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# Intelligence Report

*Soviet Antisubmarine Warfare:  
Current Capabilities and Priorities*

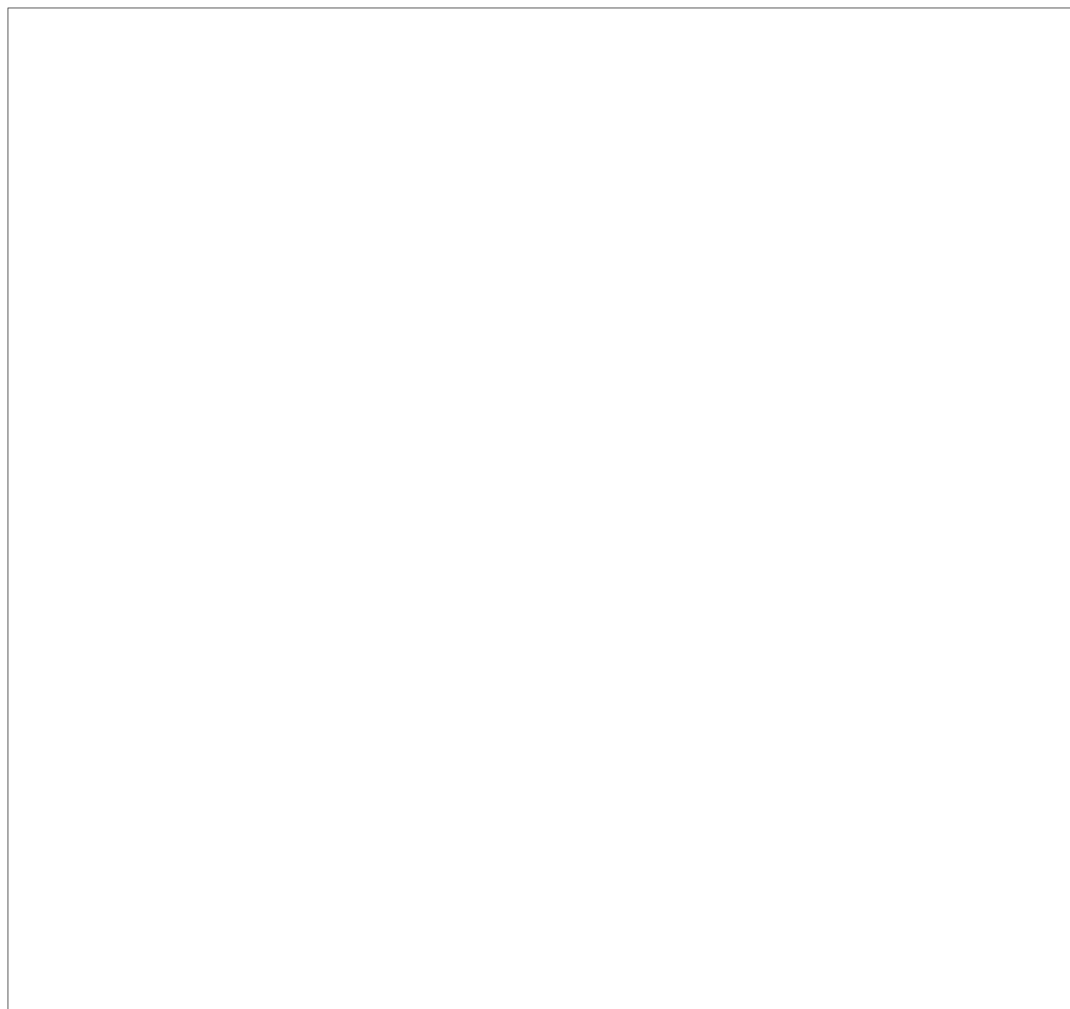
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CENTRAL INTELLIGENCE AGENCY  
Directorate of Intelligence  
Directorate of Science and Technology  
September 1972

INTELLIGENCE REPORT

Soviet Antisubmarine Warfare:  
Current Capabilities and Priorities

Introduction

During World War I the attack submarine emerged as a serious threat to surface ships on the high seas and antisubmarine warfare (ASW) became an important component of naval operations. Until the recent advent of the ballistic missile submarine, the object of ASW was the protection of warships, troopships, and cargo vessels from attack. Success in ASW meant the maintenance of a sufficient level of security at sea to preserve the strength of the fleet and ensure the transport of ground forces and war materiel. Some losses--frequently large ones--could be accepted, and destruction or neutralization of every enemy submarine was not essential.

The nuclear-powered ballistic missile submarine has radically altered the dimensions of the ASW problem. First, nuclear submarines, because of their speed and endurance and their capacity to remain completely submerged for long periods, are much harder to find and destroy than were older submarines. Second, ballistic missile submarines need not approach hostile forces to carry out their mission, and in fact purposely evade other forces. Third, and

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most important, ballistic missile submarines have a far greater destructive potential--a factor which has drastically altered ASW requirements. In past wars the limitation of damage was an acceptable goal, but in a nuclear war failure to destroy all ballistic missile submarines--leaving even a few--could mean catastrophe. A single US Poseidon submarine, for example, is capable of delivering approximately 160 nuclear warheads. The consequences of allowing even one such submarine to launch its missiles could be severe.

The beginning of the Soviet effort in open ocean ASW coincided with the post-World War II venture of the Soviet Navy from the coastal waters onto the high seas. The development of ASW defenses for the fleets at sea has occupied much of the Soviet effort since that time. The emergence of the nuclear attack submarine, moreover, has increased the Soviets' long-standing concern for the security of their coastal areas and intracoastal shipping. Consequently they initiated efforts to develop ASW defenses in coastal areas as well as on the open ocean.

A Soviet ASW response to the development of ballistic missile submarines has been less evident. Although Soviet writings since the late Fifties have indicated awareness of the threat posed by Polaris submarines, the Soviets probably had enough experience and understanding by the mid-Sixties to realize that the problem of Polaris would not readily yield to conventional naval forces.

This report evaluates the spectrum of Soviet ASW operations, including present ASW methods, the ships and aircraft employed, ASW organization, and command and control of Soviet ASW forces.\* Soviet operations are also examined to discern possibilities that previously undetected ASW systems are being employed. A summary begins on page 7.

\* ASW in this report is considered as operations against submarines at sea. Tactics such as disruption of communications or destruction of submarines in port are not discussed.

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### Glossary of Terms Used in This Report

**Attack submarine** — A submarine whose principal combat function is to destroy other submarines and surface ships. Principal armaments may be surface-to-surface cruise missiles or torpedoes.

**Ballistic missile submarine** — A submarine whose principal combat function is to launch ballistic missiles against strategic land targets.

**Barrier** — An array of sensors, usually in a line across a narrow strait, for detection of passing submarines. Barriers may be composed of ASW-capable forces or fixed sensors.

**Bistatic sonar** — Active sonar in which the receiver is located at some distance from the transmitter, thereby separating the receiver from the noise at the source. Theoretically this improves the sonar range capability.

**Bottom bounce** — A mode of active or passive sonar operation in which the active pulse or target-radiated acoustic energy is reflected from the ocean bottom to obtain increased ranges.

**Convergence zone** — Ring-like zones of sound focusing, about 25 to 30 miles from a sonar, occurring in many deep-water ocean areas. This phenomenon enables sensitive sonars to achieve extended active or passive ranges.

**Delousing** — A tactic in which forces friendly to a submarine attempt to detect and remove hostile trailing submarines.

**Direct path** — The simplest mode of active or passive sonar operation in which sound follows a direct line without being reflected.

**Infrared (IR)** — Thermal radiation of wavelengths longer than visible light, of possible application in submarine wake detection systems.

**Localization** — A phase in ASW in which the location and movement of a submarine are determined with sufficient accuracy for launching an antisubmarine weapon. This phase may also include measures to determine the identity of the submarine.

**Ocean surveillance** — A continuous watch over ocean areas for submerged submarine activity, accomplished by fixed or mobile systems.

**Open ocean ASW** — Antisubmarine warfare conducted in the broad expanses of major oceans and sea areas, as opposed to coastal areas, restricted seas, and gap areas.

**SOSUS** — Sound surveillance system, a US fixed acoustic ocean surveillance system operating at low acoustic frequencies.

**SSBN** — US Navy designation for nuclear-powered ballistic missile submarine.

**Trailing** — The tactic of following a submerged submarine with another submarine for the purpose of gathering intelligence, maintaining surveillance, or eventual destruction. Trailing may be covert or overt.

**Transducer** — A device which transforms electric energy into acoustic energy, or the reverse. Used as the sending and receiving elements in sonars.

**Variable-depth sonar (VDS)** — A sonar which can be lowered by cable from a surface ship to varying depths of several hundred feet to reach more favorable acoustic conditions.

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[REDACTED]Summary

Soviet capabilities for antisubmarine warfare fall far short of the minimum requirements for protection of the surface navy and represent an almost negligible threat to the US ballistic missile submarine fleet. The low level of effectiveness results primarily from the lack of an open-ocean surveillance system and from inadequate sensors. Soviet ASW weapons appear adequate, but delivery platforms are too few in number and are not optimized for the ASW mission. Although research and development on ASW systems are being pursued, prospects for improvement are confined principally to defense against submarines in Soviet coastal waters.

Soviet statements suggest that strategic offensive ASW--directed against ballistic missile submarines--is a major concern of the Soviet Navy. Analysis of Soviet naval operations presents a contrary view. Almost all observed ASW activity supports fleet defense and coastal ASW missions. The dominant theme in naval exercises is the defense of the ocean approaches to the USSR, especially against Western carrier strike forces.

The Soviets have two avenues of approach to strategic offensive ASW, either through open-ocean surveillance or through submarine trailing. Analysis of Soviet ASW operations, [REDACTED]

[REDACTED] and assessment of Soviet ASW-related technology indicate that the Soviet Navy does not now have an effective capability for broad ocean surveillance to detect submarines.

[REDACTED]

The Soviets have conducted several coordinated submarine transits involving Y class ballistic missile submarines and attack submarines through the Norwegian Sea. These operations suggest that the Soviets are primarily concerned with the protection of their own SSBN force. Observation of these and

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other Soviet operations and the units involved suggests that the Soviets have not developed the tactics and the submarines to trail effectively the quieter US units.

The command and control system of the Soviet Navy probably is adequate to direct surface and air forces in large-scale, coordinated ASW exercises. Command and control is, however, a potential constraint on Soviet submarine operations against other submarines. At present, the Soviets cannot maintain the continuous direct two-way communications between headquarters and trailing submarines that would be necessary for near-simultaneous destruction of an enemy ballistic missile submarine force.

Analysis of Soviet production of naval aircraft, surface ships, and submarines from the late Fifties onward indicates that no large-scale specialized ASW construction program was undertaken during that period. Although the Soviets have produced about 100 surface warships since 1958, these ships are multiple-purpose units whose ASW weapons and sensors are designed for self defense. They have also produced attack submarines--considered by the Soviets to be appropriate for ASW--at a low but steady rate. In the late Sixties the Soviets began series production of a new generation of ASW aircraft, primarily for use in coastal defense, but also including some longer range aircraft for a tactical capability against hostile submarines in the sea approaches to the USSR.

Despite a continuing effort to build ships capable of defending themselves from enemy submarines, the Soviets still are unable to protect their forces from submarine attack. The prognosis is not optimistic. Their surface forces for the near term are likely to remain vulnerable to submarines.

The Soviets have recently begun to pay increased attention to ASW operations in the sea approaches to the USSR. Without a broad area ASW surveillance system, they have little hope of success except with operations incorporating concentrated submarine

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barriers augmented by air and surface ASW forces. Even in these operations, the technical deficiencies of Soviet sensor systems are likely to prevent the Soviets from developing effective ASW defenses in their sea approaches in the near future.

Except in the waters within a few miles of naval base entrances, Soviet ASW forces have little capability to protect the coastal areas from submarine intrusions. Lack of effective detection systems and the apparent low state of crew training owing to the unchallenging nature of Soviet ASW training are largely responsible for this inefficiency.

The inadequacies of the ASW sensors--especially sonars--are a major factor limiting Soviet ASW capabilities. About 90 percent of the major ASW surface ships have sonars which provide little detection capability, even under favorable conditions. Fewer than 20 Soviet ships are equipped with the latest model sonars with range potentials similar to those of currently operational Western sonars. Even for these, however, the Soviets apparently lack the signal processing techniques used by the West and thus cannot fully exploit the potential of the sonars.

Similarly, despite steady efforts to improve them, the latest passive sonars on Soviet submarines have detection ranges of only about one-half those of modern US nuclear submarines. The difference is due in part to the greater noise generated by Soviet submarines, but probably also to technical deficiencies in the sonars themselves.

[REDACTED]

The Soviets are known to have nuclear warheads for torpedoes, but it is uncertain whether these are ASW torpedoes and, if so, how they would be delivered. They probably are developing improved acoustic homing torpedoes and may be developing a missile capable of delivering a torpedo to a range of 30 nautical miles.

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Major ASW concerns of the present are likely to influence the shape of Soviet efforts in the next several years. Requirements for coastal defense and for defending naval forces in distant deployments against Western submarines will motivate Soviet production of ASW equipment and the development of ASW forces. The Soviet coastal defense posture may be moderately improved with the development of shallow-water, medium-range detection systems and improved surface ships and submarines.

The quest for a counter to the Polaris threat will involve research and development on sensors and the development of trailing capabilities. Without a major advance in ocean surveillance technology or substantial improvement in trailing capabilities, however, Soviet anti-Polaris capabilities probably will not be substantially improved over the next five years.

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The Submarine Threat  
Confronting the Soviets

Western Ballistic Missile Submarines

The Polaris and Poseidon forces of the United States and the United Kingdom\* present a combined threat of 45 ballistic missile submarines. [REDACTED]

[REDACTED] More than 20 of these submarines are on station at any time in the Pacific, the North Atlantic, the Mediterranean, and the Norwegian Sea.

By 1976 a total of 31 of the US ballistic missile submarines will be converted to launch the Poseidon C-3 missile. The Poseidon missile delivers from 6 to 14 independently targeted warheads. Poseidon warheads further complicate the threat because of their small size and greater reentry speeds, rendering interception by ABM more difficult. The remaining [REDACTED] US and [REDACTED] UK submarines will carry the A-3 Polaris missile. The greater range of the A-3 and C-3 missiles has expanded the previous operating area for the US SSBNs by a factor of more than four.

Soviet Perception of the Ballistic  
Missile Submarine Threat

Soviet military writers began to consider the Western ballistic missile submarine threat early in its development. The Soviets may have had more confidence about dealing with the Polaris threat in 1960 than they have today. The Polaris A-1 missile of that time had a range of about 1,200 nm and car-

\* *The French are building an independent force of [REDACTED] ballistic missile submarines.*

[REDACTED] *the entire force is expected to be completed by 1978.*

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ried one warhead which slowed to subsonic speeds after reentering the atmosphere. In their long-range planning the Soviets may have envisioned that a large ASW program, supplemented by widely deployed ABM defenses, would effectively limit damage from a Polaris strike.

The Soviets probably underestimated the complexity of combating the Polaris system. Early attempts to develop a means for locating and destroying Polaris submarines were probably important lessons to the Soviets in the realities of offensive ASW. The advent of the longer range A-3 Polaris and the announcement of the Poseidon program complicated the problem even more.

To support a Soviet "bolt-from-the-blue" first strike or to weaken the US ability to strike the USSR, Soviet forces would have to conduct successful preemptive ASW attacks against large numbers of on-station submarines shortly after receipt of the order.

US analyses of such hypothetical warhead exchanges, however, show that there is no rational incentive for the Soviet Union to strike US strategic attack forces unless the Soviets possess a capability to destroy nearly all of the Polaris fleet simultaneously. [REDACTED]

[REDACTED]

The Soviets apparently decided, in view of the risks inherent in such a strategy, that their response to the US Polaris fleet should not be a defensive reaction with anti-Polaris forces, but rather a ballistic missile submarine force of their own.

#### Western Attack Submarines

The development of the attack submarine into a fast, concealed warship of high endurance and independence has had a profound influence on the world's major navies. ASW weapons and sensors are now ap-

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parent on the decks of modern major warships. These ASW armaments rank in importance with antiair and antisurface ship systems. A warship, however potent its offensive capabilities may be, is of dubious value if it cannot detect and at least evade the attack submarine. The old tactic of holding a hostile submarine down until its deteriorating battery and atmosphere forced it to face destruction on the surface has become obsolete. The nuclear submarine is free to run, possibly faster than its pursuer, and reattack from a new direction.

The US fleet has 54 nuclear attack submarines and it plans to increase that figure to about 90 by the end of the Seventies. The British Navy has [REDACTED] nuclear attack units. The US now has 40 and the UK [REDACTED] diesel-electric submarines, but most of the US submarines probably will be phased out by the end of the decade. About 65 diesel-electric submarines of other NATO countries operate within range of the coastal areas of the European USSR.

#### Soviet Perception of the Attack Submarine Threat

In recent years the Soviet Navy has increasingly exposed its forces for political and military effect in distant areas such as the Caribbean, the Mediterranean, and the Indian Ocean. The credibility of these forces as instruments of Soviet foreign policy and their viability in hostile circumstances are dependent on their defensive capabilities. The Soviets probably consider cruise missile armaments on most of their surface forces to be adequate against the surface threat. But experience has probably taught them to be less than complacent about their abilities to deal with attack submarines. They have taken measures to bolster their defenses in particularly vulnerable areas, such as the Mediterranean, through the use of surface, air, and submarine barrier forces.

