The Construction and Testing of a 33,000-Ton (M) Lift Floating Dry Dock

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The constantly increasing volume of world trade necessitates continuous enlargement of international merchant fleets. The number and size of new ships have risen sharply in recent years. In order to keep up with the demand for new ships, the world's shipyards have had to invest large sums of money, and will be forced to continue to do so. These developments lead in their turn to the necessity for greater service and repair capacities. This paper describes the way in which the installation of a new 33,000-ton floating dock enabled Jacksonville Shipyards, Inc. of Jacksonville, Florida greatly to enlarge their service and repair capacity.

The basic plan

The Jacksonville Yards being situated approximately halfway between the large consumer centers on the East Coast of America and the Gulf of Mexico, that is, the north coast of South America, it was only too natural to enlarge the docking facilities by adding a new high-performance dock. The object was to accommodate the ships of between 100 and 120,000 dwt which work in this area.

The recent trend of increasing the width of ships, especially tankers, in relation to their length was to be taken into account when planning the size of the dock. The following dimensions were chosen:

Length overall, ft	827
Length over keel blocks, ft	771
Width between inner wing walls, ft-in	148-3½
Clear inner width between dock runways, ft-in	144-4
Width between outer wing walls, ft-in	173-10
Height to upper deck, ft-in	59-8
Height of pontoon midships, ft-in	16-5
Immersion depth over keel blocks, ft-in	31-10
Height of keel blocks, ft-in	4-11
Upper-deck freeboard during immersion, ft-in	6-7
Pontoon-deck freeboard with dock in working position, ft-in	1-6
Draft with dock in working position, ft-in	14-11

Before the main dimensions could be decided on, detailed calculations had to be made to ensure that it would be possible to tow the dock across the Atlantic from Germany to Florida in one piece, for it had been stipulated that this was how delivery was to be done. The builder also had to see that the dock was completely fitted out and ready for use, including all provisions for anchorage at its mooring, and put into service in Florida with a minimum of delay.

It had been decided not to adopt the method, frequently used in the past, of section-by-section construction with subsequent assembly at the mooring. To do this would have meant higher expenditure, longer manufacturing periods, and greater risks for the purchaser; what is more, it would have meant wastage of the construction company's facilities and experience, namely, a building berth some 1300 ft long and the know-how gained from previous long tows to countries such as, Indonesia and East Pakistan.

An Atlantic crossing with a dock of these dimensions, however, had never been tried before, and the idea was to do the designing and construction proper along the following lines:

(*a*) For the Atlantic crossing, the dock's longitudinal strength was rated to meet the heaviest seas on the Lloyd's Register of Shipping scale, that is, waves 8.5 m in height (and roughly of the same length as the dock).

(*b*) Lloyd's also laid down that the dock was to be towed to Florida only during March, April and May, owing to the onset of the hurricane season in the western Atlantic in June.

(*c*) Provided Lloyd's were satisfied on point (*a*), and point (*b*) that towage began at the end of April (trip estimated at 30 days), it was expected that they would issue a towage certificate and that the competent local authorities would furnish permission for the trip to proceed.

(*d*) With conditions (*a*) to (*c*) fulfilled, towage costs and insurance fees diminished appreciably.

The dock is of caisson design with throughgoing bottom and side caissons, but no provision has been made for self-docking in any of the customary ways. It will nevertheless still be possible to clean and service the wing walls and ends of the dock by heeling and trimming maneuvers, lifting these clear of the water.

Apart from the advantages of the caisson construction principle as regards to longitudinal strength, there is another feature in this dock that reflects a recent trend in dockbuilding; namely, the trend away from the long-preferred self-docking types. Among the factors attributing to this is doubtless the higher corrosion-resistance afforded by the completely smooth, welded outer shell. The closely allied problem of marine growth, of considerable significance for the dock's lifting capacity, has thus been virtually surmounted. Moreover, present-day paints based on epoxide resin are extremely hard and last for years without rubbing off. The hardness of these epoxide resin paints is such that it prevents the razor-edged barnacle from causing the damage so feared in times past. With an absolutely tight and pore-free surface, it is impossible for rust to set in beneath the paint. In addition, the dock was furnished with cathodic protection fed by a separate electrical supply unit. This is described in greater detail in the section on electrical equipment.

The expenditure incurred by the foregoing measures bears no relation to the considerable extra cost of a self-docking design as compared with a caisson dock.

The dock was designed, rated and built in accordance with Lloyd's Register of Shipping regulations. After the commissioning and requisite trials at the moorage had been completed under the Lloyd's surveillance, the dock was awarded its classification

"+A—Floating Dock for Service at Jacksonville"

In this connection it should be remembered that the awarding of a classification, coupled with seaworthiness certificates,

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Presented at the October 5, 1973 meeting of the Southeast Section of The Society of Naval Architects and Marine Engineers.

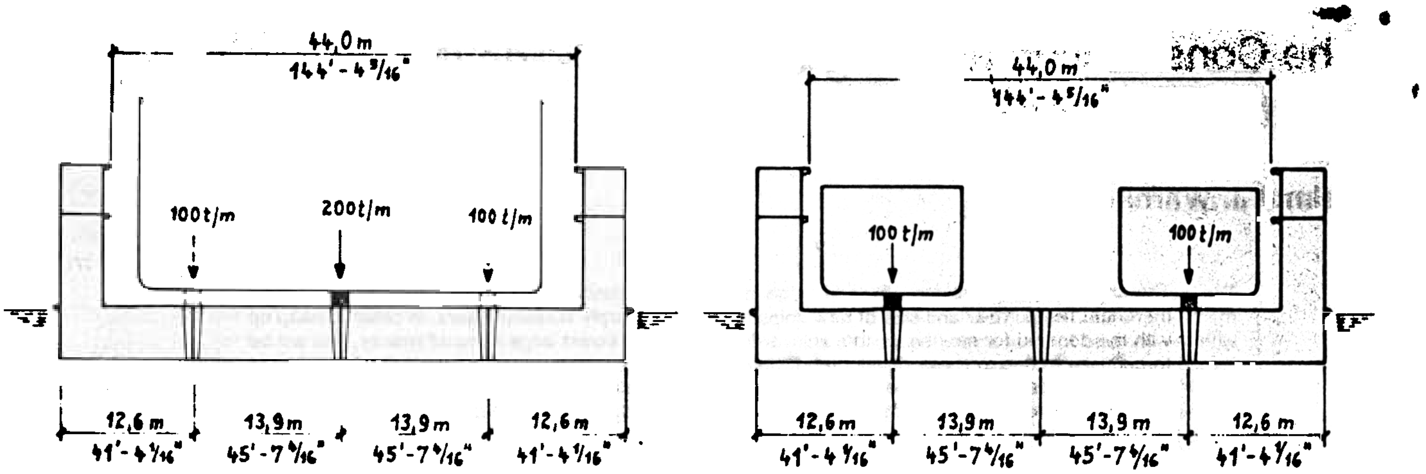

Fig. 1 Static rating of transverse strength

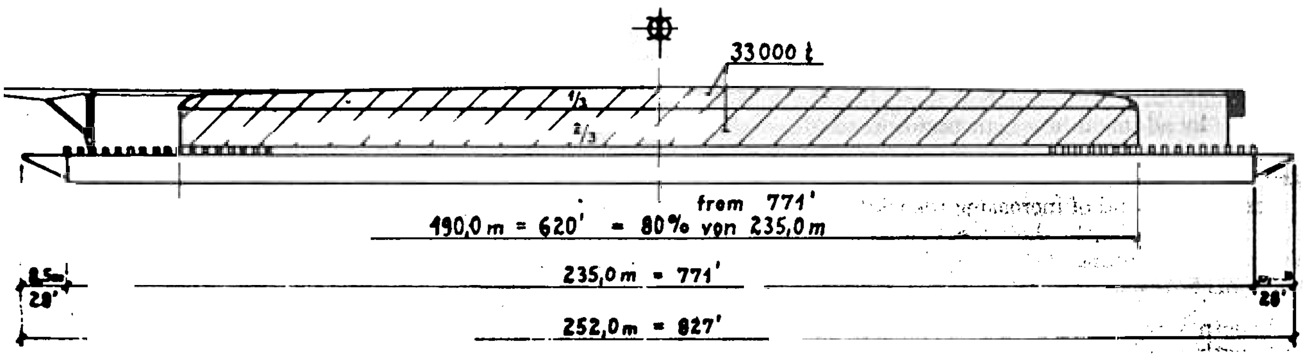

Fig. 2 Longitudinal strength calculation

both reduces insurance outlay and makes any later sale more attractive, a point that one cannot afford to overlook these days.

