THE DEVONPORT FRIGATE COMPLEX

BY

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Historical

There has been a Dockyard in Devonport, although the name Devonport is a comparatively new one, since 1691 when Charles II sponsored the building of a Yard on five acres of land in the area to the west of Mount Wise and fronting on to the Hamoaze. Over the years it has spread to the north in three well-defined steps to cover a total of 240 acres.

Between 1691 and 1850 the Yard was gradually extended up to the south side of the Torpoint Ferry. Between 1850 and 1860 the Keyham Steam Yard (FIG. 1), which consisted of the present No. 2 Basin, 5, 6 and 7 Docks, No. 3 Basin and the Quadrangle (Main Factory), was built. The cost was £1·5M and the work involved can be judged by the fact that the original ground level lay on what is now Keyham Road and the ground down to the present Yard level had to be excavated. Most of the docks were also excavated out of the rock.

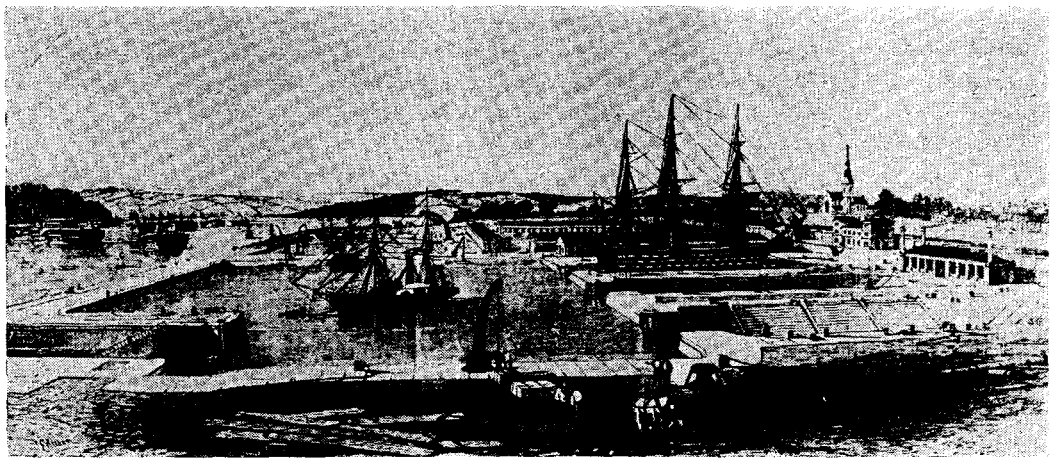

FIG. 1—HER MAJESTY'S NEW STEAM YARD AT KEYHAM IN 1853

The last big expansion programme to bring the Yard to its present size took place between 1896 and 1907 when North Yard was added at a cost of £4M; this comprised Nos. 4 and 5 Basins and the associated docks and was specifically linked to the *Dreadnought* area.

Since that time, no large scale major developments to the docks or basins have been undertaken. Nevertheless, there has been steady development both to meet production needs as they arose and also to dock the very large aircraft carriers. Since World War II, when large areas were damaged, new and replacement buildings have been constructed in the Goschen Street area of the Yard and in the Fore Street area of the old town of Devonport.

In 1968, the Trythall Report recommended that the refitting of certain classes of warships should be concentrated, or 'typed', to particular dockyards. Devonport was selected for certain classes of frigates. In 1969, approval was given for major development programmes to incorporate features of the Trythall Report and other plans for capital injection at Portsmouth, Devonport and Rosyth; Chatham was added a few years later. The Frigate Complex is an outcome of this plan and construction was started in 1972. It will cater for the *Leander* Class and the Type 21 and 22 Class frigates.

General

In order to refit frigates on a production line basis it was obvious that new production facilities were required. The Frigate Complex has evolved from a study of what is needed for this.

The overall project is a joint MOD(N)/DOE(PSA) one. The Property Services Agency of DOE is responsible for interpreting MOD requirements and for providing all the civil engineering work and they have retained Sir Alexander Gibb and Partners to do a certain amount of design.

A Dockyard Project Team, under the Yard Services Manager/Naval Base Development Manager who controls the development plan, was set up in the Dockyard to co-ordinate all MOD(N) requirements, pass them to PSA and ensure that they were interpreted correctly. This Team has needed to work very closely with the PSA team and a particular problem has been to integrate the requirements of the functional equipment into the civil engineering design as this has had to be done some considerable time before precise details of the functional equipment were known.

Another very important task was to co-ordinate the reprovision of all the services and buildings that existed on the site before the start of the project. The motley collection of buildings and huts were all in use for something