The Soviets are concerned that their relatively concentrated centers of naval and maritime activity

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along the Soviet littoral would be particularly inviting to Western submarines in war. These areas are also sensitive in peacetime as Soviet forces conduct exercises and advanced systems testing.

The Soviets regard the nuclear attack submarine as the greatest threat to their own fleet of ballistic missile submarines. They have written that they would expect to confront Western submarine barriers in areas on the routes to the open seas. The Soviets have read and discussed US proposals for trailing and escorting ballistic missile submarines. These concerns may have led them to escort some of their Y class missile submarines with their attack submarines.

#### Soviet Capabilities for Submarine Detection, Localization, and Destruction

The Soviets have recognized that they must develop systems and tactics to solve each of the three elemental tasks in ASW: detection, localization, and destruction of the target submarine.

#### Submarine Detection Capabilities

Detection has become more complex with the advent of ballistic missile submarines. The chief problem is the vast ocean area which must be searched. The more traditional problems of coastal ASW and fleet defense required the search of restricted areas along coastlines or those areas immediately surrounding deployed forces. Mobile detection systems aboard modern surface ships, submarines, and aircraft de-

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veloped for these limited area searches and for localization of targets are not adequate to the task of searching open ocean areas.

A surveillance system capable of conducting open ocean searches is a necessity for combating the ballistic missile submarine in any strategy which does not rely on trailing tactics.\* It is also a significant aid in other forms of ASW. For example, an ocean surveillance system can warn deployed forces or coastal defense units of the approach of hostile submarines.

Ocean surveillance systems could conceivably be attached to the seabed, located in satellites, positioned ashore, or carried by conventional naval forces. Such phenomena as acoustics, magnetics, wake turbulence, communications interception, infrared, and nuclear activation could possibly become the basis for an ocean-wide detection system.

\* *The subject of trailing, as an alternative to ocean surveillance, is treated on pages 49-50.*

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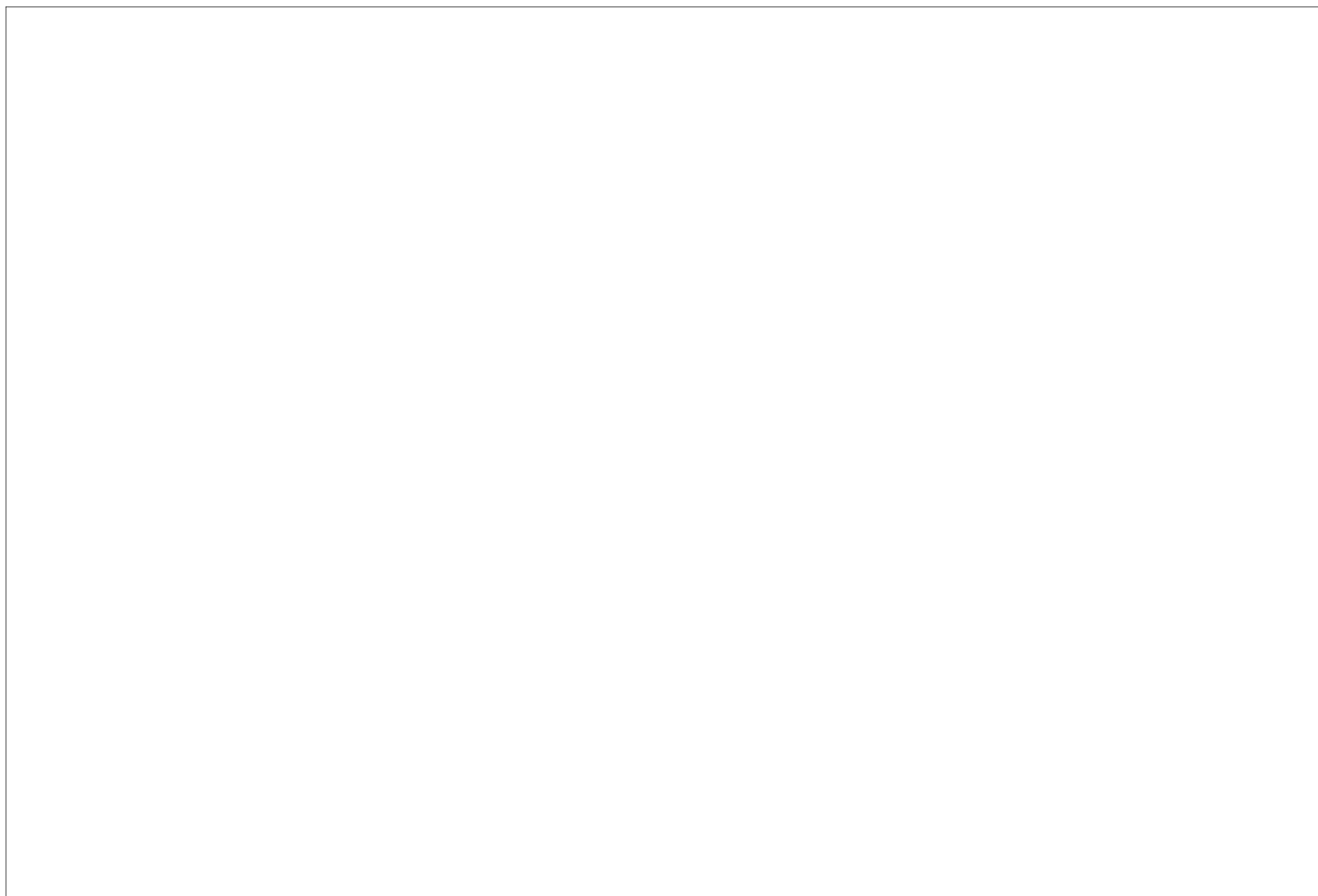
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### Detection Systems for Ocean Surveillance

There is no evidence that the Soviets have produced mobile or fixed detection devices useful for long-range detection of submerged submarines. Present Soviet sensors aboard ships and aircraft have short range and are designed for localization or small-area search.

Soviet fixed acoustic detection devices are passive systems of short range.

The Soviets have not attempted a large-scale acoustic undersea surveillance system such as the US SOSUS system.

*(Annex A of this report discusses the potential of various acoustic and nonacoustic phenomena as possible approaches to ocean surveillance.)*

### Capabilities for Localization

Soviet production programs, tactics, and training have concentrated chiefly on the localization phase of ASW.

Once a submarine has been detected by an ASW force, its position and movements must be determined with sufficient accuracy to launch a weapon. One of the greatest obstacles to the development of effective ASW sensors is the effect of environmental conditions which limit the performance of the sensor in locating a submarine. Sonar, the most widely used ASW sensor, is affected by water temperature and salinity, the depth of the target, the topography of the ocean floor, and other factors. The uncertainties involved in depending on a single type of sensor have led both the US and USSR to develop other shorter range ASW sensors, such as

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magnetic detection systems, that are not as susceptible to these particular environmental conditions.

Sonar can detect the presence of a submarine either passively by detecting the sound generated by the submarine, or actively by transmitting a sound pulse and detecting its echo. Surface ships ordinarily utilize active sonar, but submarines can employ either mode effectively. Sonar performance depends on its ability to discriminate the submarine noise or returning echo from the sonar's electrical noise, the platform's noise, and the ambient noise of the sea. In the active mode, a sonar's capabilities are also degraded by sound energy reflecting from the ocean surface and the bottom, and by the scattering and absorption of sound energy in the ocean.

The adverse effects of some natural phenomena can be reduced by using sonar which operates at lower frequencies [REDACTED]. A lower frequency signal results in less absorption of sound in the ocean. A larger acoustic array is required, however, to obtain directional accuracy at low frequencies.

Magnetic anomaly detection (MAD) devices, the second most widely used ASW sensors, measure the disturbance in the earth's magnetic field generated by a submarine. MAD sensors are usually installed only aboard aircraft because surface ships and submarines create disturbances in the earth's magnetic field which would interfere with MAD system operation.

Radar, optical, infrared, and radio direction-finding equipment are used by ships and aircraft to detect submarines at or near the surface. These systems are of limited utility in localization because of the capability of the submarine to deny their use. For example, current radar and optical systems are ineffective against submarines operating at great depths. (See Annex A for additional details.)

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## Soviet Surface Ship Sonars

Gener- ation	Type	IOC	Frequency	Deployment	Remarks
First	hull mounted	about 1950	24-30 kHz	About 40 percent of major surface forces	High-frequency region limits detection range be- cause of propagation losses. Single operating frequency vulnerable to counter- measures. Small power input requires directional transducer, which limits search rate.
Second	hull mounted	early to mid 1960s	15-23 kHz	About 50 percent of major surface forces.	Separate sonars for search and attack.
Third	hull mounted	late 1960s	8 kHz	Kresta II, Kanin, Grisha, possibly Krivak*	Apparent simple signal structure limits perform- ance, particularly in shallow water.
	variable depth	late 1960s	8.5 kHz	Krivak, Moskva, some Petyas	Helps overcome gaps in coverage resulting from the thermal layer.
Fourth	hull mounted	late 1960s	3 kHz	Moskva	May operate at large depression angles for bottom bounce and conver- gence zone detection. Has automatic system for vec- toring helicopters. Probably high source level.
	hull mounted	late 1960s	4.5 kHz	Moskva	May have additional mode, probably has track mode. High source level.

\* Krivak may have a new 4-kHz hull-mounted sonar.



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### Surface Ship Sonars

Soviet surface ship sonar development has gone through four recognizable stages since World War II. Many of the sonars presently deployed on Soviet major surface ships are limited-capability systems of the first and second generations. (*Characteristics and capabilities of each generation are summarized in the table at left.*)

First-generation sonars, the Tamir and Pegas, were installed on the majority of Soviet surface ships constructed during the Fifties and are still on about 40 percent of the operational Soviet major surface ships.

The high frequencies (24 to 30 kHz) and the low power input limit the active detection range of those early sonars to about 4,000 yards. They have little detection capability even under favorable conditions. The availability of only pre-selected discrete operating frequencies renders these models susceptible to countermeasures.

The Soviets introduced second-generation sonars in the early and mid-Sixties which are still in operation on about half of the major surface ships. Separate sonars for search and attack were installed on the ships, enabling the Soviets to make better use of the other technical improvements. The capability of the sonar was increased through the use of lower frequencies (15 to 23 kHz) and a higher power source--extending the range to about 5,000 yards under ideal conditions. An improved automated fire-control system enabled the Soviets to make better use of sonar information in directing ASW attacks.

Two third-generation sonars became operational in the late Sixties. They are the 8-kHz hull-mounted sonar on the Kanin and Kresta II and possibly Krivak destroyers, and the 8.5-kHz variable-depth sonar (VDS) installed on some Petya escort ships, the Moskva helicopter carrier, and the Krivak destroyer.\* The

\* *Characteristics of ships, submarines, and aircraft discussed in this report are summarized in Annex B.*

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## Soviet Submarine Sonars

Gener- ation	IOC	Frequency	Deployment (submarine classes)	Remarks
First	about 1950	24-30 kHz active 12.5-13.5 kHz passive 250 Hz-2 kHz passive	W, Q, Z	Uses continuous wave impulses and operates at low power levels.
Second	about 1956	15 kHz active	J, E, N, F	Operates with both scanning and search modes. Some capability to determine depth of the target. Uses continuous wave pulses.
	about 1956	500 Hz-60 kHz passive	H, E, N, F	Detection ranges less than half that of US sonars.
Third	about 1967	3 kHz active	C, V, Y, P	Does not have advanced signal format. May be able to operate on two different frequencies. May have directional and omni- directional transmission modes.
	about 1967	unknown (conformal passive array)	C, V, Y, P	Array of hydrophones conforms to hull of submarine which improves directivity and sensitivity. Operational capabilities of sonars on these classes only about half that of US subma- rine sonars.

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VDS enabled the Soviets to fill gaps in sonar coverage resulting from layers of water at varying temperatures. Fewer than 20 ships are known to have been equipped with any of these sonars to date. Maximum range from these systems is about 10,000 yards under ideal conditions.

The fourth, and latest, generation of Soviet sonars is installed on the Moskva helicopter carrier and possibly the Krivak destroyer. [REDACTED]

[REDACTED] achieve substantial improvements in detection ranges. Direct-path ranges of about 15,000 yards and convergence-zone ranges of up to 80,000 yards are possible with these sonars under ideal conditions.

[REDACTED]

#### Submarine Sonars

Soviet submarine sonars have undergone three identifiable stages of development. Despite steady improvement, however, Soviet capabilities remain inferior to those of the US. (See table of characteristics at left.)

The first postwar Soviet sonars, installed in some W, Q, and Z class submarines, were relatively ineffective as their power levels were low and their frequencies high [REDACTED]. Although some of these submarines are still operational, with the exception of the Z class they seldom deploy to the open ocean.

Soviet submarines of the J, H, E, N, and F classes were outfitted with the second generation of sonars, featuring lower frequencies and greater power. Available evidence suggests that second-generation sonars achieve passive detection ranges less than half those of modern US units.

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Soviet submarines which have become operational since 1966--the C, V, Y, and possibly the P--are equipped with powerful active sonars of the third generation.

Although a number of improvements have been incorporated into this generation of sonars, experience of US forces indicates that Soviet passive detection ranges are now perhaps half those of modern US nuclear submarines. Some of this difference probably results from the noise generated by Soviet submarines.

#### Airborne ASW Sensors

Airborne ASW sensors are capable of localizing submarine contacts when provided with initial position information. They are also employed, like submarine and surface ship sensors, for small area searches and barrier operations.

Soviet ASW aircraft are equipped with surface search radars, expendable sonobuoys, magnetic anomaly detection (MAD) gear and, in the case of the Hormone helicopters, dipping sonars for submarine search. In addition, an infrared search device may be nearing operational use.

#### Sonobuoys

The Soviets have been producing passive sonobuoys since at least 1956. Improved electronics and acoustic system reliability, observed in captured models, have not substantially increased sonobuoy detection capabilities.

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## Soviet Air-Dropped Sonobuoys

<u>Designation</u>	<u>IOC</u>		<u>Number of radio channels</u>	<u>Remarks</u>
RGAB-56 *	1956		18	No longer used
RGAB-56* (Transis- torized)	1961		18	3,000-yard de- tection range against a noisy target
RGAB-64* RGMB	1964		18	Smaller and lighter than RGAB-56 but with about the same capability
BM-1**	1971		at least 24	Much improved electronics but acoustic subsystem only slightly im- proved

\* US designation.

\*\* There is [ ] evidence of other versions of this sonobuoy, including a possible directional buoy.

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~~TOP SECRET~~Radars

Soviet airborne surface-search radars are capable of detecting surfaced submarines at ranges of up to about 100 nm and exposed masts and periscopes of submerged submarines up to about 25 nm. None of the Soviet radars is capable of reliably detecting wake effects from submerged submarines. Aircraft carrying the latest Soviet airborne radar, the Weteye, apparently make some limited area searches. The Weteye radar also selectively determines the new BM-1 sonobuoy's position.

<u>Code name</u>	<u>Aircraft</u>	<u>Maximum range (nm) for surfaced sub- marine/exposed masts*</u>
Mushroom	Hound	50/10
Short Horn	Hormone	70/15
Weteye	May ASW Bear	100+ /25

\* Based on a radar cross section of 250 square meters for a surfaced submarine and 10 square meters for exposed masts under ideal conditions.

Dipping Sonar

A dipping sonar carried by the KA-25 Hormone helicopter operates in active or passive modes. In the active mode it can make detections at ranges of 6,000 yards or more and in the passive mode, up to 2,500 yards. Range and bearing accuracies of the dipping sonar [redacted] within 100 yards of range and one degree of bearing--are superior to many other Soviet sonars, which are accurate to within 200 yards and 2½ degrees.

During the early deployments of the Moskva class helicopter carriers, operations suggested

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that the Soviets were attempting to conduct bistatic sonar sweeps using the Moskva hull-mounted sonar as the transmitter and the Hormone dipping sonar as receiver. The Hormone dipping sonar probably was designed to operate in this fashion. Bistatic operations have not been observed during the past two years. Difficulties encountered with the Moskva sonar or with data transmission probably are responsible for the stand-down, rather than shortcomings of the dipping sonar.

If the Soviets were to develop an effective bistatic sonar operation, the Hormone dipping sonar could operate in the first convergence zone, about 30 miles from the ship. At present, Hormone helicopters based on the Moskva class helicopter carrier conduct sonar operations both independently and in coordinated groups of four or more.

#### Magnetic Anomaly Detection

Soviet ASW aircraft, except TU-142s, use magnetic anomaly detection equipment for target localization and for limited area search. Since introducing this equipment in about 1960, the Soviets have deployed several MAD systems.

The latest Soviet ASW aircraft, the Hormone helicopters and the IL-38 May patrol aircraft, are probably equipped with a new MAD system. The May aircraft operate their system at about twice the altitude of earlier patrol aircraft, and tenuous evidence from helicopter operations indicates that the new MAD system has a detection radius about half again that of the earlier systems. The improved radius is estimated to be between 1,500 and 1,800 feet--large enough to justify small area searches by MAD-equipped aircraft.

Similar area searches at these higher operating altitudes have also been noted during recent Mail aircraft MAD operations, suggesting that some of these older aircraft may have been refitted with the new equipment.

