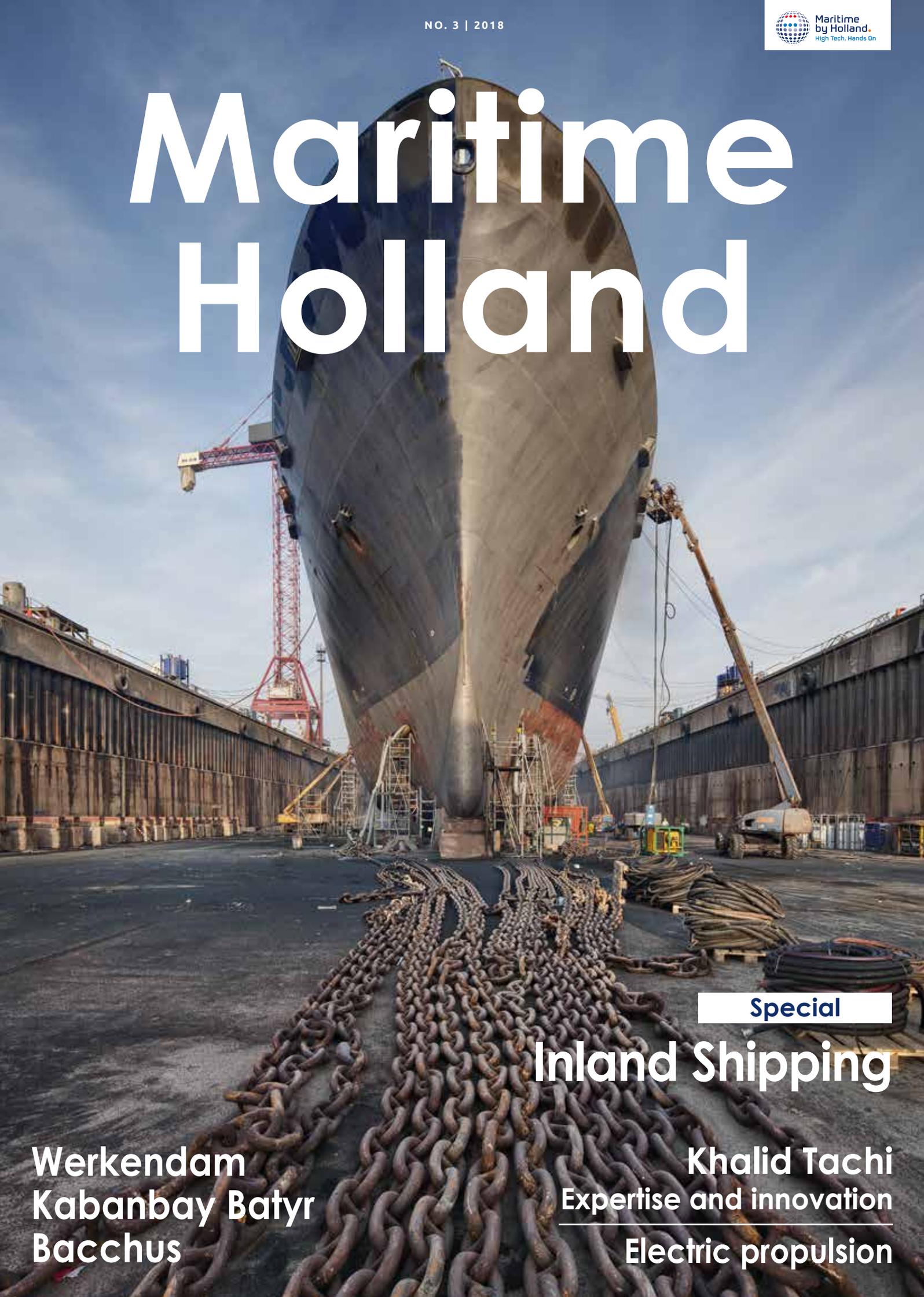


Maritime Holland



Special

Inland Shipping

Werkendam
Kabanbay Batyr
Bacchus

Khalid Tachi
Expertise and innovation
Electric propulsion

BACCHUS

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100% Dutch-built diesel-electric river chemical tanker

For many years (2000 to 2012), the building of inland tankers of 110 metres was a matter of copy-paste. A basic hullform was designed and known to perform well, and the hulls came built-in-China by the dozen on a heavy-lift vessel for outfitting in the Netherlands. Through their own research, Concordia Damen Shipbuilding (at that time Concordia Group) had already discovered that there was still a lot of optimisation potential in these vessels.