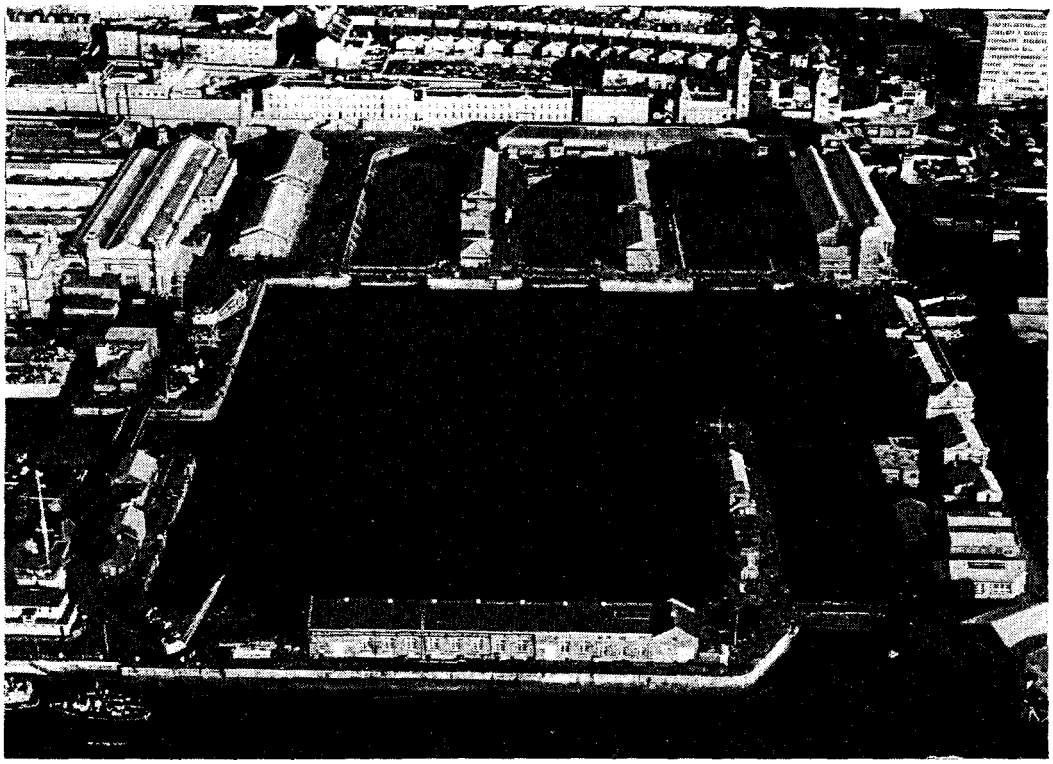

FIG. 2—THE SITE BEFORE THE START OF THE PRESENT PROJECT

or other and had to be reprovided elsewhere in the Yard. Services, mostly underground, had gradually spread during the 100 years like mole runs, and all had to be disconnected and made safe or, if they just traversed the site, diverted. This task had to be accomplished without disturbing the normal Yard production schedules. In all it took 15 months and cost £160,000. Thus, as a result of the Frigate Complex, the Yard has had many old facilities modernized.

It has long been the policy of the dockyards to have full responsibility for functional, utility and domestic machinery within the dockyards other than for major works items where the initial installation of domestic machinery has remained with PSA. However, on occasions where it is easier to take account of functional or utility machinery requirements at the time of construction by the Civil Works contractor, agreement is arrived at between the MOD(N) and the PSA to adjust the policy to the benefit of the works item. There has been such switching in the case of the Frigate Complex project in which the PSA has taken on responsibility for both the design and procurement of the pumping machinery for the docks and also for the dockside cranes which have to be integrated with the roof construction over the docks; and the Yard has taken over responsibility for the salt-water and fresh-water systems which are normally installed by the PSA.

The Complex

The area selected for the Complex was the Keyham Steam Yard where the three docks with the adjacent basin built between 1850 and 1860 were still in their original form. In recent years this part of the Yard has been used almost solely for submarine work and had no real production facilities of its own. Over the years, however, a proliferation of small buildings used for a variety of purposes had accumulated around the area. FIG. 2 shows the state of the site and it can be seen that provision of any new facilities without a major reorganization was impossible.