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#### Other Airborne Sensors

There is some circumstantial evidence that some Soviet aircraft may be equipped with an experimental detection device, possibly an infrared wake sensor. These aircraft have conducted searches at altitudes beyond the ranges of the most recent MAD systems. [REDACTED]

[REDACTED] At the present time, however, Soviet technology has probably not advanced sufficiently to support more than the development of a basic infrared localization device. (*See discussion at Annex A.*)

#### Capabilities for Destruction

ASW weapons in use in the Soviet Navy consist of acoustic homing torpedoes, standard depth charges, and small rocket-propelled charges (the MBU) fired in salvos from surface ships. [REDACTED]

their capabilities against evasive Western tactics and countermeasures are not known. In addition to these ASW weapons, the Soviets have mines which are believed to have ASW applications. (*Characteristics of Soviet naval weapons with ASW potential are tabulated on the next three pages.*)

The Soviets are continuing to develop improved ASW weapons. A missile was observed in 1969 on the Moskva's forward dual-arm launcher during a weapons readiness test. This missile has been estimated to have an antisubmarine role, and has been designated the SUW-N-1. [REDACTED]

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## Soviet ASW Torpedoes\*

<u>Designator</u>	<u>Diameter (inches)</u>	<u>Length (feet)</u>	<u>Range (yards)</u>	<u>Speed (knots)</u>	<u>Max depth (feet)</u>	<u>Homing system</u>	<u>Warhead weight (lbs)</u>
E-40-65A	16	15	8,000	27	1,000	acoustic passive/ active, 83 kHz	220
E-40-68A	(air-dropped version of E-40-65A, with similar operational parameters)						
E-45-70A	18	13	10,000	30	1,500	acoustic passive/ active	150
ET-80-A (60)**	21	26	8,000	23	660	acoustic passive/ active, 25 kHz	200

\* Soviet writings suggest that some torpedoes may have nuclear warheads. It is not known whether they are ASW torpedoes, or for what delivery platform they are designed.

\*\* Improved versions of this weapon are estimated to exist, with silver-zinc batteries to extend range and with an improved acoustic homing capability.

Soviet Rocket-Propelled Charges

<u>Designator</u>	<u>Max range (yards)</u>	<u>Weapons per launcher</u>	<u>Warhead weight (lbs)</u>	<u>Reload</u>
MBU-2500	3,000	16	80	manual
MBU-2500A	6,500	12	60	automatic
MBU-4500	5,000	6	120	manual
MBU-4500A	5,000	6	120	automatic

Soviet Depth Charges

<u>Designator</u>	<u>Length (inches)</u>	<u>Diameter (inches)</u>	<u>Explosive charge (lbs)</u>	<u>Depth settings (feet)</u>
4VM	25	8	35	40,80
M-1	17	10	55	40,70, 120,160
4VB	29	18	250	50-700
B-1	29	17	300	65-700

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Soviet Naval Mines With ASW Potential

<u>Type</u>	<u>Maximum depth (ft)</u>	<u>Explosive charge (lbs)</u>	<u>Exploder type</u>	<u>Deploying platforms</u>
Bottom-laid				
MKD	180	1,725	magnetic	surface ships and submarines
AMD 500	80	660	magnetic	surface ships and aircraft
AMD 1000	180	1,545	magnetic	surface ships, submarines, and aircraft
AMD-II	(similar to AMD 1000 but with additional acoustic sensor)			
Moored				
MAG	260	500	contact	surface ships
PLT	450	500	contact	submarines
PLT 3	420	220	contact	submarines

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~~TOP SECRET~~**Soviet Major Surface Ship Procurement and Conversions, 1962-1971**

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
<b>Helicopter Carrier</b>										
Moskva							1		1	
<b>Cruise Missile Destroyer</b>										
Krivak										1
Kresta II								1	1	
Kresta I						1	2	1		
Kynda	1	1		2						
	3									
Krupnyy										
<b>Destroyer</b>										
Kanin*							1		1	1
				3	3	4		2		
Kashin		1	1				1		1	1
SAM Kotlin*	1					1	1	2	2	
<b>Escort</b>										
	10	9					8			
						5		4	3	3
Petya			2	1	2					
			4	5	6	5				
Mirka										
<b>Patrol</b>										
							2	2	1	5
Grisha										
	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
*Conversions										

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Production of ASW-Capable  
Ships and Aircraft

Analysis of Soviet naval aircraft, surface ships, and submarines produced since the late Fifties indicates that no specialized large-scale ASW construction program was undertaken during that period. There were, however, surges in the construction of submarines armed with ballistic missiles and cruise missiles which reflected Soviet emphasis on strategic strike and anticarrier capabilities.

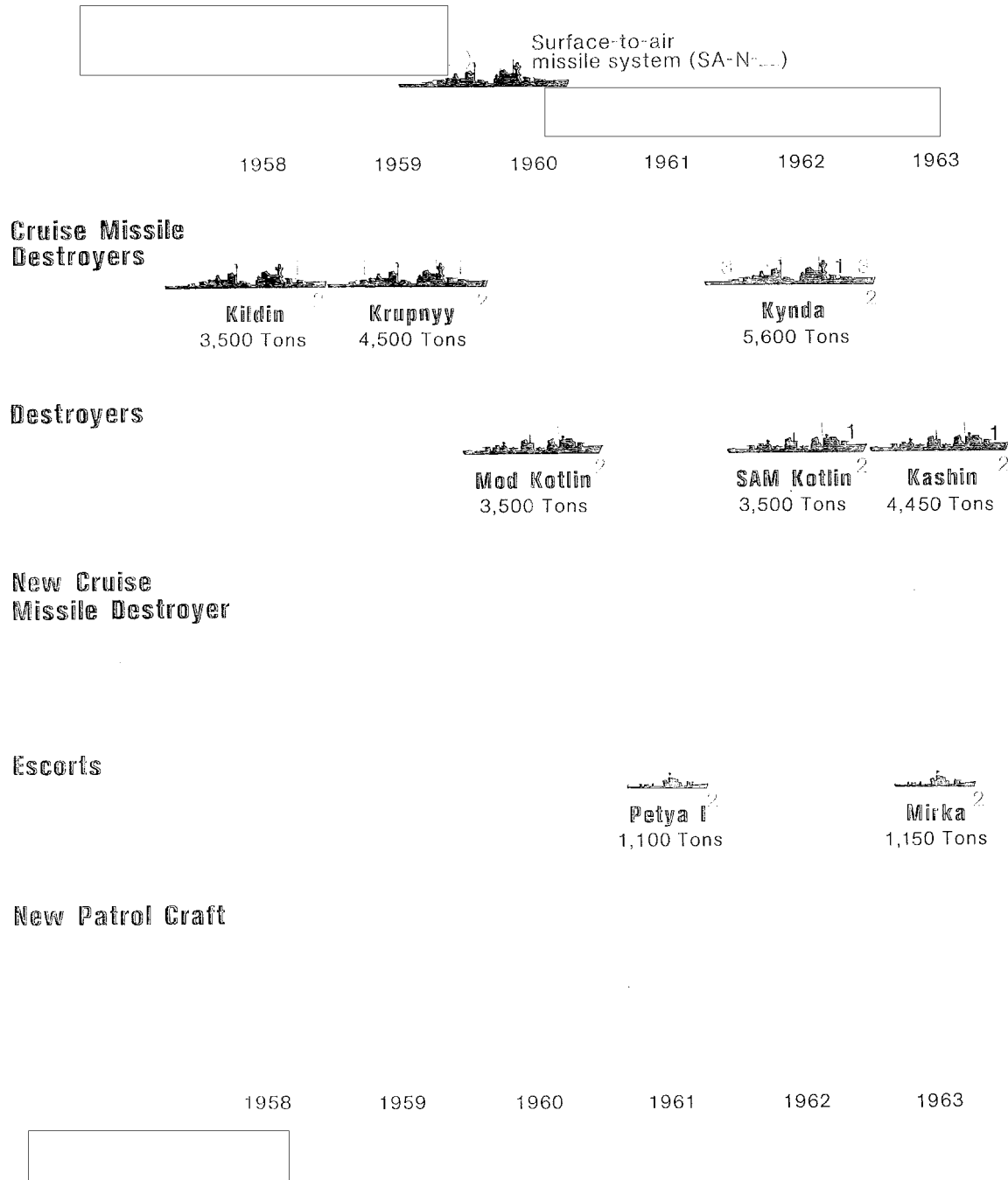
Major Surface Ships

Since 1958 the Soviets have produced about 100 multiple-purpose major surface ships. These ships were designed primarily to counter Western naval surface forces and also were armed with anti-air and anti-submarine defensive systems. The Soviets have been building three basic types of oceangoing surface warships: cruise missile armed destroyers, destroyers, and small coastal escorts. (See charts at left and next two pages.) In the mid-Sixties they built two special

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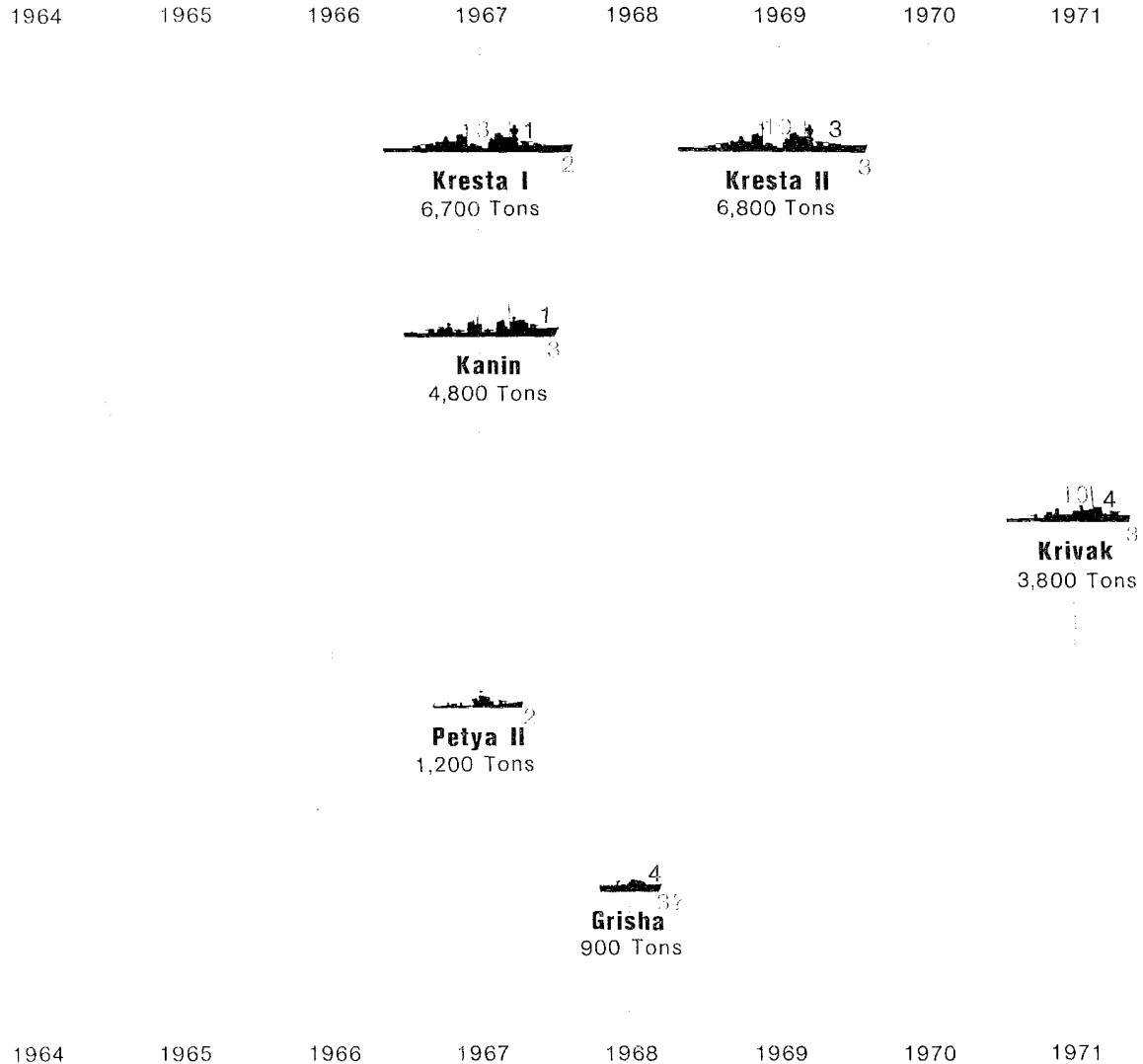
## Trends in Soviet Surface Ship Development, 1958-1971



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The Soviets undertook three major surface ship production and conversion programs from 1958 to 1971—cruise missile destroyers, destroyers, and escorts. Succeeding classes of ships within each program show improvement in weapon and sensor systems, but the multiple-mission capabilities of the cruise missile destroyers and destroyers have been maintained in preference to specializing these ships for a specific ASW mission. Production patterns appear to have shifted in the late Sixties with the curtailment of the destroyer and escort programs and the introduction of a smaller cruise missile destroyer, the Krivak, and a large patrol craft, the Grisha.

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helicopter carriers of the Moskva class intended for ASW but have since built no more of that type.

The Soviets continue to build multiple-purpose ships with improved ASW capabilities at a rate of about ten units per year. The current program consists of the Kresta II class cruise missile armed destroyer of about 6,800 tons displacement, a larger follow-on cruise missile destroyer, the Kara class of about 9,000 tons, and the Krivak class 3,800-ton cruise missile armed destroyer. In addition, they are producing the Grisha class 900-ton coastal sub-chaser at the rate of about four per year.

#### Submarines

The Soviets have been producing three types of nuclear submarines since the late Fifties: torpedo attack, cruise missile attack, and ballistic missile submarines. These types were built in two consecutive generations, the first ending about 1963 and the second still in progress.

During the first generation, the cruise missile attack submarine program was predominant in terms of units produced. (See chart at right.) Cruise missile submarines are designed primarily for attacking surface ships. During the production of the second generation, the Soviets have concentrated more on ballistic missile submarine construction. According to the Soviets, nuclear-powered torpedo attack submarines, such as the V class, are the appropriate submarines for ASW. Since 1963, these have been produced at about a constant rate of two per year. The Soviets clearly have not given a high priority to building a submarine force with a primary ASW mission.

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~~TOP SECRET~~**Soviet Submarine Construction, 1962-1971**

	Diesel					Nuclear				
	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
<b>Ballistic Missile</b>							5	6	8-9	6-7
Y Class						1				
<b>Cruise Missile Attack</b>									1	
P Class										
C Class						1	2	2	2	2
	4	6	6	6	5					
E Class						2				
J Class	2	3	2	2	2	2	3			
<b>Torpedo Attack</b>										
A Class	(The A class did not become operational until 1972)									
V Class						2	2	2	2	2
N Class	2	2	2	1	1					
B Class							1	2	1	
R Class	1									
	9									
					6					
		4	5	5						
F Class								1	3	2

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~~TOP SECRET~~ [REDACTED]ASW Aircraft

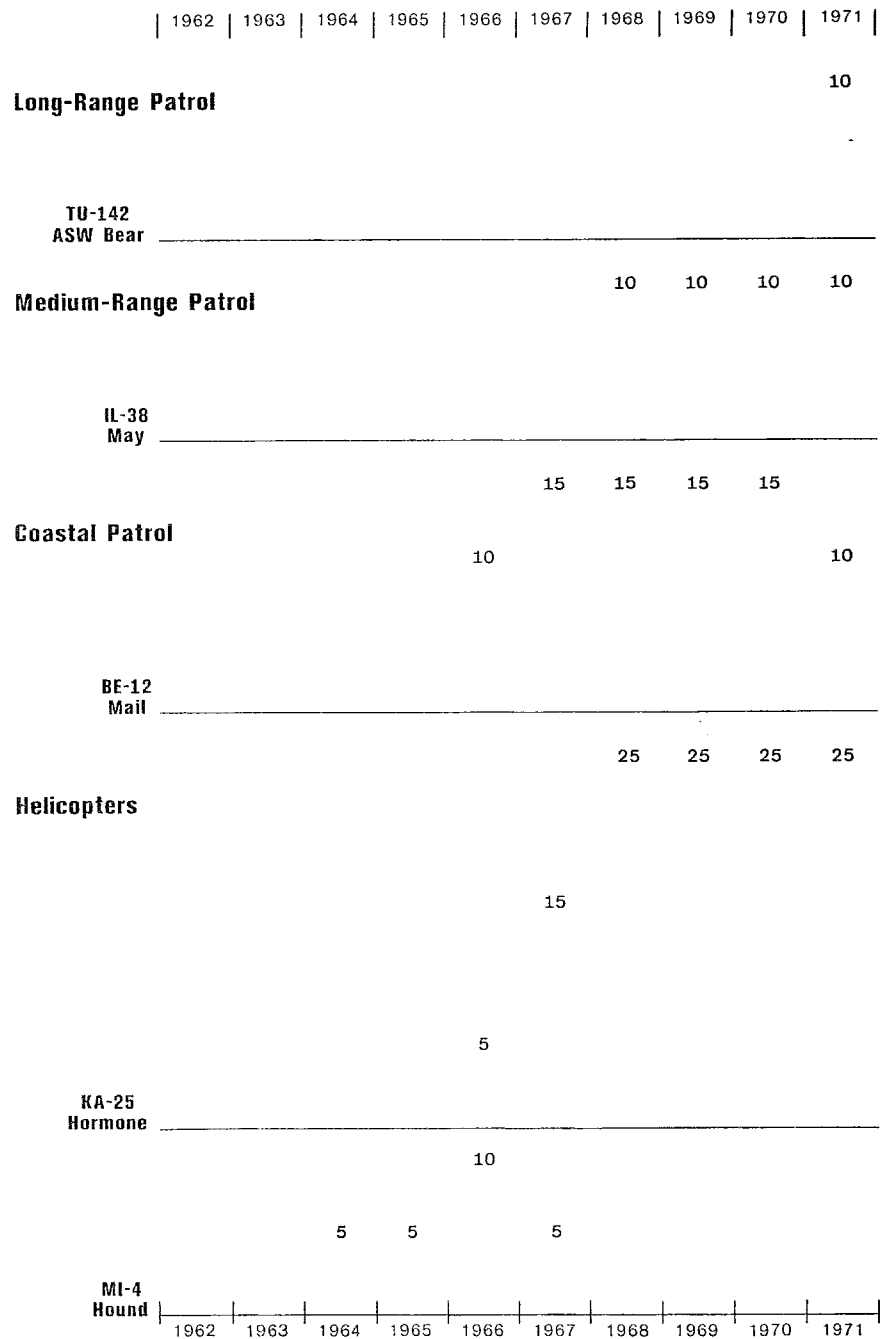
The Soviets began series production of their first all-weather coastal ASW patrol aircraft, the BE-12 Mail, in 1965. At about the same time they temporarily converted about 15 TU-16 Badger medium bombers for ASW operations as an interim measure. Prior to the deployment of these two aircraft, the only Soviet ASW patrol aircraft were flying boats, which were unable to operate during the several months of winter ice conditions.

