Design and Operation of the Ponce de Leon

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A unique ship, and to some extent the transportation system of which it is a part, is described. The ship was designed to carry 250 forty-ft highway trailers and about 300 automobiles in the New York to Puerto Rico trade on a weekly schedule. The ship is 700 ft long and 105 ft wide over the main deck; it displaces 24,000 tons at the design draft of 27 ft. A single boiler, steam turbine propulsion plant generates 32 000 shaft horsepower (SHP) driving the ship with a single screw. The vehicles are loaded through three sideports over special shore ramps and are driven to the various decks in the ship via a series of fixed internal ramps. The trailers are held in place by a combination of lashings and patented front end support stands which engage the trailer kingpin and a steel button welded to the deck. A controlled passive stabilization system based on the "U" tube tank principle is installed. It is designed to be used for list control in port by pumping all the water to one side to counteract the effects of ramp weight and/or unsymmetrical cargo loading. Terminal facilities at both ends of the run include vehicle marshalling yards, yard tractors, scales, and loading ramps.

I. Introduction

THE modern concept of a ship is to view it as part of an ocean spanning total transportation system. The Ponce de Leon, more so than most ships, can be thought of as part of such a system. In fact the story of the design and construction of the Ponce de Leon is the story of the creation of the system itself. The Ponce de Leon introduced Roll-On/Roll-Off shipping to the New York/San Juan trade, and in fact to the world, on a larger scale than has ever been known, in the sense that it is the largest Roll-On/Roll-Off ship in operation. Although the ship was the largest single item of capital expenditure involved, it did not represent the complete investment. Terminal facilities shore based loading ramps had to be designed and built for the two ports. A fleet of special loading and unloading tractors had to be provided at each port. Trailers had to be constructed and an operating organization established. Establishing working arrangements with the appropriate labor organizations and training tractor drivers for the driving conditions on the ship was no small part of the task. Figure 1 shows the Ponce de Leon entering San Juan.

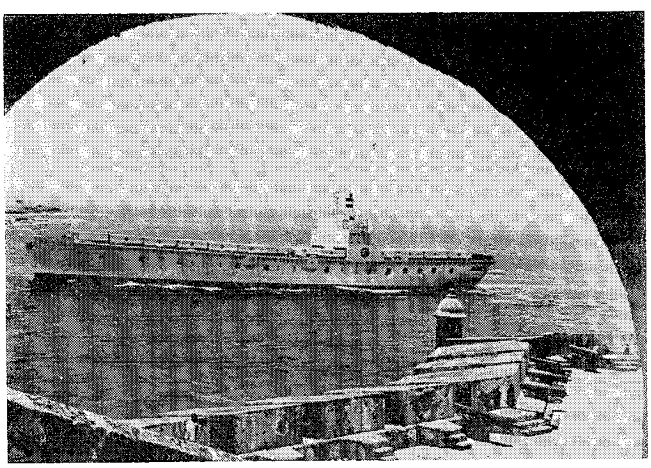

Fig. 1 Ponce de Leon entering San Juan.

The Ponce de Leon's keel was laid on February 15, 1967; the launching was on November 16, 1967, and delivery took place on March 29, 1968.

II. Design Criteria

The original concept (Fig. 2) envisioned a ship which would transport at least 250 forty-ft-long highway trailers to San Juan with weekly departures from New York. Secondly, the vessel was to carry approximately 300 automobiles and/or light trucks. All cargo was to be driven or towed aboard the ship over ramps and discharged the same way. In order to provide the weekly turnaround, it was determined that the ship would have to attain a normal operating speed in excess of 23 knots and be able to discharge and load in 12 hr. Main-

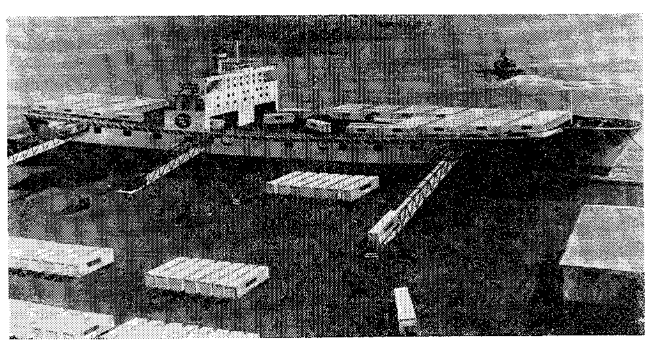

Fig. 2 Artist's conception of Ponce de Leon during cargo operations.

