similar visits were made in 1979 by an Italian squadron and, earlier in 1980, by some French ships.

Whether the Peking Government has the foreign exchange to purchase the surface-to-air missile systems, antisubmarine warfare equipment, computerized tactical data systems, and many other items required to modernize its fleet remains to be seen. Certainly, there is official awareness of the urgency of their needs for, as some senior Chinese officers explained, they are not interested in new construction but in modernizing existing ships. Modernization, they claimed, could be achieved in a shorter time. And time is vital for they claim they will be in open conflict with the Soviet Union within five years.

While this may, of course, be a crude form of incentive to speed Western industries' delivery times, it would surely be a rash Western political leader, after events in Afghanistan, who would dismiss such fears out of hand. The time, therefore, may not be far away when the West may have to decide if it is seriously to aid the Chinese in the face of what they at least see as an ever-growing threat from their northern neighbor.

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The Brazilian Mk-10 Frigates

By Eduardo Italo Pesce

All six heavily armed Vosper-Thornycroft Mk-10 frigates ordered by the Brazilian Navy in 1970 are now in service as the *Niterói* class. Four are antisubmarine frigates, and two are of the general-purpose version. These frigates are remarkable ships in every aspect, and their development, from drawing board to commissioning, was a major technical and operational achievement.

The specifications from which the *Niterói* class was to emerge were drawn a decade ago, as the major item in the Brazilian naval modernization program. The Brazilian naval authorities then invited the world's leading shipbuilding firms to submit proposals for a frigate-type design of about 3,500 tons to replace obsolescent World War II-vintage destroyers.

The Mk-10 frigate, designed by Vosper-Thornycroft, Ltd. (now part of British Shipbuilders), met the requirements of the Brazilian Navy, and a procurement contract worth £100,000,000 for six ships was signed in September 1970. Additional costs and inflation later elevated the ships' total price to £150,000,000.

Four vessels, two ASW and two general-purpose variants, would be built at Woolston by Vosper-Thornycroft, Ltd., and two ASW ships at the Rio de Janeiro Navy Yard with technical support and lead yard services provided by the British shipbuilder.

The program was ambitious. Brazilian plans included assimilation of know-how in the latest techniques of naval design and construction. In the case of the Brazilian-built units, this was of crucial importance, for the whole future of naval shipbuilding in the country depended on their successful completion.

Construction of the four British-built ships was faster than that of their locally built sisters. The keel of the leading ship of the class, *Niterói* (F-40), was laid in May 1972. She was launched in February 1974 and commissioned in England in November 1976. The other ASW ship, *Defensora* (F-41), had her keel laid in December 1972, was launched in March 1975, and commissioned in March 1977.

