G+C ADMIRAL

"Seaspeed Arabia" and "Seaspeed Asia" — the Largest Ro-Ro Ships in Service

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Introduction

Two panamax size Ro-Ro ships for world-wide service under the Greek flags were delivered to S.S.S. (Seaspeed Service) by K.H.I. (Kawasaki Heavy Industries) in February and April this year. The two ships are the first and the second ships of three sister ships to be delivered and the third ship launched and named *Seaspeed America* in March this year will be completed very soon.

Capt. N. M. Maris, the president of Morland Navigation which is an agent of Seaspeed Ferries in Europe, had foreseen today's cargo requirement of the Middle East ports two years ago and made his first step into building of these the world's largest Ro-Ro ships. Kawasaki was nominated as the most experienced ship builder in this field in Japan and joined this new project from the beginning.

The following description of these ships is based on the first ship *Seaspeed Arabia*, as these three ships are of identical design.

Design Idea

The basic idea for the design of *Seaspeed Arabia* is to load Mafis on tank top, trailers and/or Mafis on lower trailer deck and trailers and/or containers on upper deck all using four cargo lifts, and any kind of cargo on main trailer deck as long as they can be rolled on and off through the stern port or side port and the unit weight is below 1 000 tons. The clear heights chosen on each deck to make this possible are as follows:

On main trailer deck	7.00 m
On lower trailer deck	4.60 m
On tank top	3.35 m

The stern rampway and the main trailer deck were designed to have enough strength to support heavy loads which, in cooperation with a very spacious main trailer deck aft of about 26 m wide without pillars, enables easy handling of very large units of cargo as well as quick manoeuvering of trailers with heads and containers handled by forklift trucks (Fig. 4).

The panamax beam of the ship not only gives good access for cargo handling inside the holds but also gives good stability to the ship. She can load three tiers of filled containers on the upper deck with a comparatively small quantity of water ballast in the double bottom for stability purposes.

Medium speed diesel engines were adopted as main propulsion plant, which generally are more suitable than slow speed diesels for Roll-on/Roll-off ships with loading ports at the stern in view of easy cargo handling at the entrance and to accommodate greater numbers of trailers and containers.

The service speed of the ship carrying top-line cargo between distant ports had been aimed for not less than 20 knots with a total of 28 000 P.S. (B.H.P.) engines,

Principal particulars of the ships:

Length overall	
Length between P.P.	197.50 m
Breadth moulded	180.00 m
Depth to upper deck	32.20 m
Depth to main trailer deck	19.85 m
Draft (Scantling)	11.75 m
Draft (Design)	10.00 m
Deadweight (at d = 10 m)	8.50 m
Gross tonnage	22 852 t
Net tonnage	14 530 T
Machinery output	7 500 T
	2 × 14 000 P.S. (B.H.P.)
Trial speed	at 430 rev/min.
	Over 24 knots

Cargo capacity:

Cargo spaces (bale)

Main trailer deck cargo space	
Lower trailer deck cargo space	31 300 m³
Tank top cargo space	11 100 m³
Total	6 000 m³
	48 400 m³

Number of trailers and lane length

	Number of trailers (40 feet trailer)	Lane length
Upper deck	107	1 560 m
Main trailer deck	111	1 440 m
Lower trailer deck	51	760 m
Tank top	38	620 m
Totals	307	4 380 m

Number of T.E.U. containers

Total	1 375

The *Seaspeed Arabia* has been built under the supervision of Lloyd's Register of Shipping ✠ 100A1, Ice class 3, ✠ L.M.C. & U.M.S.

including delivering 2 300 H.P. for electric generator simultaneously and this has been verified by her sea trials and service voyages.

General Arrangement

In external appearance the *Seaspeed Arabia* is notable for a high superstructure located at the bow end of the ship (Fig. 1). The height comes from upper deck cargo space which is extended under the deck house and the location is for even trim during navigation, because the longitudinal centre of the gravity of the cargo is relatively aft due to the wider deck area at the after part of the ship, as compared with other general cargo ships with similar speeds, whereas there are certain limitations in regard to the position of the L.C.B. (longitudinal centre of buoyancy) to be aft considering the propulsive efficiency of the ship. The engine room is arranged at the aft part of the ship and below the main trailer deck. Engine casings and funnels are divided into two very thin constructions along the side shell (Fig. 2).

