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**ADVANCED
NAVAL
VEHICLES
CONCEPTS
EVALUATION
[ANVCE]
PROJECT**



MISSION ANALYSIS

VOLUME 4

APPENDICES A, B AND C

CLASSIFIED BY CHIEF OF NAVAL OPERATIONS(OP-96)

REVIEW ON 31 DECEMBER 1999

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ADVANCED NAVAL VEHICLES
CONCEPTS EVALUATION (ANVCE) PROJECT

Volume 4

MISSION ANALYSIS
APPENDICES A, B, and C

December 1979

Prepared by:

CHIEF OF NAVAL OPERATIONS (OP-96)

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APPENDIX A
THE OPERATIONAL PAYOFFS OF SPEED

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I. INTRODUCTION

(U) Speed is one of the most important design parameters in a military vehicle. However, the motions and forces encountered in rough seas limit the speeds attainable by conventional naval vehicles, and as speed is increased, transport efficiency is decreased. Nevertheless, high speed is a tremendous asset in military vehicles and, in most kinds of operations, a faster vehicle is preferred over a slower one, all other things being equal. In combat situations, a high-speed capability

- increases the vehicle's chances of choosing the time and circumstances of an engagement,
- enables the vehicle to avoid an undersirable engagement,
- reduces the force-level requirements necessary to maintain a given number of vehicles on station at an appreciable distance from their base,
- facilitates pursuit or evasion of enemy forces, and
- reduces a vehicle's exposure time to enemy attack, i.e., reduces its vulnerability.

(U) Speed can be achieved in a vehicle design only by a trade-off with some other platform characteristic, increased cost, or both. In terms of design trade-offs, speed can not be regarded in precisely the same way as payload or range. In the vehicle design process, the usual practice is to specify some margin over the minimum acceptable payload to cover contingencies. This need not penalize the design unduly, provided the margin is identified so the designer can check for undue escalation of margins from other sources (size and cost are approximately linear with payload). However, an increase of several knots can involve size and cost penalties greatly out of proportion to their ultimate worth.

(U) If the increased speed capability that most advanced conceptual vehicles offer over conventional platforms were available without increased investment and operating costs and without the "penalties" involved in design trade-offs, it would be exploited as much as possible. However, increased speed does mean increased cost and penalties, and thus, it becomes ultimately necessary to address the issue of speed on a trade-off basis.

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(U) This appendix addresses the operational need for speed. It is based on a study conducted early in the Advanced Naval Vehicles Concepts Evaluation (ANVCE) Project (Reference A-1) that examined the utility of speed in naval operations from both a conceptual and analytical viewpoint. In Chapter II of this appendix, the effect of speed on defensive maneuvers is discussed. Chapters III through VI treat the need for speed within each of four functionally similar groups of naval operations—moving-force, fixed area, transit-related, and special purpose. The final Chapter of this appendix presents the general conclusions and those related specifically to surface vehicles and air vehicles.

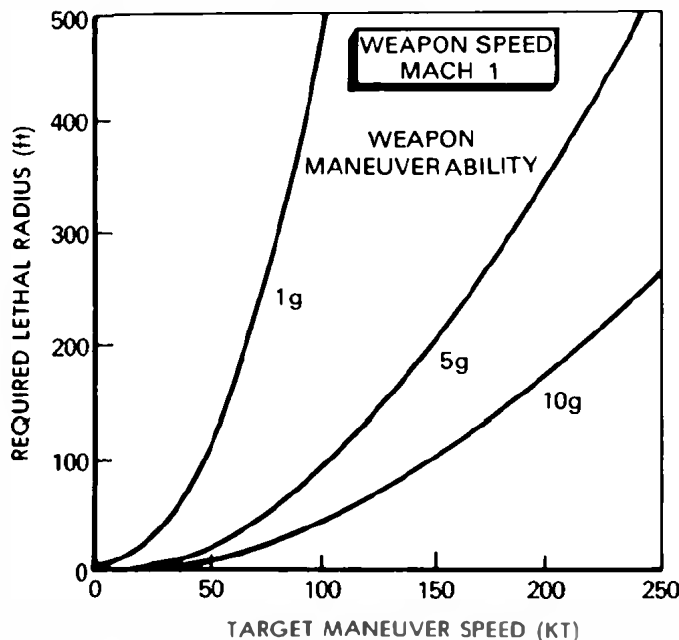
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II. DEFENSIVE MANEUVERS

(U) A classic application of platform speed, regardless of the type operation involved, is in maneuvers to avoid impact or to minimize damage by reducing the accuracy or destructive potential of enemy weapons (defensive maneuvers). High speed (50-100 kt) platforms can easily avoid or outrun torpedo attacks if they have sufficient warning; however, this is not the case with antiship missiles. Thus, it was of particular interest to ANVCE to examine the effect of platform speed and maneuverability on the likelihood of being hit by enemy missiles.