Load testing

As indicated in Fig. 1, the basis taken for the static rating of the transverse girders over the entire length of the dock was an increased load ordinate of 200 tons per meter of dock length (approximately 61 ton/ft) over the middle-line bulkhead, and as an alternative 100 tons per meter of dock length (approximately 30.5 ton/ft) over both wing bulkheads. The middle-line bulkhead and the two wing bulkheads are rated for the same load. This makes it possible to dock certain vessels on two rows of blocks, moving the center keelblocks to the side above the two wing bulkheads. The pontoon deck is specially designed to avoid having to alter the keelblocks. Besides this, it is also possible to accommodate two smallish vessels in the dock side by side.

As shown in Fig. 2, the dock's longitudinal strength for docking is calculated in conformity with the regulations of the classifying company as if the load length of the shortest vessel with the maximum docking weight of 33,000 tons were distributed over only 80 percent of the dock's length, with the vessel adopting a position exactly along the middle line.

The ship's weight curve is assumed to be a rectangle plus parabola, with the surface of the rectangle taking up two thirds and that of the parabola one third.

The dock's pontoon deck was given special reinforcement with ¾-in. plate being used throughout so that vehicles could be driven over the deck and so as to make it impervious to the tough conditions it would face.

Lifting capacity

The draft of the dock in working position is 14 ft-11 in. = 4.55 m.	
The surface area of the pontoon measures 12,203 sq m.	
This gives us a displacement of 4.55 × 12,203 =	55,700 cu m
The outer shell of the pontoon increases the displacement by a further	+200 cu m
Total	55,900 cu m
The specific weight of the water at the mooring has been simplified here and put at 1.0 to give us:	55,900 ton
Deducting the deadweight of the fitted-out dock, including the weight of two dock cranes:	−11,500 tons
we are left with	44,400 tons
From this we must subtract the residual water that cannot be evacuated from the ballast tanks (the depth assumed being 20 cm above pontoon bottom). This gives us 12,203 × 0.2 =	−2,440 tons
which leaves us with	41,960 tons
Less the quantities in the various storage tanks (full):	−310 tons
we are left with	41,650 tons
Allowing for slight siltation of the ballast tanks, we can round off our figure by subtracting another 650 tons:	−650 tons
Effective lifting force left =	41,000 tons

$$\frac{41{,}000 \text{ tons}}{235 \text{ m (length over pontoon)}} = 175 \text{ tons effective lift force per meter of dock length}$$

$$= 53 \text{ tons per ft of dock length}$$

It is therefore possible to dock vessels whose weight ordinates do not exceed the foregoing values by much, without causing any appreciable longitudinal sag, provided the vessel's weight distribution roughly corresponds to the buoyancy distribution possible above the dock's ballast tanks. As the dock's nominal lifting capacity was put at 33,000 tons, the following calculation may be done:

effective lifting capacity = 41,000 tons
less ship's weight = 33,000 tons

8,000 tons of ballast water remain in the ballast tanks

This amount of ballast is a very generous rating. Besides this, it can be readily transferred and can be used to balance trimming and heeling as well as for reducing longitudinal sag. In favorable conditions, say when docking a long vessel *on an even keel,* the length of which approximately corresponds to that of the dock, and where it has been possible to evacuate the extra 8000 tons of ballast water, the dock would be capable of docking a vessel of

33,000 tons
+ 8,000 tons
= 41,000 tons weight

Dock hull design

The entire hull was constructed of shipbuilding steel and fully welded. Depending on the crane capacities available at the builder's yard, whole compartments were prefabricated to enable as much of the welding as possible to be done with comparative ease.

This cut to a minimum the welding at the building berth. In conjunction with the welding program that had been built on the strength of past experience, this method of sectional construction minimizes weld shrinkage stress and the distortions this would otherwise lead to.

The dock hull consists of one throughgoing pontoon as the supporting structure and two throughgoing, fully closed side wings to give stability and longitudinal strength. Three longitudinal and five transverse watertight bulkheads divide the dock up into 24 ballast tanks. The transverse girders are spaced at intervals of 7.5 m.

Transverse frames were fitted in the pontoon, while in the side wings longitudinal frames, in turn supported by web frames, were put in to take the stress that arises mainly here as a result of longitudinal sagging.

To speed pontoon-deck drainage when the dock emerges from the water, each of the side wings was provided with two openings measuring approx. 5.0 × 3.0 m.

The safety decks, which form the top of the lateral ballast tanks, are housed 4.3 m below the upper deck.

The space above the safety decks is divided by bulkheads and serves to accommodate machinery and electrical installations as well as storerooms, crew quarters, messrooms, and sanitary facilities. Also located here are the tanks containing waste oil, fresh water, diesel oil, fuel oil, and treated boiler feedwater.

All the tank tops and room ceilings are arranged roughly 1.5 m below the upper deck so as to allow cableways and pipes to pass unobstructed beneath the upper deck.

Flooding and evacuation plant

The flooding and evacuation lines (Fig. 3) for the 24 ballast tanks are subdivided into six groups, each covering four tanks, with one evacuation pump with a nominal bore of 700 mm to each group. An additional connection line makes it possible to evacuate all the tanks with one pump. Thus, if the need arises—for example, if the energy supply from shore should fail completely—the diesel unit aboard the dock can be used to drive the one pump and evacuate the dock.

The ballast tank piping, which has a nominal width of 350 mm, is all made of steel and for the most part weld-connected. Flanges were used only where necessary. Clamping flanges with rubber gaskets were preferred for the bulkhead lead-throughs and telescopic pipe elements.

The six evacuation pumps each can handle approximately 1.1 cu m/sec, and a ship with a maximum weight of 33,000 tons can be docked in about 145 min. The evacuation pumps are mounted on the ballast tank floors and connected by shafts to the electrical drives on the safety deck.

Also to be found on the safety deck are the electrical drives for the slide valves, rod linkages being used in this case to operate the flood and evacuation-line slides. All the pump and slide valve drives are controlled from a central desk in the control house.

As the water of the St. John River is extremely turbid and the Jacksonville Yards are regularly faced with steep bills for continuous desludging of the ballast tanks in the docks already there, precautions were taken on this dock to limit the ingress of silt during flooding operations. An ingenious design was worked out, consisting of a vertical shaft situated in front of each of the inlets. At certain intervals there are large orifices in these shafts; when the dock is being flooded they are automatically closed by slide valves suspended from floating bodies. This has the effect of allowing only surface water down to a maximum depth of approximately 3.0 m to enter the dock, that is, barring the water below this depth, where most of the sludge is concentrated.

Dock outfit

Given a generous 1.50-m (4 ft-11 in.) height, the keelblocks permit repair workers to get beneath the bottoms of vessels without too much stooping, an advantage that should not be underestimated, bearing in mind the climate in Florida. The blocks used on this dock were once again those with steel wedge and single hardwood and softwood lining that the builders developed and that have given years of excellent service. This type of block uses very little timber and makes for extremely easy removal under the ship's load.

The job of providing lateral support for the docked vessel is performed by 16 pairs of spindle-driven bilge blocks. The spindles are operated via chains and handwheels on the upper decks. The blocks themselves can be freed even when under load and they can easily be removed altogether if necessary for repairs to the ship's bottom. One advantage of this type of block is that a new ship can be docked immediately the previous vessel has left the dock. This is effected simply by adapting the blocks by way of the spindle drives to the form of the next vessel, without any need for the dock to resurface between times.