Ten 2.9 m wide trailer lanes are arranged on the upper deck utilising the full breadth of the ship and, by limiting the mooring space fore and aft, some 107 units of 40 ft trailers or 711 T.E.U. containers can be directly staved on the deck. All these are lifted by 50 ton or 85 ton capacity cargo lifts (Fig. 2).

The main trailer deck has a similar arrangement to the upper deck and can accommodate 111 units of 40 ft trailers or 472 T.E.U.'s. The cargo lifts for the upper deck are arranged beside the streamlined engine casings and two cargo lifts, both for the lower trailer deck and the tank top levels, are arranged on the centre line in front of the engine room, symmetrically (Fig. 7).

The lower trailer deck and the tank top are served by the two cargo lifts, near the centre line and each lift is for port and starboard cargoes respectively, but, considering emergency cases, the centre line pillars on the forward portion of the decks have been eliminated to allow transverse movement of cargoes from port to starboard and vice versa. Some 51 units and 38 units of 40 ft trailers can be loaded on the lower trailer deck and the tank top respectively.

Hull Construction

Each deck is designed to have strength against axle loads of forklift trucks, trailers and Mafis, concentrated point loads of containers and special heavy loads at main trailer deck aft part. Three-dimensional space frame analyses were carried out for the main construction members of the decks and side shell, i.e. deck transverses, longitudinal beams, upright and heeled conditions to decide scantlings.

Special care has been taken against stress and vibration in the bow and stern where no pillars are arranged, especially for the large openings for cargo lifts which are provided on both sides of the upper deck at stern. Distortions around the side port opening were calculated using finite element methods to decide reinforcement, because the location of the side port is a basis to support the long overhang of the stern construction. It was found that constructions below the opening play an important role to support the overhang. Double hull constructions are adopted all through the cargo hold below the main trailer deck (freeboard deck) including the built-in duct space for the safety of the ship and her crew.

Stern and Side Rampways

Principal access to the ship for cargo is over the stern, where a large port of 7.2 m high by 12.5 m wide and a big straight-type rampway are provided. The rampway is 16.5 m long by 12.5 m wide and designed to withstand the load of not only two forklift trucks with containers in parallel, but also heavy bogies carrying 1 000 ton cargoes (Fig. 5).

A unique self-supporting device for the rampway, consisting of supporting rods and hydraulic angle adjusting mechanism, is provided to transfer cargo by Ro-Ro to/from a small vessel or barge at sea whose rampway is put upon the rampway of the mother ship (Fig. 6). The rampway is operated by an electro-hydraulic winch on the upper deck and functions as the weathertight door when in the closed position locked by hydraulic cleating devices. A control stand with observation window is provided on the main trailer deck for these operations.

Another access to the ship is a starboard side port, which has a clear opening of 6.2 m high by 6.4 m wide to pass Mafi trailers carrying containers two-tiers high and forklift trucks with 20 ft containers across. The side rampway also functions as a side shell door and is operated by an electro-hydraulic winch and designed to withstand 100 tons load. The Ro-Ro equipment of the ship, i.e. stern rampway, side rampway and cargo lifts including their covers were supplied by MacGregor Far East.

Cargo Lifts

Four sets of cargo lifts having the following characteristics are provided to transfer cargo from the main trailer deck to the decks above and below.

	Upper lifts		*Lower lifts*	
Service decks	Upper deck to Main trailer deck		Main trailer deck to Lower trailer deck to Tank top deck	
Number	1	1	1	1
Type	Chain hanging	Wire hanging	Wire hanging	Wire hanging
Size (L X B)	19.0 m X 6.6 m	18.8 m X 3.2 m	19.0 m X 3.8 m	18.8 m X 3.2 m
S.W.L.	85 tons	50 tons	60 tons	50 tons
Speed	4.2 m/min	7 m/min	6.5 m/min	7 m/min

The 85 ton cargo lift with its double width is capable of lifting L.U.F. units as well as two 40 ft trailers side by side (Fig. 7). The lifts are driven by electro-hydraulic jigger cylinders which are operated at control stands provided on each deck. The hydraulic power unit of each lift is composed of two hydraulic pumps each driven by an electric motor, so even if one of the hydraulic pumps should fail, the lift can be driven at a half-rated speed by a single pump.