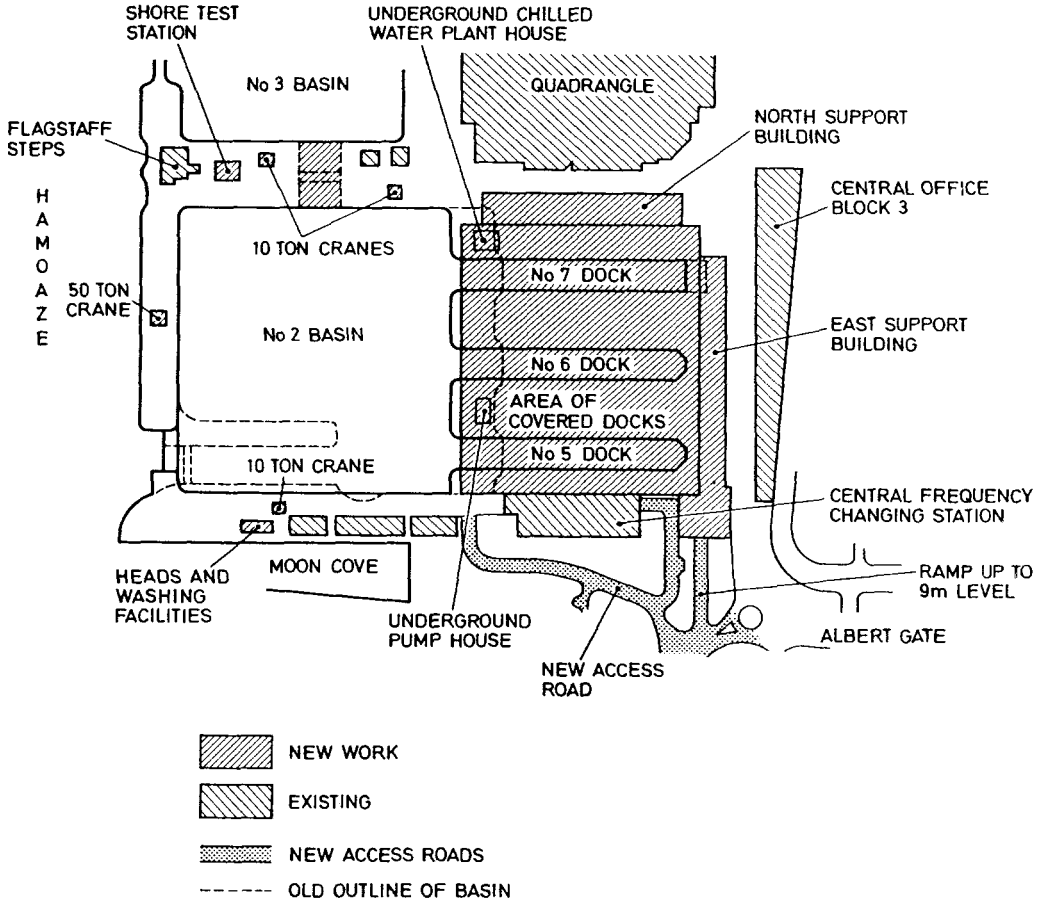

FIG. 3—SITE PLAN SHOWING NEW WORK AND ORIGINAL OUTLINE OF BASIN AND DOCKS

Initial studies of the problem of setting up a production line for refitting frigates soon showed that a major re-build of the area was required. To begin with, two of the three docks were neither long enough nor deep enough to take either modern frigates or those envisaged for the future; they would therefore have to be lengthened and deepened. All the docks were built of massive granite blocks with stepped sides. Although this gives a nice open dock and innumerable shoring altars, the former wastes valuable space and the latter is not necessary if ships of a similar size and shape are the only customers. One of the first decisions made therefore was that all the docks would be completely rebuilt almost in their original relative positions. The increase in length was to be obtained by extending them into the basin to minimize excavation and to leave ground at their heads for associated buildings.

Berthing space in the basin was previously hindered by the presence of the lock at the entrance, originally put there both to allow ship movements at any state of the tide and to serve as another dry dock if required although not used for the latter purpose for a number of years.

The new policy indicated that neither of these requirements would be necessary in the future and therefore removal of the northern arm would free the south side of the basin for a ship berth. This would be aided if the entrance was moved a few metres to the north and the south wall was re-aligned. Old policy also required that there be an emergency entrance to the basin via a caisson from No. 3 Basin directly to the north. After much heart-searching, this requirement was finally dropped thus enabling an unbroken additional refit berth to be provided on the north wall and valuable

ground to be reclaimed by filling in the old gap between the basins. FIG. 3 shows the new site plan superimposed on the original.

As it was thought that some of the benefits being gained by the ship-building industry in having covered building slips and fitting-out berths would be applicable to the task of refitting warships, an investigation was carried out. This showed that Plymouth has more than its share of inclement weather compared with the other Royal Dockyards and that certain trades normally working on the upper decks lost up to 20 per cent. of their time. Although we are not profit orientated like the Merchant Fleet, any delay in refitting ships besides affecting the earnings of the workmen also has an adverse effect on the operational availability of the Fleet. It was shown that a saving in refit time should be achieved if the three docks were covered. Although this decision was re-examined several times in the planning stage because of the additional cost, it has remained an integral part of the concept.

Offices to house the staff required for planning and controlling the ship work are to be provided in a three-storey building to the north of the docks, and there is to be a two-storey building for stores and support workshops on the east side at the head of each of the three docks.

Warships by their very nature require many mechanical and electrical services for all their complex systems. These and other services required for the normal refitting task have all been provided to access points at each berth and dock via underground subways, thus keeping the above-ground area free from pipes and cables, etc.

FIG. 4, the model of the Complex, clearly shows the main features. The size can be judged by comparing the Cover with the Old Main Office Building (in the top left-hand corner of the picture) which is itself the equivalent of four storeys high.

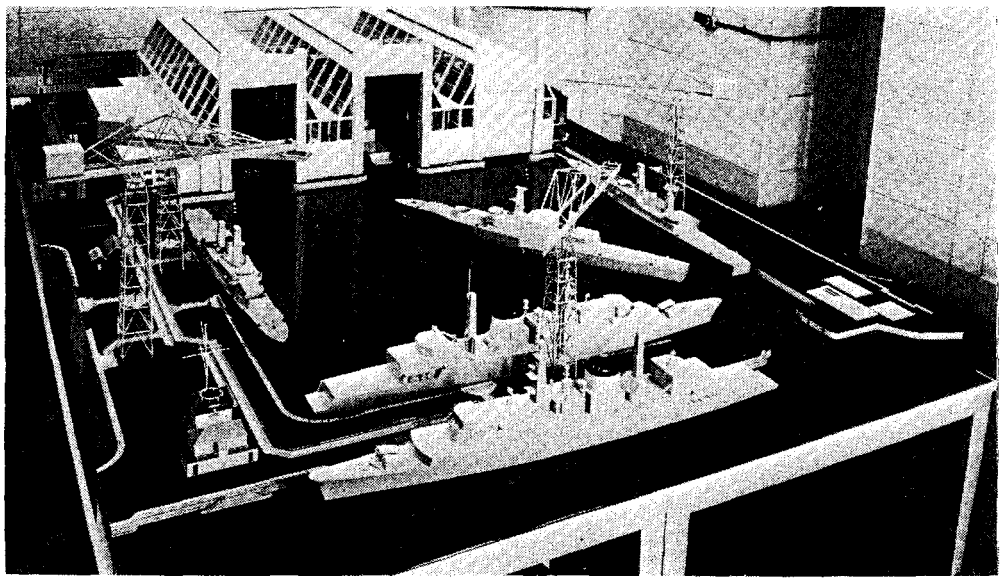

FIG. 4—MODEL OF SITE AFTER COMPLETION OF THE PROJECT

The Docks

The dock dimensions were governed by the location of the existing west wall of No. 2 Basin, which was to remain. To allow sufficient space for the largest frigates to be manoeuvred within the basin, the area that the dock entrances could be permitted to take up had to be limited. After several studies of possible dock arrangements, it was decided that all three should be 134m long, 19·8m wide, and 11m deep. This configuration also enabled a