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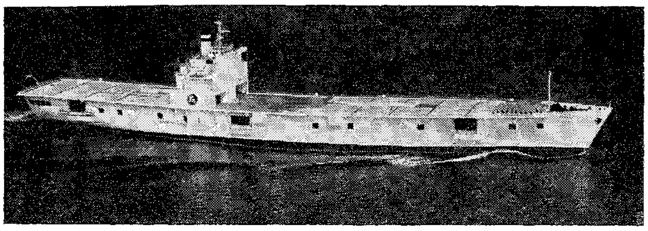

Fig. 3 Ponce de Leon on sea trials. Note the main deck overhang and the three sideports, the smaller openings are for ventilation of the second deck.

taining a regular schedule was important as a selling point to shippers; the plan was for New York cargo to be loaded on Fridays with a Friday evening departure and to arrive in San Juan before 8:00 AM each Monday morning. Almost one year of intensive consultation between owners and builders during the design stage resulted in a ship which could operate competitively in the trade.

III. General Description

The ship is somewhat unconventional in appearance with its long white hull unbroken by the usual clusters of masts and cargo gear. Figure 3 shows the Ponce de Leon while on sea trials. The three large openings in the hull on the starboard side are the sideports. Smaller openings both port and starboard provide ventilation to the second deck area. The main deck almost gives the appearance of an aircraft carrier with its 5 ft-6 in. overhang beyond the side shell for nearly the entire length of the ship. Louvered ventilation enclosures are nested up under the overhang. The principal characteristics of the ship are listed in Table 1.

There are three trailer decks, the main, second, and third; and two automobile decks, the fourth and tank top, as shown by the isometric in Fig. 4. The ship is divided into five cargo holds below the second deck with transverse bulkheads spaced 112 ft-9 in. apart forward of the engine room. The transverse watertight bulkheads are fitted with hydraulically operated watertight doors to permit vehicle traffic between the holds. The doors must be kept closed at sea to maintain the ship's standard of subdivision. The fourth deck extends forward of the engine room only. Except for the machinery casing and ramp trunks, the space between the main and second decks is devoid of bulkheads. Fuel oil and ballast deep tanks are located forward of number 1 hold and aft of the engine room. The 7 ft-6 in. deep double bottom tanks provide additional fuel oil and ballast tankage. The tanks are divided between fuel oil and ballast so as to provide a clean ballast system and enough fuel oil for a maximum operating range of 6000 naut miles. Fixed ramps are utilized

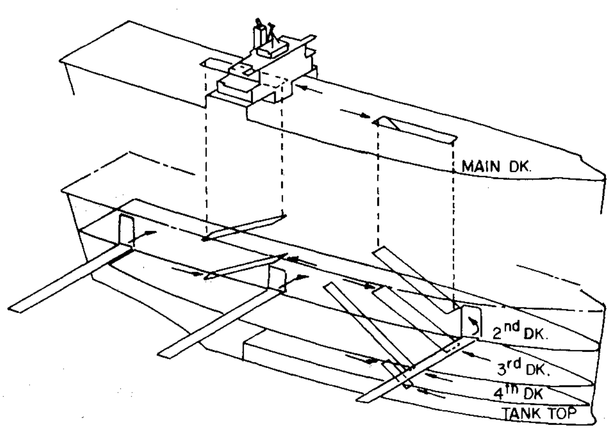

Fig. 4 Isometric arrangement.

Table 1 Principal characteristics

Length over all	700 ft-0 in.
Length between perpendiculars	643 ft-0 in.
Length at waterline	660 ft-0 in.
Breadth on waterline	92 ft-0 in.
Breadth over main deck	105 ft-0 in.
Draft, design waterline	27 ft-0 in.
Displacement at DWL	24,000 long tons salt water
Deadweight	13,200 long tons
Trailer capacity (including 60 refrig.)	244 based upon service experience
Automobile capacity	450 based upon service experience

fore and aft to drive the trailers and other vehicles from deck to deck.

A three quarters aft superstructure houses the crew, stewards stores, boiler uptakes, and navigation bridge. It is raised above the main deck to provide trailer driveways under it port and starboard. A cargo office is located on the main deck for the use of a cargo clerk during cargo operations. A longshoreman's toilet and washroom adjoin it. The fire control room is the only other compartment on the main deck. The next deck above the main deck is called the upper deck and contains the stewards storerooms, galley, crew's mess, and officers' mess. The bulk of the stewards department quarters are also on this deck. Going progressively higher, the cabin deck contains the quarters for the unlicensed members of the deck and engine departments, and the remainder of the stewards department. The boat deck contains the engineer officer quarters, the lower bridge deck the deck officers quarters and radioroom, and the navigation bridge deck contains the wheelhouse.