The upper lifts are used as weathertight covers at the upper deck level. The lower lifts are stowed on the tank top and weathertight hatch covers of the wire hanging type are provided on the main trailer deck.

Cargo Lashing

Lashing fittings for trailers are provided along the trailer lanes on each deck. These fittings on the upper and main trailer decks are also used for container securing (Figs. 3 and 9). Loose lashing equipment, i.e. lashing chains, stacking pieces, etc., are stowed in boxes provided on the side shell and in waggons for easy transportation on the ship (Fig. 10).

To improve the manoeuvrability of the ship in port, three sets of Kawasaki side thrusters (two at the bow and one at the stern) have been installed. Each side thruster, operated remotely at the centre and both wings of the navigation bridge, delivers 7.3 ton thrust through a controllable pitch propeller driven by a 470 kW electric motor. To ensure that cargo is not damaged, even in rough seas, and for the comfort of passengers and crew, retractable fin stabilizers of Brown Brothers Type 100E have been installed in addition to the bilge keels.

Above the upper deck stern mooring area, there is a helicopter landing platform of 10 m by 10.5 m supported by 10 pillars (Fig. 5).

Water Ballast Control

To adjust the heel and trim at loading/unloading, the ship is provided with two water ballast pumps of 500 m^3/h capacity each, which in parallel operation will adjust the threshold height by 5 m within one hour at ballast condition. These pumps and control valves for the heeling tanks and trimming tanks are remotely controlled from the water ballast control room which is located on the main trailer deck near the stern port, where liquid levels of all ballast and fuel oil tanks are indicated on a graphic panel.

The cargo spaces are mechanically ventilated by axial flow fans to change the air at a rate of 20–30 times/hour during loading/unloading and 10 times/hour during navigation. Air ducts are provided inside the double hull at fore and aft ends of the ship for longitudinal air flow in the cargo space.

A CO_2 fire extinguishing system and a smoke detection system are fitted in the cargo spaces. The CO_2 system is designed to discharge 85 per cent of the gas required for the cargo space within 10 minutes to comply with I.A.C.S. requirement.

Accommodation is provided for 10 officers, 25 crew and 12 passengers. An elevator is provided for access between the main trailer deck and the boat deck. Sewage from toilets is led to a non-discharge type sewage treatment plant and ...bage from the galley is led to an electric type garbage ...ning unit provided below the deckhouse.

Model Tests and Sea Trials

The following tests were carried out to confirm the performance of the hull form and the controllable pitch propeller.

Model tests:

- Resistance, self-propulsion test and wake measurement at Akashi Ship Model Basin of K.H.I.
- Stream line survey test at circulating water channel in K.H.I.
- C.P.P. cavitation test and open water test at Netherlands Ship Model Basin

Sea trials:

- Speed trial test
- Z-manoeuvering test
- Turning test
- Bow and stern thruster test
- Crash astern and crash ahead test

During the above tests, the propulsive performance, stern vibration, etc. were observed, giving good results despite the fact that the hull L/B is small and B/d is large.

Propulsion Plant and Automation

The main propulsion machinery of the ship consists of two Kawasaki-MAN 14V52/55 four-stroke medium speed diesel engines, each of which develops a maximum continuous output of 14 000 bhp at 430 rpm. These engines drive a four-bladed, 6 400 mm diameter Kawasaki Escher Wyss controllable pitch propeller at 122 rpm through a Kawasaki reduction gear and multi-disc oil clutches. The main engines and the propeller are controlled at a constant speed as main generators are driven by the main engines. The main propulsion plant is provided with an "Automatic Load Balance (A.L.B.)" system and an "Over Load Protection (O.L.P.)" system; the former balances the load of the two engines while one main engine is driving one main generator, and the latter protects the main engine from overload by reducing the propeller blade angle automatically.

The notation of Lloyd's Register "U.M.S." is given to the ship and the machinery can be operated without any attendance in the engine room for 24 hours under normal sea conditions. The main engines and clutches can be controlled locally, or remotely from the engine control room through an electric-pneumatic system for the main engines and a pneumatic-hydraulic system for the clutches (Fig. 12).