In late 1967, the Soviets began series production of their first medium-range ASW patrol aircraft, the IL-38 May. (See chart at right.) In late 1969 or 1970 the Soviets also began making an ASW version of the TU-95 Bear heavy bomber, the TU-142. The IL-38 continues in production, but at a rate of only about ten aircraft per year. The status of the TU-142 program is uncertain--by mid-1972 fewer than 15 of these aircraft had been identified. Production may be continuing at the low rate of about five aircraft per year [REDACTED].

About 1967 the Soviets began producing the KA-25 Hormone ASW helicopter for use aboard the Moskva class ASW cruisers and a few other ships. The Soviets had employed land-based MI-4 Hound helicopters for coastal ASW missions since the mid-Fifties, but did not make any significant use of shipborne helicopters until the appearance of the Hormone. The ASW Hormone is produced at the modest rate of about 25 aircraft per year.

In sum, the Soviets in the late Sixties began series production of a new generation of ASW aircraft. Two types--the IL-38 and the TU-142--were marked departures from past patterns, but most simply replaced older aircraft for coastal ASW.

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~~TOP SECRET~~**Soviet ASW Aircraft Deployment, 1962-1971**

*These figures indicate the approximate number of aircraft added to operational units each year. The total number of aircraft produced exceeds the number deployed.*

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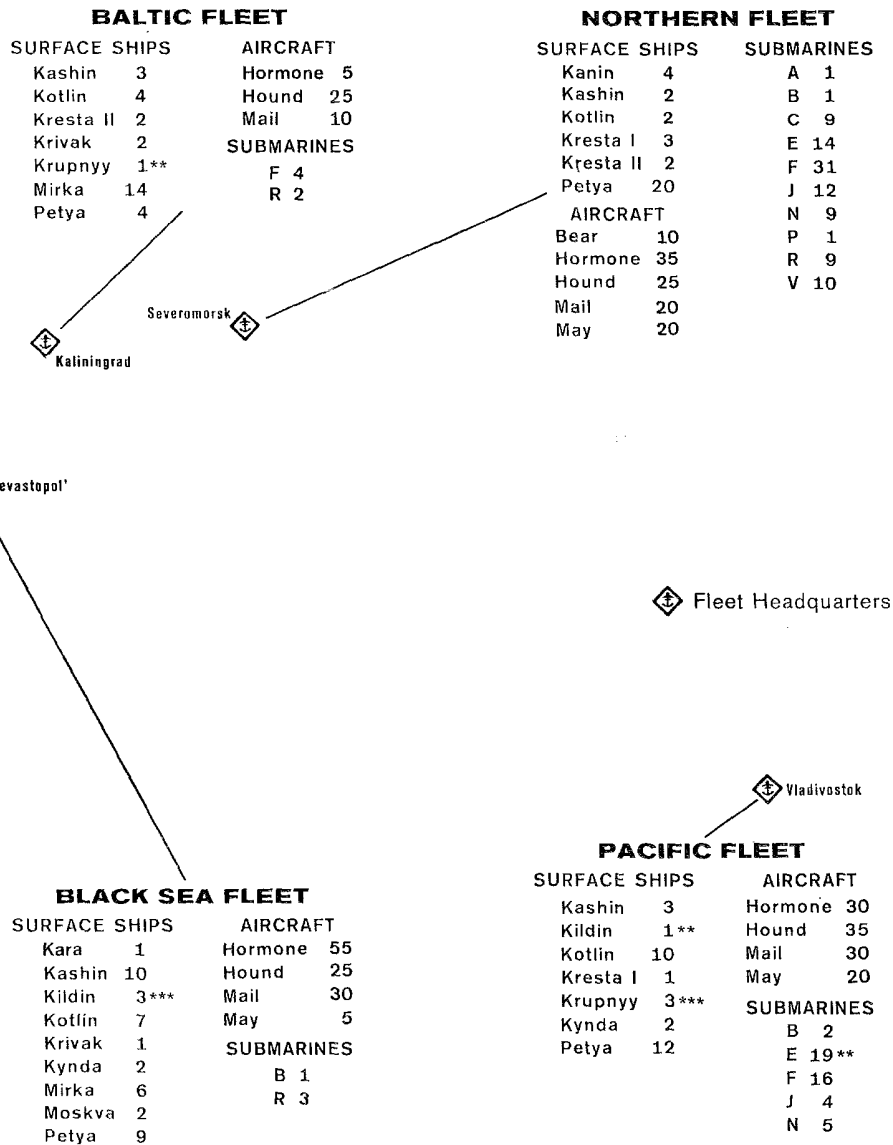
Organization and Control of  
Soviet ASW-Equipped Forces

Fleet Organization

There is no known formal organization for control of ASW forces in the Soviet Navy. Seagoing naval forces of all types are subordinate to one of the four fleets. (See map at right.) Within the fleets, ASW-equipped forces are subordinate to the fleets' major commands, as follows:

<u>Fleet command</u>	<u>ASW-equipped units</u>
Major surface forces	helicopter carriers large destroyers destroyers escorts
Offshore defense forces	escorts patrol ships
Submarine forces	all submarines
Fleet air forces	all ASW aircraft

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~~TOP SECRET~~**Distribution of Major Soviet ASW-Equipped Forces\***

\* Excluding units assigned to the Caspian Sea Flotilla

\*\* One unit undergoing conversion

\*\*\* Two units undergoing conversion

Data as of 1 July 1972

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Within these commands, the forces are further grouped into brigades and divisions by types. These organizations are charged with training and administration.

Task organizations are established temporarily for major fleet undertakings such as exercises, transits, and other operations involving numbers of ships and aircraft. These organizations may include ASW elements when appropriate.

#### Command and Control Implications for ASW

The Main Naval Staff in Moscow is ultimately responsible for all naval operations, including ASW. The four fleet commanders are directly responsible for ASW, anticarrier warfare, and all other operations in their areas of responsibility except SSBN operations. The fleets do not have deputy commanders specifically for operational control of ASW forces as do the US Atlantic and Pacific fleets. These command and control arrangements suggest that the Soviet Navy does not view the ASW mission as operationally distinct from other naval missions.

The Soviet naval command system is characterized by highly centralized operational control of ships and submarines at sea vested in the Main Naval Staff in Moscow. The chief impetus for centralization has apparently come from the need for positive control of nuclear weapons and naval forces in close proximity to Western naval forces on the high seas. The Main Naval Staff has the capability for direct control of Soviet ships and submarines in the Mediterranean and Norwegian Seas, and in the North Atlantic and Indian Oceans.

[redacted] the main Naval Staff relies on Pacific Fleet headquarters in Vladivostok for operational control of naval forces in the Pacific.

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The general command and control system of the Soviet Navy probably is adequate to direct Soviet surface and air forces in large-scale coordinated ASW operations. Limited communications capabilities, however, may be a constraint on Soviet submarines operating submerged against other submarines.

#### Submarine Communications

The Soviets have developed both short- and long-range communications systems for submarines, which are generally adequate for other than anti-SSBN operations.

Theoretically, a surface ship or another submarine could accompany a trailing submarine to act as a communications relay point and to assist in maintaining contact with a hostile submarine. Among other problems in this procedure, the submarine and surface ship would have to communicate through the thermal layer often present in the water, which tends to deflect the acoustic energy of communications systems.

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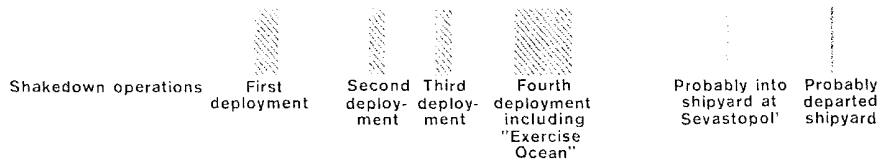
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For one-way communications from a submerged submarine to an aircraft, the Soviets have a communications buoy, designated the RBM-200

### Operations of the Moskva and Leningrad ASW Helicopter Carriers

1967 1968 1969 1970 1971 1972

#### Moskva



#### Leningrad



Located in the Black Sea area

Operations in the Mediterranean and North Atlantic

The Moskva spent 35% of its days in the Mediterranean and the North Atlantic at anchor, and the Leningrad 60%.

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## Soviet ASW Operations and Mission Capabilities

The following sections review ASW-related operations conducted by Soviet naval forces and assess the capabilities demonstrated for destroying Western ballistic missile nuclear submarines, protecting Soviet SSBNs from Western submarines, defending deployed surface forces, and guarding the ocean approaches and coastal areas of the USSR.

### Strategic Offensive ASW

Published Soviet statements suggest that strategic offensive ASW--operations directed against ballistic missile submarines--is a major concern of the Soviet Navy. These writings over the last ten years have emphasized strategic ASW priorities through discussion of the Polaris problem. They have placed little stress on the more traditional ASW tasks of fleet and coastal defense. Yet operationally the emphasis is reversed--almost all observed ASW activity supports fleet defense and coastal ASW missions. Although major fleet exercises have had a larger ASW component in recent years, only a few appear to be related to possible anti-SSBN operations.

Classified Soviet writings from 1959 through 1962 suggested an intent to develop defenses against the US Polaris force projected for the Sixties. The authors proposed using ABMs, surface ships, special ASW submarines, and ASW aircraft. The Soviets produced some of each type of system, but not in numbers sufficient to challenge the Polaris force.

### Possible Strategic Offensive Operations

The two Moskva class ASW helicopter carriers built in the Sixties probably represent early hopes for an offensive strategic ASW ship. There is no evidence to indicate, however, that either of the two Moskva class ships has located or tracked patrolling ballistic missile submarines. The Moskva class ships have normally operated in ASW defense of the Mediterranean squadron. (See chart at left.)

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The Moskva's performance as a strategic ASW system has probably been disappointing to the Soviets and may account for their decision to build only two ships of the type. As shown in the chart at left the Moskva class ships have operated at a relaxed pace. Activity since 1970 suggests that their mission has been expanded to include other operations, such as air defense and command ship roles, in addition to ASW tasks.

Both the IL-38 and the new TU-142 have conducted independent ASW operations in areas distant from the USSR. IL-38s have twice been observed operating in the Norwegian Sea in a possible anti-SSBN role during exercises, and they have operated in the sea approaches to the Pacific and Northern fleet areas and in the Mediterranean. Most activity of the IL-38s and TU-142s, however, has occurred within the fleet operating areas remote from potential Polaris patrol areas.

The majority of the IL-38 exercises observed in the first half of 1971 [REDACTED]

[REDACTED] involved only aircraft, indicating that these aircraft may work independently of other forces much of the time. From analysis of exercises, it appears that Northern and Pacific fleet ASW exercises are planned to respond to detections from ASW barrier forces in the fleet approach areas and the coastal areas.

The role of the four IL-38s stationed until recently in Egypt was less clear. Their mission in case of war was probably ASW support of the Mediterranean squadron. Routine independent IL-38 operations in the Mediterranean may have been tactical exercises with Soviet submarines or searches for NATO submarines in the eastern basin. The observed ASW operations of those aircraft reflected some limited capability to react to detections made by other means, such as radio direction finding.

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### Surveillance Capabilities

The Soviets have conducted two forms of surveillance against ballistic missile submarines. Soviet intelligence collection ships (AGIs) often monitor Polaris bases. In addition, Soviet attack submarine patrols in the Philippine and Norwegian seas and near the British Isles may be partly responsible for collecting information concerning Western ballistic missile submarines.

Intelligence collection ships observe Polaris deployment rates and collect tactical intelligence on ballistic missile submarines. They probably have determined the general schedule of Polaris operations, and communicate any changes to Moscow which might indicate differences in US strategic readiness.

Soviet submarines, among other tasks, reconnoiter the Polaris training areas and suspected patrol zones, possibly in anticipation of chance encounters. Given the capabilities of Soviet and US submarines, the best chance the Soviets have of accomplishing surveillance is in lying quietly in wait for a fast transiting Polaris submarine. [REDACTED]

As noted in an earlier section (page 20), no indications of an effective ocean surveillance system exist. Without an open-ocean detection system, trailing remains the only possible anti-Polaris tactic available to the Soviets.

### Trailing Capabilities

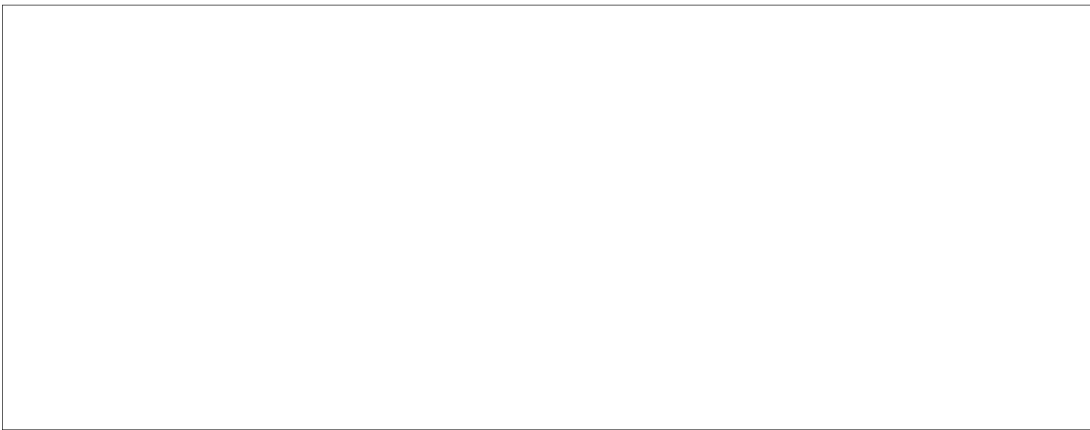
An alternative to an ocean surveillance network might be the use of attack submarines which gain contact on enemy submarines at a narrow strait or base area and then trail them. The Soviet naval leadership has been aware for several years from open sources that the US has considered this tactic as an ASW measure.

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Current Soviet submarines, however, do not have a capability for continuous trailing of US SSBNs. Although the speed and active sonar capabilities of the V class probably are adequate for overt trailing of a nonevading submarine, the requirements inherent in trailing escorted SSBNs or SSBNs employing technical or tactical countermeasures exceed the potential of the V class submarine. Even if the Soviets believed the V class submarine were adequate for trailing, they probably would calculate that a minimum of 100 submarines would be necessary to maintain a force sufficient for initial detection and trailing of the Polaris force. As of early 1972 the Soviets had only about 10 V class submarines. They are building new ones at a rate of only two per year. (See pages 38-39.)

Soviet plans to trail more than one Polaris submarine actively would have to account for the defensive reaction by the United States or the United Kingdom. Not only would assisting forces be sent to the aid of the trailed submarine, but those deploying subsequently would be given extensive delousing to remove potential trailing submarines. The Soviets might expect to trail one submarine for a short time to intimidate or embarrass the West, but active trailing against a number of Polaris submarines would probably be viewed as a risky and unworkable scheme.

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Strategic Defensive ASW

Coordinated Submarine Transits

The Soviets may be developing methods for protecting their Y class ballistic missile submarines from being trailed by Western nuclear submarines.

Since December of 1970, the Soviets have conducted [REDACTED] coordinated submarine transits of the Norwegian Sea. [REDACTED] involved Y class ballistic missile submarines proceeding to missile stations accompanied by C or V class submarines.