The wheelhouse is somewhat unusual in its arrangement. A navigation console is built against the forward bulkhead and contains the engine telegraph, remote engine throttle control, stabilizer tank controls, steering wheel, gyro compass, auto pilot, telephones, and radar. A partial bulkhead separates the chartroom from the steering area. A large window in the bulkhead allows the watch officer, when in the chartroom, to maintain a lookout and keep himself informed of activities in the wheelhouse. Electronic aids to navigation installed in the wheelhouse and chartroom include Loran, radar, and sonic depthfinder.

The location of the approximately three quarters aft engine room was dictated by the desire to avoid infringing on cargo spaces as much as possible, and at the same time to provide enough tank top area upon which to build boiler, turbine, and reduction gear foundations. Figure 5 shows a view from the stern quarter.

The power plant is fully automated and is rated at 32,000 ABS maximum horsepower on a single screw. It is a single boiler, high cycle efficiency plant, based on the General Electric MST-14 concept. Its salient features include a reheat cycle with main feed pump and main generator gear driven off the intermediate pressure and low pressure turbines, respectively. They are, of course, backed up by standby units utilizing independent turbines.

The manning scale has been held to a minimum, the complement totaling only 35. This has been possible because of the automation features designed into the ship, particularly the engine room. Table 2 summarizes the manning.

IV. Naval Architecture

The selection of a hull size and form capable of lifting the projected cargo and propelling it through the water at speeds in excess of 23 knots was the crux of the naval architectural problem. The usual parameters used in measuring a vessel's cargo capacity, such as deadweight tonnage and cargo hold cubic, are not really useful when dealing with a trailer ship. Deck areas and numbers of trailers are the meaningful characteristics here. The departure from ordinary rules of measurement becomes more apparent when it is realized that one half of the total trailer capacity of the ship is accommodated on the main deck, an area which would not ordinarily be taken into consideration when computing an ordinary vessel's cubic capacity.

It was necessary to keep in mind at all stages of hull development that sufficient double bottom tankage would have to be incorporated in the design to provide enough reserve stability to accommodate a relatively high cargo vertical center of gravity (VCG). It was also desirable to have a vessel whose trim under various conditions of loading could be maintained fairly constant without the movement of large amounts of water ballast.

Studies indicated that the vessel should have a speed length ratio of approximately 0.95 to achieve the required speed at a horsepower that could be absorbed by a single screw. Cargo arrangement studies resulted in the selection of the hull dimensions eventually used in the final design.

The cargo capacity studies were of necessity a process of trial and error since straight forward calculation of deck areas and hold volumes does not take into consideration vehicle maneuvering requirements, or the effects of obstructions such as columns and bulkheads on the stowage arrangement.

Some of the more important features of the hull are its complete lack of parallel midbody and long narrow entrance. The hull of this high speed ship is very fine lined. It has a transom stern, a large long bulb, and a large deadrise. The fine lines caused an interesting launching problem. In order to increase the rate of increase in buoyancy during launch, the ship was built on a larger declivity than that of its shipway.

Hull Appendages

The type of afterbody on this ship presented some interesting alternatives in appendage design aft. It was decided that in the interests of simplicity of construction and also of optimum water flow to the propeller, to minimize the skeg and support the propeller on struts.

The rudder is a simple spade 2% of the underwater lateral area. The top hugs the hull contour, and it is tapered toward the bottom. The cross section of the rudder is foil shaped. The propeller Vee struts are foil shaped and have an included angle of 65°.

A large diameter hollow torque tube runs from the tailshaft flange where the tailshaft emerges from the hull to the propeller strut bearing. A solid shaft would have been much heavier due to the long unsupported span involved. Withdrawal of the tailshaft is accomplished by uncoupling and dropping the torque tube. The stern tube is then drawn outboard rather than inboard as done conventionally.

A large bossing is built around the tailshaft where it emerges from the hull, and fairwaters are fitted over the torque tube flange connections. The propeller is 5 bladed, 21 ft-0 in. diam and is designed to operate at 128 rpm. It is a nickel manganese bronze propeller.

