6 hours. This is an enormous improvement compared to the 24 hours it took when the installation was still coal-fired – so before 1967. The significance of the Woudagemaal is obvious from the fact that it was deployed for a good 400 hours in 1998 and even for 10 consecutive days in the spring of 2002 – clear proof that it is a 'living monument'. And a monument that has been kept in excellent condition. The pumping-station has been designated as a State Monument enjoying much interest from an industrial heritage point of view. After it was inscribed on the World Heritage List in 1998, the pumping-station was opened to the public in July 2001. Mr E.H.T.M. Nijpels, Royal Commissioner in the Province of Friesland, performed the opening ceremony. The Ir. D.F. Woudagemaal thus became a symbol of the Netherlands' large-scale steam-powered battle against water since the middle of the 19th century. But the pumping-station was more than just the physical and technical highlight of the application of steam; it also constituted the beginning of the end of steam as a source of power in drainage technology. It can therefore also be considered a turning point in Dutch drainage history, not as radical as the transition from wind to steam, but important as the end of an era. Inscription on the World Heritage List can contribute to preserving and possibly reinforcing the recognisability of the qualities of the Ir. D.F. Woudagemaal, which helped to keep a part of the wet, low-lying Netherlands inhabitable. Preservation and possible reinforcement of these qualities stem primarily from the Dutch government's duty to maintain the site, ensuing from its inscription on the World Heritage List.



## Literature and information pertaining to the Ir. D.F. Woudagemaal

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