The electric power plant consists of two main generators of 2 400 kVA driven by the main engines and two auxiliary generators driven by auxiliary diesel engines. These large capacities meet the demand of the many auxiliary equipment installed in the ship, including three side thrusters, two fin stabilizers, four cargo lifts, 36 hold ventilating fans, 75 socket outlets for refrigerated containers, hydraulic units for mooring gears, etc.

Electric power during normal navigation is supplied by one of the two main generators, while both main generators are used during departure/arrival and the two auxiliary diesel generators are used for cargo handling.

The control system for the controllable pitch propeller, side thrusters and fin stabilizers is centralised in the wheelhouse, as are the controls for hold ventilation fan operation and monitoring system, automatic fire detection and alarm system and refrigeration container monitoring system are also centralised in the wheelhouse (Fig. 11).

A total of 75 socket outlets (25 socket outlets of 220 volts, 50 socket outlets of 440 volts) are provided for refrigerated containers on the upper deck, the main trailer deck and the lower trailer deck.

Presentation

CAPTAIN M. N. MARIS: For many years – and I would go back to 1944 – I was thinking about that fantastic little ship called the landingcraft, which I saw in action in Salerno and in France and in other places, which turned a lonely beach and a very exposed beach into a reasonably good harbour.

In 1953–54 with some English friends of mine I took part in the conversion of two small ships like that into small Ro-Ro ferries. I do not think I was the first. There were other Greeks with the same idea and something similar was happening up north. One day I was watching the loading of these ships, and to my amazement we got about six buses and trucks and about 20 cars loaded in four minutes. I asked the skipper if that was the regular thing, and he said "I have never recorded the time, but that is about it". I checked again and after several trips I realised that that was about the average time: about four minutes. So I said to myself, if you could push cargo out of a ship, properly designed to do a job of this sort in four minutes, then you have the story of success. I knew about other cargo ships, both as a captain and as an owner – my father was an owner, anyway – and I knew that contrary to what was said yesterday, in the best of ports in this world, and I am talking of places like Rotterdam and Hamburg, to manage to get more than 750 tons of breakbulk general cargo per day as an average per ship you are doing extremely well.

This thing was strengthened in my mind in about 1968 when I joined up on a service with Fred. Olsen in the Mediterranean. I then realised that using an extremely well-equipped ship of 4 500 tons, with six cranes, already built to use a palletised system, and being able at such ports as Rotterdam or London to load only about 750 tons per day at best – when I say "at best" I mean the average, not just the one day when you might get 1 000 tons, but the average from the time the ship arrives in port until she sails – then something else must be found to change this method. If you use a ship as a storehouse you are using the most expensive warehousing in the world. It is modern; it costs a fortune to build and a fortune to maintain; it is not sort of a tin roof. You have to use special steels to construct it. And it has got a short life, maybe at best about 25 years. So you have got to build a ship which, as the last thing it does, is to remain a storehouse.

This presents another problem. If, in these modern days of speed, you use this storehouse at a very high speed at sea and then you lose all the speed in port, you have just about entered into the most expensive and unlikely operation. Speed at sea may cost about 50 per cent more for just an extra 3 or 4 knots. Fifty per cent in building, 50 per cent in maintaining. The horsepower, as you know, goes up to the cube if you increase the speed.

To make things clear in your mind, say that you have a ship of 10 knots that has a consumption of 20 tons. If you raise that same ship to 20 knots your consumption would be 80 tons. That is how it can be explained in a simple way. So increasing the speed of a liner over a certain level - say the natural speed of the ship is about .7 of the square root or whatever of length as an easy way of thinking - it means you have to pay dearly both during the life of the ship and during the construction stage. But to lose the time in port means that what you spent at sea will never be recovered in port.

Another thing, the length of the ship does not increase in proportion to its deadweight. Therefore, if you build a bigger and a longer ship you would not have the space to fit more hatches, compared with the deadweight. On a length of about 450 ft, which is a 10 000-tonner, you could put five hatches. A reasonable size. If that ship is increased to 20 000 ton you may hardly have the space to put one or maybe one and a half hatches more. A hatch is not just to load cargo in; it is also to discharge cargo from. The problem is that if you have a 20 000-tonner with six hatches you have only increased the discharge time at port by about 15 per cent but you have increased the size of the ship by double. What happens in practice has been long realised by the shipowners - by the traditional shipowners and liner trades. If you have noticed, they have got stuck around the 15 000 ton size and about 15 to 16 knot speed. If they increased to 20 000 ton size the time in port has proportionately increased to the deadweight and a bit more, because you now have a deeper hull, more wing spaces around the hull and more difficult to get at.