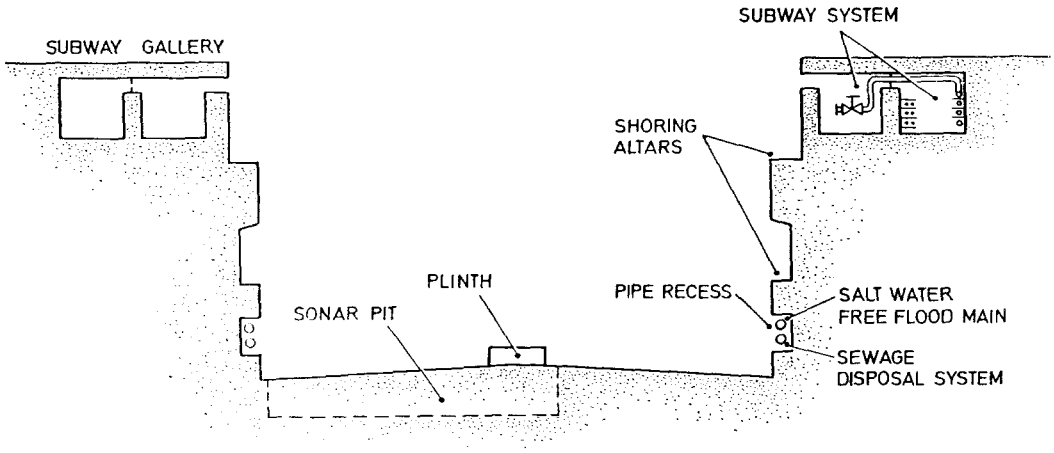

FIG. 5—CROSS-SECTION OF A DOCK

berth length of 157m to be fitted in on the east/west axis of the basin. Since the frigates to be handled range in length from 113m to 131m and in displacement from 2800 tonnes to 3900 tonnes, it is evident that there is little room for any increase in the size of future frigates to be handled by these docks.

Sonar domes dictate that the docks have to be deepened in the appropriate place to enable these protuberances to be lowered and removed from under the ship.

There is a central plinth on which conventional wooden blocks are placed on which the ship docks; this runs the entire length of the dock floor except in way of the sonar pits. For drainage the docks are built with a declivity of 1 in 300 and a camber of 1 in 50. Conventional wooden shores are used and are located on one of the two altars running the entire length of the docks. Hydraulically-operated shores were considered but proved too costly. FIG. 5 shows a cross-section of one of the new docks.

Ships, once presented to the dock entrance, will be drawn into the dock

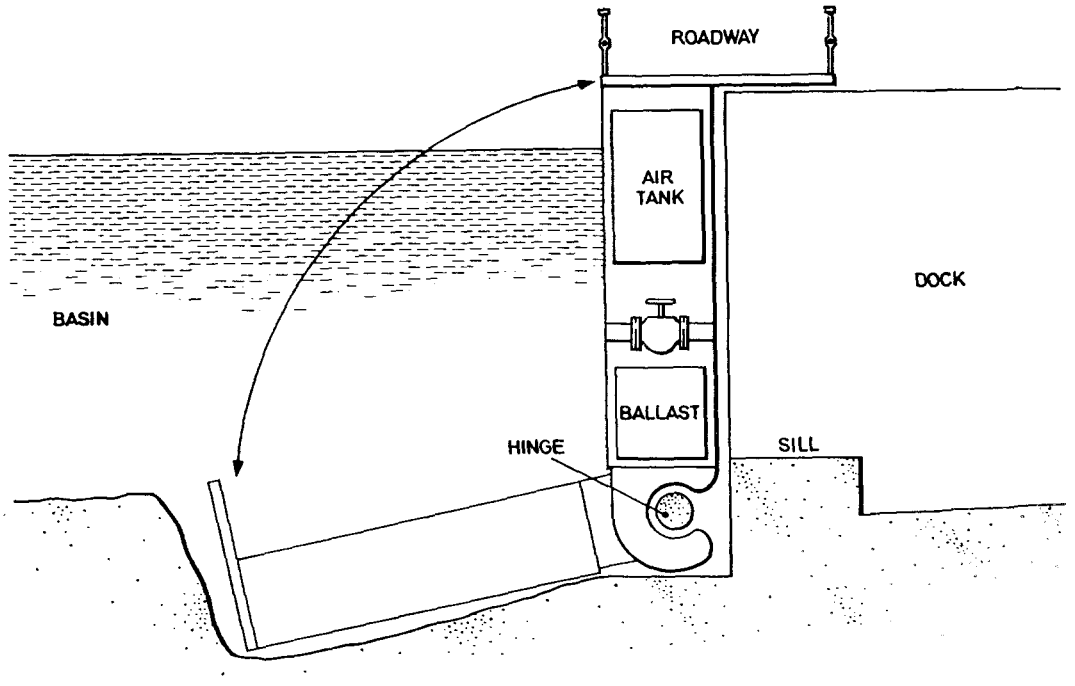

FIG. 6—FLAP GATE

by docking trolleys controlled by one man from a control room at the head of each dock, thus saving both time and manpower.