(U) Figure A-1 shows the impact of a platform speed on its ability to avoid being hit by an enemy weapon (for example, a missile). The figure shows a basic case for a target maneuvering to avoid being hit. The target and the missile are assumed to be heading directly at each other before the target maneuvers. The missile is assumed to have a minimum turning radius, governed by its speed and a number of g's it can pull. At the optimal separation distance from the missile, the target is assumed to turn instantaneously (essentially with a tactical diameter of zero) to an escape path normal to the minimum turning-radius path of the missile.

(U) The three curves in Figure A-1 represent three levels of missile maneuverability (in g's that it can sustain in a turn) and indicate the lethal radius that would just reach a target executing the escape maneuver at the speed indicated. Any greater target speed would constitute a successful escape. Thus, a target moving at a speed of 100 kt could escape a 1g missile having a warhead with a lethal radius of less than approximately 500 ft.



(U) Figure A-1. IMPACT OF SPEED ON LETHAL RADIUS

(U) However, the figure is only illustrative of the maneuver problem. The target, for example, is assumed to turn instantaneously where in fact, tactical diameters of most surface platforms are directly proportional to the platform speed. In the 100-kt speed region, these tactical diameters are thousands of meters.

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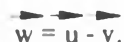
III. MOVING-FORCE OPERATIONS

(U) Moving-force protection operations are defined as those taken to protect a force that is in transit or is moving during the course of the operation. Moving-force protection operations are extremely important to a mobile, flexible navy fulfilling global commitments. The effect of high-speed in the movement of forces is examined from three separate perspectives: speed in the protected force, the protecting force, and the combat suite.

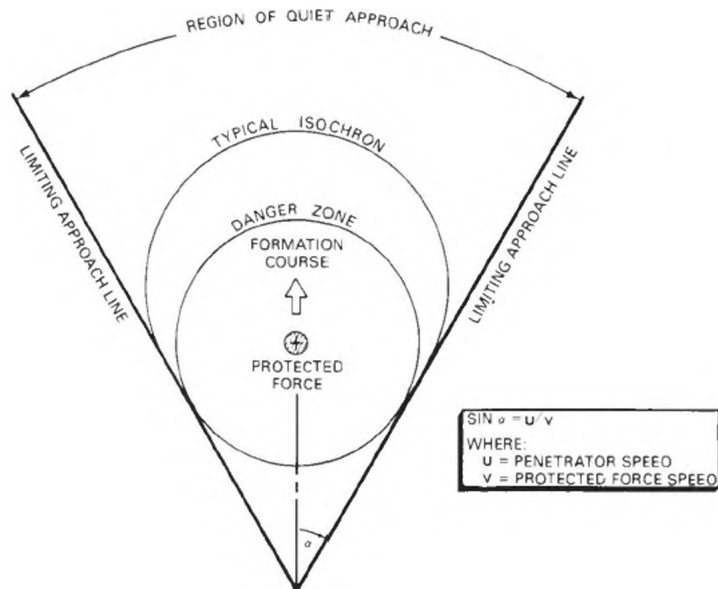
I. SPEED IN THE PROTECTED FORCE

(U) The logical starting point for a discussion of the utility of speed in a protected force is the "limiting-lines-of-approach" concept (Reference A-5). Figure A-2 illustrates the essential features of that concept and is used as the basis for this discussion.

(U) As in other parts of this report, the maximum quiet speed, u , of a hostile submarine plays an important part in the tactics. This speed is given in References A-3 and A-6 as about 10 kt, although it may be increased by future improvements in design. Since the speed of advance (SOA), v , of the protected force exceeds that of the quiet submarine, enemy submarines will have to accept (a) being confined to the limited approach zone or (b) being detectable at much greater ranges because of greatly increased radiated noise that can be detected passively. Although high-speed penetrators can operate on the rearward flanks of the protected force formation, they could be detected by a moderate number of escort submarines operating behind the protected force. Thus, the present discussion is confined to the penetrators that are operating at or below their maximum quiet speed. The penetrators will move with a relative velocity vector, w , obtained by