So when they were approached by Chem-Contrans AG, a Swiss tanker company owned by Mr. and Mrs. Olislagers from Belgium, for a new vessel, Concordia Damen Shipbuilding proposed to start the project with a clean slate, rather than to continue building a vessel based on the design of the previous vessels.

A completely new design takes some extra time, and the required delivery time was very short, but the needed time was reduced by building the entire vessel in the Netherlands. After all, the time needed for transportation of the hull from China was therefore minimised. The hull was built in Ridderkerk, at Massive Dynamic Constructions.

Concordia Damen Shipbuilding

The new ship, named *Bacchus*, is the first delivery since the creation of the Concordia Damen Shipbuilding, a joint venture between Concordia Group and Damen Shipyards. Co-owner and technical director Bert Duijzer explains: "Many people seem to think that Concordia Group was acquired

by Damen Shipyards, but this is incorrect. In reality, we have started an intensive collaboration with Damen Shipyards, which are our neighbors across the river and will be mutually beneficial. Both of our companies had been building both seagoing and inland vessels. From now on, the seagoing vessels will be handled by Damen Shipyards and worldwide all inland vessels will be handled by Concordia Damen Shipbuilding. This will allow us to focus on our core activity - which is inland shipbuilding. The owners of inland vessels typically wish to walk into a shipyard and discuss a new project directly with the yard manager, something which is almost impossible in a large organization like Damen Shipyards. At the same time,

Damen has a massive global sales network, which will now be used also for the sales of inland vessels built by Concordia Damen Shipbuilding, a true equal joint venture in which both partners amplify the potential of each other."

Design

From other projects, Concordia Damen Shipbuilding knew that there is not much saving potential in the bow shape, but there was significant room for improvement in the aft ship. This was especially aided by the fact that the yard chose for a diesel-electric propulsion system, even if it is with conventional shaftlines. The electric motors have a much shorter length than a complete diesel engine/gearbox package, which means that the aft hull shape can start to climb much earlier - resulting in a more slender aft ship with significantly lower resistance.

The aft ship optimization was realized using Computational Fluid Dynamics with SIP Marine (based in Drunen, the Netherlands), which is also the supplier of the propellers. The result is spectacular. In 2007 Chemcontrans took delivery of *Comus II*, a vessel with near-identical cargo capacity, length and beam. While *Comus II* had two main engines of 1507 kW each for her propulsion, *Bacchus* reaches the same speed with only two electric motors of 600 kW each. Of course there are some losses in the transition from mechanical power to electrical power and back, but these are close to nothing compared to the gain in the required propulsion power. Each propeller is housed in a so called Highspeed nozzle from SIP Marine, which have a slimmer profile and struts instead of a headbox. Behind each nozzle is a pair of Easyflow rudders from De Waal (Werkendam, The Netherlands), which also supplied the Stuwa propeller shafts, seals and steering gear. The bow thruster is a four channel thruster from Verhaar Omega.

Diesel-electric

The diesel-electric propulsion was not only chosen for the freedom it gives to redesign the aft ship. André Brandt from Hybrid Ship Propulsion explains: "People often think that a vessel like this has a very narrow

HULL AND PROPULSION HIGHLY OPTIMISED

The hull was built in Ridderkerk and launched with large floating cranes



Outfitting was done in Werkendam at Concordia Damen Shipbuilding

PM motors

For the propulsion motors, Hybrid Ship Propulsion proposed permanent magnet motors. While being more costly than the standard squirrel-cage electric motors, they have the advantage of being more compact, and have a higher efficiency at half speed. While squirrel-cage motors lose 20 to 30 per cent in efficiency at half speed, this is less than 10 per cent for permanent-magnet motors. SIP Marine optimised the propellers taking into account the high available torque at low speed delivered by the electric motors, which lead to a more efficient propeller design.