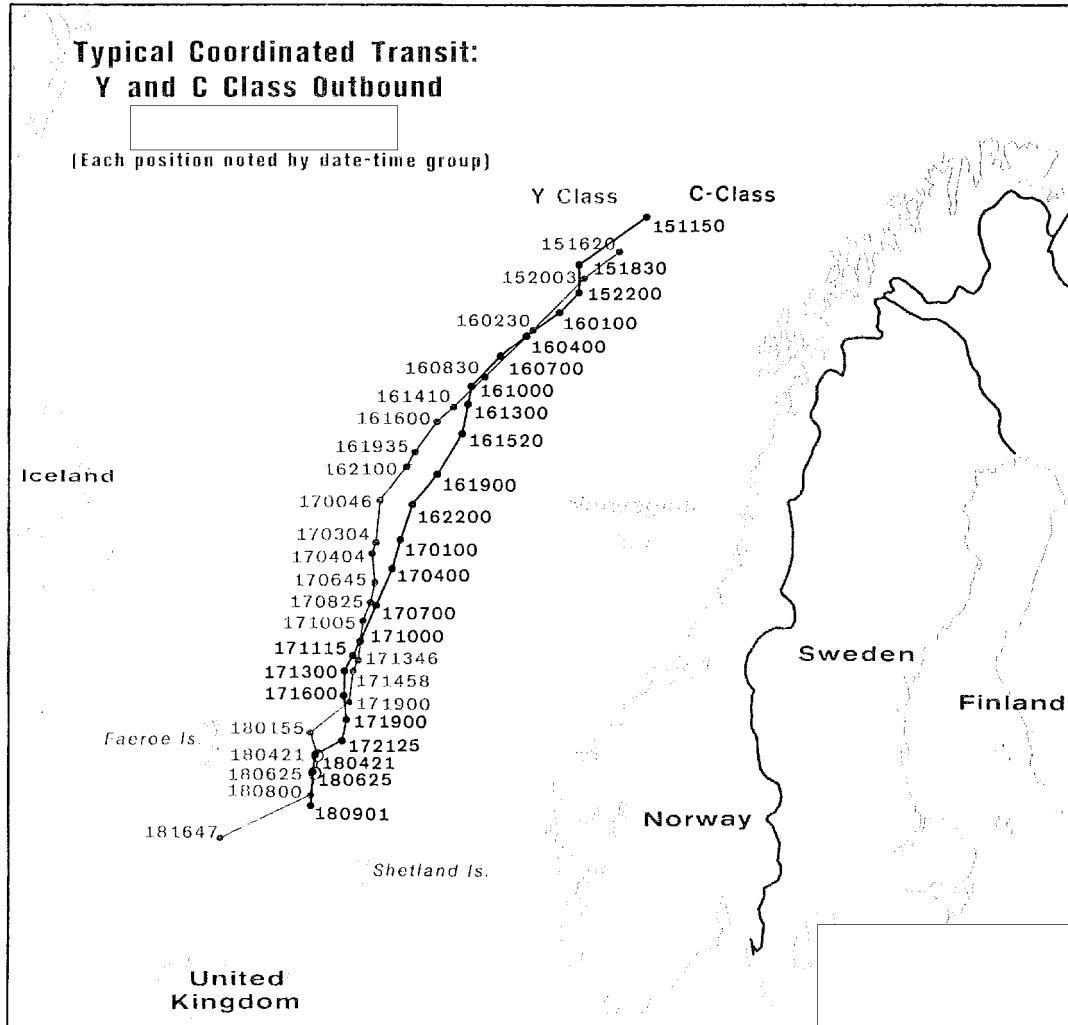
[REDACTED]

Historically, the Soviet Navy has been more inclined to operate submarines in consort with other forces, including other submarines, than Western navies. The merits of coordinated submarine operations were noted by Admiral Pantaleyev in 1961 in a classified Soviet publication. Two submarines operating together made the first Soviet submarine fleet transfer around Cape Horn. Groups of about six submarines transit in company from the Barents to the Mediterranean and back about every six months.

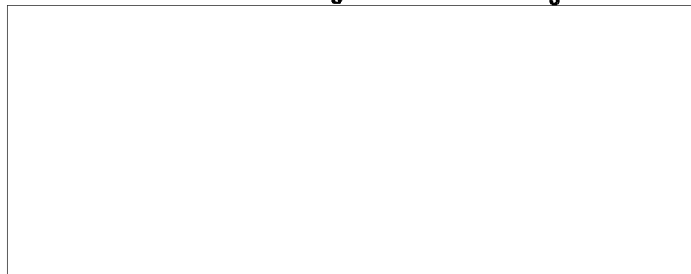
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**Coordinated Transits of the Norwegian Sea Involving Y Class Submarines**



*\*Speculative. Data insufficient to establish nature of operation.*

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Judging from Soviet sensitivities, probable requirements, and force capabilities, the transit activities are probably defensive in nature. The Soviets may have reacted to Western ASW threats by escorting some of their deploying SSBNs, believing that a second submarine could deter or counter-detect a trailer.

Although the coordinated transits could be trailing practice for offensive ASW, it seems likely that they are part of a program for the defense of Y class SSBNs. Even if the primary purpose of the coordinated transit is defensive, however, the tactical experience gained is directly applicable to trailing.

#### Strategic Defensive Capabilities

Escorting Y class ballistic missile submarines could be an effective measure for discouraging or detecting potential covert trailers. If the escort is far enough behind the Y class, the trailer might interpose itself between the two, possibly subjecting itself to counterdetection by the escort. Trailing the escort is an alternative approach, but in that case contact with the Y class probably would be broken, sacrificing the mission objective.

Once the presence of a trailing submarine is disclosed, the escort could assist the Y class in attempting to evade by the use of counter-measures and evasion tactics, or both might simply elect to outrun the trailer, using their speed advantage.

#### Defense of the Fleet

The new Soviet naval strategy of the Sixties increased operations in distant ocean areas and brought with it a requirement for fleet defense against submarine attack. Shore-based ASW systems were not available in the new operating areas.

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The forces had to be able to fend for themselves in distant operations. Naval construction programs were influenced--self-defense against submarine attack was emphasized sometimes even in preference to offensive striking power. Since 1960 no new class of Soviet major surface ships has been built without ASW systems.

#### Command and Control

The tactical commander of a Soviet task group in distant waters is normally responsible for ASW protection of the group. When ASW aircraft operate with surface forces, the ASW surface commander designates an ASW ship to coordinate the aircraft tactics with the surface forces.

#### Operations and Exercises

In Soviet naval operations, major combatants generally do not use ASW screens defensively. (Screen-type formations are used to broaden the width of offensive ASW sweeps.) These ships operate most of the time either in small groups of 2 to 5 ships or independently, and must rely on their own defense capabilities. There appears to be no important place in Soviet operational doctrine for escorting combatants or their support ships on the high seas, although the Soviets practice the escorting of merchant and amphibious group convoys.

In Mediterranean operations, where there are normally about 15 to 20 surface combatants, the Soviets generally do not employ ASW screening forces even during exercises. They have, however, practiced forming surface ship and submarine barriers across the Sicilian Straits and to the south of Crete to seal off the central and eastern Mediterranean from submarine attack. The four IL-38 aircraft formerly stationed in Egypt practiced fleet defensive roles against their own submarines both in airborne ASW barrier operations and in general reconnaissance missions.

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### Fleet Defense Capabilities

Although fleet defense is simpler in concept than strategic ASW, the Soviets still lack a generally effective defense for their ships against Western nuclear submarines. Modern submarine weapons have effective ranges well beyond the potential direct path ranges of almost all Soviet sonars. Moreover, Western submarines have operated within sonar range of Soviet forces in the Mediterranean usually without reaction. This may be explained by such factors as environmental effects, inferior signal processing equipment in the sonar system, or sleepy sonar operators.

Despite a continuing, concentrated effort to build ships which can defend themselves from enemy submarines, the Soviets have little chance for an effective fleet defense. Improving tactics, weapons, and acoustic sensors will probably at best keep pace with submarine weapons development. The Soviet fleet is far from secure from submarine attack.

### Defense of Sea Approaches

The Soviets probably are becoming more concerned about the capabilities of Western attack submarines in the sea approaches to the USSR. Soviet naval operations have recently begun to reflect increased ASW interest in such areas, probably related to a concept for forward ASW defense of the USSR's coastal shipping lanes and naval concentration areas. The Soviets may also have a heightened desire to protect surface ships and submarines deploying to distant areas through these waters.

### Command and Control

The control of forces engaged in ASW in the sea approaches is the responsibility of the fleet commander. Forces used in ASW operations in the Norwegian Sea and the Pacific approaches include

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the ASW-equipped ships of the major surface forces, submarine forces, and long-range ASW aircraft. The Northern Fleet headquarters at Severomorsk and, in the east, Vladivostok provide the control points for their operations. The Main Naval Staff in Moscow is capable of controlling ASW operations of surface ships in the Norwegian Sea.

The tactical organization for forces in the approaches is not well defined. When combined operations occur, the officer in tactical command of the surface forces exercises immediate tactical authority over ASW surface ships and an undefined measure of control over cooperating submarines and aircraft.

Control of independent ASW operations by submarines in the Norwegian Sea is probably shared by the Main Naval Staff in Moscow and Northern Fleet headquarters. Similar arrangements probably exist between Moscow and Pacific Fleet headquarters for control of submarines in the Pacific. Independent ASW aircraft operations are controlled by the respective fleet aviation headquarters.

#### Exercises

Almost every year the Pacific and Northern Fleets each conduct a major exercise

The ASW aspect of these exercises has grown to include what probably are combined ASW barrier and search operations off northern Norway or near the Kurile and Japanese island chains.

Although the Soviets apparently devoted some training time in Exercise Ocean to ASW defense in the ocean approaches to the USSR, over three-fourths of the defending forces were principally involved in anticarrier and antishipping operations.

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ASW training operations in the Norwegian Sea in defense of the ocean approaches are still small. The trend suggests, however, that the Soviets plan to commit ASW forces there in time of war rather than to defend against submarines only near the coasts of the USSR.

The situation is somewhat different for the Pacific Fleet. There the exercise forces deploy along the Japanese and Kurile island chains, making use of the natural geographic features. The barrier thus formed serves as a forward defense against both submarine and surface threats to the Soviet Far East south of the Kamchatka Peninsula.

In the last year or so, the Pacific Fleet has begun to conduct air ASW operations in the sea approaches to the far eastern USSR. Judging from the trend in the Northern Fleet, where the earlier IL-38 ASW units were formed, the Pacific Fleet ASW patrol aircraft will probably provide support to other ASW forces operating in the sea approaches.

#### Approach Defense Capabilities

The Soviet capability to determine the presence of transiting Western submarines through the sea approach areas depends on ASW barriers. Because of the deficiencies of Soviet sensor systems, overall detection capabilities would not be much improved in the Norwegian and Barents sea areas even if all of the barrier forces were devoted to ASW rather than to countering surface ships. In the Pacific, although the force size and disposition during exercises would otherwise seem adequate to detect transiting submarines, sensor deficiencies render effective ASW defense there unlikely for the near future.

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Without an ocean surveillance system the Soviets probably will continue to rely on barrier forces for detection in the sea approaches. These barriers will require large numbers of forces--more than they have used in the past--consisting of submarines, surface ships, and aircraft.

#### Defense of Coastal Areas

The Soviet Navy has continued to maintain a concern for the security of the USSR's coastlines. This concern for an element of naval warfare which has been downgraded by most modern navies can be traced to several long-term influences. Until the last decade, for example, the chief missions of the Soviet Navy were the protection of seaward flanks of the Soviet army and of the coastal areas of the USSR.

#### Command and Control

Soviet naval base commanders are responsible for the defense of coastal sectors adjacent to their bases. These commanders have at their disposal combat-ready detachments of the offshore defense force. Escorts and patrol craft comprise the ASW elements of this force. The base commander can augment his assigned offshore defense forces with elements from the major surface forces, the submarine forces, and the fleet air forces. There is evidence that ASW air regiments maintain some of their aircraft in a ready status, and that the same may be true of submarines.

Combat information posts, located at or near the naval bases, are used to integrate control of coastal air and sea forces with coastal observation stations. Coastal observation stations monitor ASW sensors such as hydroacoustic devices, electronic intercept equipment, and radar. [REDACTED]

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The coastal observation stations, a few naval (and occasionally KGB Border Guard) ships, and naval aircraft carry out routine ASW surveillance tasks in the coastal regions. These efforts probably would be ineffective against modern quiet nuclear submarines except near choke points and harbor entrances where intruding submarines would be forced by geography to approach within detection ranges. Submarines could detect shore- or ship-originated radar emissions and active sonar transmissions early enough to avoid detection.

A portion of the coastal ASW forces apparently are poised for reaction to submarine contacts. [REDACTED]

[REDACTED] Aircraft ordinarily arrive in the contact area first--helicopters with dipping sonar and fixed-wing patrol planes with MAD gear and sonobuoys. Ships operating nearby are often diverted to the scene, then augmented by surface forces from the base. [REDACTED]

[REDACTED] The degree to which submarines are used in coastal ASW, however, is unclear.

#### Coastal Defense Exercises

Most Soviet naval exercise activity occurs in the coastal areas near fleet bases. [REDACTED]

[REDACTED] both multiple-force and single-unit exercises occur there. The most active of the ASW exercise areas are near the Northern and Pacific Fleet base areas.

The majority of these exercises are conducted by forces of coastal defense types, suggesting a substantial commitment to coastal ASW. [REDACTED]

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Coastal Defense Capabilities

Except in the waters within a few miles of naval base entrances, Soviet ASW forces have little capability to protect their coastal areas from submarine intrusions. The lack of reliable submarine detection systems, and the low caliber of the crews--owing to the unchallenging character of Soviet ASW training--are largely responsible for this inefficiency.

Outlook for Soviet ASW

Major ASW concerns of the present are likely to influence the shape of Soviet efforts in the next several years. Requirements for coastal defense and defending naval forces in distant deployments against Western naval submarines will probably continue to motivate Soviet production of ASW equipment and development of ASW forces. The quest for a counter to the Polaris threat will involve research and development on sensors and development of trailing capabilities. Without a major advance in initial

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detection technology, or a substantial improvement in trailing capabilities, the anti-Polaris program will probably not result in the development of large forces in the next five years. The Soviets will continue their efforts to develop capabilities required in all ASW for localization and destruction. They will also expend efforts on developing systems capable of conducting limited area search in restricted areas.

Improvements in platforms will include further development of specialized ASW systems such as the IL-38 aircraft, and the continued incorporation of ASW capabilities in their multipurpose ships such as the Krivak. Programs such as the A class submarine probably represent efforts to improve platform capabilities.

The quest for a trailing capability is likely to lead to improvements in sensors. Current Soviet test and evaluation programs for improved magnetic detection equipment, sonars, and other sensors indicate that the Soviets will probably make considerable improvements in the next few years in their capability to carry out the localization phase of ASW. Similarly, ongoing development programs for ASW weapons over the next few years should improve Soviet capabilities to carry out the destruction phase of ASW.

The Soviets will continue to deploy their surface forces to distant areas and this will probably lead them to seek better tactics and defensive procedures against submarine attack. The coastal defense posture may be moderately improved with the deployment of shallow-water, medium-range fixed ocean detection systems and improved surface ships and submarines. The Soviets can also be expected to continue to emphasize the extension of ASW defenses beyond the coastal areas into the Norwegian Sea approaches and the waters along Japan and the Kuriles.

Only a breakthrough in the ocean surveillance technology or in trailing capability would allow the

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Soviets to begin to come to grips with the Polaris and Poseidon problems. Considering the magnitude of the task and the current state of Soviet programs, they will probably not achieve any significant open-ocean surveillance capability or fully develop trailing capability within the next few years.

To achieve an effective ocean surveillance system, the Soviets would probably have to mount a complex, costly, large-scale development program extending over several years. Such a program would probably be detected, but it is less certain that it would be readily identified as an anti-Polaris program.

Development of an effective trailing capability also would be a major undertaking. It would require development of a large force of submarines, improvements in sensors and communications, and extensive training.

Less ambitious strategic ASW objectives--the ability to locate and destroy a few US SSBNs--may appear to improve Soviet capabilities, but analysis shows that the Soviets would have purchased little security with such a program in a full-scale war because of the destructive capability of the remaining forces. The Soviets probably also recognize that the acquisition of a capability to neutralize some Poseidon submarines might be considered by the US as undermining its deterrent credibility and result in an upgrading of the US ballistic missile nuclear submarine force.

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## Annex A. Technical Analysis of Potential ASW Detection Methods

This annex describes certain physical phenomena which are associated with the operation of nuclear submarines and which might be exploited to develop ASW detection systems. The current Soviet potential for developing ASW detection systems based on these phenomena is examined in the light of the experience of US research and development in these areas and what is known of Soviet research and development progress.

The results of this analysis, along with the findings of other analyses developed in the main part of this report, sustain the judgment made in the report that the Soviets do not now have effective broad area ocean surveillance systems. In this context, only systems with a potential for searching at least several hundred square nautical miles of ocean per hour are defined as ocean surveillance systems, lower search rate systems being more applicable to the localization problem than to the initial detection problem.

Any effective Soviet ocean surveillance system would be complex and costly, and its development would likely extend over several years. If the Soviets were to undertake such a large program, however, considerable delay might ensue before intelligence identified it correctly, although evidence that some large program was under way would probably be obtained soon after its development began.

### Systems Based on Acoustic Phenomena

#### Passive Fixed Systems

The Soviets are aware that the US has had success with fixed passive acoustic undersea surveillance systems. They realize that this has been the most straightforward and successful approach to the ocean surveillance problem.

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The Soviets have done much theoretical work on low-frequency sound propagation, and have conducted at-sea propagation experiments in the appropriate frequency regions. There are, however, five factors which limit the Soviet potential for exploiting acoustic techniques to detect US submarines:

-- One main limitation is a fundamental geographic problem. Long-range, passive acoustic detection systems work only in deep water--in most areas of the world at considerably more than 1,000 feet. Except for certain areas in the Pacific, such regions lie at great distances from the Soviet coastlines. Moreover, the Soviets do not have allies which are strategically located for the emplacement of such systems.