Table 2 Manning chart

Deck dept.		Engine dept.		Steward dept.	
Master	1	Chief engineer	1	Chief steward	1
Mates	4	Assistant engineers	5	Chief cook	1
Radio operator	1	Electrician	1	Cook/baker	1
Bosun	1	Deck engine mechanics	3	Utility	1
Able-bodied seamen	6	Wiper	2	Bedroom steward	1
		Total	12		
Ordinary seamen	3			Messmen	2
Total	16			Total	7

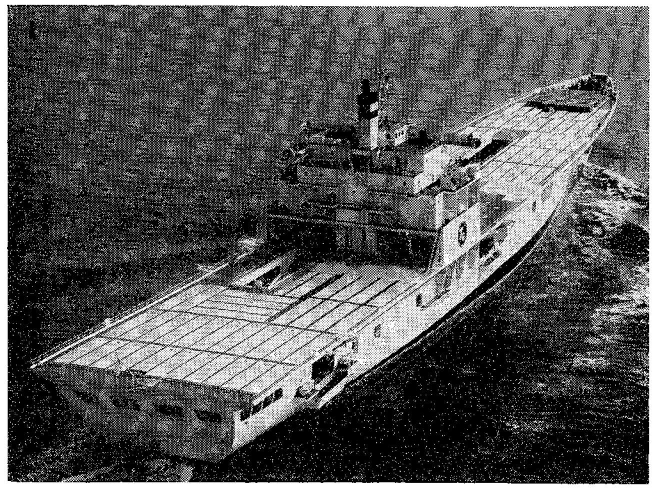

Fig. 5 Quarter view of Ponce de Leon on sea trials. Note the aft ramp pocket and hoisting tackle.

Trim, Stability, Subdivision

In a ship with as fine underwater form as the Ponce de Leon, it is difficult to keep the cargo centers low. Because of the nature of the cargo, the main cargo spaces are on the upper decks and the secondary spaces where the smaller vehicles are stowed are on the lower decks. This is the reverse order of things as found on most ships and results in high cargo centers of gravity. In addition, the use of the second deck as the freeboard deck limits the allowable angle of windheel to about 9° if one half the freeboard is used as the limiting heel criteria. This in turn results in a relatively high required GM.

In order to provide the ship with adequate reserve stability, the tank top was placed a high 7 ft-6 in. above the baseline to form large double bottom tanks. There is adequate tankage for a clean ballast system even if the ship makes two round trips to Puerto Rico without refueling.

The ballast deep tanks forward and aft allow the ship to be trimmed as desired without pumping the water in the double bottom tanks. In actual practice, the ship is permanently ballasted with fresh water as deemed necessary to provide adequate stability for any practical condition of loading. Certain deep tanks are also permanently ballasted to provide vessel trim within acceptable limits during all foreseeable conditions of loading. Thus, the necessity of pumping ballast during the course of most voyages is eliminated.

One compartment subdivision was incorporated in the design and, of course, the vessel can meet the stability requirements of one flooded compartment.

V. Structural Design

The ship meets the highest classification standards of the American Bureau of Shipping and in addition meets special requirements for driving and stowing trailers and other vehicles on the decks. The main hull girder is all mild steel and includes the main deck even though that is not a watertight deck. Special consideration had to be given to maintaining structural continuity around the loading port and ventilation openings. They are heavily framed and surrounded by heavy insert plates. Transverse framing is em-

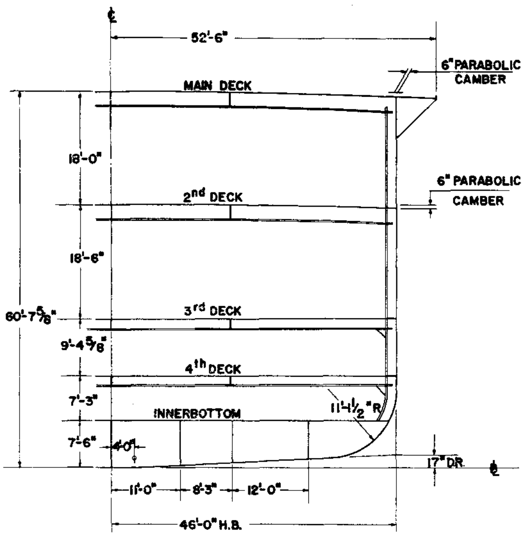

Fig. 6 Midship section.

ployed throughout the side shell on 33-in. centers with deep web frames generally at every fourth frame. A rigid double bottom structure is formed by solid floors under every frame intersecting a series of full depth longitudinal girders.

Special consideration had to be given to designing the decks to support the vehicles. Rather than employ a uniform load criteria for the decks, a typical load distribution for the type of vehicle to be stowed on the deck was developed. Most of the trailer deck space was designed for this type of load. It was deemed advisable, however, to set aside the forward part of the second deck for so-called yard trailers or those trailers which are loaded to higher than highway allowable weights and which, therefore, have to be partially loaded and unloaded in the trailer marshalling yard. In addition, a space in the vicinity of the forward side port was designed to accommodate a heavy lowbed type trailer weighing up to 100 short tons (ST). A midship section is shown in Fig. 6.

