



Photo by Nick Franken

AUDACIA

BULKCARRIER CONVERTED INTO DYNAMICALLY POSITIONED PIPELAY VESSEL

Builders: Keppel Verolme Shipyard, Rozenburg, The Netherlands

Owners: Allseas, Châtel-Saint-Denis, Switzerland

When the bulk carrier 'Geeview', built in China, came up for sale shortly after delivery in 2005, Allseas saw this as an excellent opportunity to expand its fleet of deepsea pipelaying vessels. Offshore contractors often prefer a conversion over a newbuilding because things need to go a little faster in that industry. The 'Geeview' was sold because price fluctuations in the bulk carrier market meant that more profit could be made by selling the vessel than by operating it for many years. The acquisition price of around 38 million euros for an almost new vessel is small in comparison to the additional conversion cost of 300 million euros. One can almost consid-

er this as a Dutch newbuilding project, with the hull and primary systems built in China. Allseas operates a fleet of well-known pipelaying vessels such as the 'Lorelay', 'Tog Mor' and 'Solitaire', the world's largest pipelaying vessel. Unlike the 'Seven Oceans' from Subsea 7 featured in June this year, which stores its pipes (up to 16" diameter) pre-welded on a large reel, the 'Audacia' is equipped to perform the welding of rigid pipe at sea. This allows the installation of thicker pipes, with an outside diameter up to 60 inches. Depending on the diameter, 'Audacia' can lay pipes up to a depth of 3500 m at a rate of 4 to 7 km per day.

Bulk carrier conversion

The concept of the ship was entirely developed in-house by Allseas Engineering in Delft (NL). Besides considerable time and cost savings, the modification of an existing bulk carrier gives the 'Audacia' a clear advantage in speed. The original propulsion system has entirely been retained, giving the vessel a cruising speed of 16 knots. This has been achieved by laying the pipes over the bow, instead of the stern as seen on other vessels in her class.

With a maximum beam of 32.6 m, the 'Audacia' can pass through the Panama Canal. Its length without the stinger is 225 m. The



Bulkcarrier 'Geeview' before for the conversion

accommodation has been entirely renewed to provide for the 240 crew employed on board, in single and double cabins. The original accommodation tower was taken off in the shipyard and replaced with a new, longer superstructure. The accommodation was installed by OACG from Rotterdam.

Main characteristics

The vessel is classed by Lloyd's Register of Shipping with class notation ✱ 100 A1 DP(AAA). She has the following dimensions:

Principal particulars

Length incl. stinger	330 m
Length excl. stinger	225 m
Stinger length	106 m
Breadth	32.26 m
Depth to main deck	19.2 m
Draught excl. thrusters	9 m

Performance

Cruising speed	16 knots
Diesel-electric power	35.100 kW
Diesel power	10.500 kW
Pipe storage capacity	16.000 ton

Pipelaying

Maximum diameter including coating	60 inch
Maximum water depth	3.500 m
Laying speed	5 to 7 km/day

Firing line

The area where the pipes are assembled, welded, tested and coated is called the "firing line". This area runs from the stern to the bow and is covered by a shelter. Usually, the ship will receive a regular supply of pipes from other ships during pipe laying (a 24 ton capacity pipe transfer crane loads the pipes on board), but to provide a buffer for bad weather, the ship also has four holds for a total of 16.000 tons of pipes. The pipes can be taken out of the storage holds with overhead beam cranes.

They are then transferred to the beginning of the firing line. In the firing line are 12 workstations for welding, non-destructive examination of the welds and field joint coating. Several stations each do a welding pass and then several stations carry out the non-destructive examination and the coating of the welds. The seven welding stations make use of the Phoenix automatic welding system, which was designed and fabricated in-house by the shipowner, Allseas. For every step, the ship sails 12 m forward allowing a new pipe to be added to the firing line at the stern.

Constant tension

While dynamic positioning can keep the ship at a certain location, the ship will still move because of the waves and wind. During pipe installation, the goal is to keep the pipe as stationary as possible. This is done by applying a constant tension on the pipe. With any given motion of the ship, the tensioners will haul in or let out a bit of the pipe to keep it exactly in the same place relative to the bottom. Another crucial role of the tensioners is to

The conversion at full steam



prevent the pipe from buckling under its own weight. The amount of tension applied is dictated by the depth, the weight of the pipe and the vessel motions. The tensioners on 'Audacia' were taken off 'Solitaire' during its last refit. The three 175 ton tensioners together can provide a pull of 525 tons. They are placed on special bearings that are capable to absorb all loads (including uplift) during pipelaying activities. This is achieved by using specially designed elastomeric elements built into the structure. The welding stations in the firing line are positioned in carts on rails which are attached to the pipe, so they remain stationary to the pipe independent of the ship's motions. The 'Audacia' has no active stabilizers, yet with this arrangement she can lay pipes in seastates with a significant wave height of up to 3 metres.

