



# Analysis and experience combined in design

Danske Færger's new large high speed ferry had to meet stringent route and environmental specifications laid down by the Danish transport authority

In 2008, the Danish transport authority, Trafikstyrelsen, put the ferry routes from the island of Bornholm out to public tender. The operator which was known as Bornholmstrafikken at that time won this tender, which specified that the route between Rønne, Denmark and Ystad, Sweden, needed a larger capacity vessel than the 86m-long *Villum Clausen*, operating there since 2000. *Villum Clausen* has carried around a million passengers a year since its delivery.

Bornholmstrafikken has been through several management changes since then, firstly

amalgamating with the Clipper Group to become Nordic Ferry Services and this year merging with Sydfynske to form Danske Færger. However, the newbuilding order the company originally placed with Australian yard, Austal, in March 2009 has remained unaffected.

The 112.6m-long aluminium catamaran *Leonora Christina* is the result of the contract, and with a maximum deadweight of 1,000 tonnes, the vessel is the largest Austal has built, in terms of volume and weight. The ferry is named after 17th century princess, *Leonora Christina*, a daughter of the Danish King Christian IV and it reportedly cost approximately €60 million.

*Leonora Christina* will replace *Villum Clausen* in the winter season, when the older vessel will be laid up. In the summer high season, both vessels will work alongside each other. Trafikstyrelsen originally specified that the new vessel should enter service in September this year, but the fast



*Leonora Christina should transport 10,000 passengers a day in each direction*

ferry is on schedule to begin operating in June. The delivery date is slated as 1 May.

Using traffic projection models, Trafikstyrelsen specified that the vessel must be able to carry 1,400 passengers, 30 to 35 crew, 357 cars or 243 cars and 300 lane metres for trucks and trailers. According to Bent Hansen, Danske Færger's superintendent, "We had to prove capable of transporting 10,000 passengers a day, each way." He said that Austal won the order as "it was able to deliver a tailor-made high speed craft

which fulfilled our requirements".

One of the main requirements was to design the vessel to match the bow and stern ramp arrangements of *Villum Clausen* as far as possible, to reduce the cost of any port alterations. "Both vessels have a 'drive through' concept with a stern and bow ramp opening," said Mr Hansen. "Some changes necessarily had to be made to the harbour facilities. The new vessel is higher, wider and longer. This means that a new gangway, provisions facilities and electrical shore connection facilities were needed. However, by making the position of the bow door/ramp the same, the original shore-based loading ramp at Rønne could be reused almost unchanged." Furthermore, the larger ship capacity meant that the waiting areas in Rønne and Ystad had to be enlarged.

The design also took into account a specified turnaround time of 30 minutes. "We concentrated on making sure passenger and vehicle flow on and off the boat was really optimised," said James Bennett, Austal's technical manager. To ensure a short loading and unloading time the loading ramp in the port of Ystad had to be renewed with a wider one.

Mr Bennett explained, "Much of my work was taken up with doing a really detailed port inspection and understanding the ship-to-shore interface. We worked extremely hard to make sure the passenger

### LEONORA CHRISTINA

<b>Operator</b>	Danske Færger A/S
<b>Builder/designer</b>	Austal
<b>Length, oa</b>	112.6m
<b>Beam, moulded</b>	26.2m
<b>Depth, moulded</b>	8.5m
<b>Draught, max (including T-foils)</b>	4.9m
<b>Deadweight, max</b>	1,000 tonnes
<b>Trial displacement</b>	Lightship + 544 dwt
<b>Speed</b>	37.6 knots at 90% MCR
<b>Passenger capacity</b>	1,400
<b>Vehicle capacity</b>	357 cars or 243 cars and 300 lane metres
<b>Class</b>	DNV +1A1 HSLC R2 Passenger Car Ferry A EO (5.0m significant sea)





High passenger comfort was specified for the catamaran

entry and the catering facilities also matched, because the port of Rønne has a dedicated catering tower for the vessel where garbage is taken onshore and fresh food is loaded on board. As we built *Villum Clausen* as well, being familiar with the design helped.”

These considerations impacted the general arrangement and Austal aimed to design the vessel so that passengers enter the vessel in “an area where they feel welcomed into the boat”. This included wide alleyways near the atrium area so that passengers can disperse into the vessel in an efficient manner.