Dynamic wheel loads of 15% were applied to the static loads in all cases and the dynamic effects of rolling and pitching of the ship were computed and applied to the design.

It was found that the large numbers of trailers which could be stowed at the ends of the ship, particularly on the main deck, coupled with the fine lines of the ship resulted in a hull with relatively high hogging moments. This became the governing factor in determining the midship section modulus. The midship section modulus is maintained throughout the midship 0.4 length.

There is an almost complete lack of transverse bulkheads between the second and main decks. Transverse rigidity in this portion of the hull girder was achieved by the construction of box-like antiracking webs between the second and main decks over the transverse bulkheads below the second deck.

The extremely fine entrance in the area of the load waterline presented an interesting problem in fabrication and rigidity of structure. The solution was to insert a large steel casting in the stem. It is about 13 ft high and extends 10 ft aft of the forward perpendicular. It is machined to provide a fair surface which blends into the fabricated hull around it.

VI. Vehicle Stowage and Maneuvering Including Special Fittings

One of the more interesting aspects of the design was the development of the trailer stowage arrangement. The Ponce de Leon departs from the usual Roll-On/Roll-Off ship in that side ramps are used rather than a stern ramp. Therefore, instead of a straightforward entrance and drive to the parking place, the vehicles entering a side ramp must make a right angle turn in order to get into the fore and aft driveway. In addition, with more than one access ramp being used at one time, it is necessary to arrange traffic patterns that do not cross or conflict. The midship ramp cannot be used by trailers and is used primarily as the auto loading ramp in order that the automobile operation might be divorced as much as possible from the trailer operation. The midship ramp secondly is used for empty tractor traffic. During loading, after leaving its trailer on the ship, the empty tractor will exit over the midship ramp when possible, in order to leave the trailer ramps free for trailers. The opposite procedure takes place during discharging.

The arrangement of the ship allows trailers entering through either of the trailer ports, to proceed directly to the main deck via internal ramps, to stowage areas on the second deck, or to ramps down to the third deck. Some trailers, particularly those that stow just inside the sideport, must be backed aboard. Automobile loading on the lower decks can proceed independently of the trailer loading. The autos and other light vehicles proceed directly to the fourth deck over the midship auto ramp. It is possible to stow autos on both the tank top and fourth deck simultaneously.

Tie Down Equipment and Methods

The trailers are lashed to the deck by means of a combination of wire rope lashings and specially-built stands to support the front end. These patented stands, called Roloc stands and illustrated in Fig. 7, are an outgrowth of the special design work for the ship system. The stands are fitted under the trailer by locking into their king pins while the trailers are in the marshalling yard. The procedure is to back a tractor into the stand until the tractor's fifth wheel engages a king pin on the underside of the top of the stand. The tractor, by means of its hydraulically actuated fifth wheel, then lifts the stand clear of the ground and backs it under the front end of the trailer until the spring actuated locking mechanism on the stand engages the trailer king pin. The tractor then tows the trailer and box stand aboard the ship, or leaves it in the marshalling yard for future stowage. The height of the box stand ensures that the weight of the trailers is taken off the landing gear. As a rule, during the several days prior to the ship's arrival when trailers are being received in the marshalling yard, the yard tractors are used to place the stands under the trailers. Each assigned trailer space on the ship has a steel button welded to the deck at the point where the support stand is to be placed. The bottom of the box stand has a "V" shaped notch in it. As the trailer is backed into position, the notch guides the stand until its apex is brought hard against the button. A locking pin on the stand is then rotated by hand until it drops into a hole in the button

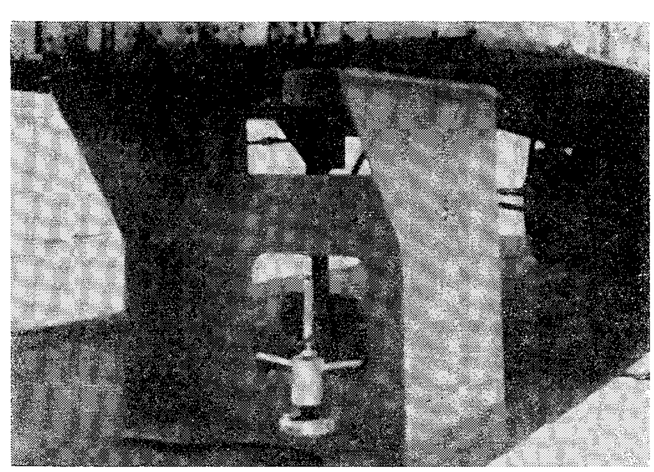

Fig. 7 Trailer Roloc stand.

and again rotated until it is locked in the button. This procedure accomplishes two things: first, it ensures that each trailer is located exactly where it is supposed to be and second, it secures the front end of the trailer securely to the deck. The rear end of each trailer is secured to the deck by two 35,000-lb capacity adjustable lashings.

