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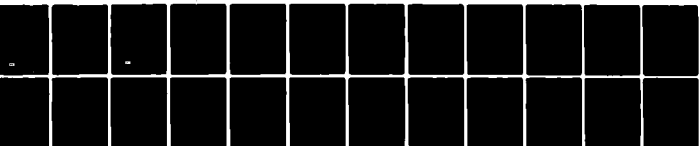
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WESTERN EUROPEAN AND NATO NAVIES, 1980

The 14 navies of Western Europe and NATO (excluding the U.S. Navy) include some of the largest and best equipped fleets in the world, excluding those of the two superpowers. Most of them have significant ongoing procurement programs, some of them in the context of long-term naval program-laws. Their naval armaments industries are now equipping not only their own fleets but also those of most of the world's smaller navies. While none of them is large enough to rival the navy of either superpower, the non-U.S. NATO navies together constitute a major Western resource that could tip the balance in a naval conflict with the Warsaw Pact.

Navies are extremely complicated organizations, but their most characteristic feature, and the one used most often to judge their strength, is their combatant ships. When looking at new developments in the forces of these navies, notably new ship procurement programs, the initial impression is one of radical change. Indeed, major advances in capabilities are being made, due to advances in technology and to the tendency of successive ship designs to increase in size. However in most of these navies one thing has tended to remain relatively constant -- the overall force structure. The mere fact that most ships last well over 20 years means that changes in force structure will be a gradual process, and this tendency has been reinforced by factors such as

limited financial resources, conservatism in naval leaderships, and, in the case of NATO navies, a relative continuity in missions during the period NATO has been in existence. In this initial survey of the 14 Western European and NATO navies, we will focus on identifying changes and continuities in their combatant ship force structures during the last 30 years. This will enable us both to determine the role that ships now under construction will assume in the fleets and also to suggest with some confidence what new procurement efforts are likely to be undertaken in the future.

For purposes of comparison, ships have been grouped in the following categories: carriers, cruisers, destroyers, large frigates (which over time have increased in size within the general range of 1600 to 4200 tons full load), light frigates (1000 to 1600 tons), patrol escorts (800 to 1000 tons), large patrol craft (400 to 800 tons), fast attack craft (armed with anti-ship missiles or torpedoes), submarines, minesweepers (here limited to wooden-hulled ships over 290 tons full load), minelayers, and major amphibious ships (LSD and LST). Reclassifications of ships among combatant categories (notably from destroyers to frigates) have for the most part been ignored. Ships are counted as in the inventory from commissioning until they are deleted from the list or unambiguously relegated to auxiliary or subsidiary service. The survey is conducted in geographical order from the north west-

ward around Europe to the Mediterranean. Canada is also included since it is a NATO country.

The Swedish navy is the one navy of the 14 that is not associated either directly or indirectly with NATO. Its primary mission is deterrence or disruption of an invasion of Swedish territory, the main threat being from the east. Sweden, which now has only two destroyers in commission, has gone farther than the other Nordic countries in renouncing large ships in favor of fast attack craft and submarines. The number of these latter two types has not increased since 1960, however, and, in fact, the submarine force has declined since 1974 from its previous average of 22 units to 14, despite the introduction of three Nacken-class submarines in 1979-80. The near-term future of this submarine force appears assured by plans to modernize some of the oldest boats and by the order just given for the first unit of the new A-17 class. The fast attack craft force, which averaged around 40 units from around 1956 to 1975, will probably stabilize at 35 units after completion of the Jagaren class. In light of the cancellation of the M-70 minesweeper program, Sweden's minesweeping force is likely to decline. The naval minelayer force, which will soon consist of three modern ships, is backed up by some small Coast Artillery minelayers.