Many methods were developed, and upon these lines probably the best thing was the open hatch bulk carrier. It is an excellent ship and unbeatable in its own trade. But an open hatch bulk carrier cannot carry well either containers or rolling cargo. So in its own line it is a ship that will remain - I have no doubt about that.

The other way to deal with quick discharge in ports was the container. In 1966 across the Atlantic I think there were about 15 000 containers carried. You can hear plenty of rumours around, but it seems likely that there are 1 million now. So the container was a very successful operation. There is no doubt in my mind that it is another ship that will stay around for a long time.

But the open hatch bulk carrier or the container ship cannot carry all the cargo there is. The bulk carrier is ideal for bulk cargoes, and the container ship is ideal for containers. I have no doubt in my mind. But not all cargoes can be containerised. If you take a container, you have finite dimensions and, what is also most important, finite weight. You have to get something in either 20 ft or 40 ft by 8 ft or 8 ft 6 in. But if you are restricted to this, you are probably forgetting about 40 per cent of the existing general cargo. This figure is arbitrary - I do not know exactly. But from our trade, having Ro-Ro ships, we find many a time that between 30 and 40 per cent of the cargo cannot be containerised, or in some cases it would not be economical to containerise. We can use flats, we can use Mafis, we can use other systems.

Weight is another important factor. I have had heavy lift ships and I can tell you - start handling a 90 ton heavy lift and you are already into difficulties. Take it up to 200 tons and the difficulties increase. At about 300 to 350 tons the shipyards of today say that you will get into problems. So we have another kind of cargo which the container ship and the ordinary bulk carrier is no good for.

One has then to try to say, "What ship can I build to solve all these things?" I think that the best is a Ro-Ro ship, and the Ro-Ro ship must be big. It must be strongly built. It must be able to be a heavy lift ship. It must be able to be a container ship. As a matter of fact, I think I want to term that ship the real honest-to-goodness general cargo ship. Because we are using the stern method or any other method, it has not changed its colour.

The ship goes into port, discharges the cargo in approximately 24 hours, it utilises about 30 men to do it with, it only takes a minimum of waterfront space - which is the very important one - in the port, and the port authorities may have to provide even backstage, let us say, the real compound where the cargo is stored for the Customs men to get at it and spend all the time in the world checking it.

With this in mind, and thanks to Kawasaki's very efficient initial design, we - and when I say "we", I think there were about 120 people designing for about 18 months - we designed the *Seaspeed Arabia*. Mr. Macduff, although he did not take the classification of this ship, was of great help, as a personal friend and as a wise friend. I also had, without any shadow of doubt, the most efficient team from Lloyd's, who really went into it, because we were entering a new field. There were many things we did not know. We had to go back to manufacturers to ask them simple questions. What is the weight of a certain forklift, and what are its tread areas? And believe me, they had to think again, because that was not so important to them as it was to us. There were other minor things. How many forklifts will they work on one particular deck at a time? That is important too. And what kind of lifts shall we have on this ship? We tried the method of ramps, and when you have a height of 8 m between the decks the ramp has to be at least 80 m long. Even on a ship that is almost 200 m that is a very long ramp. Also there are disadvantages. If you want to handle, say, 20 ft containers sideways on a ramp, that ramp has to be 6.20 m. So for all these reasons we decided that lifts must be the best. Then came the question: what speed should the lifts have?

As I said, in 18 months' time we think that we may have solved most of those problems.

Mr. Ando from Kawasaki will now take over and tell you the technical details of how we did it. But there is one thing. These ships did prove a success. They seem to be doing a good job and we are quite happy with them.

MR. ANDO: Representing Captain Maris and Mr. Tani I should like to introduce to you some of the characteristics of *Seaspeed Arabia* and *Seaspeed Asia* which are now the largest Ro-Ro ships in the world. The two ships are the first and second of three sister ships, and the third ship, *Seaspeed America*, will be delivered to the owners very soon.