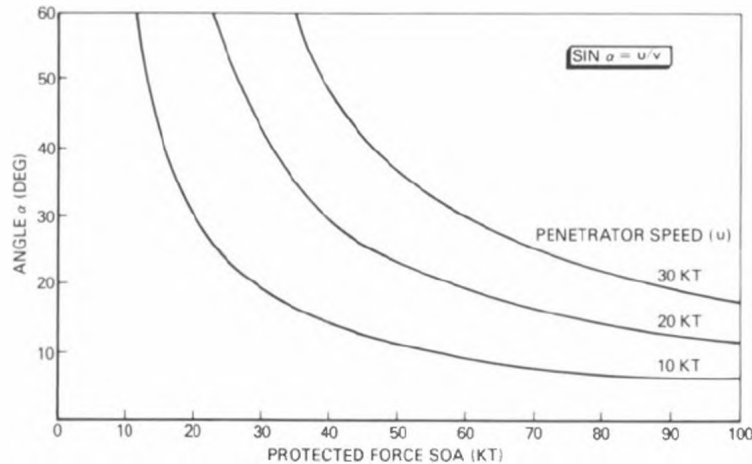

$$w = u - v.$$

(U) The danger zone shown in Figure A-2 contains the protected force and is bounded by a curve that is the locus of points that the penetrator must reach in order to fire a weapon at a unit of the defended force. Since the goal of the protecting force is to detect and kill enemy submarines attempting to penetrate the screen before they reach the danger zone, the escorts must detect the penetrators by the time they enter some larger region beyond the danger zone. Such a region is bounded by a line of equal approach time, called an isochron. As shown in Figure A-2, the limiting approach lines are tangent to the danger zone, sloping to the right and left at an angle, α , from the line of advance of the formation. As shown, α is the angle whose sine is equal to the maximum quiet submarine speed divided by the SOA of the formation.



(U) Figure A-2. LIMITING LINES OF APPROACH CONCEPT

(U) Figure A-3 shows the size of angle α as a function of the SOA of the protected force for enemy submarine speeds of 10, 20, and 30 kt. As shown in the figure, for a 10-kt penetrator, a small increase in protected force SOA within the 15- to 30-kt range yields a proportionately greater amount of decrease in angle α . However, for the same 10-kt penetrator, the curve flattens out when the protected force SOA is above about 40 kt and yields little additional benefit from any increase in formation SOA. The angle α corresponds to the minimum change in the direction by the formation that would be required to place the penetrator outside the limiting lines of approach. The smaller the angle is, the less the time required for the force formation to turn, the easier to control the formation during the turn, and the less distance added to the intended transit.



(U) Figure A-3. THE EFFECT OF FORMATION SPEED

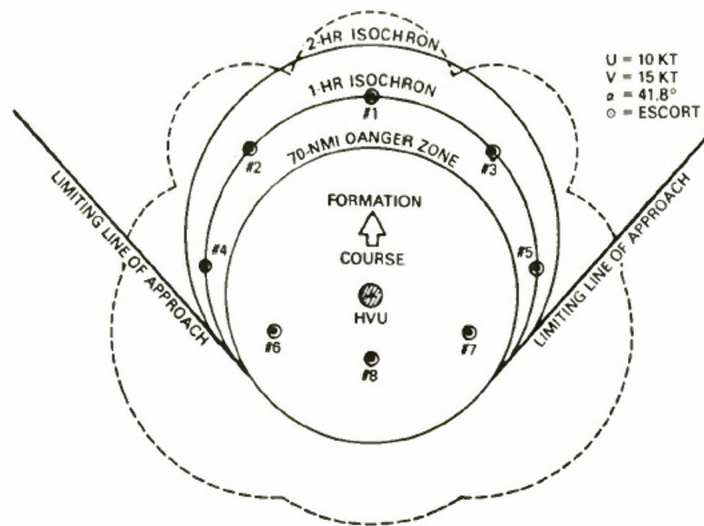
(U) Other factors being equal, a high SOA for the protected force not only makes the job of protection easier but also tends to reduce the number of ASW escorts required. With a high SOA, angle α decreases and the size of the quiet approach region diminishes; therefore, fewer ASW escorts are required to provide the force for the same degree of protection. Figure A-4 showing 15- and 30-kt SOAs illustrates this principle.

(U) With respect to the impact of speed in the protected force, this analysis considered only protected force SOAs in the range of 15 to 30 kt. In considering surface effect ships (SES), carriers, or high-speed amphibious warfare ships capable of 50- or 60-kt SOAs, even a 30-kt penetrator cannot increase angle α to more than 37 or 30 deg, respectively. That means that even ignoring noise, a submarine whose maneuvering speed is 30 kt cannot approach the protected force except from in front within 30 or 37 deg of the line of advance in force.