The Norwegian navy is responsible for the defense of the long Norwegian coast against attack by nearby Soviet sea and air forces and for operations on two vital sea routes -- the approaches to

the Baltic and Barents Seas. She allowed her destroyer force to disappear in the 1960s but renewed her frigate force by building five Dealey-class ships. A decision will have to be made soon on their replacement. She has augmented both her submarine and fast attack forces since the 1950s. Eight new small submarines have just been ordered in Germany to replace some of the existing 15 boats, and the Hauk class is the latest of several classes that have kept the fast attack force at a strength of around 46 units since around 1967. The minelaying force is led by two modern ships. Norway has retained her minesweeping force (now 10 MSC) intact, but has not updated it, and its future is not clear. The Norwegian air force operates about seven P-3B maritime patrol aircraft.

The Danish navy is concerned primarily with defense of its territory and operations in the Baltic approaches. Over the years its inventory of large frigates has dropped from 5 to 2 (which recently completed a mid-life overhaul), backed up by 3 to 4 patrol escorts and light frigates (the new Nils Juel class is now replacing the Triton class). The submarine force has doubled from 3 to 6 units, and plans are being made to replace some older submarines with German Type-210 units. The fast attack force has remained constant at around 16 units, ten of which today are of the new Willemoes class. As in Norway and Sweden, the minelayer force of seven units is reasonably up to date, but the small force of eight coastal minesweepers has been unchanged since the 1950s.

The navy of the Federal Republic of Germany has the mission of coastal defense and Baltic operations, but has also assumed another mission: cooperation in sea-control operations by larger ships in the North Sea. (This mission gained importance in 1980 when West Germany lifted a self-imposed restriction on naval operations north of 61° north.) West Germany has had 17 destroyers and large frigates since the early 1960s, but 10 will have to be replaced soon. To do this West Germany is now building six Bremen-class frigates and considering construction of two more. The German fast attack force has been at or above its current level of 40 boats since the early 1960s, and 10 Type-143A vessels are now building to replace the 10 oldest units. (The U.S. PHM class was originally programmed for this purpose but was dropped due to cost.) The submarine force of 25 boats is to be maintained by construction of the Type-210 submarine. The 18 coastal minesweepers still in service were built in 1958-60 but have all been updated, 12 by conversion to minehunters and 6 by conversion to control ships for "Troika" drone minesweepers. Unlike her neighbors to the north, West Germany has not maintained a naval minelaying force. The West German navy has two squadrons of F-104 fighter-bombers, which are to be replaced by Tornados, and one squadron of Atlantic maritime patrol aircraft, whose weapons and sensors are to be updated under a major new program.

The force structure of the Royal Netherlands Navy has changed very little over the last 30 years, except for the elimination of

a light carrier, but the missions of the ships have changed. Plans now are for the Netherlands to provide in the Atlantic and the Channel three escort groups (each with a leader, six frigates and an underway replenishment ship) and to operate in the North Sea a group of four smaller escorts and an offensive submarine force. She is also to operate mine countermeasure forces off her coast and in the Channel. Thanks to the Kortenaer frigate program and the modernization of the Van Speijk class, her force of destroyers and large frigates, which consisted of 18 ships in 1951, will soon consist of 18 modern frigates. The submarine force, which has consistently contained around six units, is being updated by construction of two Walrus-class units. The Alkmaar minehunters program should help stop the decline of the Dutch minesweeping force, which fell from 52 to 21 MSO and MSC in the 1970s. The ships that are needed for the fleet's missions but have not yet been ordered are one escort group leader to supplement the two Tromp-class missile destroyers and replacements for the existing smaller escorts, which date from 1954. Plans are being made to build a SAM variant of the Kortenaer-class to serve as leader and four 2500-ton M-class frigates for North Sea duty. The Dutch recently decided to buy 13 P-3C maritime patrol aircraft to replace 15 Neptunes. They also have seven Atlantics.

The Belgian navy owned two frigates in the early 1950s and operated some large steel minesweepers as escorts until 1969, but the commissioning of four Weilingen-class frigates in 1978 marks

her most effective participation to date in the mission of helping to protect shipping in the Channel. The rest of the Belgian navy has been a minesweeping force, which declined along with those of other NATO navies but which is to be renewed by construction of 10 tripartite minehunters in the 1980s.