Kawasaki has built many types of ships, such as U.L.C.C.'s, cargo ships, bulk carriers and so forth, as the other major shipbuilders do, but in regard to Ro-Ro ships we are the most experienced shipbuilder in Japan with some 20 Ro-Ro ships delivered and/or under contract.

Our first Ro-Ro ship was delivered to Australian National Line eight years ago. Two passenger car ferries were delivered to a domestic owner five years ago. Five hybrid ships, which are a combination of feeder container ship and Ro-Ro ship are included in the numbers. Two Bo-Ro liners, which were introduced by Captain Tornqvist at this conference last year, are now being built in the Kobe works. Nine Ro-Ro trailer carriers, the type of which is represented by *Seaspeed Arabia* which I am going to present today, have been or will be built in the Kobe works.

Editor's Note: From this point, Mr. Ando's presentation largely followed the written paper and is not therefore, repeated here.

CHAIRMAN: We are very indebted to the authors. Mr. Ando has made a very good presentation. The conference is entirely indebted to Captain Maris for his, in my opinion, too honest statement about the *Seaspeed Dora*, but he is a man who is prepared to help other owners and I thank him for that on your behalf. The discussion is now open.

MR. J. M. BATES (Lloyd's Register of Shipping, London): I should like to refer to the remarks made by Captain Maris at the beginning of his presentation. I refer to the incident concerning the loss of the *Seaspeed Dora*. One would think that a Roll-on/Roll-off ship which has very adequate stability in seagoing conditions would be utterly safe in port. One must realise that the curve of righting levers of stability is established by the inclusion of the effect of a huge superstructure, which at sea is intact. Once you open a single door in the superstructure you remove the important effect of the buoyancy on the stability of the ship. If you have a ship which has minimum freeboards calculated from the second deck or the main deck, which has a high beam, it is possible that the movement or removal of a relatively small load will impose a heeling moment on the ship sufficient to immerse the seal on that side door. Unless the door is shut immediately the entry of water into the ship will add its own heeling moment to the moment imposed by the moving load. There will be also a free surface effect, which together may be sufficient to destroy completely the small amount of reserve stability left to the ship, assuming the superstructure to be open. If that condition arises there is no possible action from the crew, except to get off the ship, because once the ship starts going no amount of human action will be able to avoid the inevitable.

So in those conditions you may have a perfectly safe seagoing ship, which will be at risk in port.

I will give you another instance of a ship which was on its way to port in a river. The crew decided to open the stern door before arriving at the quay. The ship went round a bend in the river at fairly high speed, causing a heeling moment, and the corner of the stern door caught the water. Water poured into the ship and also capsized for the same reasons. The heeling moment may have had different causes, but the effects were the same.

It is possible, as Captain Maris has said, to bring about remedial actions which are simple and relatively inexpensive. My society would be only too pleased to participate with owners in assessing the risk of any of their ships. Thank you.

CHAIRMAN: Thank you, Mr. Bates. I do not know whether Captain Maris wishes to add to Mr. Bates' remarks, which have been an outline of possibly a real proposal.

CAPT. MARIS: I think that the rules should be changed. It is a very simple thing. It would not affect at all the working of the ships. No owner should be scared of immense expenses. It is very simple, very easy. We must make it clear to everybody here, no matter what the crew is nor what the crew can do, the ship will sink. It is as simple as that. Let us take away that risk. It will cost something like $2 000 or $3 000. It must be done immediately. I have done it on my ships. I stopped them and I did this. I lifted the door up 1.50 metres and that is it. If any pilot suggests that he cannot go up 1.50 metres, he must retire.

MR. T. J. WARD (B. & I. Line, Dublin): I notice that the total capacity of the Seaspeed vessel is 307 trailers, which means 614 moves for a full trailer turn-round. Did the designers have a particular rate of discharge or a total turn-round time in mind in the design of the vessel and in lift speeds, locations and that kind of thing?

CAPT. MARIS: This number of trailers – 307 – is a complete misconception. We are never interested to load 307 trailers on this ship. You could put it in another way. These ships can always take about 600 – or a bit more, in fact – 40 ft containers at the same time. We are interested that the two lower decks of the ship could be used maybe for trailers. The time to discharge this ship, with a competent crew of about 30 men and seven forklifts – the theoretical time – is five hours. If we double that it will come to 10 hours; if we double that again it will come to 20 hours. We estimate that 24 hours should do the job. As a matter of fact, it does it – about 18 hours – we can load the ship completely.