Hinged flap-type gates are provided for each dock and for the basin entrance, as opposed to the older type of floating caisson. These dock gates are interchangeable, and a spare gate is being purchased. The gates are raised by machinery situated in the adjacent dockside. It will thus take one man a matter of minutes to open a dock instead of many men a considerable time to move a conventional floating caisson. A cantilevered roadway across the gate tops assists access around the Complex. Balancing valves and culverts are incorporated and the gates are designed to be tight against a given reverse head. FIG. 6 shows a typical gate.

A sewage main is installed in each dock bottom together with a free-flooding salt-water main; the latter is required for magazine flooding and for certain ship equipment.

De-watering of the dock and adjustment of the level in the basin is accomplished from a new pump-house situated underground between 5 and 6 docks. Three 6500 tonnes/hour pumps are fitted, two of which will be used to pump a dock dry in two hours. Three smaller drainage pumps (2000 tonnes/hour) also are fitted for dealing with any leakage. The pumps and associated valves are arranged to give a very versatile system. Salt water for the fire-mains of the Complex and the rest of the Yard, if required, is provided by three 500 tonnes/hour pumps.

Cranage over the docks is provided by a semi-portal level luffing 20 tonne crane each side of each dock. They run the full length of each dock on one rail at cope level and another one at the 14 metre level on the main cover columns. Each crane will plumb beyond the centre-line of the dock but, to lift aerials and other equipment high up on the masts, a 5 tonne radio-controlled overhead traveller is provided on the centre-line. FIG. 7 shows the arrangement.

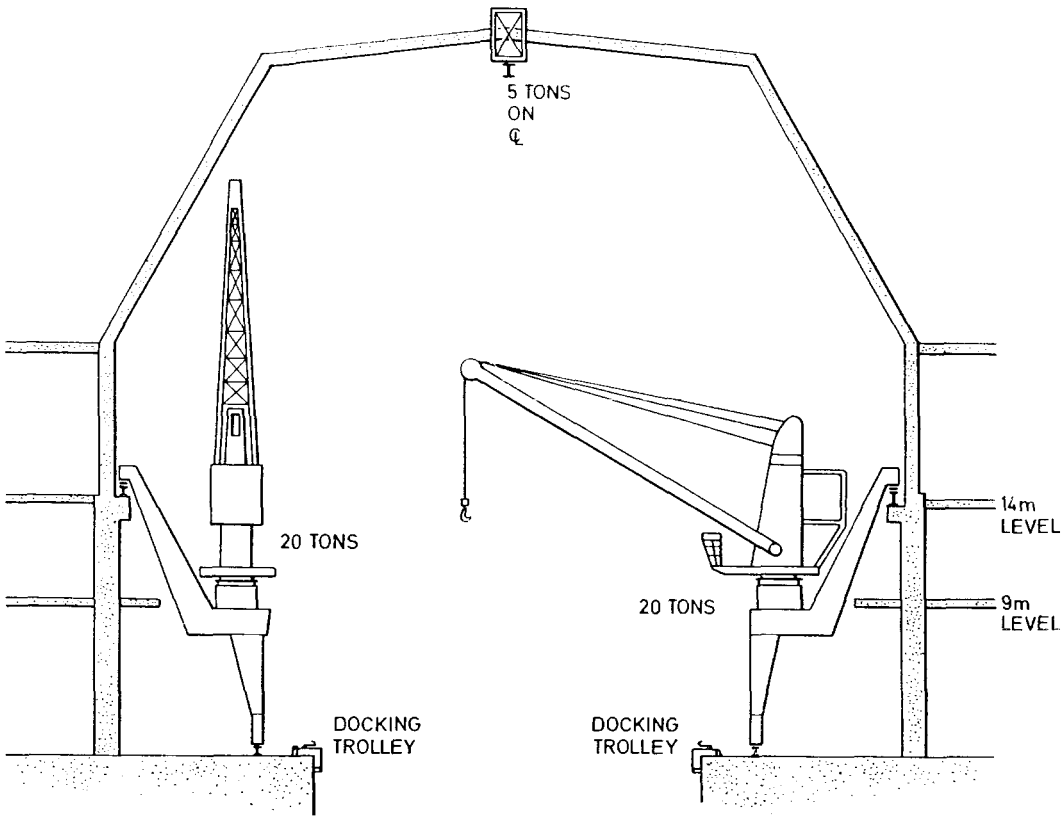

FIG. 7—CROSS-SECTION OF COVER SHOWING DOCK CRANES

The crane strength has been designed to be associated with a layout of suitable strong points on the dockside enable replenishment-at-sea rigs to be tested whilst a ship is in dock.