106 m stinger

Whereas all other pipelaying vessels lower the pipes from the aft of the vessel, on the 'Audacia' this is done from the bow. A gigantic 106 m long stinger is fitted for this purpose. The stinger is a cantilevered slide, guiding the pipeline gently into the water from the horizontal position on deck to a vertical position aimed at the depths. It is composed of three hinged sections with a total weight of 770 tons. During transit, the stinger can be lifted out of the water by a large 550 ton crane on the bow. It then extends some 40 m above the surface to avoid any damage from wave impact.

Load sensors

To accurately govern the tensioners and the DP system, the 'Audacia' is equipped with a wealth of measuring devices. Technofysica from Barendrecht has supplied, a.o. the following devices:

- Stinger pipe load monitoring system,
- Control & load measurement of stinger handling system,

- Control & load measurement of stinger adjusting system,
- Load measurements in various guide sheaves related to: tail anchor winch, TSA winch, A & R guide sheaves,
- Tensioner (load verification) load link load cell, capacity 350 tonnes.

Diesel-electric propulsion

To allow for exact dynamic positioning, the original propulsion system has been extended with 6 retractable electric thrusters, each converting 5 MW of electric power into 80 metric tons of bollard pull. The power for these thrusters is generated in two added engine rooms, each holding three 5850 kW generator sets based on Wärtsilä 9L38B engines. In normal operation, only two of the three generator sets in each engine room will be running, with one on standby.



One of the two added engine rooms



The Phoenix automated welding system



The tensioners keep the pipe stationary and prevent buckling

The 550 ton A-frame being placed onboard

The six retractable Wärtsilä thrusters are of the type FS3500 and can be steered through 360 degrees. The propellers are located in nozzles. The total installed electrical power amounts to a solid 35.100 kW. By comparison, the original propulsion installation (non-electric) delivered only 10.500 kW. The vessel is classed as a DP (AAA) vessel, which means that it can still be dynamically positioned even if one of the engine rooms goes totally off-line. The original bow thruster was kept in service to provide for low-speed manoeuvring in shallow waters.

During transit, the 'Audacia' always sails on the original direct-drive diesel installation. While pipelaying, the diesel-electric propulsion with 6 retractable thrusters is used for dynamic positioning and the conventional propulsion is taken off-line.



Collaborative effort

The electrical engineering for the propulsion was done by Imtech Marine & Offshore from Rotterdam, collaborating with GTI. Together they installed 8000 cables totalling 375 km, with 20.000 connections. The work represented 400.000 man-hours, but was completed in only 40 weeks. GTI also took care of the outfitting and piping installation of the two newly added engine rooms, a work of 175.000 man-hours which took about 8 months. With Bakker from Sliedrecht also involved in the electrical installation, drive, control and automation systems, this is a rare case where the two Dutch giants of electro-technical engineering were working side by side.

Hydraulic power

Many systems on board the ship make use of hydraulic power. The entire system was engineered by Bosch Rexroth and is based on 2 hydraulic power units. The larger one is powered by 5 main pumps of 240 kW and a smaller one with 2 x 66 kW main pumps. The hydraulic consumers include the various cranes, the pipe tensioners and a number of winches supplied by Emcé. A 550 ton abandonment and recovery winch allows the pelaying to be interrupted for bad weather and to be resumed later on. A large A-frame with a safe working load of 550 ton on the starboard side approximately

The helipad is on the aft deck



Bosch Rexroth supplied the hydraulic installation

amidships is used for the installation of pipe line end manifolds (PLEMs). These are



The 'Audacia' was christened on May 8th 2007

attached to the end of a pipeline and allow pipelines to be routed from this point.

Two bridges

The 'Audacia' is equipped with two separate bridges: one for normal navigation and one dedicated to dynamic positioning. The navigation and communication equipment was supplied by Radio Holland. Sperry Marine took care of the complete refit and commissioning of the bridge equipment. For the main engine, electronic control has been provided through the systems supplied by SAM Electronics.