The main and second decks have a regular pattern of D-rings welded to the deck for the engagement of a hook on the end of the lashings. The third deck has a regular pattern of cloverleaves cut in the deck for the engagement of a ball on the end of the lashings. These cloverleaves also facilitate the exhaust of diesel and auto fumes from the spaces under them.

The autos are lashed down with adjustable length lashings. Four lashings are used on each vehicle, one at each corner.

Refrigerated Trailers

Spaces are provided for the stowage of sixty refrigerated trailers, thirty-one on the main deck and twenty-nine on the second deck. The stowage spaces selected for these trailers are each equipped with flexible electric cables which receive power from the ship's service supply. The cables are stowed on spring loaded reels mounted under the main deck over or under the trailer space it is to serve. When a refrigerated trailer is brought into its stowage space, its diesel power is shut down since it would be impractical to run it during the entire trip. The flexible cable is then plugged into a receptacle on the underside of the trailer. On the second deck the cable is simply pulled down from overhead. On the main deck some special cutouts are used to pull the flexible cable through from the underside of the deck.

VII. Ramp Design

Interior Ramps

The vehicle ramps in addition to supporting the weight of vehicles negotiating them must be compatible with the tractive power of the vehicles. The principal parameter which had to be determined was the ramp angle or incline from the horizontal. It was decided that with a decent tractive surface a tractor could pull a loaded trailer up a ramp with a 10° incline, thus the incline chosen for the interior ramps.

The maximum ramp break angle that the trailer landing gear will clear, when at their normal elevation, is about 8°. Breaks in the ramp angle were, therefore, built into the head of each ramp. In order to achieve a smooth transition, the ramp break was divided into three slopes of 1°, 4°, and 7°. A short transition slope of 4° was built into the bottom of each ramp to keep the angle between the tractor and its trailer from becoming too large as the rear wheels of the tractor pass over the base of the ramp.

The automobile ramp requirements were not as stringent as those for the trailer ramps. Automobiles can easily negotiate the 14° incline installed. The breakover at the top is eased with a single 7° section. A similar section is installed at the bottom.

Table 3 Shore ramp dimensions and characteristics

	Fwd.	Mid.	Aft
Over-all length	172 ft-10⅞ in.	142 ft-5 in.	161 ft-1⅝ in.
Truss length	121 ft-5 in.	100 ft	109 ft
Designed operating angle	7°	7°	7°
Width between truss centerlines	25 ft	22 ft	22 ft-4 in.
Width of tractive surface (min.)	14 ft	20 ft	12 ft
Design load (max. vehicle wt)	200,000 lb	15,000 lb	80,000 lb

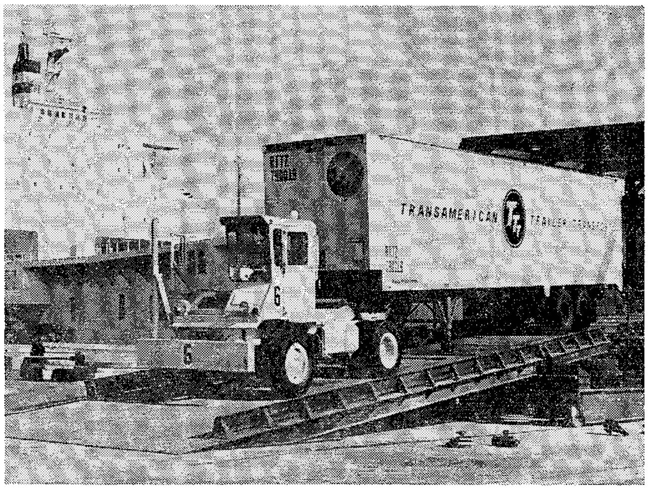

Fig. 8 Trailer being towed ashore.

Exterior Ramps

The exterior loading ramps presented some unique problems. In addition to providing the tractive surface and inclines compatible to the traffic, they also had to accommodate vertical movements of the ship due to tide changes and draft changes resulting from cargo operations. Horizontal movements generated by such things as inaccurate positioning of the ship, surges due to the wakes of passing ships, and uneven stretching or slacking of mooring lines must be accommodated by the ramps, although they do not lend themselves to as near predictions as the vertical movements mentioned above. A gross movement of 25 ft forward or aft of the mid position of the ramp on the pier was selected as a limit beyond which any conceivable movement would not occur.