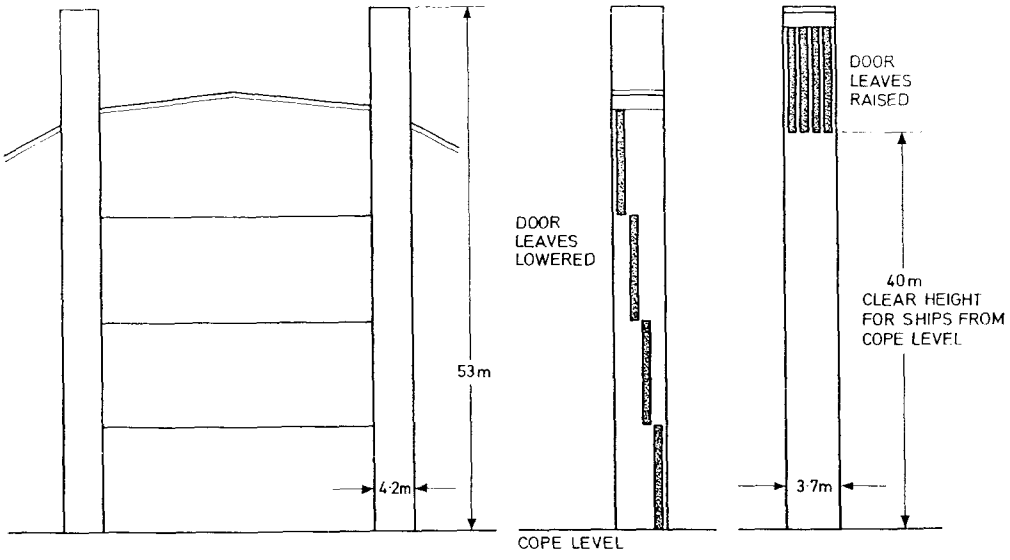

FIG. 8—DOCK ENTRANCE DOORS

The Cover

The cover is perhaps the main feature of the Frigate Complex. One cover, divided into three bays, spans the three docks. It is 150 metres long by 165 metres wide with an overall height of 43 metres. Including the docks, it encloses a volume of approximately one million cubic metres.

Ships enter the docks and cover via doors at the west end. Each door consists of four leaves which rise vertically in separate guides in a similar manner to those on the space vehicle assembly building at Cape Kennedy. For ventilation purposes the top and bottom leaves can be opened independently.

FIG. 8 shows that the doors are supported by 3·7m × 4·2m hollow reinforced concrete towers 53 metres high, the walls of which are only 250mm thick. The towers were erected by the continuous slip forming process and each took only just over a week to reach its full height. The cover is supported to the 14-metre level on reinforced concrete columns and from there a steel portal frame is employed. Between each dock and across the head of all three there is a roadway at the 9-metre level which gives access into the stores in the East building. This facilitates the movement of stores to and from the ship and keeps them clear of the actual dockside, thus making more room available there for production work.

The Support Buildings

The three-storey North building is built adjoining the cover over the northernmost of the three docks. This block runs almost the entire length of the dockside and is essentially a personnel block. It houses the offices for the dockyard planning and control organization for the refits of the frigates; offices for ships' officers and an amenity centre for 300 of the workforce are also provided. There is a maintenance workshop for the Yard Services Department and also spaces for visiting contractors who may be working on ships.

The East support building at the head of the docks is made integral with the dock covers and is given over to a number of supporting workshops at

the dockside level. At the first-floor level, the space is devoted to stores. This building incorporates the novel feature of an access ramp for lorries from the roadway at its southern end and there are further access roadways direct to the 9-metre level roadways alongside the docks. Thus, as well as keeping the dockside level clear of stores as already mentioned, this design feature takes up a lot of the void space under the dock covers. In the East building, besides the stores and workshops, there is a similar amenity centre for the workforce as in the North building. The workshops and stores provided in this building are:

Joiners Shop	Machine Assembly Shop
Lagging Store	Machine Shop (Small)
Electrical Assembly Shop	Plate and Angle Store
Cable Store	Loan Tool Store

Mechanical and Electrical Services

Apart from the new chilled water system, all the services systems required in the ships are supplied from existing dockyard mains but are distributed around the Complex in an entirely new underground subway system; FIG. 9 shows the extent of the ducts. The subway ducts are 2·5 metres square and it can be seen that over a certain length a double subway is provided; this is to keep the two legs of the dockyard 11 kV ring-main system separate. The total length of the subways is approximately 1600 metres. Services exit from the subway via service galleries, two at each wet berth and three on each side of each dock. All pipes and cables to ships come out of the side of the service galleries, thus keeping the cope edge or berth free of the usual tangle of gear.

Services being run in the subways are:

Mechanical	*Electrical*
LP steam and condensate return	11 kV 50 Hz ring-main
LP air	6·6 kV 60 Hz ring-main
Salt water	60 Hz 440 volt main
Fresh water	50 Hz 430 and 110 volt main
Chilled water	Capstan power ring-main
Demineralized water	Telephones
	Miscellaneous controls and communications
	Generator test cabling
	Street lighting
	Flood-lighting
	Subway lighting and power.

Oxy-acetylene is also being distributed to all berths and docks but in separate trenches for safety reasons; this forms part of what is believed to be the largest distribution system in Europe for this particular service.

As a general rule, mechanical and electrical services are kept on separate walls but inevitably, particularly at intersection points, some inter-mingling takes place.

Each gallery is divided into three bays: one for mechanical services, one for electrical services and the third for chilled water and its associated controls. To prevent inadvertent flooding of the subways, the galleries are completely separated from the subways and cable and pipe entry holes are sealed. Access to the galleries is via a manhole on each side. Access to the subways is via manholes at each dead-end and other selected points and by steps at the end of each dock arm. Removable roof sections are provided in each leg for getting in long lengths of pipe, etc. A flood warning system is also being fitted.