Forward engine room

Another advantage of the diesel-electric propulsion plant is that it allowed to place the generators in the foreship. This makes the accommodation and wheelhouse exceptionally quiet and free from exhaust smells. The generator sets (3 sets with a Caterpillar

C18, rated at 550 kW and one set with a Caterpillar C7.1, rated at 200 kW) are located in two separate engine rooms to ensure redundancy. On *Bacchus*, this means a lower forward engine room and a higher forward engine room. The "propulsion room" in the aft ship contains only electrically powered equipment and still has so much free space - in spite of a number of large Variable Frequency Drives - that the space is used for a ping-pong table, indeed a rare sight in engine rooms on ships.

Cargo

Bacchus will be used to transport chemicals such as acids or paraffine for Stolt-Nielsen. Some of these cargoes have to be heated to remain in liquid state and the cargo tanks have a thermal oil heating system, allowing the cargo to be kept at 90 degrees Celsius. The thermal oil is heated in a diesel-fired boiler from Heatmaster in the lower forward engine room. All cargo-piping has a tracing

system, which consists of electrical heaters. The cargo tanks are built of Duplex stainless steel and are an integrated part of the structure. This chemical tanker being new to Concordia Damen Shipbuilding, the shipyard had a lot of support from owner's representative Sjaak Oudakker, who is also a ship owner with a vessel under construction at the shipyard. Together they designed the cargo piping system which is so extensive that it is possible to carry a different cargo in almost each of the 13 cargo holds. The holds are separated by corrugated bulkheads, and a cofferdam amidships also houses the slob tanks, where tank wash water can be stored until it can be discharged to shore. Each cargo hold has a Marflex deepwell pump for unloading, which consists of a submersed pump part at the bottom of the tank which is driven by a long drive shaft by an electric motor on deck. Being a gas tanker also lead to a number of requirements, for example regarding the distance between openings in the accommodation and the cargo area and the size of freeing ports in the bulwarks on the foredeck (to avoid heavier-than-air gases to remain trapped). Bert Duijzer also points out the excellent collaboration with Lloyd's Register to ensure compliance with all the regulations.

High standard

Even though this is a commercially owned and operated tanker, with alternating crews, the standard of the accommodation does not fall short of that of owner-operated inland tankers., which are famous in the shipbuilding industry for their lavish interiors. Built by Hoogendoorn interiors (Werkendam, the Netherlands), the accommodation has five single cabins and a spacious lounge/

operational profile (constant speed and displacement), but this is actually not true. The difference between sailing upstream fully loaded and downstream empty is huge, so for 50 per cent of the sailing time, the vessel is sailing off the design point. Add to that all the time spent maneuvering (locks, harbors, etc.) where diesel-electric is clearly beneficial. Furthermore, the cargo pumps require a significant amount of electrical power, and a diesel-electric plant allows us to use the same engines for these kind of operations."

André continues: "We have now delivered more than thirty vessels with a hybrid or diesel-electric propulsion plant, but for each of them, the choice of voltage, frequency, DC or AC and equipment is entirely different. We optimize these variables in function of what the ship has to do and the balance in cost and weight between cables and equipment. In this case, the optimal choice led to an AC-powered system with a voltage

of 480V at 60 Hz, which is converted to 200V / 50 Hz for the hotel consumers."

Significant gains are possible with a diesel-electric propulsion, if designed wisely. Even more than a reduction in fuel consumption and CO₂ emissions, it's a matter of reducing NOx and SOx emissions and particulate matter (P.M.). Modern common-rail diesel engines may still be very energy-efficient at low loads, but their emissions of NOx, SOx and P.M. increase significantly at an off-design point. Appropriate engine loading is as important as after-treatment of exhaust gases, while a combination of both

is of course the better choice. On *Bacchus*, no exhaust after-treatment systems (aside from noise dampers) are installed, as these are not required at the moment.