The ramps in New York are identical to the ramps in San Juan except in the manner in which they are retracted when not being used. In Table 3 are listed the principal dimensions and characteristics of the ramps.

Because of the variables involved in the exterior ramp elevations, and the fact that it was deemed important that heavily laden tractors not stall on the ramps, the maximum design ramp angle of 7° was selected, as opposed to the 10° angle used for the interior ramps. Figure 8 shows a typical trailer being towed ashore.

All three ramps are supported at the pier end on trucks which travel on crane rails. The ship ends are supported by pockets on the side shell of the ship into which a male piece at the head of the ramp is placed.

The ship is fitted with ramp winches and falls positioned under the main deck overhang. The ramps are lifted into place by sets of block and tackle which are hooked to each offshore corner of the ramp. Each side of the ramp has two falls, each with its own winch. One fall is attached to the extreme outboard end of an outrigger under the main deck and the other is attached further inboard. This allows the ramps to be burtoned into position over the ramp pocket on the side shell and to be lowered until the insert piece is engaged in the pocket. The procedure is reversed to move the ramps clear of the sockets. Once the ramps are clear of the sockets, they are lowered to 16 wheel dollies in San Juan and to rollers in Staten Island. Tractors then engage king pins mounted on outriggers alongside the ramps to pull them clear of the ship. In San Juan, the ramps are pulled back 40 ft so that the pier apron is clear and other ships can be worked when the Ponce de Leon is not there. In Staten Island, the ship ties up to the south side of a narrow finger pier which must also accommodate other ships on the north side. In order to keep the ramps from infringing on the north side cargo operations, 40-ft-wide floats have been permanently moored to the pier. The ramp rollers are mounted on them. The ramps can then be retracted until they clear the ship. The rollers on the floats are hinged at the base so they can be rotated into an almost horizontal position in order to eliminate any chance of interference with the ramp while it is engaged to the ship.

VIII. Ventilation in Vehicle Holds and Fume Detection and Fire Smothering System

Ventilation requirements in the cargo holds are dictated by the quantities and type of fumes which have to be dissipated. The basic criteria is not to allow more than 100 ppm of carbon monoxide in the atmosphere. Since the vehicles only run in port during cargo operations, the cargo hold ventilation is only required to be run in port. The system adopted consists of mechanical supply to the fourth deck and tank top of cargo holds 1–3, and to the third deck of cargo holds 4 and 5. Natural exhaust takes place up the ramp openings and through the cloverleaf cutouts on the fourth and third decks. Airlifts are provided at the second deck to exhaust the air to the atmosphere without destroying the watertight integrity of that deck. The airlifts as well as the air supply ducts are equipped with water tight (WT) closures and fire dampers.

An attempt was made to eliminate the possibility of the formation of pockets of carbon monoxide. This was done by extending the air supply ducts fore and aft on each side of the cargo holds with louvers spaced at frequent intervals. This in combination with the high air velocities achieved maintains a constant circulation of air in every part of the cargo holds.

A vapor detection system for the vehicle spaces below the second deck is designed to provide an alarm signal when the vapor level reaches 100 ppm. A sampling and detection panel is installed in the fire control room on the main deck and a remote alarm and cycle control panel is installed in the engine room at the operating platform.

A CO_2 smothering system is provided for fire protection in the enclosed vehicle spaces as well as the machinery spaces and storerooms. The semienclosed vehicle stowage spaces on the second deck are protected by a sprinkler system.

IX. Roll Stabilization and List Control

In order to minimize the vehicle tie down requirements as much as possible, a roll stabilization system was installed in the vessel. Various systems were considered and a controlled passive "U" tube type tank system was the one decided upon. Fin stabilization was considered at one stage, but the requirement that the ship be able to be stabilized while dead in the water ruled the fins out. The controlled passive system consists of a tank on each side of the vessel above the tank top. The two tanks are joined by a water duct just above the tank top. An air duct with air control valves joins the tops of the tanks. The water duct is sized so that the system's natural period corresponds with the ship's fastest estimated period of roll which is 10 sec. At rolling periods longer than this, the gyro sensing unit in the system controls the air valves causing them to lag so that the passage of air from tank can only take place near the ship's actual period of roll but 90° out of phase with it. Since in order for water to move from one tank to another a like amount of air must be displaced, the water is restrained from moving except as the air control valves permit. The tanks extend from the double bottom tank top to the second deck, a height of some 35 ft. The water level in the tanks is maintained at about 16 ft. The equipment is controlled from the wheelhouse control panel located in the navigation console.