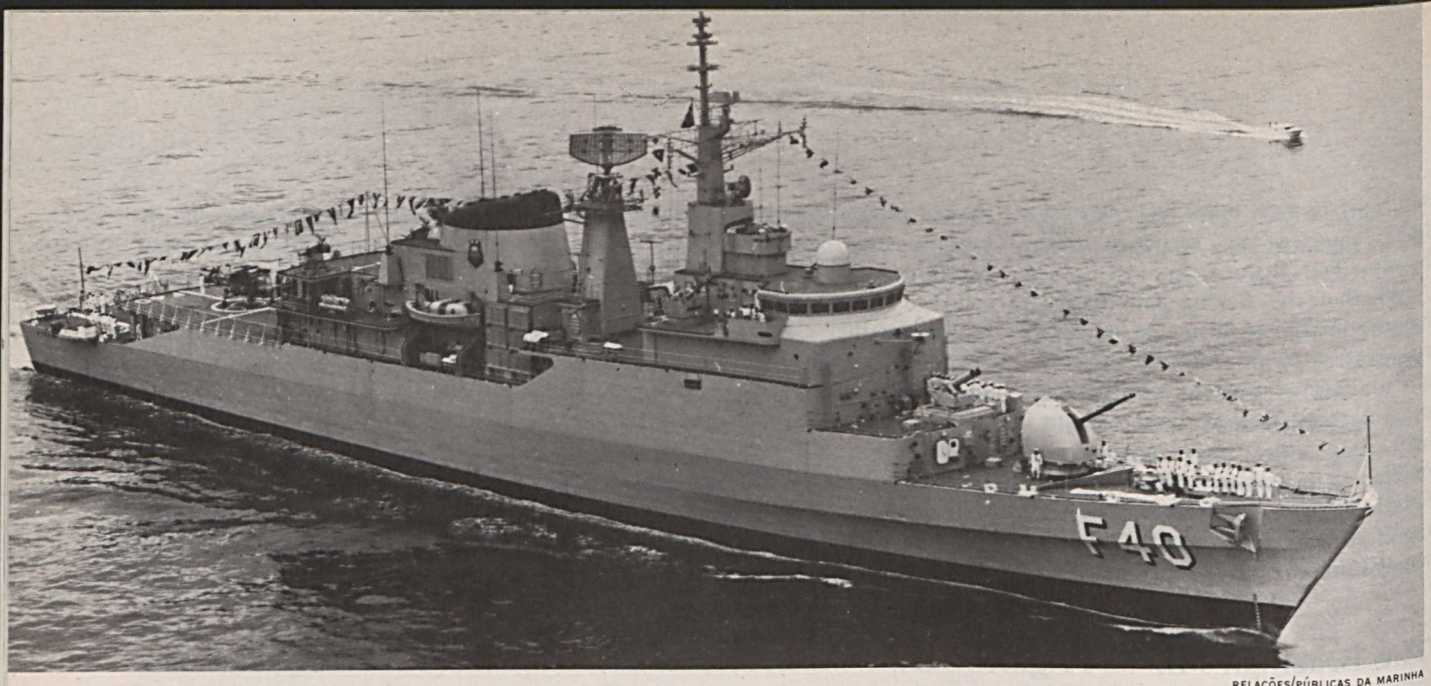
As for the two general-purpose frigates, the *Constituição* (F-42) was started in March 1972, launched in April 1976, and commissioned in February 1978; the *Liberal* (F-43) was started in May 1975, launched in February 1977, and put in service in November 1978. After commissioning, the four ships completed a working-up period in U. K. waters before joining the Brazilian Navy. The first ship arrived in Brazil in August 1977, and the last in December 1979.

Construction of the two Brazilian-built ASW vessels was delayed by several technical problems. Both ships had their keels laid in June 1972. The *Independência* (F-44) was launched in September 1974 and put in service in September 1979. The *União* (F-45) was launched in March 1975 and commissioned in September 1980. The unusually long fitting-out period was caused by the lack of experience of local yards with such complex designs.

In spite of that, it is reported that the performance of the two locally built units is considerably better than that of their British-built counterparts. The excellence of the ships is a tribute to the quality of the work performed by the Brazilian yard. It is also a sign of maturity of the country's growing shipbuilding industry, an industry that built ironclads and monitors of local design in the mid-19th century.

Possessing a high degree of operational reliability, the ships are a major addition to Brazil's defense capabilities at sea, and make a significant contribution to the security of the Western Hemisphere. Together, they form a small, but powerful fleet with concentrated firepower packed in six 3,800-ton hulls. These little "capital ships" are the heralds of a new age, and their sophisticated systems will be a challenge to the technical skills of Brazilian naval personnel.

The appearance of the Brazilian frigates also created a sensation in the international naval scenario. Indeed, during the Zaire crisis of May-June 1978, the then U. S. Chief of Naval Operations, Admiral James L. Holloway III, traveled *incognito* to Rio de Janeiro in order to make a personal evaluation of the frigates. He took a ship to sea and made all sorts of evolutions with her. This fact passed un-



RELAÇÕES/PÚBLICAS DA MARINHA

The Niteroi*-class frigate program—the ASW version is pictured—is an example of Brazil's determination to modernize its fleet.*

noticed by the Brazilian press, with the exception of a brief note in a magazine. The following week, President Carter asked the Brazilian Government for "diplomatic support" in the Zaire affair.

The *Niterói*-class frigates have an overall length of 424 feet, a beam of 44 feet 3 inches, and a deep draft of 13 feet 3 inches amidships. They displace 3,200 tons standard and 3,800 tons at full load.