Other equipment aboard that was adapted to dock service includes deck superstructure and fittings, such as companions, ventilator housings, access pits, hatchways, ladderways, railings, catwalks, and rubbing strakes.

In view of the climatic conditions the dock would operate in, the synthetic ceilings used for crew quarters and messrooms were fitted with thermally insulating sheeting.

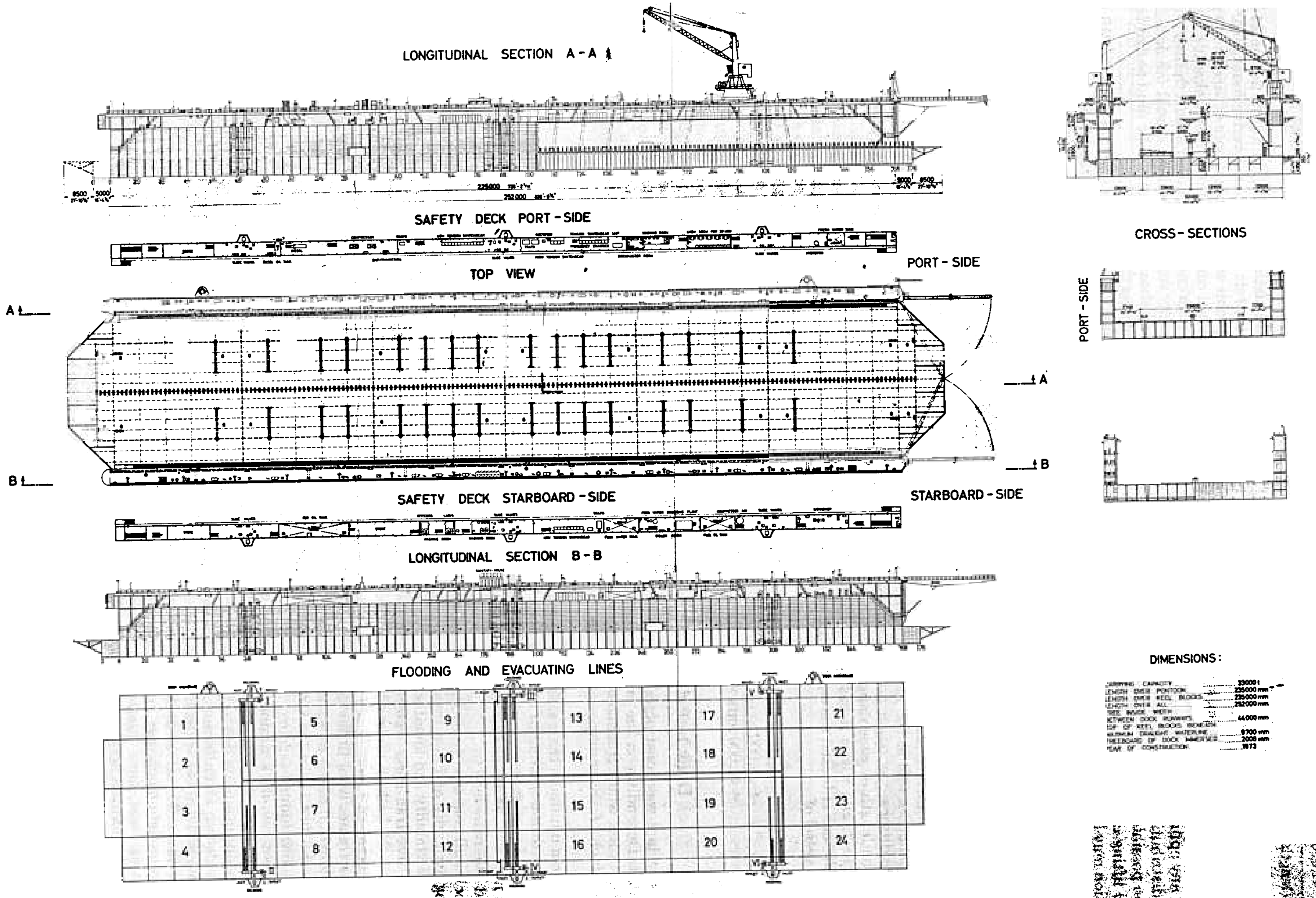

Fig. 3 General layout

Carrying four capstans at the ends of the upper decks, each with a tractive force of 12 tons, and two 6-ton capstans midships on the upper decks, the dock is more than amply equipped for hauling operations. With the help of block and tackle and guide pulleys, the capstans can also contribute considerable assistance when work has to be done on ship's propeller, propeller shaft, or rudder.

The gear units for these capstans are housed below the actual deck, while the capstans themselves are welded into the upper deck with massive plates, making fitted bolts and shearstrips unnecessary. The two upper decks are connected by a double-winged bridge intended for personnel only. This can be opened if need be for extra-long vessels.

On one side of the dock on the upper deck is the control house, where all the instrumentation for control of docking maneuvers is centralized. The following is a list of the most important equipment in the control house:

- 24 pneumatic water-level indicators for ballast tanks
- 2 pneumatic draft gages
- 1 longitudinal deflection meter
- 1 transverse deflection meter
- 1 optical sag indicator
- 1 hydraulic sag indicator
- 1 meter pendulum with adjustable scale
- 24 slide-valve operating levers for the individual ballast tanks
- 12 levers for the inlet and outlet slide-valve drives
- 6 switches and ammeters for evacuation pumps
- 1 schematic of ballast tanks showing positions of all slide valves
- various ammeters and voltmeters for HT and LT and for emergency
- diesel alternator
- emergency switches for HT shore connection
- emergency switches for ventilation system
- various switches for dock lighting.
- telephone, intercom, and loudspeaker systems.

On the starboard side there is a workshop fitted out with bench, small lathe, column-type drilling machine, assorted tools, cupboards and shelving. Dock tools, paint, timbers, ropes, etc. are stored in rooms on the safety deck. Extra-large hatchways in the upper decks give dock cranes access to these storage rooms.

Pipework installations

Telescopic piping was used for the ballast tank ventilation system in the lateral wing caissons. In the central tanks, swivelling arms were attached at the lower ends. These enable the upper deck freeboard desired to be swiftly, easily, and accurately attained without any need of flame-cutting equipment.

The fire-fighting and foam appliances are fed by two pumps with a delivery of 200 cu m at 90 m WG and 300 cu m at 30 m WG. Distributed over the pontoon and the upper decks are totals of 38 hose connection points and 10 foam blowers. Further connections are provided at the ends of the dock for fire-fighting craft. The huge delivery of the pumps also makes it possible to fill the ship's tanks for tank trials.

The fresh-water system, used by docked vessels as well as for the dock's own sanitary facilities and the boiler plant, is fed from a 50-cu m tank with hydrofor. This tank can be topped up even at low pressure by means of a specially provided shore connection, particularly during the night.

Housed on the port side of the dock are wash and shower rooms for the dock crew, while similar facilities for the complement of the docked vessel are located on the starboard side. A sanitary station with seven toilet cubicles and further washing facilities are to be found on the upper deck. Electric calorifiers are of course available in various rooms.

A waste-oil line with three connection nozzles and a 200-cu m storage tank fitted with radiators allows oil to be transferred from the docked vessel to the dock, the return being effected with the aid of a toothed wheel pump fixed on the safety deck and capable of handling 100 cu m/hr at a head of 80 m. The pump has a steam-heated base to facilitate the handling of heavy oils.

Installed on both sides of the dock are compressed-air manifolds with a total of 56 connection couplings at pontoon deck and upper deck levels. A transverse connection line runs through the pontoon, and a 10-cu m buffer tank is located on one side of the dock.

These lines are fed by two screw compressors, each handling 2000 cu m/hr at 7 kg/sq cm gage. The compressor oil/air coolers themselves are on the upper deck so that heat can be dissipated straight to atmosphere. Adequate lines were provided for cleaning the inlets of the fire-extinguisher pumps by blowing through air.