MR. WARD: Loading and unloading?

CAPT. MARIS: I should like to say loading and unloading, but then maybe you could read "Alice in Wonderland". No. I think loading and unloading operations should take about 60 to 70 per cent more. It would be a rather dangerous thing and extremely difficult thing to do at the same time – dangerous from one point of view. Some of the boys down in Dammam, for instance, took it to be a racing course. We saw forklifts breaking all speed records. So if it was loading and unloading I think the records would be broken.

DR. I. L. BUXTON (University of Newcastle upon Tyne): I wonder if I could ask a technical question about the seagoing condition of the ship, taking a typical condition with trailers and containers or whatever Captain Maris considers to be an average one. What is the seagoing deadweight and how much water ballast is there in this condition and what is the metacentric height?

CAPT. MARIS: I think Mr. Ando will answer part of it, but the ship is designed that with average cargo and bunkers she does not require any water ballast. I should like to see Dr. Gilman (sic) after. The actual deadweight you can load on that ship, taking an average container of 15 tons for simplicity, is about 20 000 tons of cargo. The total cubic capacity of the ship in cubic metres is over 60 000 tons (sic).

Regarding the metacentric height of the ship, I can give you one condition we had recently. The ship was almost full and it was about 1.40 metres. I should like to point out one thing. If you design a Ro-Ro ship with a very high G.M. you are asking for trouble, serious trouble. A series of these ships that were originally designed because of fear with a high G.M. and everything else, had to be fitted with huge tanks on the bridge level of about 100 tons to reduce the G.M., because with a very high G.M. we had some experience of such a ship in the Irish trade. We found out that the roll period of eight to nine seconds was the best we could get, by even using the flume or similar type stabilizing systems. With that roll period, because of the G.M. you have the equal forces of a car spinning off to 18 miles per hour and braking or being hit by a brick wall. That happens every eight seconds. Let naval architects note this. I would be prepared to give them the figures.

The most incredible thing is that when you load, for instance, on the Irish trade reefer boxes and the meat is hung, the effect on the springs of the vehicle is such that you can never really tie it down on deck, not really. So you have got to find another system. For the benefit of other operators, the best system we have found under very heavy conditions – and I have had ships running in the Irish trade with Force 9 and Force 10 without any damage – was to use very wide belts of nylon.

CHAIRMAN: Thank you very much indeed for that excellent advice. Could I call on Mr. Ando to give some additional stability information?

MR. ANDO: I will show you one of the calculations – the result of the water ballast condition – full load condition. We loaded trailers full to the draught of 10 m. In this condition we load water ballast of 2 400 t. This is just to replace water ballast for fuel oil. In this condition we keep the G.M. of 1.33 m, and even trim.

DR. BUXTON: Cargo deadweight?

MR. ANDO: In this condition the deadweight is 22 800 tons.

DR. BUXTON: Cargo weight is?

MR. ANDO: About 18 000 tons.

CHAIRMAN: Next question, please?

MR. M. BRAUN (Hansa Line, Bremen): I have two questions really. One was on the speed of discharge, which was asked before. You have a fairly large container capacity on your ship, most of it on deck, I presume. Do you have an experience factor as to how many boxes you discharge per hour by way of loading them on a chassis – forklift, I believe, is the instrument you are using – and then getting it down by lift and driving it out of the stern gate?

The second question I have is on your ramp. Your ship is quite unusual inasmuch as you have a relatively short straight stern ramp, whereas ships of that size usually have quarter ramps or slewing ramps for the purpose of making them independent of port installations and also to permit them to work at container terminals that in many cases have no Ro-Ro corner. I would therefore like to ask what your criterion was to choose this particular type of ramp.

CAPT. MARIS: With regard to the speed of discharging containers, it depends solely upon the kind of labour you have. You can get 100 per hour or 30 per hour. It does not depend on the ship. It is very hard to put a figure.