In contrast with most small ships with heavy armament, these frigates are not cramped or short-ranged, and their seakeeping qualities in South Atlantic weather conditions are excellent. The twin-rudder, twin-screw, fin-stabilized hull is highly maneuverable and offers an excellent platform for weapons and helicopter operations.

The *Niterói*-class frigates offer a good mix of offensive and defensive capabilities, being able to engage air, surface, and submarine targets with equal accuracy. It should be noted that the general-purpose derivative has more ASW armament than most ASW frigates of Western design.

The two versions have a slightly different weapons fit, with the main difference being in the long-range missile system. While the ASW ship can attack submarines at extended ranges in any weather with Ikara, the general-purpose derivative has a medium-range ASW capability and Exocet surface-to-surface missiles for engaging surface targets at ranges up to 40 kilometers. Both versions carry a Westland WG-13 Lynx helicopter for ASW and surface attack.

The Ikara, the most complex weapon system aboard, is a specially developed version with automatic-reloading capability, known as BRANIK (Brazilian Navy Ikara). The ships are fully protected against nuclear, biological, and chemical (NBC) contamination, and carry the following armament:

- 1 single Vickers Mk-8 4.5-in. dual-purpose gun forward on the ASW version; or 2 guns, 1 forward and 1 aft, on the general-purpose version
- 1 single Ikara ASW missile launcher aft on the ASW version; or 2 twin MM-38 Exocet antiship missile box-shaped launchers amidships on the general-purpose version
- 2 triple Seacat surface-to-air missile launchers on the helicopter hangar
- 2 single Bofors 40-mm. L/70 close-in defense guns on the bridge
- 1 twin Bofors 375-mm. ASW rocket launcher forward
- 2 triple Mk-32 ASW torpedo mounts amidships
- 1 depth-charge rail for 5 charges aft (not actually fitted)
- 2 multiple 2-in. rocket flare launchers amidships

Aviation facilities include a helicopter platform, hangar, and workshops aft. Each ship carries one operational helicopter and spare parts for more. The Brazilian Navy operates nine Western Lynx helos for the *Niterói*-class frigates. They can classify and pursue an underwater contact and attack with two Mk-46 ASW-homing torpedoes. For surface detection and attack, they are equipped with a Ferranti Seaspray radar and AS-12 air-to-surface wire-guided missiles.

The electronic equipment on board the two frigate types is similar. The surface-to-air and surface-to-surface weapon control systems are nearly identical. For guns and missiles, two Selenia RTN-10X radar trackers (forward and aft) are fitted; the after tracker, with associated closed-circuit television (CCTV), controls the Seacat missile. There is also a pedestal sight for Seacat and a look-out and aiming (LAS) sight for each Mk-8 gun. Exocet missiles receive launching instructions from the main data system.

The ASW vessels have an Ikara tracker radar dome, and missile in-flight control can be shifted from one ship to another. Control of all underwater weapons is automated.

The sensors suite comprises the Plessey AWS-2 S-band air warning radar with associated Mk-10 IFF, Signaal ZWO-6 navigation and surface search radar, and two types of sonar: the hull-mounted EDO 610E in all ships, and the towed EDO 700E variable-depth set in the two ASW vessels built in England. Decca electronics countermeasures (ECM) equipment in several frequency bands is fitted, and a considerable effort was made to eliminate interference be-

tween the radar sets.

Command and control facilities are provided by the computer-assisted action information system (CAAIS). This system includes three Ferranti FM 1600B computers and provides control of shipboard sensors and weapons from the operations room—or combat information center (CIC)—which coordinates all command and control functions.

Air operations are also directed from the operations room. It incorporates closed-circuit TV monitors, the Deccascan CA 1600 radar displays, the sonar sets, the electronic warfare equipment, and the weapon system automation (WSA) consoles of the surface-to-air, surface-to-surface, and ASW armament. Computer-generated electronic data displays (EDDs) are used, and all equipment is redundant with cross-connection facilities provided.