For tank cleaning and for use by docked vessels there is on the port side of the dock a steam boiler with a wet steam output of 5 ton/hr and a service pressure of 10 kg/sq cm gage. Firing is by way of light fuel oil.

A fully automatic water treatment plant draws on the freshwater system in order to keep the 100-cu m storage tank full. The fuel oil tank also holds 100 cu m and is fitted with radiators. The steam discharge line is provided with six outlets beneath the dock runway on the port side.

Preservation

All the surfaces of the dock hull were sandblasted either during or after assembly in accordance with the B Sa 2 grading as per the Swedish tables. The external surfaces of the pontoon up to the pontoon deck were given two coats of a synthetic compound paint with an epoxide resin base, resulting in a total thickness of approximately 250 μm. The interior surfaces of the ballast tanks and the exteriors of the lateral caissons were sprayed twice with a coal-tar pitch solution with epoxide additives, giving a total layer of 300 μm.

Special treatment applied on the strength of results of many years of tests in Singapore and Port Fouad has improved both the bonding and the heat resistance of these paints to such an extent that they probably represent the best preservative means available today for docks.

All other surfaces that come into contact with the water only occasionally, or never at all, were given the normal lead oxide oil coating and appropriate top coats.

Cranes

The dock was completed by the mounting of two dock cranes. The crane rails and other equipment for the cranes have already been provided. The design of the lateral caissons makes allowance for cranes with the following dimensions:

Lifting capacity regardless of boom position, tons	12.0
Hook height above top of rail, m	22.0
Lowest hook position below top of rail, m	18.0
Craneway gage, m	3.90
Maximum working radius, m	26.0
Minimum working radius, m	8.0
Lift time for 12 ton, m/min	6.5
Lift time for 6 tons m/min	13.0
Inching	1:10
Luffing, m/min	35
Precision luffing	1:5
Rotation, rpm	1.5
Travel, m/min	30.0

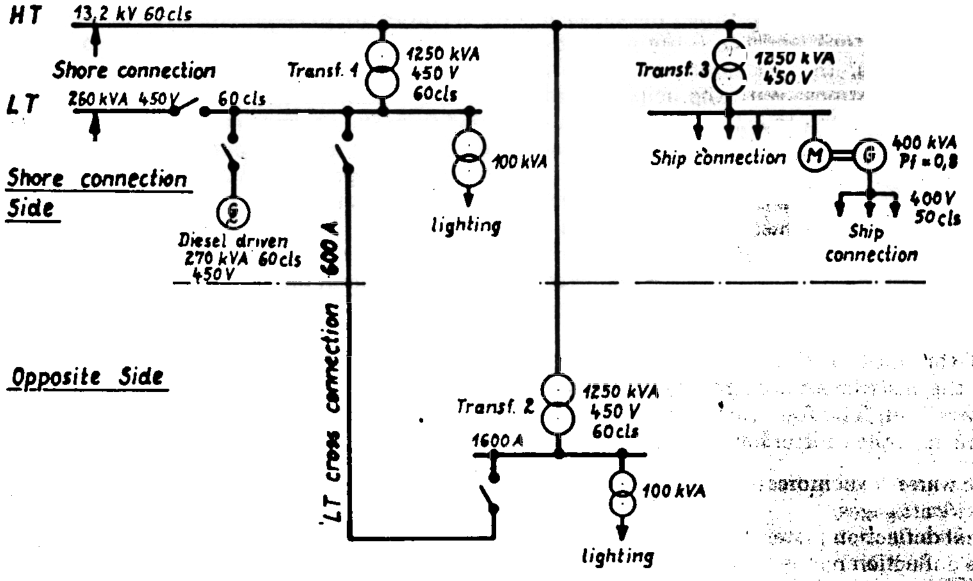

Fig. 4 Connection diagram

Each of the gantry feet on which the crane moves comprises three wheels supported by rocker arms. The dock can heel up to 5 deg without affecting the cranes' stability, whether they are loaded or not. The cranes are fully operable under longitudinal inclination up to 0.4 percent and transverse inclination up to 0.5 percent. The travel-gear brake can be relied on to hold the cranes in longitudinal inclinations of up to 2.25 percent. Additional safety is afforded by the presence of four rail clamps, and every movement is limited by a lever or spindle-triggered arresting system. An automatic device to prevent overloading is also provided.

Electrical equipment

Rating of the comprehensive electrical equipment was made based on VDE Rules considering an ambient temperature of 45 C. All major system components and all machinery were built to Lloyd's Register of Shipping rules and standards. Inspection of the entire electrical system was made in the frame of dock classification by Lloyd's.

All plant components were brought into harmony with U. S. requirements and standards in detailed discussions held with the customer. For instance, all wearing parts—such as lamps and receptacles—are of U. S. make to simplify spare parts stocking.

Electric energy from shore is supplied to the dock via one connection box on the shore side and one on the dock side. The following connections were made (see Fig. 4):

Main supply: HT 13,200-v, 60 cps, three-phase ac, 3.00 Mva.

Emergency supply: LT 450-v, 60 cps, three-phase ac, 260 kva.

Further, various cables for telephone, fire alarm and emergency HT trip.

High tension supplied from shore is transformed on the dock into 450-v operating voltage.

Further voltages generated:

- 230-v, 60 cps, three-phase ac for lighting system, via two air-cooled transformers.
- 120-v, 60 cps, LT via local transformers for receptacles and connection boxes for portable consumers.
- 400/230-v, 50 cps, three-phase ac, generated by frequency transformer, power 400 kva, for the supply of three ship connection boxes.
- 110/220-v dc, generated by silicon rectifier for the supply of three ship connection boxes.

Switch gears are installed on either dock side in the safety decks and numerous subdistribution panels feed the various consumers.

Ships docked can be supplied with three-phase ac, 60 cps, three-phase ac, 50 cps, or dc from connection boxes mounted on the port side.

Emergency power for the dock can be supplied by a diesel-driven emergency alternator of 270-kva capacity in case the shore connections break down.

A battery-fed emergency lighting system is included. Rating of lighting for decks and rooms is ample.

Receptacles and connection boxes are provided for small consumers, portable lighting equipment, and medium consumers up to 200 amp.

A combined paging and intercommunication system serves for command-giving. Communication between the yard and ships docked is established by a telephone system.

The cabling system installed conforms to load tables established for this particular dock and approved by Lloyd's. The cables laid of various types are plastic-sheathed.

The electric corrosion-protection system installed on the dock operates with additional current supply. Around the dock approximately 40 round anodes are suspended from the dock bottom, which are connected via flexible cables with potential-controlled rectifiers mounted on the safety deck. Electrodes inserted in the dock wall continuously meter the potential. The system mounted on the port side also protects the quay's new sheet-piling.

As the yard will be forced to redredge the dock pit every year, it was an absolute necessity to suspend the anodes from the dock hull.

Dock anchorage

Detailed studies had to be conducted to find an effective and economical solution to the problems connected with the anchorage of the dock. The various possible solutions available had to meet hurricane requirements. The customer decided in favor of a solution where tubes fitted on the dock are