A list control valve in the water duct was installed to permit pumping all the water in the system over to one tank. This is only done in port to counter the heeling effects of the shore ramp weights or unsymmetrically loaded cargo. The tanks are on the bilge and ballast system and with both bilge and ballast pumps operating, it is theoretically possible to make a complete transfer of water in less than 30 min. Under most conditions of loading the tanks will correct for 6° of list or more.

We found it difficult to relate stabilization system test data to actual roll damping to be expected at sea. Since sea conditions and wave characteristics at sea are of an infinite variety, it is impossible to recreate a given sea condition in the laboratory. The design criteria for the system on the Ponce de Leon was to provide a degree of stabilization equal to that indicated by tests which were designed to simulate a sea generated by Beaufort force 5–6 winds. The test results indicated that a reduction in amplitude of the mean $\frac{1}{3}$ highest rolls under most conditions of displacement and GM would be on the order of 40–50%.

X. Terminal Facilities and Equipment

The terminal facilities in both ports have many features in common, but in appearance and many other ways they are quite dissimilar. The main features that they have in common are trailer and auto marshalling yards, office facilities, trailer weighing scales, and loading ramps. In San Juan all of the vehicle marshalling areas and indeed, the entire shore facility is a unit immediately contiguous to the ship's berth. The vehicle parking areas are all out in the open. In New York, on the other hand, the vehicle marshalling areas are several hundred yards from the ship's berthing pier and the autos are held under cover on a nearby pier.

Twenty-four Ottawa Hustler tractors are maintained in the system, with 8 staying in Puerto Rico and 5 shuttling on the ship, so that during operations 13 are available in Puerto Rico and 16 are available in New York. The Ottawa was selected for, among other things, its short turning radius, small size, ease of operation, and tractive capability. It also lent itself to relocations of the fifth wheel which were necessary to handle the trailer support stands.

Transamerican Trailer Transport (TTT) leases and operates about a thousand 40-ft highway trailers which were built to its own specifications and which form about 70% of trailers lifted, the balance coming from shippers or land carriers. This ability to lift any highway equipment, regardless of specification, is one of the major operating advantages of the ship. Tank trailers, lowboys, and rolling equipment of all types and ownership are carried.

XI. Operating Experience

The Ponce de Leon concept of ocean transport has found ready acceptance in the trade for which she was built. Her cargo handling speed has equaled what were considered somewhat optimistic design goals. The speed with which the ramps can be lifted and engaged, or disengaged and lowered, has been a surprise to some who thought the simple burtoning rig might be unhandy.

The ship's speed at sea has been more than adequate, having made the passage to San Juan in 56 hr on occasion. Her normal arrival in New York on Thursday morning gives her an extra day in New York on most trips.

Her flexibility in accommodating varieties of cargo cannot be matched by conventional container ships or even general cargo ships. Such unconventional cargo as steam rollers, road graders, garbage trucks, and buses are not uncommon sights, and the heaviest need no special lifting gear to get them aboard since they just roll up the ramps. Flat bed trailers with lengths of pipe far in excess of a trailer's 40 ft are normally parked at the stern on the main deck and the pipe allowed to protrude past the transom.

Since the vessel was delivered, a pair of detached edible oil tanks have been installed. They are suspended from the main deck above the line handling area on the second deck aft. To load them, a tank truck is driven aboard and the pump on the truck used to transfer its cargo to the tanks. To discharge in San Juan a flexible hose is dropped over the side to a waiting truck on the dock and the cargo allowed to gravitate out.

Some departures from anticipated cargo handling procedures have taken place since the ship went into service and in fact, TTT is still developing refinements to its operation. It has been found impractical to stow trailers on the ramps as originally planned. Although the trailers themselves can be secured adequately on the ramps, the cargo inside is often not properly secured and slides toward the low end of the trailer. The ship has experienced burst trailer doors and cargo spilling on deck. It has been found necessary to lash tank trailers more securely than dry trailers, since in heavy weather, the liquid surges back and forth in the tanks causing the trailers on occasion, to work their way off their support stands.

It has been found desirable to stow the larger trucks moving as cargo in a few of the more difficult spaces for trailers to maneuver since these vehicles require a high overhead clearance, and stow more rapidly than trailers. Very often also the area of the second deck over number 3 hold will be left clear of trailers and the spill over of trucks from the lower decks will be accommodated here. The ability of the longshoremen to take advantage of the space available has caused the number of automobiles being stowed in a given area to exceed the planned capacity by up to 20%.

The entire venture, from concept to execution, has been most successful. Its technical and economic success has had its foundation in the close relationship developed between, the designer–builder, and the owner–operator. Starting with a one and a half page performance specification, both parties have felt free to innovate and more than meet the challenge of the original concept.