The British Royal navy, once the world's largest fleet, is still the most important non-superpower navy. However, two decisions taken during the 1960s have profoundly altered its missions and operational behavior: the decision not to build a new-generation aircraft carrier and the decision to withdraw from east of Suez. The full effect of the first decision was finally felt in 1979 when Britain's last attack carrier, Ark Royal, was retired without relief. In partial compensation, however, RAF squadrons of Buccaneers and Phantoms (eventually to be replaced by Tornados) were dedicated to maritime operations around the British Isles. The effect of the second decision has been that, even though Britain occasionally sends task groups to operate overseas, nearly all her forces are committed to NATO to operate in European waters (the eastern Atlantic and the Channel) in case of war.

When looking at the force structure of the Royal navy since 1951, one finds a pronounced decline in nearly all categories of ships. This, however, is due in part to the fact that the British navy was practically the only European fleet to emerge from World War II with the makings of a large reserve fleet. By looking carefully at the figures, however, one can discern some trends and

continuities. The decline in the larger classes is indisputable: even the large destroyers of the postwar Devonshire class are beginning to disappear, and only three new ships larger than destroyers, the V/STOL and helicopter carriers of the Invincible class, have been provided for. (It should be noted, however, that Britain is also maintaining four SSBNs and has just decided to update this force.) The main sign of continuity can be seen in the large frigate category. If one includes in this category the destroyers converted to frigates in the early 1950s and the new Sheffield-class, the force of large frigates built or converted since World War II has remained between 50 and 60 units since 1961. The Leander modernization programs and continuing production of the Sheffield and Broadsword classes will probably keep it there. The 12 second-line frigates of the Dundas class have been disposed of, and, unless some of the new Type-24 export frigates are acquired, they are not likely to be replaced. The shift from diesel to nuclear submarines led to a decline in the attack submarine force from 46 in 1967 to 27 today: construction of a new diesel submarine class, the Type-2400, is now under consideration to prevent further decline. Britain's minesweeper force has declined in size since the mid-1960s along with most other NATO mineforces, but it is now being upgraded qualitatively by production of the Brecon-class minehunters. Britain no longer maintains a force of fast attack craft, and her eight large amphibious ships are used for logistics support or for seamanship training. The

RAF maintains four squadrons of Nimrod maritime patrol craft. Some of these are being converted to airborne early warning aircraft, and the rest are being updated.

At the other end of the Atlantic sea lanes, the Canadian navy has concentrated since the late 1950s almost exclusively on maintaining an effective anti-submarine destroyer and frigate force for service both off her long Atlantic and Pacific coasts. Nearly all other major ship types, including minesweepers, have been disposed of or relegated to subsidiary functions. Between 1955 and 1964 Canada built 20 frigates, which gradually took over from her 32 war-built destroyers and frigates. Of her current inventory of 23 frigates, only the four Iroquois class are fully up to date, and a new patrol frigate, which has now advanced nearly to the contract definition stage, is urgently needed to prevent a decline in the force. Beginning in 1949 Britain loaned Canada three submarines to provide training services for her frigates, and this is now the function of Canada's three Oberon-class submarines. Canada has begun taking delivery of 18 Aurora maritime patrol aircraft (a variant of the U.S. P-3) to replace her Argus fleet.

The French navy differs from the other NATO navies discussed here in two respects. First, France is the only country which is a full member of NATO's civil organization but whose forces are not integrated into NATO's military organization. Second, the French navy is the only one of these navies that still has an important mission outside Europe. Its four missions (which have

changed little since the advent of de Gaulle) are: to participate in nuclear deterrence by maintaining an SSBN force, to maintain surveillance over and, if necessary, to defend the maritime approaches to France in both the Atlantic and the Mediterranean; to retain at sea and overseas the ability to act as necessary to fulfill France's diplomatic obligations and defend her interests; and to carry out public service, or coast guard, tasks.