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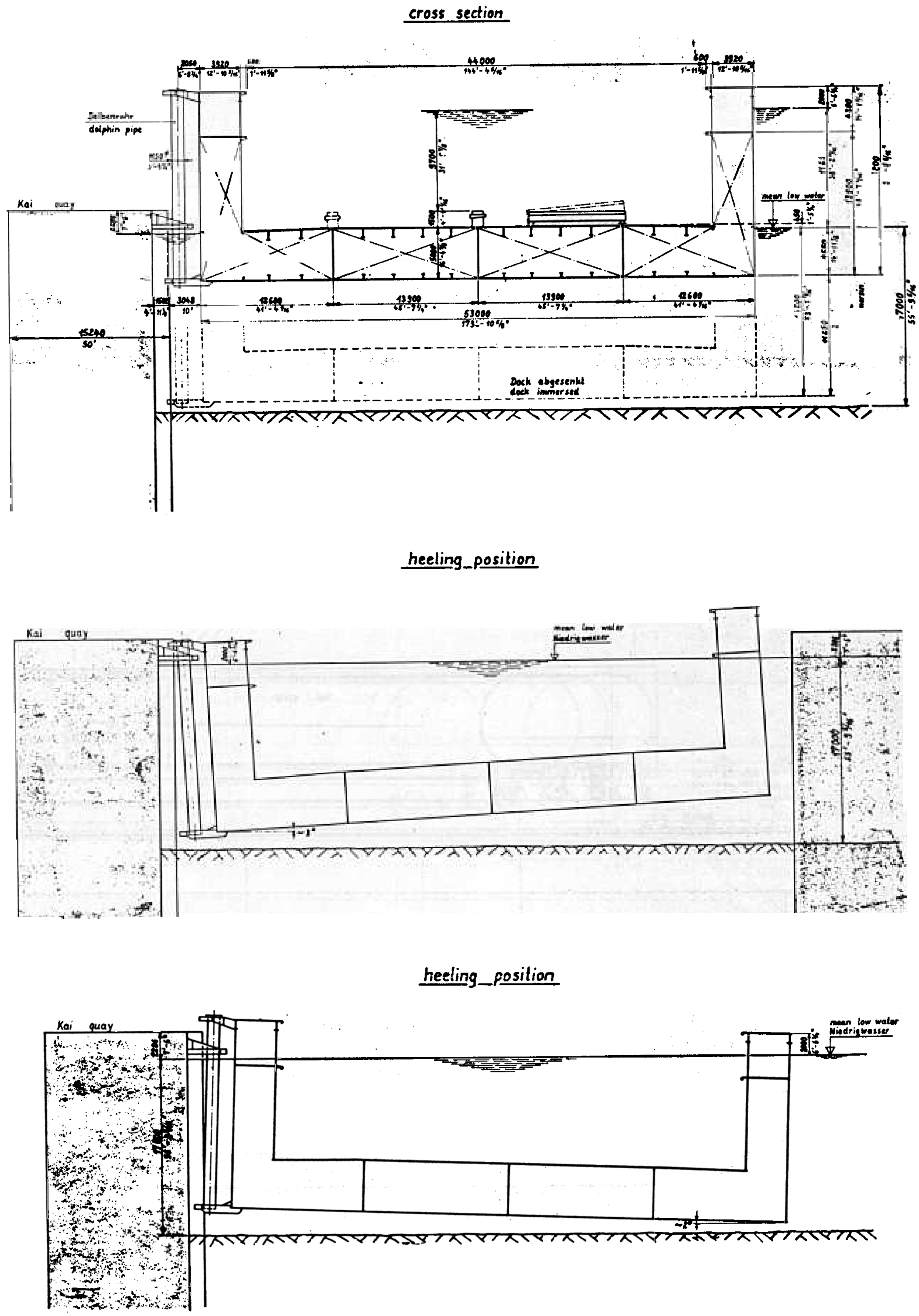


Fig. 5 Dock anchorage

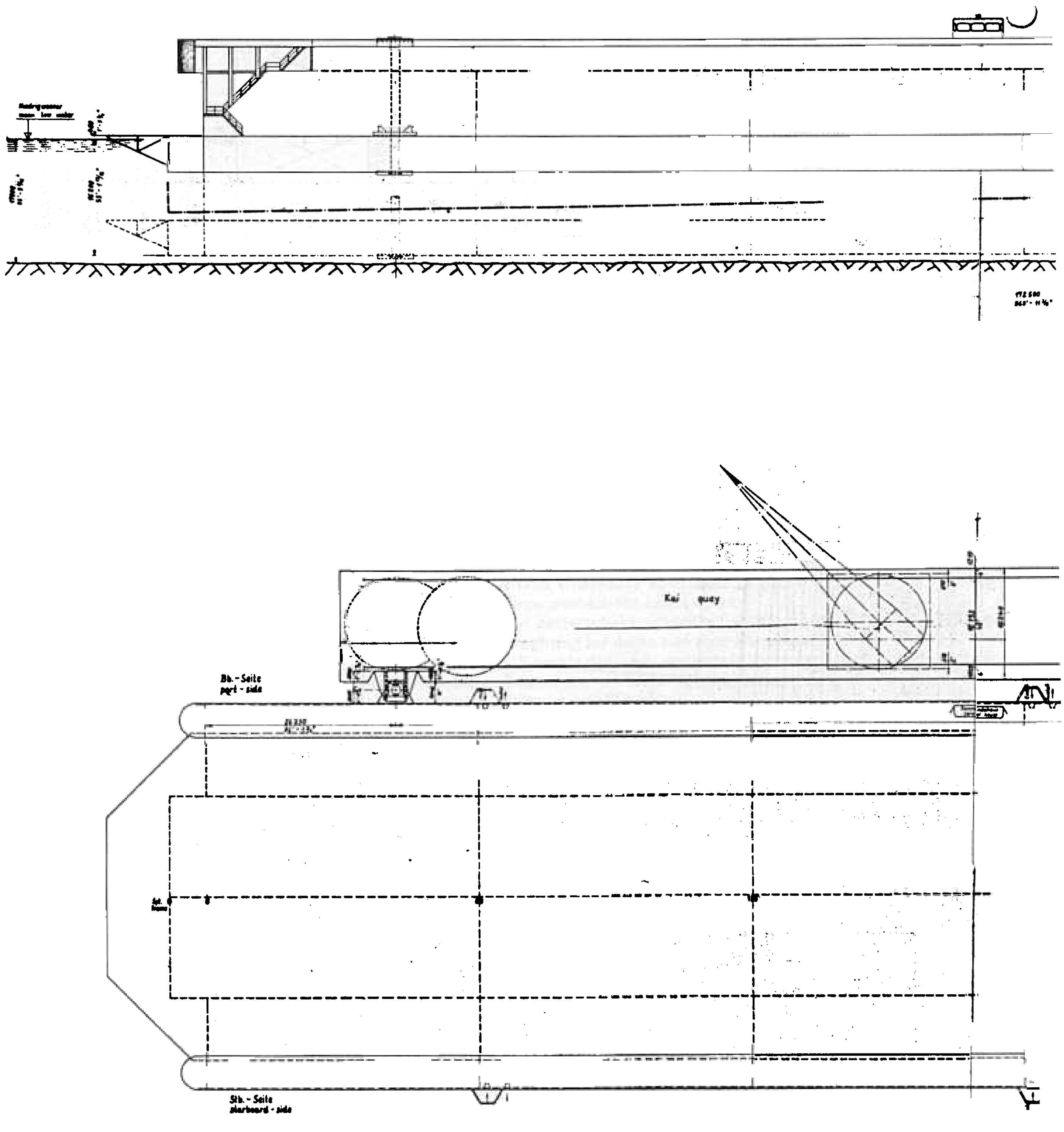
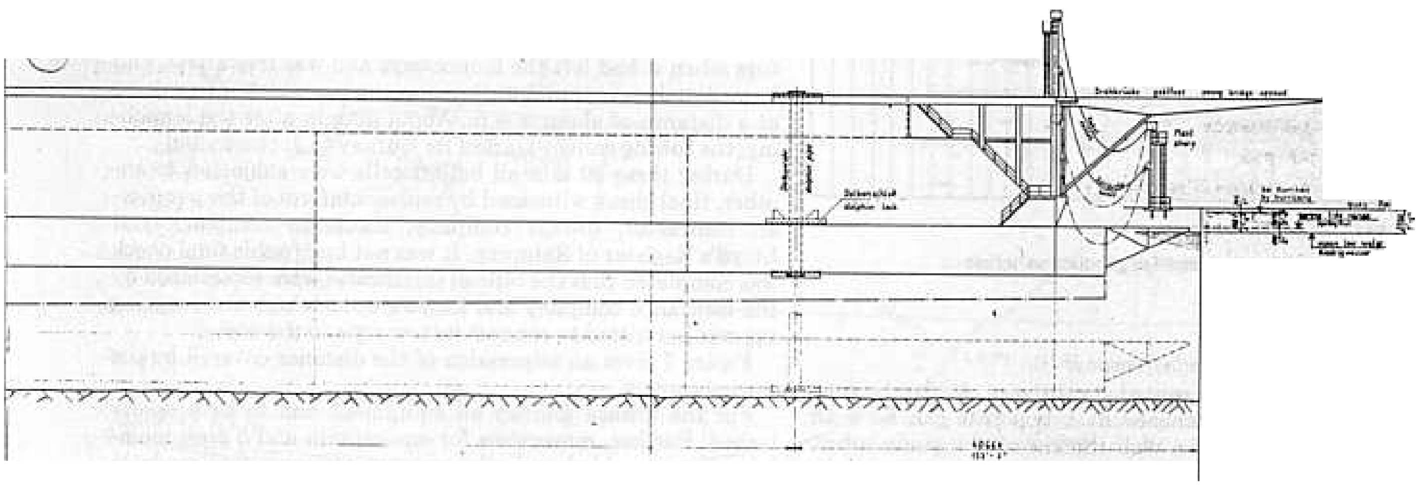
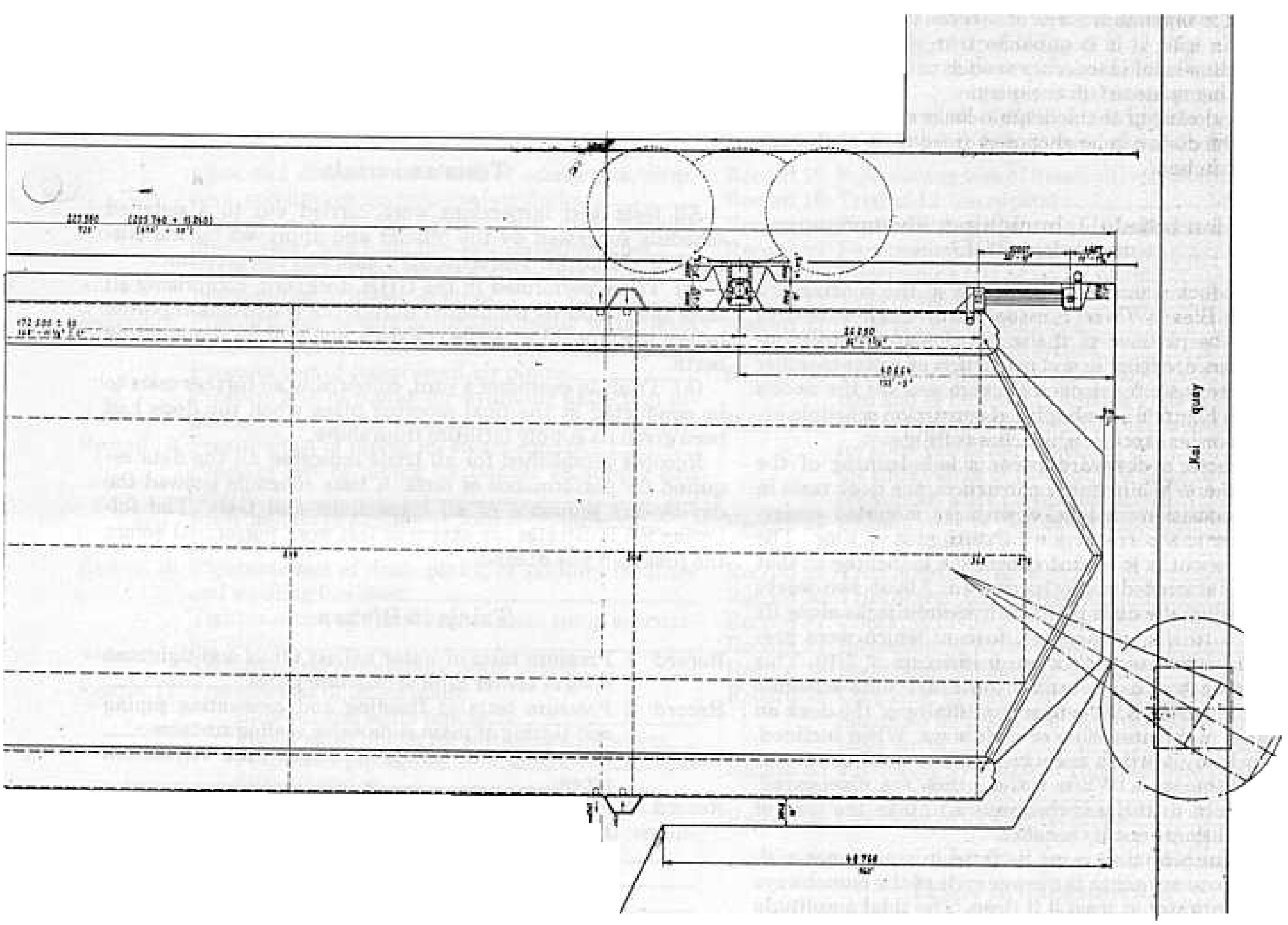