The emergency diesel generator



They supplied a diesel manoeuvring system (DMS 2100), an electronic governor system (EGS 2000) and an engine safety system (DPS 2100). The bridge interface is based on a familiar Windows environment.

Conclusion

The 'Audacia' was christened on May 8th 2007, in the presence of about 700 guests. After finishing her first job in the North Sea, the 'Audacia' will sail to the Bay of Bengal in India, where she will lay gas pipelines together with other Allseas ships to a total length of 313 km at a water depth up to 1200 m. The repair of damages caused by hurricane Katrina and the high oil price has caused a boom in the offshore construction market, which keeps on going till today. In 2006 the Keppel Verolme yard booked a record turnover of 160 million euro. After the refit of 'Solitaire', the conversion of 'Audacia' has strengthened the customer-supplier bond between

Allseas and Keppel Verolme.

Subcontractors and suppliers of equipment fitted on board the 'Audacia' (partial list)

- Aalborg Industries, Spijkenisse** : Energy Management System; extension / modification steam boiler plant; system components
- ABB Marine & Turbocharging, Rotterdam** : checking main engine turbocharger;
- Aces Direct, Tilburg** : computer hardware & software
- Advantec Electronics, Oudenbosch** : encapsulated power supplies
- AE Sensors, Dordrecht** : sensor ("string-pot")