The ships can exchange data with other CAAIS-equipped units through data link, and a radio-teletype (RATT) report is used to transfer data to non-computer ships equipped with a conventional CIC. If needed, each ship can take over command of another frigate, and issue helm and engine orders by remote control. Worldwide communication facilities are provided, and the ships can receive satellite communications equipment. Much of the external and internal communication equipment fitted is Brazilian.

The main engine installation consists of two Rolls-Royce Olympus TM 3B gas turbines of 28,000 s.h.p. each and four MTU MA 16V 956 TB 91 diesels each of 4,200 s.h.p. in combined diesel-or-gas (CODOG) turbine arrangement—one turbine and two diesels on each shaft, driving an Escher-Wyss controllable-pitch propeller through an SSS clutch and David Brown reduction gear. Twin rudders and Vosper-Thornycroft nonretractable fin-stabilizers are fitted.

The engines are run from the ship's control center, with an unmanned engineroom, and speed may be selected from the bridge by remote control. Maximum sustained speed is 28 knots with the gas turbines and 22 knots on four diesels. Endurance at 17.5 knots with two diesels is 5,300 nautical miles. The ships are fitted for replenishment at sea.

The ships were designed according to strict endurance and habitability requirements needed for open-ocean operations. They can carry 480 tons of fuel oil and 26 tons of helicopter fuel. Fresh water storage capacity is 50 tons, plus stores for 45 days.

Personnel accommodation standards on board the frigates are high. They operate with a crew of 21 officers and 180 men. Officers live in single-person cabins and senior ratings in three-bunk cabins, and the four messdecks for junior ratings are built around a central recreation space. All living spaces are air-conditioned.

The air-conditioning plant was designed for tropical operations, and can be sealed in case of NBC contamination. Electrical power is provided by four diesel-generating units, each of 1,000 kW. Ship's services also include modern galley and sick bay, and the wardroom easily becomes an emergency operating room.

The *Niterói*-class frigates are the first generation of a whole new breed of ships for the Brazilian Navy, which will ultimately form the nucleus of a small balanced fleet. While the ships are not a genuine product of Brazilian know-how, they are a fine design, and their characteristics will surely influence the development of Brazilian-designed warships in the future. The Brazilian Navy plans to modify the basic design for other duties. Indeed, the same hull was adopted for the new training ship being developed by the Bureau of Naval Engineering. Design work for this ship was completed in 1980, and she will be built at the Rio de Janeiro Navy Yard.

The Brazilian Navy also plans to replace the aging destroyer fleet with a new class of corvettes now in the preliminary design stage. This class will probably incorporate many of the innovations introduced in the Mk-10 design.

One such innovation is maintenance by replacement. The frigates were designed according to this concept under which minor repairs and routine maintenance can be performed by the crew at sea, or in port with dockyard support. However, when an engine or another part of equipment requires a full overhaul, it is removed and repaired ashore. The ships have experienced some maintenance problems during their first years of operation, but these are being gradually solved as the personnel gets used to the new equipment.

Fast technological change results in premature obsolescence and, because of that, today's ships get old quickly. The *Niterói*-class frigate will already be somewhat obsolescent in the late Eighties. Indeed, some of the equipment on board is already behind new developments.

Some deficiencies of design have also been identified. There is a requirement for an efficient anti-missile defense system, such as Seawolf, to replace the obsolescent Seacat. Also, the Exocet antiship missile on board the general-purpose frigates has a somewhat short range, in comparison with other systems such as Harpoon and Otomat/Teseo. If a missile with longer range is used, however, it will need targeting by helicopters or other units.

A larger air complement, in the form of a second helicopter, would increase the ships' surveillance and strike capability, especially if fitted with Sea Skua air-to-surface missiles. But every ship is essentially a compromise solution, and some characteristics will aways be sacrificed in favor of others. Some of the deficiencies will be corrected during the ships' operational lives, and some in the design of following classes.

In these days, it is rare for any weapon system to become operational without any major problems, or even to become operational at all. This is true for both major and minor powers. The Mk-10 frigate program demonstrates the will of a small navy to overcome budgetary limitations and meet its commitments with modern equipment.

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