-- Complementary to the geographic problem is an apparent Soviet deficiency in cable technology. The most recent evidence indicates that the Soviets are several years behind the US in low-impedance underwater cable technology.

To build a SOSUS-like detection system they would need to

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make cable runs on the order of 1,000 nm, or to develop a satellite readout capability.

-- A third constraint is the apparent Soviet lack of a low-frequency signal processing capability. Such a capability is notably lacking in current Soviet naval equipment and would be necessary in the development of a detection system of the SOSUS type.

-- A fourth factor that may be hindering the Soviets in perfecting detection systems of this type is their proclivity for using rigid hydrophone arrays in acoustic systems. The BM-1 sonobuoy is the only known Soviet acoustic device which uses a flexible array of hydrophones. Even in this case, the Soviets probably designed this multiple hydrophone set for reliability rather than as a first attempt at flexible arrays. Flexible arrays are a practical necessity for a deployable SOSUS type of system.

-- The quietness of US nuclear submarines is perhaps the most intractable of the problems the Soviets are encountering in ASW. Although SOSUS can detect Soviet submarines fairly reliably, these targets are an order of magnitude noisier than modern US ballistic missile submarines. SOSUS cannot reliably detect US submarines. The Soviets would have to exceed the capabilities of SOSUS to a marked degree to detect US nuclear submarines on patrol in the open ocean.

The Soviets have developed short-range, passive acoustic detection devices which they use to protect harbors and ports. A few passive acoustic systems such as the Ingul device have probably been emplaced in the Pacific to monitor areas of straits and entrances to ports. These are apparently in relatively shallow water and probably are of limited range--less than 100 nm. Ingul devices are thought to be located off Petropavlovsk and Vladivostok.

In the Northern Fleet area the Soviets have experimented with moored buoy detection devices and may be deploying them at strategic points. The earliest installation was probably near Russkaya Gavan, and [redacted] it may have become operational in 1967. The most recent activity is off North Cape, where the Soviets may

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have emplaced a few of these moored buoys connected by cable to shore. If cable laying did occur, it involves the longest cable run to date by the Soviets--over 100 nm. These installations, if beyond the experimental stage, are probably intended to provide early warning of incursions of foreign submarines into areas close to Soviet naval bases in the Barents Sea area.

In addition, the Soviets have been working since the early Sixties to develop a passive surveillance system to monitor the Arctic Ocean region under the ice cap. Some of this work has been in support of under-ice operations by Soviet nuclear submarines and has involved underwater communications research. Equipment shipments and other evidence indicate that work is also being done on passive acoustic, under-ice detection systems. Relatively simple systems could monitor significant areas in the Arctic Basin owing to the natural ducting effect occurring at the interface between the cold, stable water and the bottom of the ice cap.

#### Passive Mobile Systems

An alternative approach to obtaining broad area surveillance with a passive acoustic system involves the use of a mobile sensor such as a towed array. The Soviets have used towed single hydrophones in seismic work in the Pacific, and clearly understand the theory involved. A few W and Z class submarines in the Pacific have been observed with winches and other suspect devices on their stern areas, but there is no confirming evidence that the Soviet Navy has ever used a towed array. (A towed system, however, could go undetected for some time.)

The Soviets could, potentially, make important gains through the use of towed arrays, which greatly increase low-frequency detection capabilities. Their submarines could use towed arrays to detect trailing submarines. Because a towed system moves the sensors away from the high noise level of the towing submarine, the Soviets could use this approach in an attempt to overcome their relative

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noise disadvantage and prevent US submarines from trailing them. Surface ships could use towed arrays to increase their ASW search areas. This approach would be particularly useful in the Mediterranean, where strong thermal gradients in the water and high background noise are problems.

There are some constraints which may be hindering or preventing Soviet development of towed-array submarine detection systems. They may have problems with transducer quality and with the necessary signal processing equipment to take advantage of this approach. The greatest potential for the towed array appears to be in the low-frequency region. But the Soviets have displayed little ability to produce systems in this frequency range.

#### Active Acoustic Systems

Low-frequency active acoustic systems have been proposed in the US for monitoring extensive ocean areas. High-frequency active systems have been proposed for monitoring small areas or straits.

There is no evidence that the Soviets have any system of this type under development. Limitations on their transducer capability and overall cable technology probably prevent their development of active low-frequency area surveillance systems. High-frequency systems are possibly within their capability, but the cable runs necessary to connect to any areas of strategic significance would be prohibitive. Satellite readout is possible but expensive. [REDACTED] Providing power to the devices would still be a problem. Active systems are especially susceptible to countermeasures. There may be some application for harbor defense, where the active capability overcomes the high background noise that limits passive systems in such areas.

#### Infrasonic Phenomena

The band of acoustic energy below 10 Hz is generally termed the infrasonic region. [REDACTED]

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[redacted] In addition, turbulent wake decay may generate infrasonic signals. Some recent Soviet publications show considerable interest in propagation of sound at these frequencies in the ocean. The Soviets have indicated that they believe there may be a propagation "window"--a narrow frequency region where propagation loss in the ocean is very low--in the vicinity of 5 Hz.

The principal problems that would be involved in attempting to build a system to exploit sound in the 5-Hz region involve the high ambient noise in this region from shipping and wave action, coupled with the low level of these signals originally and the limitations on attainable array gains due to the extremely long wavelengths involved. Calculations indicate that the energy radiated by a submarine in this region would be virtually undetectable at any reasonable range. There is no evidence of actual Soviet efforts to develop an operational system of this type.

#### Magnetic Detection Systems

The magnetic field of a submarine results from the magnetization of ferrous materials in the hull and internal equipment. A net magnetic moment is produced by a combination of the permanent magnetization caused by the magnetic history of the submarine and the moment induced by the magnetic field of the earth. The magnetic anomaly produced is small in comparison to the intensity of the earth's magnetic field.

[redacted]

Presently operational saturable-core magnetometers are sensitivity limited and can provide detection ranges of 1,000 to 1,400 feet under favorable conditions. The newest optically pumped magnetometers have a sensitivity of .01 gamma, and can obtain detection ranges of 2,000 feet under good

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conditions. Signal processing and information handling problems, however, generally constrain the practical ASW application of magnetometers with sensitivities greater than .01 gamma. The earth's magnetic field in comparison is approximately 50,000 gamma, and anomalies in this field must be rejected by processing. There is no evidence of Soviet use of any techniques more sophisticated than simple correlation and coincidence signal processing in the frequency ranges appropriate to the more advanced magnetometers.

There are several methods by which improved sensitivity may be obtained, but none appear to have any detection potential beyond a mile or two. An optically pumped magnetometer should be capable of a sensitivity of .001 gamma, and zero-field resonance cesium magnetometers could theoretically obtain a .0001 gamma sensitivity. Superconducting magnetometers using the Josephson effect could yield a sensitivity better than .00001 gamma. Inhomogeneities in the ambient magnetic field are much greater than this and reduce the potentially achievable range. Even these more sensitive magnetometers, unless employed in extensive grids, would be appropriate only for localizing previously detected submarines.

The Soviets are actively engaged in an extensive program to improve their MAD capability. The success of their efforts is evidenced by their being the first to develop a self-oscillating, metastable helium magnetometer. Research being carried out at a magnetics laboratory for the electronics directorate of the Soviet Navy involves cesium, and may be aimed at development of a magnetometer. In addition, some classified Soviet work in superconductivity may have application to the development of superconducting magnetometers.

Present Soviet aircraft MAD gear is estimated to have a detection range of 1,500 feet. The Soviets' extensive effort in MAD sensor technology should allow them to extend this somewhat. Evidence from recent naval aircraft operations indicates that im-

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provements have been made. Their weakness in signal and data processing will probably limit them to at most a 50 percent increase in range in the near future.

Fixed magnetic detection systems are principally limited in range by variations in the ambient magnetic field. They are quite useful in constricted areas, such as in harbors. The Soviets have used magnetic loop detection systems for harbor defense for several years. The [REDACTED] system located across the approaches to the harbor at Petropavlovsk is one example. This system is backed up by an acoustic system to discriminate against surface shipping. Some of the work being conducted at the magnetics laboratory at Krasnaya Pakhra may be for further development of such magnetic detection systems.

Broad area magnetic surveillance systems, however, require automatic monitoring of, and compensation for, changes in background noise. The information processing requirements for such systems exceed those of any of the presently realizable systems. In addition, the physical extent of such a system--laying a grid across the floor of a whole ocean--makes this approach unlikely. There is no evidence that the Soviets are developing any large area coverage systems based on magnetic detection principles.

#### Electromagnetic Systems

The electromagnetic signature of a submarine includes extremely low-frequency electric and magnetic fields due principally to modulation of the galvanic currents which flow between the hull and the propulsion shaft. This modulation results from variations in the resistivity of the current paths produced by the rotation of the shaft, and produces an electromagnetic field oscillating at a frequency corresponding to the shaft rotation rate. Theoretical work to date indicates that detection ranges of up to about 3,000 feet could be obtained by arrays of fixed sensors using this principle.

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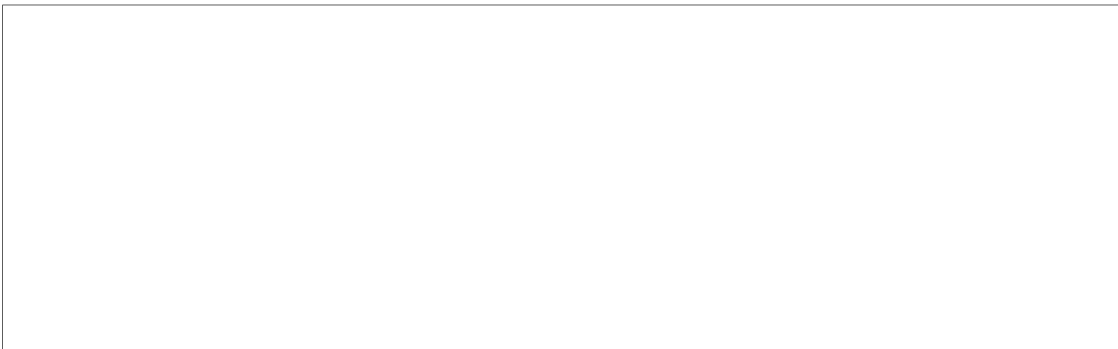
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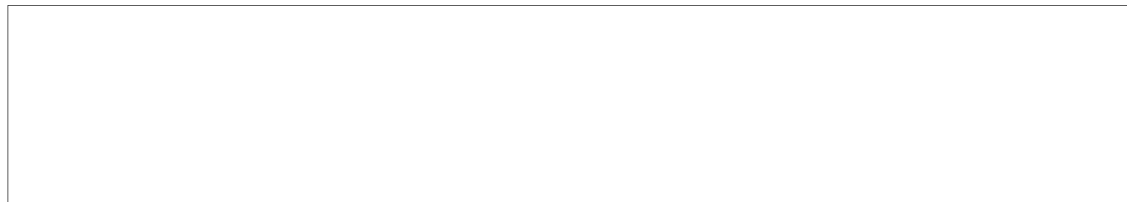
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Another source of electromagnetic radiation from submarines is the energy radiated at ship's service turbine-generator frequencies by radiation through the hull and through leakage paths at hull penetrations. Studies indicate that detection ranges up to about one mile could theoretically be obtained by exploiting this phenomenon.

Electromagnetic detection techniques, therefore, have some potential applicability for ASW. Their very short range, however, limits their applicability to barrier operation in shallow water in constricted areas. Platform self-noise would restrict their usefulness on a mobile platform.



The motion of a submarine through the water can cause scattering of natural and artificial electromagnetic fields. Potentially, this scattering phenomenon could be used in a submarine detection system. Theoretical studies indicate, however, that the maximum achievable range against a modern nuclear submarine would be less than 500 feet.



#### Radar Detection Systems

Radar can be used to detect submarines in two ways. First, masts such as periscopes, antennas,

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and snorkels which protrude above the surface of the water can return a radar signal. Second, it is sometimes possible to detect surface effects caused by a submarine's wake or by its trailing communications wire.

#### Mast Detection

The vulnerability of a submarine to detection is increased whenever it extends a mast above the surface.

The main physical problem encountered in searching for an exposed mast of a submarine is in discriminating the target return from the background sea clutter. High-resolution radar technology using short pulses and pulse compression techniques which improve the discrimination capability of the radar is being pursued by the Soviets. The principal problem which they face is that of adequately processing the information obtained.

Mast detection is not completely reliable because a submarine can control its mast exposure to reduce the risk of detection. Moreover, a high sea state greatly reduces or prevents detectability.

#### Trailing Wire Detection

When there are no masts or antennas extending above the surface, a submarine may still be vulnerable to detection by radar if it has extended a trailing wire communications antenna. [REDACTED]

[REDACTED] the principle is well known, and similar techniques may have been used in recent Soviet efforts to map ice fields using side-looking infrared sensors.

#### Surface Effects Detection

Even when there are no protrusions through the sea's surface and no trailing wire, a submarine may be detectable by radar because of the surface effects caused by the motion of the submarine through the water. These effects are subtle and difficult to detect using conventional radars. The development of ultra-high resolution radars and synthetic aper-

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ture radars may make this detection technique useful. The deeper and the slower the target, the smaller are the surface effects produced. In addition, when the sea is rougher than about State III, the surface effects are masked by the sea turbulence.

The development of advanced ASW radars may represent one of the more promising approaches for the Soviets in developing improved ASW sensors. The communications wire trailed by US SSBNs makes them vulnerable to radar detection, as does the occasional exposure of masts and periscopes. Soviet technical literature [REDACTED]

[REDACTED] indicate that the Soviets are working on such experimental advanced radars, perhaps with a view to ASW applications. Radars designed for wake detection, however, are probably farther in the future because the wake signatures of submerged submarines are less distinguishable than those of exposed masts and trailing wire antennas. Problems with signal processing to overcome sea state masking will probably continue to hamper efforts in this area.

### Nuclear Detection Phenomena

#### Neutrons

The reactor of a nuclear-powered submarine produces an intense neutron flux which cannot be completely shielded. When the submarine is submerged, direct detection of the escaping neutrons is possible only at short ranges--on the order of tens of feet--and only with sophisticated equipment, because water is an excellent neutron moderator.

[REDACTED]

#### Antineutrinos

The operation of a fission reactor produces prodigious quantities of antineutrinos--essentially massless particles which have extremely small absorption cross sections. These particles cannot be

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shielded by any means--in fact, the vast majority of the neutrinos produced by a nuclear reaction could pass through the earth without being absorbed. Although the absorption cross section is exceedingly small, the number of antineutrinos produced in a reactor is so large that a workable submarine detection system based upon antineutrino detection is conceivable.

There are two possible approaches to building such a system. A mobile system could detect the increased presence of antineutrinos as a platform approached an operating nuclear submarine. The detector would have to be very large, however, probably larger than an aircraft. The size necessary to obtain any reasonable range rules out this approach for a mobile ASW sensor.

In an alternative approach, a fixed detector could be built to monitor an area of ocean. This would require a detector that could indicate the direction of the momentum vector of the original antineutrino to provide a bearing indication. The physical dimensions of a detector which would preserve momentum and have a reasonable capture cross section would probably rival the US Navy's Project Sanguine in size. Although nothing is known about Soviet work in this area, the development of detectors of this type would be difficult to conceal because of their great size. Also, no known nuclear reaction with a reasonable antineutrino capture rate preserves momentum. This approach to ocean surveillance would therefore appear to be infeasible.

#### Activation Radionucleides

The radiation escaping from an operating nuclear submarine can cause stable elements present in seawater to become radioactive. Of these, radioisotopes of sodium and chlorine appear most likely to be detectable. It is possible to build detectors which can sense the trace quantities of such radioisotopes in the wake of a submarine, but there are no indications that this is a reliable detection technique.

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[redacted] a gamma ray spectrometer designated Vityaz used for detecting, analyzing, and recording radioactive emissions from trace quantities of radioisotopes in seawater. The Soviets had reportedly had success in detecting their own nuclear submarines [redacted] with such a system.

There have been no conclusive experiments indicating detection of the wakes of US submarines by such techniques. Even if workable detectors were developed, these techniques would probably always be inferior to acoustic techniques and could easily be defeated by countermeasures.

#### Optical Detection Methods

Submarines can be detected optically by both active and passive systems, but only short ranges have been achieved to date, even in clear water. In bright sunlight, submarines have been seen and photographed from aircraft at depths as low as 150 feet. The employment of low light level television could possibly match this capability for nighttime search operations. Ranges of present passive sensors, therefore, would not be sufficient for search operations.

Soviet passive optical capabilities appear to be limited. Whereas they are just beginning to outfit their ASW aircraft with searchlights for night work, US ASW aircraft are removing their searchlights in favor of low light level systems. The Soviets are known to be working on high-energy lasers operating in the blue-green region of the spectrum where attenuation in the ocean is the least. No foreseeable improvements in technology, however, would make underwater laser or optical systems competitive with acoustic systems, or an aircraft-mounted optical system competitive with MAD gear. Similarly, no foreseeable improvements could make optical systems competitive with radar systems for detecting masts and periscopes, nor could projected optical systems

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be competitive with IR and radar techniques for detecting trailing wires. There may be some advantages in optical systems for wake detection over IR and radar systems, but the information processing problems are beyond the capabilities of any existing systems.