Fig. 5



top-view



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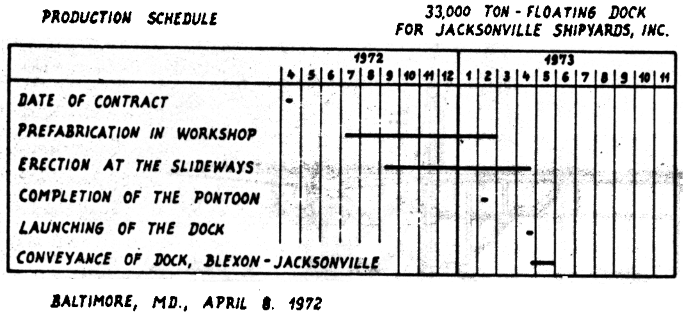

Fig. 6 Simplified production schedule

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guided in dolphin locks mounted on the pier. As can be seen from Fig. 5, the dock anchored at two points can be both trimmed and heeled. The wall thickness of the guide tubes, which are of high-tensile steel and have a relatively small diameter considering the high stress imposed, is stepped, with the maximum thickness amounting to 54 mm.

The arrangement of a round and an oblong dolphin lock ensures exact transmission of the forces introduced. With the wind force acting on the dock longitudinal side, the maximum transmission rate on the locks is *512 tons* per guide tube, while with wind on the dock cross side, only the round lock has to accept a maximum force of *305 tons*. By arranging an oblong hole in a lock, it is possible to trim the dock and to compensate dimensional inaccuracy such as might occur while the locks are being mounted on the quay.

Opening and closing of the dolphin locks are relatively simple, so that the dock can be anchored or freed from anchorage in about half an hour.

Construction schedule, launching, and conveyance to Jacksonville

While the dock was under construction at the contractor's dockyard at Blexen (Weser estuary/North Sea), extensive work had to be performed at the mooring place in Jacksonville; for instance, dredging and construction of a pier together with preparatory work for dock anchorage and for the dock's supply pipes. Figure 6 is a simplified construction schedule established for order execution, which was fully met.

The contractor's dockyard permits side-launching of the docks built there. While under construction, the dock rests in a horizontal position on blocks, with jacks mounted underneath to permit the correction of setting at any time. The complete dock outfit is mounted before the launching so that towage may be started directly afterward. About two weeks before launching, the dock is tilted by hydraulic jacks along its centerline on to the launchways, fifteen of which were prepared for this particular dock at an inclination of 1:10. This preparatory work was performed to an exact time schedule with a view to ensuring both proper positioning of the dock on the launchways and installation of slide ways. When inclined, the dock is held by winches anchored ashore, until about one hour before the launch. When the winches are disengaged, perlon ropes fixed to the launchways are to take the load of the dock until they are cut by hatchet.

The exact launching time must be fixed in accordance with the tide tables to ensure that the lower ends of the launchways are covered with water at least 3 ft deep. The tidal amplitude in the dockyard is about 12 ft.