The ferry is broadly categorised into five compartments: three car decks and two passenger decks. The compartments in turn include vehicle garage, bridge deck, mezzanine deck, main deck and upper deck.

Austal is used to building large fast ferries, having constructed its first 100m-long vessel in 2001, *Euroferries Pacifica*. For *Leonora Christina*, the yard had to bring the hull out of the shed in order fit the whole bridge structure onto it.

A duration of 80 minutes was specified for *Leonora Christina's* route, rather than a particular speed, the same as predecessor, *Villum Clausen*. This equated to a calm water speed of 37.6 knots at 90 per cent MCR. Austal worked with Swedish research and development consultants, SSPA, to calculate the

speed of the vessel. SSPA performed a route analysis using Austal's powering calculations and resistance data for the hull and computer-modelled the vessel's predicted voyage to compute the contract speed.

The catamaran can carry up to 160,000 litres of diesel fuel and at trials displacement has a maximum range of approximately 610nm at 90 per cent MCR and 20 per cent reserve.

The Danish government strictly controls the performance of vessels on this route. Metered timers at each port automatically monitor when the ferry departs and arrives for each trip. At the end of every month the government and the operator receive a performance report – if the vessel has been late then the operator gets penalised.

As a Danish flagged vessel, *Leonora Christina*

## EQUIPMENT/OUTFIT

<b>Main engines</b>	4 x MAN B&W 20V 28/33D
<b>Output</b>	4 x 9,100kW at 1,000 rpm
<b>Gearbox</b>	Reintjes 7541
<b>Waterjets</b>	4 x Rolls-Royce Kamewa 125 SIIINP
<b>Propulsion control system</b>	Rolls-Royce
<b>Generators</b>	4 x Caterpillar 230kW
<b>Bow thrusters</b>	2 x retractable propulsion unit type HRP 3001 RT
<b>Navigation equipment</b>	Kelvin Hughes

also had to comply with stringent wave wash and noise and vibration legislation. Every fast ferry in Denmark has to provide a wave wash report that examines the proposed route and shows that the vessel's speed and direction will not result in waves higher than a set limit of 0.47m in height when the wave is in 3m of water.

The reason for these strict levels is that in the early days of fast ferry operations there were some incidents of large waves reaching the shorelines of some islands, resulting in complaints. The Danish government responded by bringing in this legislation to protect shorelines and people swimming on these beaches in the summer.

Mr Bennett reported, "We have performed a number of calculations and modelled the vessel on the route and the contours of the sea bed. Using our computational fluid dynamics software we were able to provide a prediction of the wave wash from the vessel on the route and when approaching the port of Rønne. This work has been submitted to the Danish Hydraulic Institute and they have accepted the findings. During the vessel's sea trials we will measure the actual wave wash from the vessel and demonstrate the accuracy of the computer simulation."

The design of the vessel limited the wave wash by employing a blunt bow shape. "If you design a vessel with a narrow hull you will automatically generate a much kinder wave signature," said Mr Bennett. Minimising the transom immersion also

enabled low wave wash levels.

Noise and vibration was limited thanks to large silencers on the generators and the four MAN B&W 20V 28/33D main engines. A Reintjes 7541 gearbox has been installed on board and propulsion is provided by four Rolls-Royce Kamewa 125 SIIINP waterjets.

The air intake fans on the vehicle decks are mounted in sound attenuating boxes which uses specially designed acoustic attenuation equipment. Danish noise and vibration firm, Ødegaard & Danneskiold-Samsøe acted as consultant in this regard, as it did for *Villum Clausen*.

Additionally, *Leonora Christina* had to have good seakeeping, as up to 16m per second/32 knot winds can occur on the route. "There was a lot of seakeeping analysis done internally within Austal to make sure we had the right hull design," said Mr Bennett. "This included analysing the volume distribution on the underwater shape of the hull and providing our own ride control equipment, consisting of T-foils forward, interceptors aft and T-Max rudders."

Danske Færger specified a particular requirement for high standard restaurant facilities. "It's unusual for a fast ferry to see such good quality food. It was a really important aspect of the tender that the galley spaces were designed to its specification," commented Mr Bennett. The operator also placed emphasis on comfortable passenger facilities, including seating and a large shop. **PST**



*The hull during construction at Austal's Western Australian yard*