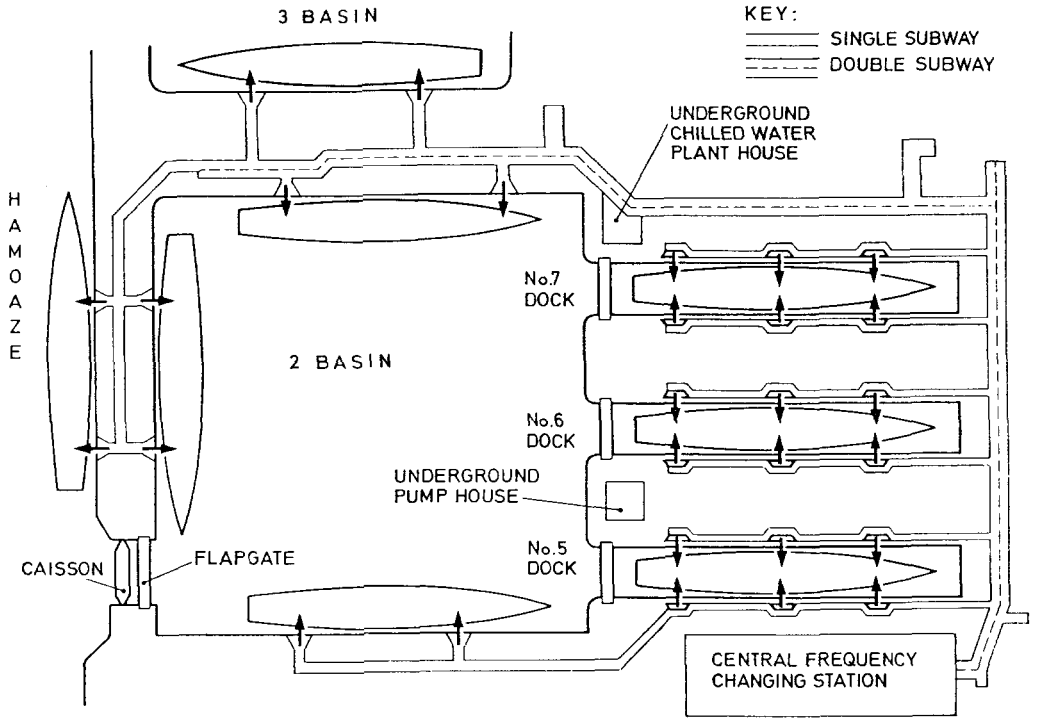

FIG. 9—SUBWAY SYSTEM SHOWING SERVICE OUTLETS AROUND DOCKS AND BERTHS

Chilled Water Plant

Modern ships require vast quantities of chilled water both for habitability and more especially for weapon systems. If systems can be 'kept alive', considerable time can be saved in testing and tuning at the end of each refit. Hence, even during refits, there is a requirement for chilled water to be supplied within close temperature limits.

An underground plant house capable of housing four plants each of 2·5 BTUs/hour capacity (325 tonnes/hour) is situated to the west of the North support building. Three plants are being installed at first together with a sophisticated control system to enable the varying demands of the different types of ship to be met as they are connected in random fashion around the Complex. It is believed that this system will be unique in both the size of the distribution system and the nature of its loading.

Cranes

The cranes inside the cover have already been mentioned. To serve ships at the wet berths, a 50-tonne crane is being provided on the West wall to cater for heavy lifts from ships at the tidal berth or in the basin and three 10-tonne cranes are being built, one on the South wall and two on the North wall to serve Nos. 2 and 3 Basin berths. All cranes are of the fixed cantilever type and, where placed in the middle of the arm, have a base large enough for lorries, etc. to pass through. FIG. 10 shows the siting and coverage obtained.

Generator Shore Test Station

Modern ships' weapons and other equipment require a highly stabilized electrical power supply. Although ships' generators are designed to produce this, after refit they require to be comprehensively tested before they can be put into service. This has previously been done by bringing a sophisticated load barge to the ship. In the Complex, a shore facility is being provided

permanently connected to four berths and will be able to test three 1-MW generators simultaneously with two of them in parallel if required.

Tank Cleaning Plant

Ships entering refit require fuel tanks, bilges, and boilers, etc. to be cleaned either to enable work to be done or for preservation purposes. This task has previously been done by a Tank Cleaning Vessel which moves around the dockyard to wherever it is required. A fixed plant is being provided in the Frigate Complex on the South wall to give this service.

Dirty Workshop

A small dirty workshop with cleaning tanks is being built to supplement the existing Yard facilities. It will deal with smaller items removed from ships before despatch to the Main Factory.