On the other question, I think you will find out that slewing ramps have one great difficulty. They cannot absorb high tide ranges. It is far easier to consider the full length of the ship – 200 m – as a ramp than have a long ramp astern. What most people forget, and especially people who are new in the game, is that you have got to pass a 40 ft long trailer over the ramp. If you are at the corner and you do not make it straight with the whole ship, you will break an awful lot of legs. Today legs cost about £500 a pair, so you are in for a lot of repairs to your trailers. If you are carrying Mafis, one of the dangers is, as it is with a ramp inside the ship, that if you exceed about 10 degrees the Mafi gets unhooked. We almost lost the leg of one of our men under similar conditions. So you have to aim to have such balancing arrangements for the ship to become a part of the ramp so you have 212 m, as in the case of the *Seaspeed Arabia*, which can take up to 10 m variation of tide.

When you have a slewing ramp it is a very simple experiment. I advise you to get a set of Meccano in your home. Put it up and you find one thing. With a slewing ramp – I will try to demonstrate it as much as I can – if the ramp is like that, on the side, and the ship goes down, one part of the ramp is not touching the wharf. That is the difficulty of a slewing ramp. It is much better to have an auxiliary side ramp, as we did and a much cheaper proposition, than have a slewing ramp. The other difficulty is that a slewing ramp cannot be built very easily for loads over 150 tons. So I have an idea that a man who is building a Ro-Ro ship must think of the 300 tons and 400 tons weight offered, and he must not turn them off because he is the only one who can do it. At 500 tons hardly any ships in the world will do it. At 1 000 tons there are none. So why miss that golden opportunity?

MR. H. M. OTUOZE (Nigerian Ports Authority): Captain Maris mentioned *Seaspeed Asia* and *Seaspeed Arabia*. I wonder what type of design he has for Ro-Ro vessels coming to West African ports, taking into consideration our infrastructure and the technical details that are required for such Ro-Ro vessels to come to our ports.

CAPT. MARIS: I have looked very carefully at Lagos, but Ro-Ro cannot exist without the port authority. That is fundamental. A Ro-Ro is a very expensive ship if it stays in port. The only thing it has over its competitors is the rapid time of discharge in port. If the ports authorities are willing to do that they will save billions of dollars for themselves, because I can assure you we can build an excellent terminal, the most modern terminal for Ro-Ro ships, at possibly no more than $3m or $4m, and I would say that for a container ship it would be about $20m. You only need a jetty of about 40 to 50 m width extending to a draught, in your case, of no more than 8 m, or maybe 10 m if you want to think of these bigger ships in the future – I mean draught of a ship – so you would need about 12 m.

In your case, I would think that a Ro-Ro from Europe of 100 to 130 trailer capacity, which would normally be 300 containers, should be enough. But you must be willing – and that is essential – to discuss with owners of Ro-Ro ships – owners, nobody else – a prospective design for a terminal. Unfortunately, even in the construction industry of today, there are very few companies which really know. It is only the port authorities who know and the owners; the port authorities who have used Ro-Ro – Felixstowe, Liverpool or Southampton. So if you contact people like that I am sure the Lagos problem could be solved in about six months' time. And for no more than about $5m.

MR. W. WITELSON (Zim Israel Navigation Company, Haifa): I should like to ask Captain Maris two questions. How do you handle the containers? Do you use ordinary forklifts or bottomlifts, or do you use side loaders with a spreader up?

And Mr. Ando, what were the reasons for deciding to have a single propeller on such a large vessel?

CAPT. MARIS: We use all three systems. We cannot recommend anything especially. The only thing – the forklift with top spreaders or bottom forks is probably the most commonly used, and it does look like giving a better chance. Side lifts we are using on certain occasions, where something is stuck on the very side of the ship or we have a space there and we can push it right in like that. But generally I would say the forklift would be superior.

MR. ANDO: Mr. Tani will talk about the propeller.

MR. TANI: I did not design the propeller for this vessel. We have much experience with the single propeller with a rather smaller vessel, high powered. You saw one hybrid container ship. We have a single propeller with 46 000 hp in one shaft. Of course, in this case we made extensive study to avoid any cavitation, vibration and so on. So far we are successful with this design. So we think, therefore, even with this vessel, single screw is much more efficient and we can solve all the problems of hazardous vibration or cavitation.

CHAIRMAN: Thank you, Mr. Tani.

Gentlemen, I regret that I must bring to a close the discussion on this paper. I would ask you to give a vote of thanks to the authors.