One other application of optical detection techniques is the use of optical interference sensors to detect the turbulent wake left by a submarine. This appears to be one of the most promising approaches for detecting turbulent wakes. Because of the dissipation of wakes, lack of classification capability, and directional ambiguity, these techniques would be useful in trailing situations, but would probably not be of much value in area search.

#### Detection Through Wake Effects

The passage of a submarine through water produces a wake with physical properties which are slightly perturbed in comparison with the surrounding water. Also present within the wake are minute quantities of materials left behind by the submarine. A variety of sensors are capable of detecting this wake. Some of these sensors show promise as aids to submarines for trailing other submarines.

#### Refractive Index Changes

The passage of a submarine through water causes changes in both temperature and salinity. These changes produce a change in the local refractive index of the water. Optical interference systems can detect these changes and thus allow the submarine's wake to be localized. A localization system based on this technique, capable of detecting wakes up to several hours after the passage of a submarine, could theoretically be built now.

#### Turbulence

A submarine passing through water leaves behind it a turbulent wake which can be sensed with adequate pressure transducers. US sensors of this type have provided detections of wakes up to one hour behind a target submarine.

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[REDACTED] [REDACTED]

Of the possible systems discussed above, development of a pressure transducer turbulence detection device seems the most likely. [REDACTED]  
[REDACTED]

certain tactical aspects of some of the coordinated transits of the Norwegian Sea by Soviet submarines could be explained either by the existence of such devices or by long-range underwater communications.  
[REDACTED]

[REDACTED] The problems of limited search rate, high false-alarm rate, lack of classification capability, and susceptibility to countermeasures appear to preclude the development of any area search system based upon wake sensing devices. However, the application of such devices for maintaining covert trailing of a submarine once initial detection has been accomplished is a likely Soviet development, either now or in the near future.

#### Reverberation

Remote wake sensing may be possible using ultrasonic or optical sensors to detect the volume reverberation of the turbulent wake. This could allow a trailing submarine to operate with a depth separation of up to a few hundred feet, a valuable aid in trailing.

#### Chemical Detection

Trace amounts of various chemicals are introduced into the ocean from a submarine, some continuously and some intermittently. Corrosion and erosion products such as minute quantities of antifouling paint from the hull, copper and nickel from the piping which carries coolant water, and zinc from sacrificial anodes are introduced into the water continuously. In addition, when a modern submarine is operating submerged, the by-product hydrogen gas from the oxygen generators is discharged continuously. These chemicals are the most likely candidates for a chemical-based detection system because they are continuously produced.

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The concentrations of the chemicals in a submarine wake are typically only a few tenths of a part per billion above the background levels in the ocean, and their detection would require extremely sensitive instruments. Chemical detection techniques will probably always be inferior to wake turbulence detection techniques because the physical wake is much more stable and defined.

There are several indications that the Soviets are working in various areas with potential application to wake detection systems. These research programs include development of lasers operating in the blue-green spectrum, detailed turbulence studies, experiments with optical and ultrasonic interference measurement systems, and sensitive chemical detectors. Some of the various devices protruding from the hulls of certain Soviet submarines may be experimental wake detection devices.

#### Elint Detection

The Soviets have a large system of fixed land-based HF intercept sites backed up by mobile systems and by installations in collaborating communist countries. They also have a growing Sigint satellite program.

The usefulness of a Soviet intercept system is circumvented by the ability of a submarine to conduct a patrol in radio silence. The Soviet intercept effort, therefore, does not constitute a comprehensive and effective submarine surveillance system.

#### Infrared Phenomena

An operating submarine, particularly a nuclear submarine, produces changes in the thermal reflectivity and emissivity microstructure of the sea surface above it. This can be caused by temperature changes in the water due to heating effects from the submarine, particularly if the submarine is shallow or hovering. It can also be caused by the anisotropic distortions of the sea surface caused by the

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wake left by objects which protrude through the surface such as masts and periscopes, or by a trailing wire. Even when there are no protrusions, a submerged submarine leaves a trail of surface microstructure anomalies owing to wake effects which rise to the surface. Perhaps the most effective means of searching for these microscopic discontinuities is by analyzing infrared radiation which is reflected from the sea surface.

Infrared sensors appear to have significant potential for airborne ASW systems, as they can provide a greater area coverage than MAD gear although they entail a higher false-alarm rate and demanding signal processing requirements. For any sort of broad ocean surveillance application, however, it appears necessary to use a satellite-borne system. The high atmospheric absorption of infrared energy is a major limiting factor for satellite-borne systems.

An operating submarine continually introduces heat into its environment, primarily through its use of seawater as a coolant. In large nuclear submarines, the rate of coolant flow can be several thousand gallons per minute, with an increase in temperature of 10°C or more. A submarine which is operating very shallow, as in the case of an SSN copying or sending communications, or one which is hovering at greater depths, as in the case of an SSBN about to fire its missiles, causes a measurable rise in the temperature of the sea surface immediately over its position because of convective flow of the heated water. This greatly enhances the detectability of the submarine.

Masts or periscopes protruding through the sea's surface produce linear thermal discontinuities which can persist for hours in a low sea state. Such tracks have been observed stretching for miles behind submarines.

Trailing wire antennas generate a linear thermal discontinuity on the sea surface which can also persist for hours in a low sea state. The form of the discontinuity is somewhat different from that left by a mast or periscope, and is much broader.

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Some of the perturbations which produce the wake effects discussed earlier rise with time to the sea surface where they produce a trail of anisotropic disturbance of the infrared microstructure of the sea surface. This effect is much more subtle than the others mentioned and far more difficult to detect.

Analyses of these phenomena indicate that an effective infrared ASW sensor system would have to be capable of monitoring a range of wavelengths, with sensitivities of .001°C or better, and with narrow instantaneous fields of view.

The Soviets have developed and operated airborne IR sensors for such applications as mapping of ice fields.

Soviet research and development on IR sensors is well advanced. The Soviets have shown considerable interest in developing sensors with high sensitivities in the short wavelength region necessary for atmospheric transmission. Their technical publications indicate that they are specifically interested in the development of sensors capable of monitoring the microstructure of the sea surface.

Even with the development of the necessary sensors and satellite vehicles, an enormous signal-processing problem remains, greater than any thus far encountered. Detection of submarines from a satellite using IR sensors with an acceptably low false-alarm rate would require an extremely sophisticated automatic pattern recognition capability even with the best of sensors. It is unlikely that the Soviets now have, or will have within the next few years, an operational broad area IR detection system. They have, however, probably begun testing and evaluation of airborne IR sensors for limited area ASW search and localization. IR systems will always be hampered by problems with rough water--sea states higher than State III--and rain or fog, which absorb IR radiation.

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~~TOP SECRET~~Annex B. Characteristics of Soviet ASW-Equipped Forces\***Moskva Class** ASW Helicopter Carrier

Length ..... 620 feet  
 Beam ..... 112 feet  
 Displacement ..... 20,000 tons  
 Maximum speed ..... 29 knots  
 Endurance ..... 14,000 nm at 12 knots  
 Units operational ..... 2  
 IOC<sup>a</sup> ..... 1968  
 Active sonar  
     ..... 3- and 4.5-kHz hull-mounted  
     ..... 8.5-kHz VDS (variable-depth sonar)

## ASW weapons

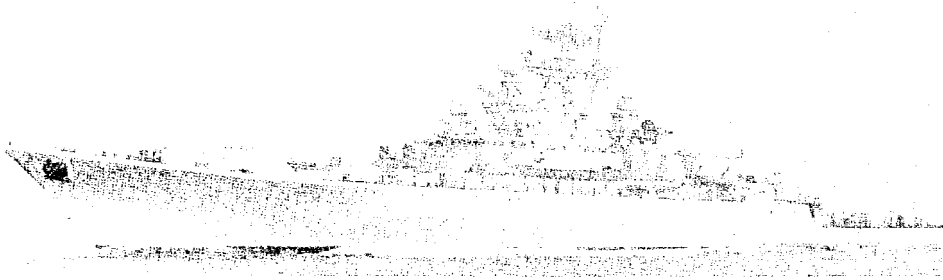
..... dual SUW-N-1 launcher  
 ..... 2 quintuple 21-inch torpedo tubes  
 ..... 2 MBU-2500A<sup>b</sup>  
 Helicopters ..... 20 Hormone

The Moskva is equipped with a 3-kHz sonar, probably intended for convergence zone and possibly bottom bounce operation. The 4.5-kHz sonar is probably for target tracking, and may have an RDT (rotating directional transmission) mode. It appears that the Soviets originally intended the Moskva class helicopter carriers to be capable of conducting bistatic sonar searches, using their hull-mounted sonar as the source and the Hormone helicopter dipping sonars as receivers. The Soviets may have encountered difficulties in attempting to exploit this complex technique. They have not been observed conducting such operations during the past 2 years. The Moskva underwent an overhaul from late January to early August 1971, during which the Soviets may have taken steps to overcome these difficulties.

- a. *IOC (initial operational capability) is the date when the first unit of a class of ships becomes available for operational service.*

\* *The numbers of operational units listed in this annex are current figures as of 1 July 1972.*

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~~TOP SECRET~~**Krivak Class** Cruise Missile Destroyer

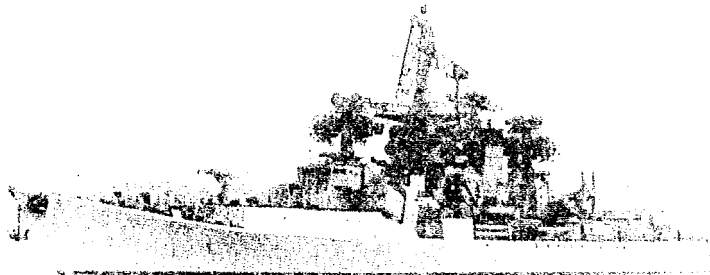
Length ..... 410 feet  
 Beam ..... 47 feet  
 Displacement ..... 3,800 tons  
 Maximum speed ..... 32 knots  
 Endurance ..... 5,000 nm at 15 knots  
 Units operational ..... 3  
 IOC ..... 1971  
 Active sonar  
     ..... possibly 8-kHz hull-mounted<sup>a</sup>  
     ..... 8.5-kHz VDS

## ASW weapons

..... 2 quadruple 21-inch torpedo tubes  
 ..... 2 MBU-2500A  
 ..... 2 mine rails

Helicopters ..... none

Krivak construction apparently will be a large building program. Construction is under way at shipyards on both the Baltic and Black seas.

**Kresta II Class** Cruise Missile Destroyer

Length ..... 522 feet  
 Beam ..... 56 feet  
 Displacement ..... 6,800 tons  
 Maximum speed ..... 34 knots  
 Endurance ..... 7,000 nm at 14 knots  
 Units operational ..... 4  
 IOC ..... 1969  
 Active sonar ..... 8-kHz

## ASW weapons

..... 2 MBU-2500A  
 ..... 2 MBU-4500A  
 ..... 2 quintuple 21-inch torpedo tubes  
 Helicopters ..... 1 Hormone

The Kresta-II 8-kHz search sonar probably is supplemented by a separate target-tracking sonar.

a. *There is a possibility that this sonar is in the 4-kHz range.*

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~~TOP SECRET~~**Kresta I Class** Cruise Missile Destroyer

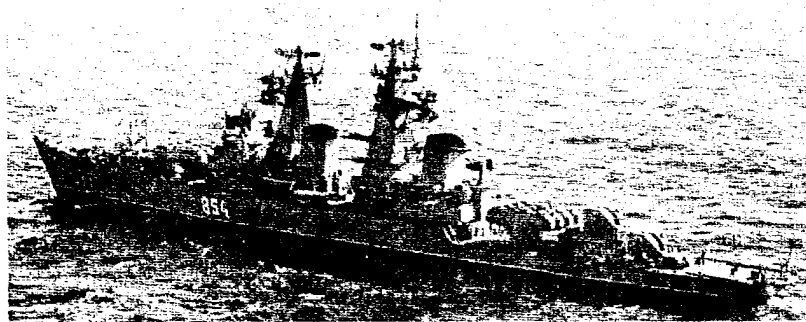
Length ..... 510 feet  
 Beam ..... 56 feet  
 Displacement ..... 6,700 tons  
 Maximum speed ..... 34 knots  
 Endurance ..... 7,000 nm at 14 knots  
 Units operational ..... 4  
 IOC ..... 1967  
 Active sonar ..... 15- to 23-kHz

## ASW weapons

..... 2 MBU-2500A  
 ..... 2 MBU-4500A  
 ..... 2 quintuple 21-inch torpedo tubes

Helicopters ..... 1 Hormone

The Kresta-I search sonar, which operates at one of several fixed frequencies, probably is augmented by a target-tracking sonar operating at a separate fixed frequency in this band.

**Kynda Class** Cruise Missile Destroyer

Length ..... 465 feet  
 Beam ..... 52 feet  
 Displacement ..... 5,600 tons  
 Maximum speed ..... 36 knots  
 Endurance ..... 7,000 nm at 14 knots  
 Units operational ..... 4  
 IOC ..... 1962  
 Active sonar ..... 15- to 23-kHz

## ASW weapons

..... 2 triple 21-inch torpedo tubes  
 ..... 2 MBU-2500A

Helicopters ..... 1 on pad

The Kynda is equipped with a search sonar operating at one of several fixed frequencies, probably augmented by a separate target-tracking sonar operating in the same frequency band.

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~~TOP SECRET~~**Krupnyy Class Cruise Missile Destroyer**

Length ..... 452 feet  
 Beam ..... 49 feet  
 Displacement ..... 4,500 tons  
 Maximum speed ..... 35 knots  
 Endurance ..... 4,700 nm at 15 knots  
 Units operational ..... 1  
 IOC ..... 1959  
 Active sonar ..... 15- to 23-kHz

**ASW weapons**

..... 2 triple 21-inch torpedo tubes

..... 2 MBU-2500

**Helicopters** ..... none

The Krupnyy is equipped with a search sonar operating at one of several fixed frequencies [redacted], probably augmented by a target-tracking sonar operating at a separate frequency in this same band. Krupnyys are being converted to Kanins in the only known Soviet conversion program which involves the installation of a more modern hull-mounted sonar.

**Kildin Class Cruise Missile Destroyer**

Length ..... 415 feet  
 Beam ..... 43 feet  
 Displacement ..... 3,500 tons  
 Maximum speed ..... 36 knots  
 Endurance ..... 4,700 nm at 11 knots  
 Units operational ..... 1  
 IOC ..... 1958  
 Active sonar ..... 15- to 23-kHz

**ASW weapons**

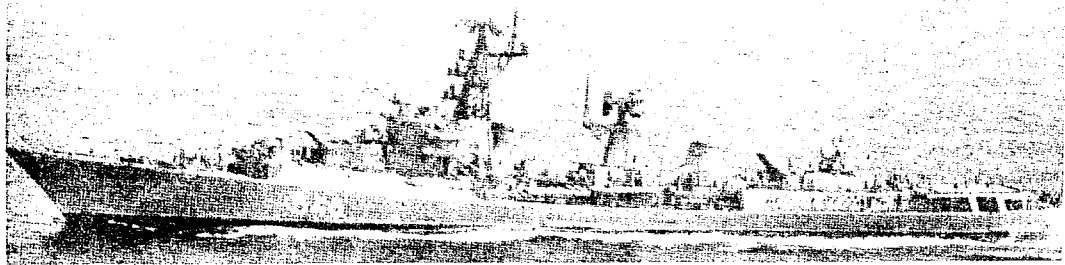
..... 2 twin 21-inch torpedo tubes

..... 2 MBU-2500

**Helicopters** ..... none

The Kildin sonar, which operates at one of several fixed frequencies [redacted], probably is augmented by a target-tracking sonar operating at a separate fixed frequency in this same band. This class is in the early stages of conversion. The cruise missiles are probably being removed and replaced by a surface-to-air missile launcher. Three units are presently believed to be undergoing conversion.

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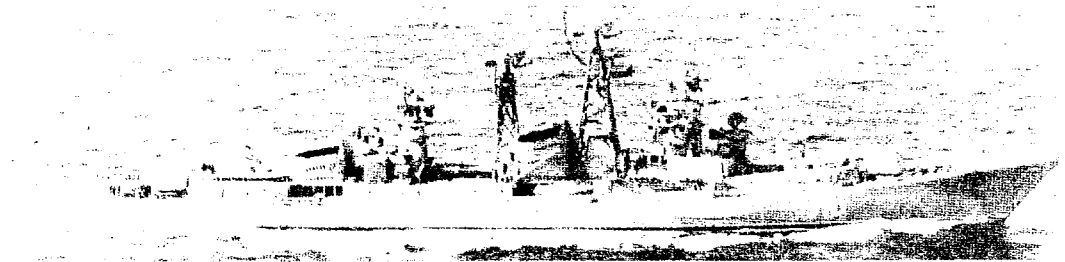
~~TOP SECRET~~**Kanin Class Destroyer**

Length ..... 460 feet  
 Beam ..... 49 feet  
 Displacement ..... 4,800 tons  
 Maximum speed ..... 35 knots  
 Endurance ..... 4,700 nm at 15 knots  
 Units operational ..... 4  
 IOC ..... 1967  
 Active sonar ..... 8-kHz

**ASW weapons**

..... 3 MBU-2500A  
 ..... 2 quintuple 21-inch torpedo tubes  
 Helicopters ..... 1 on pad

Kanins are the result of the conversion of older Krupnyys. This is the only known Soviet surface ship conversion program in which an improved hull-mounted sonar system was installed.