The French navy's force structure is distinctive in that it is the only European navy to retain an attack carrier force. France has had three to four carriers (including helicopter carriers) since 1953 and will retain the current two attack carriers and one helicopter carrier into the 1990s. Her two attack carriers have just been updated by major overhauls and by procurement of the Super Etendard attack aircraft with a tactical nuclear capability. In the 1990s they will be replaced by two 32,000-ton nuclear-powered carriers. France also has five SSBNs in service and is building a sixth. She has continuously had a handful of cruisers or large missile destroyers to escort the carriers. Her force of destroyers and large frigates remained continuously around 45 units from 1957 to 1974, thanks to a major construction effort in the 1950s, but since then 19 ships have been stricken from the list and only four new ones delivered. The new light frigates of the D'Estienne d'Orves class are taking over the missions of a once numerous class of 450-ton U.S.-type large patrol craft, of which only two survive. France's attack submarine force

has grown steadily from 13 in 1951 to 22 today. A decision has been made that all future French submarines will be nuclear, and, while this will give the French new capabilities, it will also result in reduced submarine force levels. As in other NATO navies, France's minesweeper force increased greatly in the 1950s and has since declined: it is being upgraded qualitatively by the conversion of 10 MSO to minehunters and the construction of 15 new Eridan-class minehunters. Despite the leadership of French industry in the fast attack craft market, the French navy has acquired only a few such ships, and those only for patrol duties. France's nine large amphibious ships are used mainly for logistics duties. The French navy has just begun a program that will replace her Atlantic maritime patrol aircraft with 46 "new-generation Atlantics." France is now completing a six-year naval construction program, and the results of that program and recent French long-range plans will be presented later in this survey.

The Portuguese navy is primarily concerned with the security of three strategically important areas: the Azores, Madeira and Portugal itself. Its colonial mission ended in 1974-75 with the loss of the remaining colonies. Well before that time, however, Portuguese forces began to decline in strength. Until 1969 the combined frigate-destroyer force remained constant at about 13 units, but then it declined rapidly and now consists of seven frigates, completed to 1950s designs between 1966 and 1970. Portugal's force of large patrol craft (PC) and her minesweeping

force (supplied by U.S. and NATO aid) disappeared between 1967 and 1976 except for four minesweepers. In this period of decline the only new construction was 10 light frigates of the Joao Coutinho-class and 10 small patrol craft of the Cacine class. New frigate construction will be necessary if Portugal is to retain a serious anti-submarine capability. Her submarine force has remained constant at around three units.

Spain is not a member of NATO, but coordinates her defenses with some NATO countries by means of bilateral agreements. The primary mission of the Spanish navy is to help maintain sea control in three key areas: the Mediterranean west of the Balearic and Alboran Islands, the Straits of Gibraltar, and the Atlantic between Spain and the Canary Islands. The large number of old ships that were in the Spanish navy in the 1950s have only partially been replaced. In the early 1950s it had six cruisers, 21 destroyers, 18 gunboats and minelayers which served as large frigates, and nine 1400-ton torpedo boats in service or under construction. It now has one light carrier, 13 destroyers, six large frigates and eight light frigates, of which all but five large missile frigates of the Baleares class and three new light frigates of the Descubierta class will have to be retired in the near future due to age. Spain is currently completing five more light frigates of the Descubierta class and plans to build a light carrier and three Peary-class large missile frigates, but these will not compensate numerically for the losses. Spain's submarine

force has remained relatively constant at eight ships, and she currently is building four French Agosta-class ships which will probably replace four World War II U.S. boats. Her force of nine fast attack craft declined to two by 1974, but since then she has built 12 new ones of the Lazaga and Barcelo classes which, however, are used on patrol duties and do not regularly carry missiles or torpedoes. Spain has retained all but one of the 12 MSC she received from the U.S. in the 1950s, and in 1971-72 added four ex-U.S. MSO with some mine locating capability. Since 1976 Spain's carrier has operated seven Harrier V/STOL aircraft (called Matadors) in addition to helicopters. The Spanish Air Force operates six P-3A maritime patrol aircraft.