As the general weather situation prevailing in the North Sea and the English Channel on the scheduled launching date (April 17th, 1973) did not permit the towage journey to be started immediately (this decision being made by the towage contractor and the insurance company), launching was postponed to April 21st, when it was performed smoothly after the weather had improved. The dock was taken over by four port tugs when it had left the launchways and was free afloat, and immediately was towed to the seagoing tug which was waiting at a distance of about 500 m. About 30 min after the launching, the towing convoy started its journey to Jacksonville.

During these 30 min all ballast cells were subjected to another, final check witnessed by representatives of the purchaser, contractor, towage company, insurance company, and Lloyd's Register of Shipping. It was not before this final check was completed that the official certificates were established by the insurance company and Lloyd's upon which the seagoing tug was permitted to connect its tow rope to the dock.

Figure 7 gives an impression of the distance covered by the towing convoy.

For the towage journey all equipment had to be properly lashed. Further, messrooms for one captain and 5 crew members were provided and all necessary arrangements made aboard the dock for a towage journey of five weeks. As a general rule, the platforms of the dock can be disassembled nowadays, and are lashed on the caisson deck during towage, with the individual sections so positioned that they serve as breakwaters for heavy seas. The platform substructure can be easily and speedily reconnected, by so-called pins, with the dock front walls.

All further towage arrangements were agreed in detail with the consulting engineers of the transport insurance company, the mariners' association, and the towage company, and were subjected to very thorough checks. The four towage eyes were rated for a tow-rope pull of 150 tons each.

Tests and trials

All tests and inspections were carried out to a detailed schedule suggested by the builder and approved by the customer and Lloyd's. The schedule comprised two sections:

(*a*) Trials performed in the GHH dockyard, comprising all tests that could be conducted during the construction period before the launching, while the dock was still on the building berth.

(*b*) Trials in customer's yard, comprising all further tests to be conducted at the final mooring place when the dock had been given its supply facilities from shore.

Records established for all trials indicated all the data required for performance of tests. A time schedule showed the day-by-day sequence of all inspections and tests. The following list illustrates the extent of test work performed before the first ship was docked.

Trials in Blexen

Record 1 Pressure tests of water ballast tanks and tightness tests of center tank ventilation pipes______

Record 2 Pressure tests of flooding and evacuating piping and testing of main slide valve sealing surfaces______

Record 3 Presetting and testing of center tank ventilation pipes______

Record 4 Pressure tests of tanks for diesel oil______
Pressure tests of tanks for fresh water______
Pressure tests of tanks for bunker oil______
Pressure tests of tanks for faeces______
Pressure tests of tanks for feedwater______
Pressure tests of tanks for fuel oil______

Record 5 Pressure tests of both safety decks______

Record 6 Presetting and testing of lateral tank ventilation

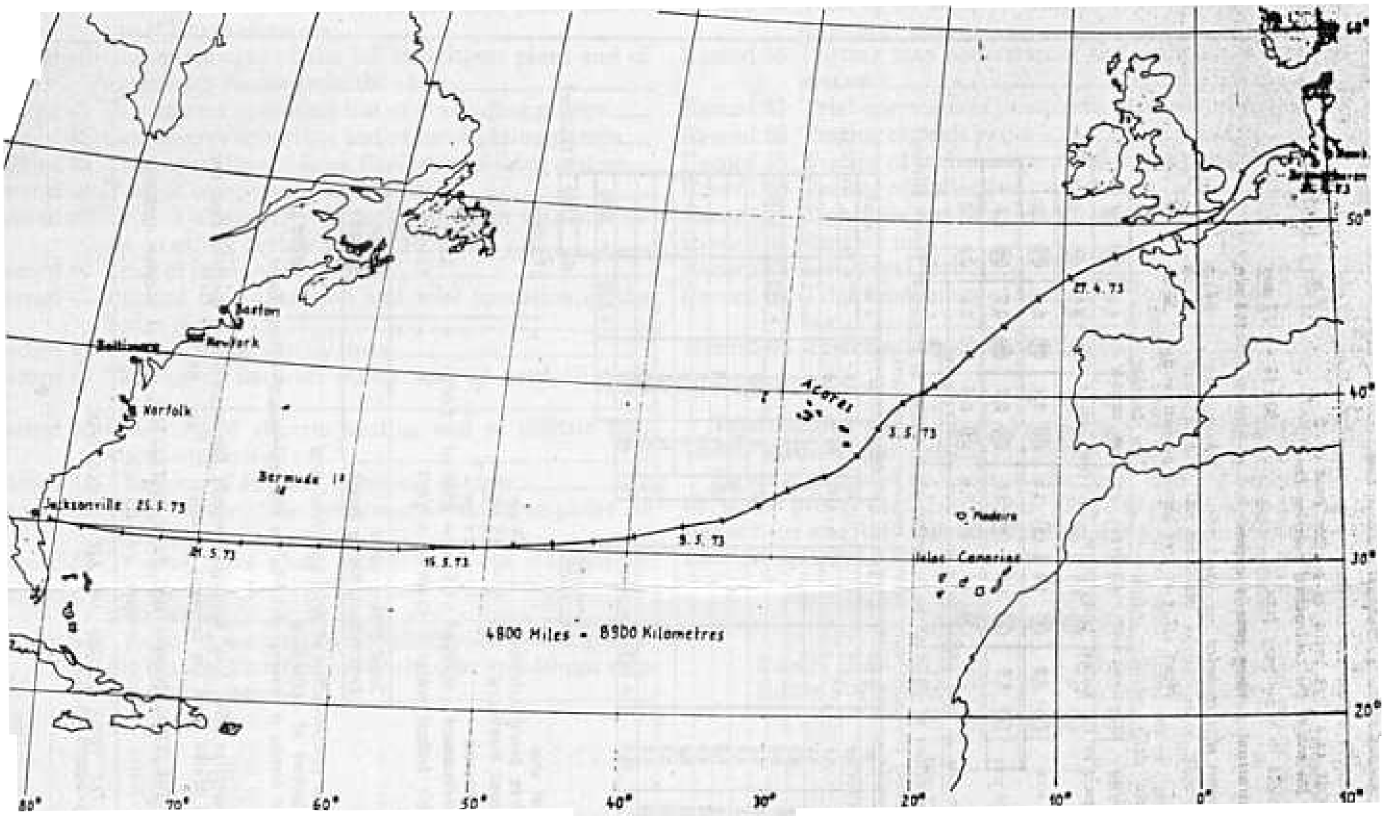

Fig. 7 Towage journey

pipes and dimensional check of access pits, scuppers, and drainpipes below safety decks

Record 7 Pressure test of fire-fighting and deck washing pipe system, and foam fire-extinguishing pipes
Pressure test of fresh-water distribution pipes
Pressure test of diesel oil pipes

Record 8 Pressure test of piping for pneumatic water-level indicator and draft meters
Pressure test of compressed-air piping
Pressure test of piping for hydraulic deflection indicator

Record 9 Pressure test of piping for steam supply
Pressure test of piping for bunker oil supply and return
Pressure test of heating in bunker oil tank
Pressure test of heating in fuel oil tank

Record 10 Tightness test of drain piping of sanitary facilities and washing facilities
Tightness test of diesel engine room sump evacuating piping
Tightness test of day-tank drain piping

Record 11 Pressure test of boiler plant:
Blowout and scum piping
Fresh-water piping for softening equipment
Feedwater piping
Fuel-oil piping

Record 12 Pressure test of faeces drain piping

Record 13 Measurements of insulation of electrical equipment

Record 14 Functioning test of fire-fighting pump

Record 15 Functioning test of evacuating pumps

Record 16 Trial of electrically operated main and distributing slide-valve drives, including the electric control system

Record 17 Functioning test of diesel-driven alternator

Record 18 Trial of 12-ton capstans

Record 19 Trial of 6-ton capstans

Record 20 Functioning test of compressors

Record 21 Functioning test of boiler plant

Record 22 Trial of receptacles

Record 23 Trial of lighting facilities

Record 24 Trial of ventilation system

Record 25 Trial of loudspeaker and intercommunication system and of internal telephone system of the dock

Record 26 Trial of manual drives and linkage for slide valves
for slide valves of connecting lines
for slide valves of fire-fighting lines (distribution)
for various slide valves and valves