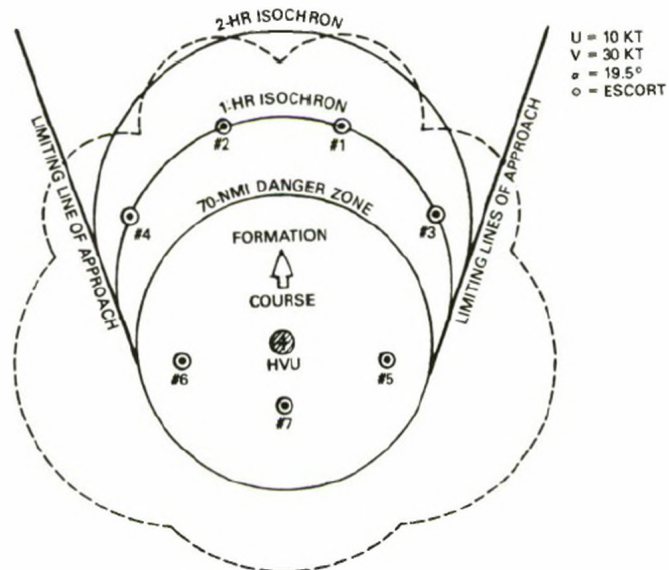
2. SPEED IN THE PROTECTING FORCE

(U) As demonstrated in the previous section, a high SOA for the protected force is beneficial because it (a) increases the penetrator's difficulty, (b) decreases the area that the protecting force must protect, and (c) results in the less-expensive force since fewer escorts are needed. This section focuses on the *protecting* force (those forces providing defense for the *protected* force). In considering the impact of speed on the protecting force, both categories of ANVs (air and surface) are examined in antisubmarine warfare (ASW) and antiair warfare (AAW) operations.

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(a) 15-kt SOA WITH EIGHT ESCORTS



(b) 30-kt SOA WITH SEVEN ESCORTS

(U) Figure A-4. IMPACT OF FORMATION SOA ON NUMBER OF ESCORTS REQUIRED

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(U) In Volume 2, speed is shown to be an important design parameter for air vehicles. A parametric study that preceded the air vehicle point designs addressed the following four questions on an iterative basis:

- What is the job to be done?
- How much speed is available?
- How much speed is essential to do the job?
- What design alternatives exist?

As a result of that study, the design speed derived for each top-level requirement (TLR) for the air vehicle point designs represents a compatible match between capability and requirements to at least a first-order level of accuracy.

(U) On the other hand, the establishment of design speeds for the surface vehicles was not approached in terms of mission needs. Rather, the task of specifying design speeds for the surface combatant designs was addressed primarily from a "technology push" standpoint, by asking the following two questions:

- How much speed is available?
- How best can it be used?

Therefore, it became necessary during the mission requirements analyses to raise the following three corollary questions:

- How much speed is essential in the surface combatants?
- What alternatives exist?
- What factors are limiting with respect to speed?

The remainder of this section will deal with these latter questions as applied to surface ANVs.

(U) Given that high speed is desirable in the protected force, it follows that it is at least equally desirable in the protecting force. The question is how much is enough.

2.1 ASW Operations

(U) In ASW sensors postulated for 1995, the emphasis has been placed on passive acoustic detection. These sensors achieve their best performance at low to moderate speeds;* however, most advanced vehicles are capable of higher speeds than those of conventional ships. Therefore, what is demanded is a two-phased, cyclical tactic that would take advantage of a platform's and sensor's best performance range while maintaining a high average SOA to take advantage of the benefits of high speed in the protected force. One such tactic is called "sprint/drift". Figure A-5 shows the tactic with a towed-array sensor.

(U) In addition to the high-speed sprint followed by a low-speed, listening period, the diagram shows the effective sonar range and the overlap area that is covered both at the end of one drift period and at the beginning of the next one. The basic expression relating the key sprint/drift parameters is

$$t_c = \frac{kR \left(\frac{1 - V_D}{V_s} \right)}{SOA - V_D}$$

where t_c = cycle time (hr),

R = detection range (nmi), normally the direct path or continuous coverage range,

V_D = drift speed (kt),

V_s = sprint speed (kt),

SOA = speed of advance of the protected force (kt), and

k = overlap factor.