Due to the power management system onboard, only the required number of generators is running at any given time, which significantly reduces the running hours and therefore the maintenance costs in comparison to a diesel-direct ship, where always two main engines and a generator are running to provide the needed power. While a diesel-electric vessel may have a higher build cost, these costs are earned back multiple times in the lifecycle costs due to savings on fuel costs and maintenance. There is a trend that shipbuilders are judged on lifecycle costs (calculated based on an operational profile) rather than pure build costs, which is definitely an advantage for the Dutch shipbuilding and ship design industry.

CLEAN-SLATE DESIGN

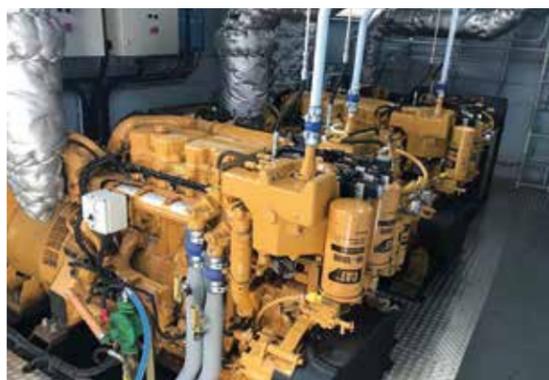
The wheelhouse is a pleasant workspace



The accommodation is exceptionally silent due to the forward engine room



Concordia Damen's core business is designing and building inland waterway, offshore and seagoing vessels with an innovative and economic profile. Our designs combine clients' wishes with technical and financial expertise. Down-to-earth-management enables us to successfully build vessels worldwide. Besides shipbuilder, we are a reputable shipbroker and manage a fleet of inland navigation vessels.



A power management system ensures gensets run properly loaded



The permanent magnet propulsion motors ensure high efficiency at partial loads

mess room. A crane and stowage position for a car is provided. The entire wheelhouse and its roof can be lowered to reduce the draught of the vessel to only 5.2 metres. The wheelhouse was built by Kampers, and the navigation and communication equipment supplied by Radio Holland and installed by Oechies Elektrotechniek, the parent company of Hybrid Ship Propulsion.

Conclusion

For Concordia Damen Shipbuilding, the build cost difference in hull building is still

in favor of building hulls in China. Concordia Damen Shipbuilding has a local team on site to ensure the quality of the production.

While *Bacchus* marks a significant step forward from previous builds, according to Bert Duijzer, it is just another step towards complete electrification of inland shipping. Neither the battery technology (and pricing) nor the recharging infrastructure are in place at the moment, but Duijzer is convinced that electrical power will be the most feasible and affordable solution for

inland shipping in the long run. Indeed, the next two vessels - which are already under construction - will also be diesel-electric but will also incorporate a significant battery pack. With inland shipping on the rise globally, as a cleaner and less congested alternative to road transport, and the Dutch maritime industry at the forefront in innovation in this field, the future in this market is looking better than it has looked for a long time.

Bruno Bouckaert

Principal particulars

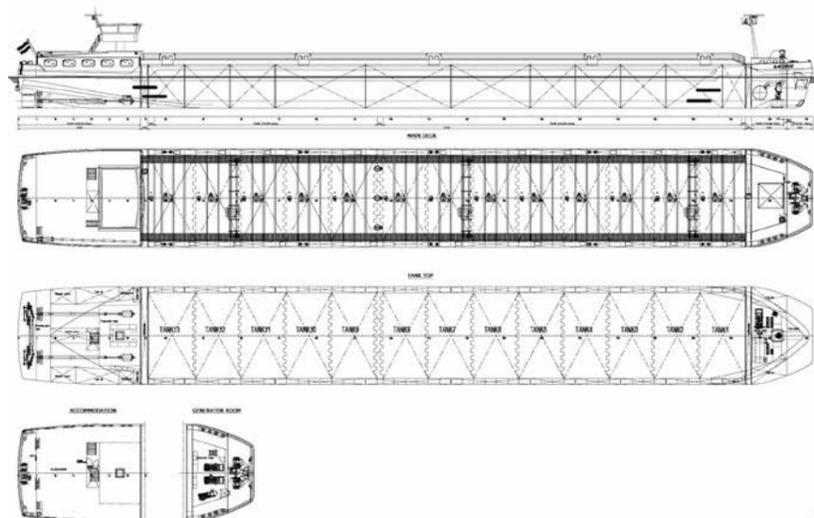
Builder
Concordia Damen Shipbuilding, Werkendam, the Netherlands