Record 27 Examination of timberwork

Record 28 Trial of connection bridge

Record 29 Trial operation of bilge blocks

Record 30 Trial of warping carriages

Record 31 Checking of dock dimensions

Record 32 Inspection of ballast tanks

Record 33 Inspection of painting work

Record 34 Checking of inventory parts, spare parts, documents to be delivered with the dock, and of other loose parts

Record 35 Producing evidence of completeness of dock's outfit and equipment

Record 36 Checking of locking facilities

Trials in Jacksonville

Record 37 Determination of dock weight

Record 38 Trial of public telephone system, fire alarm system, HT-emergency connection, clock system

Trial docking, Record № 65

Main dimensions of ship:			
	Overall length:	818'	= 249,30 m
	supported length of keel:	733'	= 223,40 m
	overall width:	125'	= 38,10 m
	draught forw.:	10'	= 3,05 m
	draught aft.:	17'	= 5,20 m
	transversal inclination:	4" heel	= 0,10 m
	displacement:	27.300 t	
	centre of gravity:	388,5'	= 118,40 m from the aft perpendicular

Measurements after immersion

Water levels in ballast tanks after immersion:

Port side	① 9,60 m	⑤ 10,20 m	⑨ 9,50 m	⑬ 10,0 m	⑰ 10,0 m	㉑ 9,40 m
	② 11,30 m	⑥ 11,60 m	⑩ 11,20 m	⑭ 9,20 m	⑱ 11,60 m	㉒ 11,20 m
	③ 11,40 m	⑦ 11,40 m	⑪ 11,40 m	⑮ 9,30 m	⑲ 11,30 m	㉓ 11,50 m
Starboard side	④ 5,70 m	⑧ 10,00 m	⑫ 9,80 m	⑯ 10,10 m	⑳ 10,10 m	㉔ 9,60 m

Readings of draught scales:

Port side entrance	5,90 m (19' 4")	Port side connection bridge	5,90 m (19' 4")
Starboard side entrance	5,90 m (" ")	Starb. side connection bridge	5,90 m (" ")
Mean value entrance	5,90 m (" ")	Mean value connection bridge	5,90 m (" ")

The optical deflectionmeter indicates 1,0 cm camber
The hydraulic deflectionmeter indicates 2,5 cm camber

Inhauling and alignment of ship with subsequent measurements

Inhauling of ship starts at	10^{25} h
Ship is moored and aligned at	11^{10} h
Main pumps start at	11^{13} h
Opening of outlet and distributing slide valves at	11^{14} h
Keel blocks contact the ship at	11^{20} h
Closing of distributing slide valves at	11^{25} h
Bilge blocks support the ship at	12^{45} h

Draught scale readings:

port end entrance	2,90 m	port end connection bridge	5,04 m
starboard end entrance	3,00 m	starboard end connection bridge	5,14 m
average value	2,95 m	average value	5,09 m

The optical deflectionmeter indicates 6,0 cm camber
The hydraulic deflectionmeter indicates 8,5 cm camber

Slide valves open again at 12^{45} h
(This is the begin. of the contractual pumping time.)

The closing and opening of individual slide valves during evacuation is to be entered into the table on pages 3, 4 and 5, so that the whole period during which the slide valves were closed can be determined.
slide valve closing time 13,0 min.

The 4 corners of the pontoon deck emerge which corresponds to a free board of pontoon deck of 0 — 14^{45} h — 33.000 t Ship (93 min.)
(This is the end of the contractual pumping time.)

This results in a pumping time of 90 − 13 = 77 min.

The contractual pumping time is approx. 145 min.

Measurement of free board:			
	port side	53 cm	51 cm
	starboard side	58 cm	63 cm
	Mean value of free board of pontoon deck		56 cm

The optical deflectionmeter indicates 3 cm camber
The hydraulic deflectionmeter indicates 4 cm camber

Water levels in the ballast tanks in m (pressure gauge reading):

port side	① 1,9	⑤ 1,3	⑨ 1,5	⑬ 1,1	⑰ 1,0	㉑ 1,8
	② 1,9	⑥ 1,1	⑩ 1,1	⑭ 0,7	⑱ 0,7	㉒ 2,0
	③ 2,0	⑦ 1,1	⑪ 1,4	⑮ 0,8	⑲ 0,6	㉓ 2,0
starboard side	④ 1,9	⑧ 1,0	⑫ 1,2	⑯ 0,8	⑳ 0,5	㉔ 1,8

Determination of ideal lifting force and trim water reserves

After deduction of 20 cm of ballast water which cannot be evacuated (where existing) the following evacuable water volumes remained in the tanks

	Tank	m	× m²	= m³
Port	1	1,7		
	5	1,1		
	9	1,3		
	13	0,9		
	17	0,8		
	21	1,6		
Starboard	4	1,7		
	8	0,8		
	12	1,0		
	16	0,6		
	20	0,3		
	24	1,6		
		13,4	× 473	= 6340
				Σ 6340

	Tank	m	× m²	= m³
Port	2	1,7		
	22	1,8		
Starb.	3	1,8		
	23	1,8		
		7,1	× 590	= 4190
Port	6	0,9		
	10	0,9		
	14	0,5		
	18	0,5		
Starb.	7	0,9		
	11	1,2		
	15	0,6		
	19	0,4		
		5,9	× 521	= 3070
				Σ 7260 = 13600 m³

Weight of ship		=	27 300 t
Mean free board achieved	56 cm		
contractual freeboard	35 cm		
plus freeboard	21 cm		
plus displacement	12,203 m² × 0,21 m = 2560 m³ × 1,003	=	+ 2570 t
Evacuable ballast water	13600 m³ × 1,003	=	+ 13640 t
cranes		=	− 510 t
	Ideal lifting force		43000 t
	Contractual lifting force		33000 t
Water for compensation of trim and heel and for reduction of deflections			10000 t

This means a reserve of 30 % on the contractual lifting force

Notes

Dock inspection after trial docking, especially the inspection of pontoon deck and of keel blocks gave the following results: ALL OK

THE TRIAL DOCKING HAS BEEN SUCCESSFUL

Fig. 8 Excerpt from trial docking record No. 65

Record 39 Commissioning of the HT-switchgear plant and of the HT-transformers
Record 40 Commissioning of the LT switchgear plant and of emergency feeder from the shore
Record 41 Continuous operation test of evacuating pumps
Record 42 Continuous operation test of fire-fighting pumps
Record 43 Trial operation of foam fire-extinguishing system
Record 44 Trial of compressed-air system
Record 45 Trial of electrically driven compressor with air vessel on safety deck of starboard side
Record 46 Trial of fresh-water system
Record 47 Putting into operation and trial operation of the boiler plant
Record 48 Trial of steam supply lines
Record 49 Testing of used-oil pump and of used-oil tank heater
Record 50 Checking of electric heating and of electric hot-water supply system
Record 51 Checking of automatic battery charger
Record 52 Trial of the diesel-engine-driven, three-phase ac alternator
Record 53 Trial of three-phase ac 440-v, 60-cps ship supply system with transformer and 60-cps ship connection boxes
Record 54 Trial of three-phase ac 380/220-v, 50-cps ship supply system with frequency changer and 50-cps ship connection boxes
Record 55 Trial of dc supply, 110/220-v, 300-amp, including dc supply boxes
Record 56 Putting into operation of the cathodic protection system
Record 57 Trial operation of pneumatic water-level indicators
Record 58 Testing of draft gages
Record 59 Testing of inclinometers and meter pendulum
Record 60 Testing of deflection meters
Record 61 Tightness test of rooms on safety deck
Record 62 Sagging test
Record 63 Structural test
Record 64 Trial immersion of unloaded dock, including timing
Record 65 Trial docking

Trial docking was conducted on August 18th, 1973, with the tanker *America Sun* serving as the test vessel.

Figure 8 provides an excerpt from trial docking record No. 65, which proves that the carrying capacity specified in an earlier section was fully met and that pumping was completed before the contractual time available had elapsed.

Discussers

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