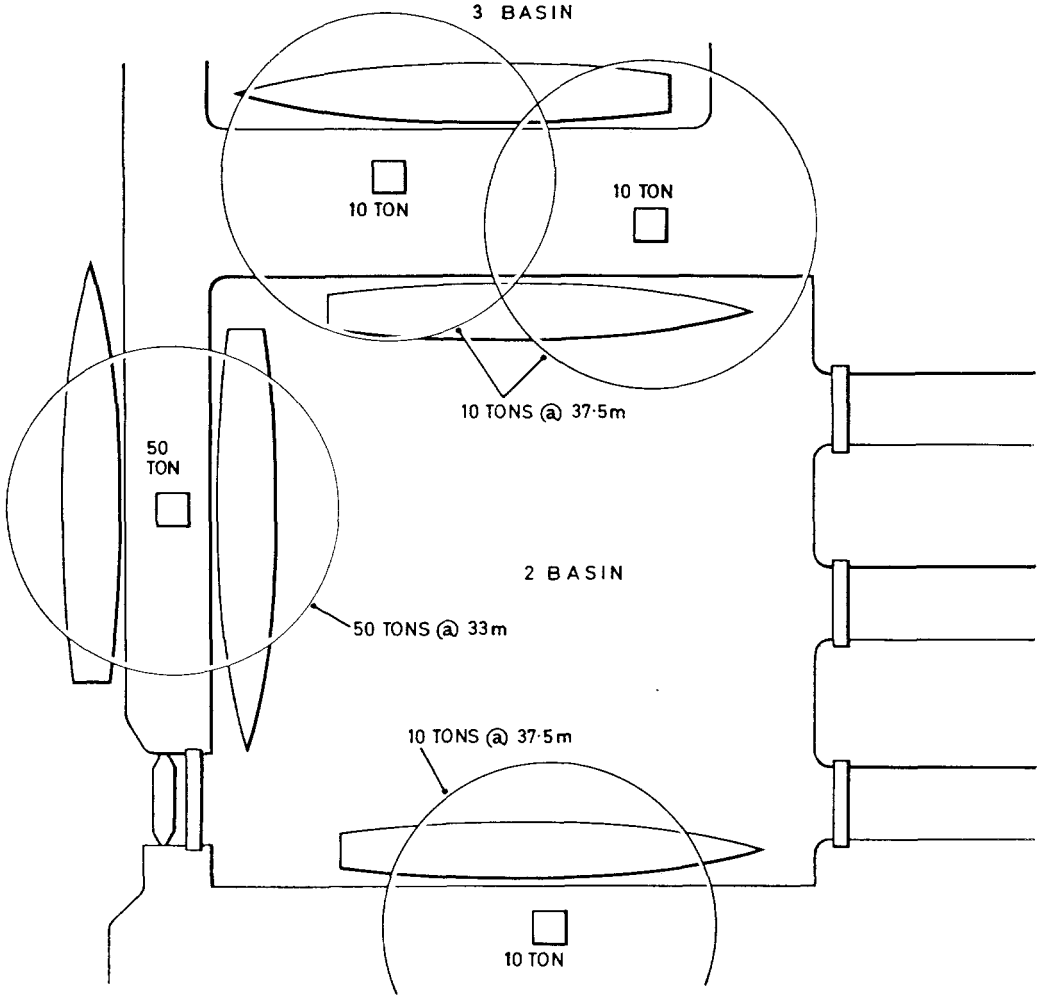

FIG. 10—CRANE COVERAGE AROUND BASIN

Progress

Comparison of FIGS. 2 and 11 indicates the changes and the progress which has been made after nearly two years work on the project. It can be seen that 7 Dock is nearing completion; the towers for the Cover doors are all built; and the Cover supports around 7 Dock are almost ready for the first of the main frames. The North support building is in the right foreground with a section of the double subway underneath.

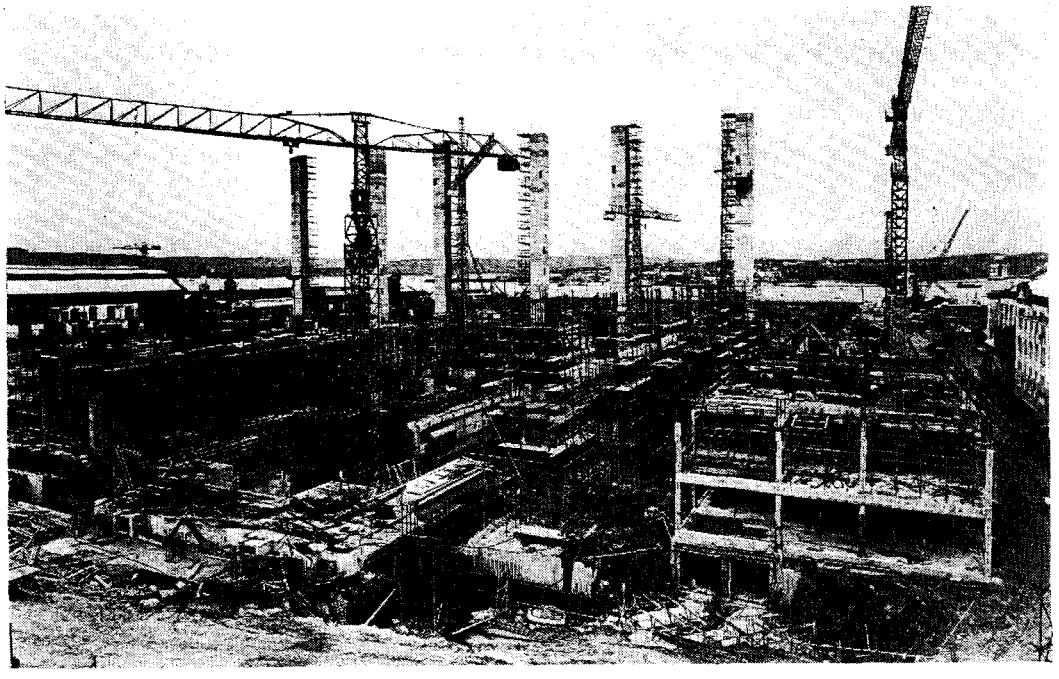

FIG. 11—PROGRESS OF THE PROJECT BY APRIL 1974

Although the civil engineers have been helped by a relatively dry period which has meant few days lost, the three-day week has had its effect. This together with a shortage of labour and materials and a rockfall in one of the docks has given rise to a delay of nine months in the completion date.

Much to everyones surprise, little of interest was found when No. 2 Basin was pumped dry for the first time within record. A few small unexploded shells were the main items of interest. A large amount of lost naval stores or antiques which most people had anticipated or hoped for failed to materialize.

Of greater concern was one of the highest tides of the century which, increased by the wind, threatened to come over the top of the cofferdam placed across the basin entrance.

The majority of the MOD(N) contracts have been placed and installation of the plant and systems is due to start in March 1975. Completion of the whole Complex is due by the end of 1976.

Conclusion

When complete, the Complex will provide unique and unrivalled facilities for refitting frigates. It has already generated intense interest amongst other navies and once again Britain can be said to have pioneered the way.