Owner
ChemContrans AG, Zug, Switzerland

Length o.a. 110.00 m
Beam mld. 13.50 m
Design Draft 4.52 m
Depth 5.80 m
Deadweight 4,300 tonnes (payload)

Generators 3 x 550 kW each
Harbour Generator 1 x 200 kW
Propulsion 2 x 600 kW
Max speed 19 km/h

Capacity
Crew 5
Cabins 6
Cargo tanks 4,940 m³
Fuel tanks 93.5 m³
Fresh water tanks 23.6 m³
Ballast water tanks 1,487 m³



Subcontractors and suppliers of equipment fitted on board the *Bacchus*, YN CS 810

All Pumps Holland, Papendrecht: pumps; **Asto**, Raamsdonkveer: alignment main engines; **Blokland Non Ferro**, Slidrecht: boxcoolers, Shell tubes coolers; **Blommaert**, Werkendam: stainless steel works, masts, wheelhouse stairs; **CCM3**, Werkendam: outfitting; **ClimaLogic**, Dordrecht: ventilation system, stainless steel lockable grilles, degassing ventilators; **De Waal**, Werkendam: *Stuwa* propeller shaft installation, *Stuwa* propeller shaft seals, *Stuwa* steering installation, *EasyFlow* rudder system; **Dik den Hollander Maritiem**, Werkendam: complete upholstery house and wheelhouse, including PVC floors, window coverings, sun protection, furniture, mattresses and bed textiles; **Dockmarks**, Zwijndrecht: lettering; **Heatmaster**, Hendrik-Ido-Ambacht: cargo heating installation; **Hoogendoorn maritime betimmeringen en interieurbouw**, Werkendam: carpentry accommodation and wheelhouse; **Hybrid Ship Propulsion**, Rotterdam: electric propulsion including PM electric motors; **Installatiebedrijf Hoko**, Werkendam: complete sanitary installation; **Kampers Pumpservice**, Puffershoek: *Kampers* pump for residual cargo / slops; **Kampers Shipyard**, Puffershoek: wheelhouse and lifting pedestal; **Kieboom Werkendam**, Werkendam: complete ship inventory; **Leemberg Pijpleidingen & Apparatenbouw**, Zwijndrecht: deck and cargo piping; **Lloyds Register EMEA Marine**, Rotterdam: classification; **Marflex Europe**, Oud-Beijerland: *Marflex* deepwell pump and stripping pump; **Nelf Marine Paints**, Marrum: paint; **Nidec**, Slidrecht: *Leroy-Somer* marine alternators; **Oechies Elektrotechniek**, Rotterdam: electrical installation with *Radio Holland* navigation & communication equipment, satellite connection, air-conditioning system, underfloor heating, complete tank gauging system and installation of tracing, *Radio Zeeland* pilot; **Oonincx Scheeps onderhoud**, Werkendam: christening platform; **Orlaco**, Barneveld: CCTV system; **P.Stam Las en Constructiewerken**, Wijk en Aalburg: engineroom floors; **Pon Power**, Papendrecht: *Caterpillar* marine generators sets, *Caterpillar* diesel motors with *Leroy-Somer* marine alternators; **Rafa**, Leusden: windows; **Sip Marine**, Drunen: propellers and high speed nozzles; **Speadheat Breda**, Breda: underfloor heating in accommodation and wheelhouse; **Thermon Europe**, Pijnacker: heat tracing and electronic control systems; **Theunissen Technical Trading**, Malden: *Pesch / Seematz* window searchlights and window wipers; **Tresco Engineering**, Antwerp, Belgium: *Tresco Navigis* navigation program; **Van Wijk Stuurhuizen**, Werkendam: aluminum doors; **Van Wijk**, Werkendam: car crane; **Verhaar Omega**, Sassenheim: *Verhaar Omega* bow thruster installation; **Windex Engineering**, Hardinveld-Giessendam: air conditioning, overpressure installation.