Elastomeric bearing tensioners



- Air Products Nederland**, Amsterdam:gasses cutting- and welding processes
- Ajax Fire Protection Systems**, Amsterdam:sprinklers; watermist system
- Alfa Laval Benelux**, Breda:freshwater generator; bilge water separator
- Allweiler Pumps Benelux**, Utrecht:pumps
- Amatec**, Alphen ad Rijn:stainless steel technical springs
- Anker, Het**, Schelluinen:windows & portholes
- Batt Cables**, Oud Beijerland:flexible halogen free shipboard cable
- Bayards Aluminium Constructies**, Nieuw-Lekkerland:helideck; engineering; platforms; lighting & firefighting
- Blok-Interrek**, Rotterdam:office furniture; desk-chairs
- Blomsma Signs & Safety**, Zoetermeer:safety signalling marks IMO / SOLAS
- Bodewes Winches**, Nieuwekerk a/d IJssel:stinger winches
- Boer Plastik de**, Heemskerk:polycarbonate clear facemasks
- Boer Staal, De**, Uitgeest:steel plates; bulb flats; tubes
- Bosch Rexroth**, Boxtel:hydraulic power units- equipment- piping & installation
- Breedveld Staal**, Krimpen a/d IJssel:steel
- Castrol Marine**, Rotterdam:lube oils
- Consilium Marine Systems**, Schoonhoven:fire detection equipment
- Corrosion & Water-Control**, Moerkapelle:anode system stinger protection
- Datema Delzijl**, Delfzijl:nautical inventory & safety- fire-fighting, medical-, distress signals & rescue equipment; nautical electronic charts & books; navigation lights; *Light Partner* lighting systems & safety signs; navigational instruments
- Econosto Nederland**, Capelle a/d IJssel:valves & fittings
- Eekels Pompen**, Barendrecht:pumps
- EMCE Machinefabriek**, Voorhout:winches; capstans; storage reels, bollards, rollers, chocks
- Emha Technisch Bureau**, Ridderkerk:*Chockfast Orange*® epoxy installation works; pipe handling equipment
- Fuglesangs**, Rotterdam:*Garbarino* engine pumps
- Future Pipe Industries**, Hardenberg:glassfibre reinforced pipe systems for sea water cooling systems
- Goffin Meyvis Analytical & Medical Systems**, Etten-Leur:*Rion* sound level meters
- GMS Instruments**, Rotterdam:thermometers, meters; measurements; switches; calibration equipment; sight glasses
- GTI Marine Offshore**, Rotterdam:ships electrical systems; piping installation
- GTI Seton Pijpleidingen**, Dordrecht:electrical installation; piping systems
- GN Piping / IHC Piping**, Sliedrecht:piping installation forward equipment room
- Hatenboer-Water**, Schiedam:freshwater treatment equipment; freshwater hydrophore & treatment unit; hot water calorifiers
- Hempel (The Netherlands)**, Vlaardingen:paint systems
- Hertel CKT**, Rotterdam:persons accommodation
- Hollandia**, Krimpen a/d IJssel:steelstructure new accommodation; reinforcement & alteration sections hull and decks
- Hoogland & Massee**, Dordrecht:steel tubes; flanges; elbows; fittings
- Huisman Special Lifting Equipment**, Schiedam:*Itrec* mast crane; pedestal mounted offshore crane with automatic overload protection
- Hytrop Hydrauliek**, Sliedrecht:hydraulic engineering for flipper system
- International Paint**, Rhooon:coating systems pipeholds, engine rooms, tanks
- Intersona**, Heerde:calculations
- Imtech Marine & Offshore**, Rotterdam:LV switchboards; additional thrusters; thrusterdrivs for A&R winch and tensioners; electrical installation & engineering;
- Johnson Controls Systems & Service**, Dordrecht:HVAC system; chilled water plant; mechanical ventilation; steam unitheaters
- Jong & Lavino, De**, Geldermalsen:steel plates
- Kooyman-Shipchandlers**, Dordrecht:galley-, cabin equipment/utensils; all catering supplies food & non-food
- Kranendonk**, Rotterdam:insulation; persons accommodation upholstery; floor systems; floor coverings; sanitary systems
- Kroon Techn. Groothandel**, Hoogezand:ship's locks & hardware
- Lankhorst Touwfabrieken**, Dordrecht:*Eurofloat* mooring ropes
- Leeuwen Jr's Buizenhandel, Van**, Zwijndrecht:pipes & components
- MAN Rollo**, Zoetermeer:emergency marine genset
- Materiaal Metingen Europe**, Ridderkerk:anodes for thrusters
- Mechelen Lifting Gear, Van**, Bergen op Zoom:steel wire rope sheaves; sheaves
- Mennens Schiedam**, Schiedam:steel wire ropes; chains; shackles; high pressure hydraulics
- Nieuwburg L. & Zn**, Krimpen a/d IJssel:rubber hoses & flanges
- Nobel en Zn Filtration & Separation, A.**, Zwijndrecht:all filter spares main- & auxiliary engines and equipment
- Northrop Grumman Sperry Marine**, Vlaardingen:upgrade navigation & communication systems; re-fit & commissioning all bridge equipment
- Observator Instruments**, Ridderkerk:*Hepworth* window wipers
- ODS**, Barendrecht:pipes; tubes; flanges; welding elbows; reducers; couplings
- Radio Holland Netherlands**, Rotterdam:navigation- & communication systems; audiovisual equipment
- Redwise Maritime Recruitment**, Bunschoten:crew
- Reikon**, Spijkenisse:*Azuce* pumps
- Rubber Design**, Heerjansdam:flexible suspension exhaust system; stainless steel bellows exhaust system
- SAM Electronics Nederland**, Rotterdam:diesel manoeuvring system; electronic governor system; engine safety system
- Ships Spares Logistics**, Rotterdam:custom formalities; express deliveries spare parts & furniture
- Techno Fysica**, Barendrecht:monitoring system; stinger handling system (SHS); stinger adjusting system (SAS); load measurements; tensioner load link load cell
- Temaro**, Rotterdam:fire retardant curtains; roller blinds; *Solasolve*® sunscreens
- Theunissen Technical Trading**, Malden:*Aqua Signal* lighting; *MCT Brattberg* cable transit seals; *Zenitel* communication equipment; *SeaTeleCom* communication equipment
- Trelleborg Bakker**, Ridderkerk:design, manufacturing, testing, supplying bearings tensioners
- Uittenbogaart, T.B.U.**, Rotterdam:*Deerberg* waste management system; *Biocompact* sewage treatment plant & transfer plant; *Jets* vacuum toilet system; *Wine/WT* doors, VT sliding-doors, firedoors, tank vent check valves
- Venteville**, Rotterdam:*Chloropac Electro-catalytic* anti-fouling system; pump; *Kockum Sonics* TYFON auto controller
- Viking Life Saving Equipment**, Zwijndrecht:life boat; rescue craft; life raft
- Wärtsilä Nederland**, Zwolle:*Wärtsilä* diesel generator sets; steerable thruster retractable design
- Westfalia Separator Nederland**, Cuijk:fuel and (tube-) oil separators & *Visco* booster units
- Winel**, Assen:WTS doors; weatertight musketeer doors, tank check valves, A60 interior doors
- Witt, Jan de**, Bussum:*Momec* doors
- Wolf Products, De**, Yerseke:embarkation and pilot ladders; life jackets; safety pictograms