**Kashin Class Destroyer**

Length ..... 472 feet  
 Beam ..... 52 feet  
 Displacement ..... 4,450 tons  
 Maximum speed ..... 38 knots  
 Endurance ..... 7,500 nm at 10 knots  
 Units operational ..... 18  
 IOC ..... 1963  
 Active sonar ..... 15- to 23-kHz

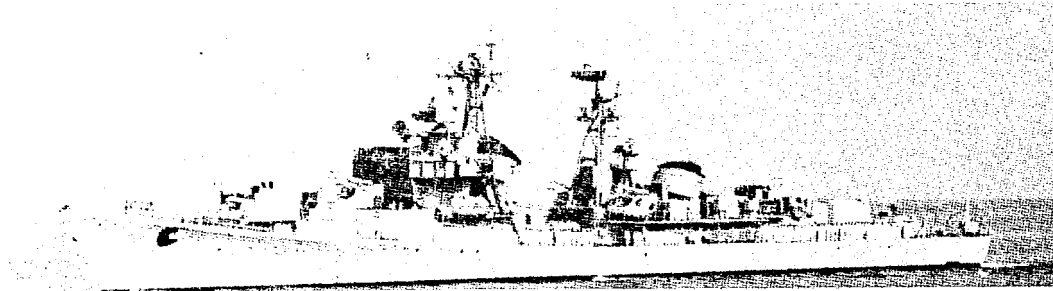
**ASW weapons**

..... 2 MBU-2500A  
 ..... 1 quintuple 21-inch torpedo tube  
 ..... 2 mine rails  
 Helicopters ..... 1 on pad

The Kashin is equipped with a search sonar which operates at one of several fixed frequencies [redacted]. This is augmented by a target-tracking sonar which operates at a separate fixed frequency in this same band. Kashins are undergoing extensive overhaul, essentially in the order in which they were originally built. In the future the Soviets may, during overhaul, equip their Kashins with the Krivak-type VDS.

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~~TOP SECRET~~**Kotlin Class Destroyer**

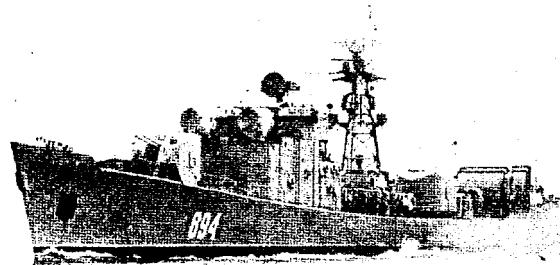
Length ..... 415 feet  
 Beam ..... 43 feet  
 Displacement ..... 3,500 tons  
 Maximum speed ..... 36 knots  
 Endurance ..... 4,700 nm at 11 knots  
 Units operational ... 23 (includes all versions)  
 IOC ..... 1954  
 Active sonar ..... 15- to 23-kHz

**ASW weapons**

..... 1 quintuple 21-inch torpedo tube  
 ..... 2 MBU-2500  
 ..... 2 MBU-4500  
 ..... 2 mine rails

Helicopters ..... some have landing pad

The three types of Kotlins differ principally in armament. The characteristics listed above are for the modified Kotlin. The unmodified Kotlin has two quintuple 21-inch torpedo tube installations, six depth charge mortars, and no MBUs. It may also be equipped with an older sonar [redacted]. The SAM Kotlin has two MBU-2500 or two MBU-2500A launchers, and carries neither mines nor depth charges.

**Mirka Class Escort**

Length ..... 268 feet  
 Beam ..... 30 feet  
 Displacement ..... 1,150 tons  
 Maximum speed ..... 30 knots  
 Endurance ..... 4,800 nm at 10 knots  
 Units operational ..... 20  
 IOC ..... 1963  
 Active sonar ..... 15- to 23-kHz

**ASW weapons**

..... 1 or 2 quintuple 16-inch torpedo tubes  
 ..... 2 or 4 MBU-2500A  
 ..... 1 depth charge rack

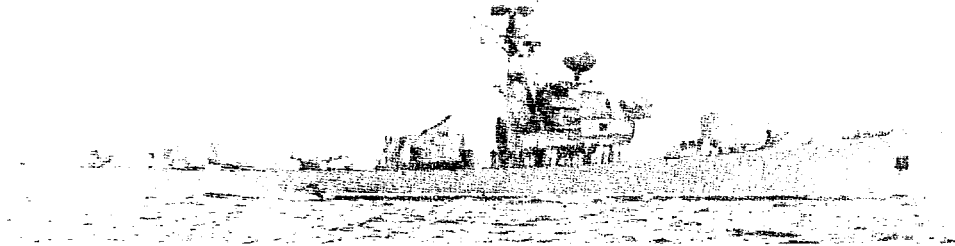
Helicopters ..... none

The Mirka search sonar operates at one of several fixed frequencies [redacted]

[redacted] It probably is supplemented by a separate search sonar operating at another fixed frequency in this band. Some Mirkas have been equipped with the same dipping sonar used by the Hormone helicopter, probably as a makeshift VDS installation.

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~~TOP SECRET~~**Petya Class Escort**

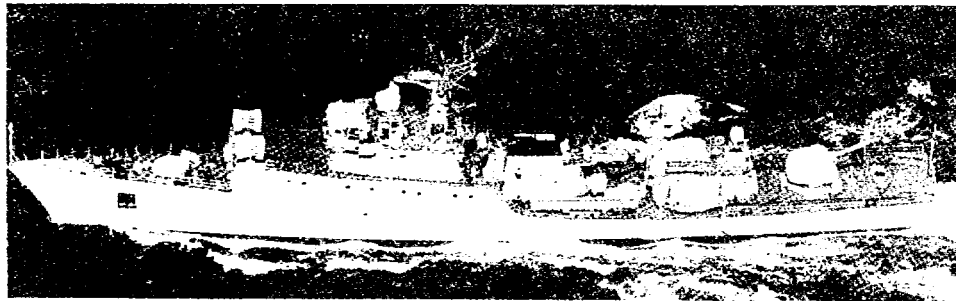
Length ..... 268 feet  
 Beam ..... 30 feet  
 Displacement ..... 1,100 tons  
 Maximum speed ..... 34 knots  
 Endurance ..... 4,900 nm at 10 knots  
 Units operational ..... 47  
 IOC ..... 1961  
 Active sonar ..... 11- to 23-kHz

**ASW weapons**

..... 1 or 2 quintuple 16-inch torpedo tubes  
 ..... 2 MBU-2500A or 4 MBU-2500  
 ..... 2 depth charge racks

Helicopters ..... none

The Petya is equipped with a search sonar which operates at one of several fixed frequencies. This is augmented by a target-tracking sonar which operates at a separate fixed frequency in the same bands. Some Petyas are equipped with VDS installations resembling the one on the Moskva.

**Grisha Class Patrol Ship**

Length ..... 235 feet  
 Beam ..... 30 feet  
 Displacement ..... 900 tons  
 Maximum speed ..... 36 knots  
 Endurance ..... 4,500 nm at 10 knots  
 Units operational ..... 11  
 IOC ..... 1968  
 Active sonar ..... possibly 6-8-kHz

**ASW weapons**

..... 2 twin 21-inch torpedo tubes  
 ..... 2 MBU-2500A  
 ..... 2 depth charge racks

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### A Class Torpedo Attack Nuclear Submarine

Length ..... 260 feet  
 Beam ..... 32 feet  
 Submerged displacement ..... 4,300 tons  
 Maximum speed ..... unknown  
 Operating depth ..... unknown  
 Units operational ..... 1  
 IOC ..... 1972  
 Active sonar ..... unknown

#### ASW weapons

..... possibly a rocket torpedo\*  
 ..... possibly torpedoes

\* "Rocket torpedo" is a Soviet designation for a weapon possibly similar to the US ASROC or SUBROC.

The appearance of only one A class to date, together with its extended fitting-out period, suggests that the A may be an advanced technology prototype. Possible exploratory areas include advanced sensors, nonstandard hull materials, and exotic propulsion techniques. The possible association of a rocket torpedo with the A class suggests that it may be intended for an ASW role.

### V Class Torpedo Attack Nuclear Submarine

Length ..... 308 feet  
 Beam ..... 33 feet  
 Submerged displacement ..... 5,300 tons  
 Maximum speed ..... 32 knots  
 Operating depth ..... 1,300 feet  
 Units operational ..... 10  
 IOC ..... 1968  
 Active sonar  
 ..... 3-kHz  
 ..... 7-and 27-kHz

ASW weapons ..... 32 torpedoes

Although little technical information is available concerning the V class passive sonars, the overall passive sonar detection range capability of the V is probably only about half that provided by modern US equipment under similar conditions.

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~~TOP SECRET~~**E-I Class** Torpedo Attack Nuclear Submarine

Length ..... 375 feet  
 Beam ..... 30 feet  
 Submerged displacement ..... 5,500 tons  
 Maximum speed ..... 28 knots  
 Operating depth ..... 1,000 feet  
 Units operational ..... 3  
 IOC ..... 1961  
 Active sonar ..... 15 -kHz

ASW weapons ..... 22 torpedoes

E-I attack submarines are the result of conversions of E-I cruise missile units. The passive sonar installation may have been improved, with the refitting of equipment approaching that of the V class in capability, but limited by the generally higher noise levels of the E-I at most speeds.

**N Class** Torpedo Attack Nuclear Submarine

Length ..... 360 feet  
 Beam ..... 30 feet  
 Submerged displacement ..... 5,400 tons  
 Maximum speed ..... 30 knots  
 Operating depth ..... 1,000 feet  
 Units operational ..... 14  
 IOC ..... 1959  
 Active sonar ..... 15-kHz

ASW weapons ..... 32 torpedoes

The N class passive sonar capability probably provides detection ranges less than half those of modern US equipment under similar conditions.

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~~TOP SECRET~~**P Class** Cruise Missile Nuclear Submarine

Length ..... 354 feet  
 Beam ..... 38 feet  
 Submerged displacement ..... 6,700 tons  
 Maximum speed ..... probably 30 knots  
 Operating depth ..... at least 1,300 feet  
 Units operational ..... 1  
 IOC ..... 1971  
 Active sonar ..... possibly 3-kHz

ASW weapons ..... probably torpedoes

Although the P class is believed to be primarily intended for an anti - surface ship role, it has some ASW capability. The passive sonar installation on the P is probably similar to that on the V.

**C Class** Cruise Missile Nuclear Submarine

Length ..... 308 feet  
 Beam ..... 31 feet  
 Submerged displacement ..... 4,800 tons  
 Maximum speed ..... 27 knots  
 Operating depth ..... 1,300 feet  
 Units operational ..... 9  
 IOC ..... 1968  
 Active sonar  
 ..... 3-kHz  
 ..... 7- and 27-kHz

ASW weapons ..... 18 torpedoes

The C class passive sonar capability is estimated to be similar to that of the V.

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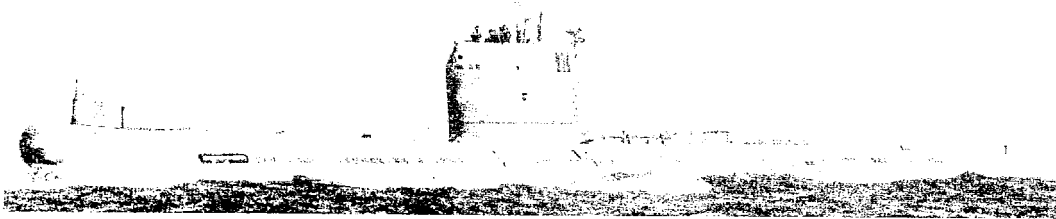
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~~TOP SECRET~~**B Class** Torpedo Attack Submarine

Length ..... 230 feet  
 Beam ..... 32 feet  
 Submerged displacement ..... 2,900 tons  
 Maximum speed ..... 18 knots  
 Operating depth ..... 900 feet  
 Units operational ..... 4  
 IOC ..... 1968  
 Active sonar ..... unknown

ASW weapons ..... 12 torpedoes

Although there is no evidence concerning the B class sonars, they are probably improved over those of earlier Soviet diesel submarines and may approach the capabilities of the V class.

**F Class** Torpedo Attack Submarine

Length ..... 300 feet  
 Beam ..... 24.5 feet  
 Submerged displacement ..... 2,300 tons  
 Maximum speed ..... 16 knots  
 Operating depth ..... 920 feet  
 Units operational ..... 51  
 IOC ..... 1959  
 Active sonar ..... 15-kHz

ASW weapons ..... 22 torpedoes

The F class is equipped with the Feniks passive sonar

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~~TOP SECRET~~**TU-142 ASW Patrol Aircraft**

Operating radius  
 ..... 3,350 nm (3 hours on station)  
 Payload ..... 13,500 pounds  
 Units operational ..... 10  
 IOC ..... 1971  
 ASW weapons  
 ..... depth bombs  
 ..... mines  
 ..... torpedoes  
 ASW sensors  
 ..... Weteye radar  
 ..... BM-1 sonobuoys

These ASW versions of the TU-95 [ ] the new BM-1 sonobuoys and probably have a monitoring capability for these buoys similar to or greater than that of the IL-38. They can conduct either extended-range patrols or long-duration patrols at shorter ranges. These aircraft probably are not equipped with MAD (magnetic anomaly detection) gear because of the problems that would be encountered in attempting to operate such a large fast aircraft at the very low altitudes necessary for MAD operations. They may be equipped with a new infrared sensor.

**IL-38 May ASW Patrol Aircraft**

Operating radius  
 ..... 1,350 nm (3 hours on station)  
 Payload ..... 6,400 pounds  
 Units operational ..... 45  
 IOC ..... 1968  
 ASW weapons  
 ..... mines  
 ..... depth bombs  
 ..... torpedoes  
 ASW sensors  
 ..... Weteye radar  
 ..... BM-1 sonobuoys  
 ..... MAD

To date, IL-38 Mays have [ ] the newer BM-1 sonobuoys, [ ]

[ ] The IL-38 may not be capable of monitoring the older sonobuoys and probably carries them only to expedite turnover operations with BE-12s. IL-38s can employ large numbers of the newer BM-1 sonobuoys; [ ]

[ ] Some IL-38s may carry a new infrared sensor.

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### BE-12 Mail ASW Patrol Aircraft



Operating radius . 750 nm (3 hours on station)  
Payload ..... 17,500 pounds  
Units operational ..... 90  
IOC ..... 1966  
ASW weapons  
..... depth bombs  
..... mines  
..... torpedoes  
ASW sensors  
..... Mushroom radar  
..... RGAB-56 and RGAB-64 sonobuoys  
..... MAD

To date, BE-12 Mails have [redacted] the older RGAB-56 and RGAB-64 sonobuoys, [redacted]

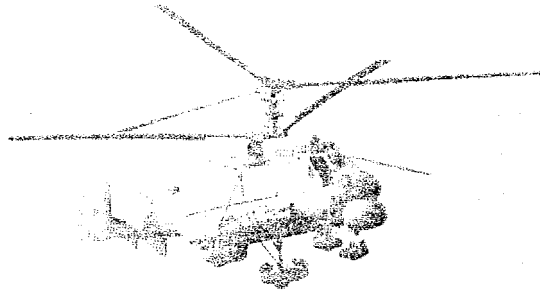
[redacted] The BE-12 probably lacks the capability to monitor the new buoys, and may carry them only to expedite turnover operations with IL-38s. Some BE-12s apparently have been refitted with an improved MAD gear, [redacted]  
[redacted]

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### KA-25 Hormone ASW Helicopter

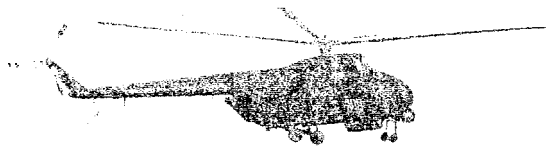
Endurance ..... 2 hours  
 Payload ..... 3,000 pounds  
 Units operational ..... 125  
 IOC ..... 1967  
 ASW weapons  
     ..... depth bombs  
     ..... torpedoes  
 ASW sensors  
     ..... Big Bulge radar  
     ..... RGAB-56 and RGAB-64 sonobuoys  
     ..... towed MAD  
     ..... 15- to 16-kHz dipping sonar



The Hormone is operated from the Moskva and Leningrad as well as from some Kresta-IIs. In addition, it is replacing the Hound as a land-based ASW helicopter.

### MI-4 Hound ASW Helicopter

Endurance ..... 2 hours  
 Payload ..... 1,350 pounds  
 Units operational ..... 110  
 IOC ..... 1953  
 ASW weapons  
     ..... depth bombs  
     ..... torpedoes  
 ASW sensors  
     ..... Mushroom radar  
     ..... RGAB-56 and RGAB-64 sonobuoys  
     ..... towed MAD



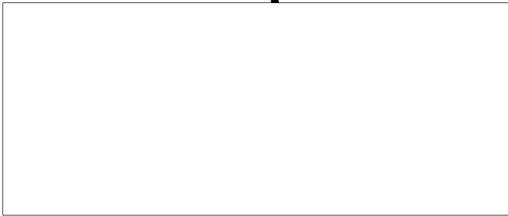
The Hound is a land-based ASW helicopter that is being phased out in favor of the more versatile Hormone.

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