The Italian navy is responsible for defending Italian trade routes and territory, controlling choke points, and escorting NATO naval forces, all in a vital part of the Mediterranean. The number of large ships that it has maintained to carry out these missions has remained almost constant for the past 30 years; today Italy has three cruisers (which also have helicopter facilities), six destroyers and six large frigates of the Alpino and Cigno classes. In addition, since the early 1960s, she has built eight frigates of the Bergamini and Lupo class that were smaller than most of their foreign contemporaries but had many of the same capabilities. In 1975 a navy law was passed to provide for the updating of this force; the 13,250-ton helicopter carrier Guiseppe Garibaldi was to replace two of the cruisers, two missile destroy-

ers were to replace four units of the Impavido and Indomito classes, and eight Maestrale-class frigates were to replace the eight units of the Cigno and Bergamini classes. The carrier and six of the frigates have been ordered, but funds were not available to begin the other four ships. Two missile destroyers of an improved Audace class with gas turbines are now proposed in the latest budget.

The number of smaller surface combatants in the Italian navy declined sharply in the period. The number of patrol escorts and light frigates has decreased from 34 to eight. A new 1000-ton class is said to be in the planning stage. The number of fast attack craft has also declined sharply, from a peak of 31 to the present five, four of which are old. Six Nibbio-class hydrofoils are now under construction. Italy's mine force has declined from a peak of 60 in the early 1960s to 34 old ones today. Eight of these are being converted to minehunters, and four new minehunters of the Lerici class are under construction. In contrast, the submarine force has increased gradually over the years to the present 10 units. Two additional Sauro-class submarines are building under the navy law to replace some ex-U.S. units. The Italian Air Force has not yet made a decision concerning replacement or updating of its 18 Atlantic maritime patrol aircraft.

The Greek navy has the missions of preserving the territorial integrity of Greece, including all her Aegean Islands, and supporting NATO operations in the critical Southern Flank area.

Since the early 1950s, Greece has consistently had an average of 16 destroyers and large frigates; her current inventory consists entirely of World War II units which, despite being modernized, need replacement. Greece has just purchased one Kortenaer-class frigate in Holland (the sixth in the Dutch series) with options on a second and on a license to build more with Dutch help in Greece. Greece formerly had as many as 15 large patrol craft of various types, but these have disappeared and, since 1967, she has concentrated on building instead a large force of fast attack craft for operations against surface ships. She now has 21 such craft with five more very near completion. Her submarine force declined to two boats in the 1950s, but beginning in 1971 she built it up to its current level of 10 by building eight Type-209 class submarines in Germany. Her mine warfare force has remained constant at 13 to 15 minesweepers and two minelayers. Finally, Greece has constantly maintained a force of eight to ten large landing ships (LST and LSD) which is now one of the largest NATO amphibious forces in Europe.

The Turkish navy has essentially the same missions as the Greek navy and has a very similar force structure, although in the case of Turkey there has been a noticable rise in numbers of ships since the late 1960s. The destroyer and frigate force has grown from 10 in 1951 to 15, although 13 of these are of World War II vintage and will need replacement. The submarine force was built up from its previous level of 10 units to 14 between 1969

and 1973, and has been kept at or above that level by acquisition of Type-209 submarines, which are now being built in Turkey. The modern fast attack force was established in 1964 and now includes 23 units, with four more reported to be on order. The force of wooden minesweepers increased from 11 to 22 units since 1951, offsetting the disappearance of a large number of steel minesweepers. The minelaying force increased from five to nine ships since 1951, although only one of the nine now in service is modern. Finally, Turkey acquired two LSTs in 1973-74 to add to her collection of smaller landing craft, and is now building LSTs and smaller amphibious ships in Turkey.

There is not space to analyze the capabilities of the ships of these 14 navies, but we must take note of the recent proliferation of two types of systems, anti-ship cruise missiles and ship-board ASW helicopters. The former enables many NATO ships to meet their Soviet counterparts on equal terms or better, while the latter gives many of them, including some large coast guard ships, a substantial standoff ASW capability. The spread of area-AAW missile systems has been less spectacular; they are limited to newer cruisers and destroyers, five Spanish frigates, and some Spanish and French frigates just beginning construction.

In some of the non-U.S. NATO navies, current force structures are the result of comprehensive, multi-year new-construction programs sanctioned by the legislature. France is approaching the end of such a program, the Fourth Program Law of 1977-82, and the

1981 budget documents enable us to estimate the success of that program and its impact on the structure of the French navy in 1990. In addition the details of a long-range plan drafted in 1978 have been made public, and as a result we now also know what the French navy thinks (or hopes) its structure will be in the year 2000.

Perhaps the clearest way to estimate the success of the 1977-82 law is to see how many of the ships that were to be delivered during the period were delivered and how many to be ordered were ordered. Based upon 1980 projections, actual deliveries will match planned ones very closely: only three large frigates are to be delivered instead of four planned, but one more light frigate, one more replenishment ship, and two more amphibious ships will be delivered than planned. Orders for new ships also match the program reasonably well, in that ships added to the program since 1976 roughly counterbalance those deleted. Orders were added for one SSBN, two large ASW frigates, three light frigates and one oiler; and orders were deleted or deferred past the program period for one small nuclear V/STOL carrier (PA75), one large AAW frigate, three minehunters and two patrol craft. The deferral of the V/STOL carrier was followed in 1980 by a French decision to build two larger nuclear-powered carriers with conventional aircraft in the late 1980s and 1990s (the first is tentatively scheduled to be ordered in 1983 and the other after 1988). In general the 1977-82

program was successful -- far more so than previous French naval programs.

Table 1 summarizes the actual or expected force structure of the French navy at five points in time: the beginning, the middle, and the end of the 1977-82 program; 1990; and 2000. It should be noted that the figures for 1990 exclude all ships ordered after 1982: this probably affects primarily the mine and patrol craft. The figures for the year 2000 are a "model navy" used for planning purposes; while not derived directly from current forces or programs, they do take into account an estimate of fiscal constraints. Table 1 indicates that in most areas the French expect to be able to maintain their existing force structure to the turn of the century.

Our survey of the 14 navies of Western Europe and NATO indicates that, with some exceptions, they have succeeded in maintaining the numbers of ships in certain key categories at relatively constant levels during the past 30 years and have laid the groundwork for continuing to do so in the 1980s. Particularly impressive is the fact that the 12 non-U.S. NATO navies plus Spain currently have almost 240 destroyers and large frigates, supplemented by over 40 light frigates. They thus have more major surface combatants than does the Soviet navy, though their total tonnage is not as high. The combined force level of destroyers and large frigates has remained surprisingly constant in many of these navies over the last 30 years. The 150 submarine and 170 fast at-

TABLE 1

ACTUAL AND EXPECTED FRENCH NAVAL FORCES, 1976-2000

	<u>31 Dec 76</u>	<u>31 Dec 79</u>	<u>31 Dec 82</u>	<u>1990</u>	<u>2000</u>
<u>Strategic Forces</u>					
SSBN	4	4	5	(6)	(?)
<u>Combatants</u>					
Carriers ¹	3	3	3	3	2
AAW Ships ²	7	7	6	5	9
ASW Ships ³	13	13	14	10	18
Avisos and Escorts ⁴	27	24	23	20	18
SSN	0	0	0	5	10
SS	21	22	19	6	4
Patrol Craft	30	26	23	9+	10
Mine Craft	29	29	25	20+	40
<u>Auxiliaries</u>					
AO, AR	9	9	9	11	12
Amphibious	9	9	9	11	9

Notes

¹Includes one helicopter carrier to the mid-1990s.

²All cruisers, destroyers, and frigates with area-defense SAM

³Destroyers and large frigates beginning with Aconit (1970)

⁴Modern light frigates and large frigates built before Aconit

tack craft in these navies tend to be concentrated on the northern and southern flanks. In general, mine forces were allowed to decline through the 1970s, but major new minehunter programs are now in progress in five countries. One must conclude that these navies have the capability to make a major contribution in the event of a NATO war, as well as supporting their own national objectives.

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PP 297 - Classified

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