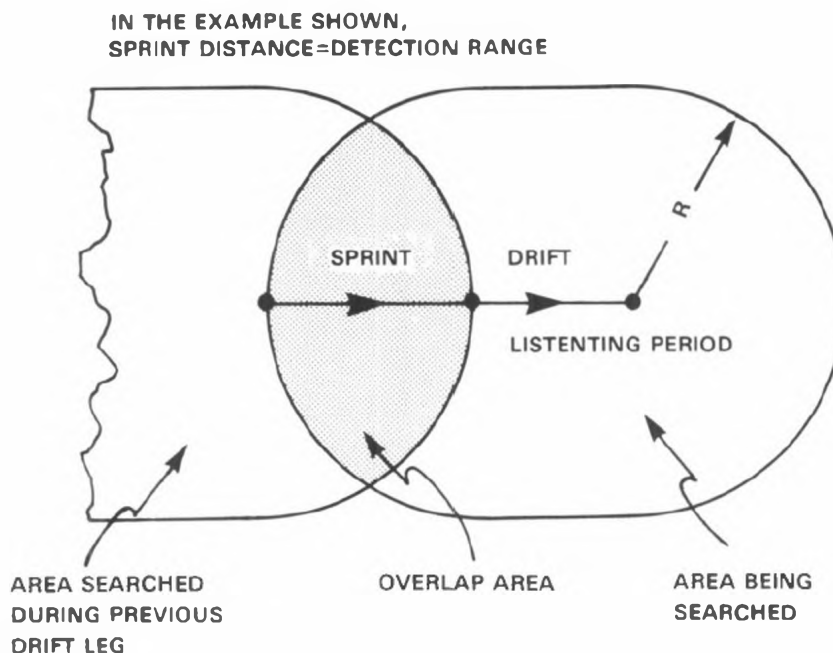
The cycle time is the sum of sprint time, t_s , and drift time, t_D . The relationship between sprint distance ($V_s t_s$) and the detection range of the sonar is given by

$$V_s t_s = kR.$$

* This performance refers to those sensors towed by or attached to the searching ship and not to remotely deployable arrays.

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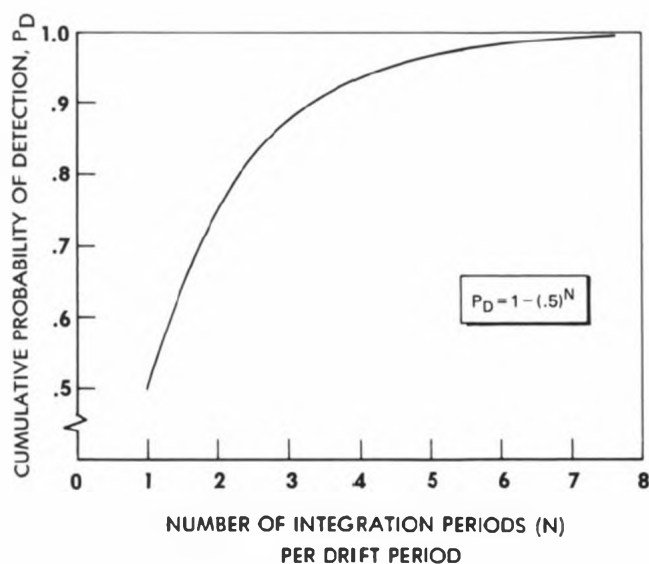
The overlap factor can take on values from 0 to 2; the diagram (Figure A-5) shows the overlap for $k = 1$, or a sprint distance just equal to the detection range. The situation in which $k = 2$ is sometimes referred to as a nonredundant search since there is no overlap. For $k = 0$, there is a 100 percent overlap; in actuality, that would no longer be a sprint/drift tactic but merely a continuous search ($SOA = V_D$). The concept of overlap is important in the sprint/drift tactic because it protects against a penetrator that enters the area during the sprint period. Although the analysis deals only with regular cycles, randomness is advantageous in further protecting against penetration by a smart penetrator.



(U) Figure A-5. USE OF SPRINT/DRIFT TACTIC WITH A TOWED ARRAY

(U) In selecting the “best” possible sprint/drift tactic for a given operation, the planner treats R , k , and SOA as givens, and varies V_D , V_S , t_D , and t_S within reasonable limits. With the towed array, for example, V_D is limited to a maximum of about 15 kt, the speed at which flow noise begins to exceed ambient-noise background conditions. With active-passive reliable acoustic path (APRAP) sonar the maximum V_D permissible when the dipping sensor is being reeled out or in or is searching at depth is 3 kt or less; preferably the platform should be dead in the water. V_S cannot exceed either the maximum or survival speed of the sensor, whichever is lower.

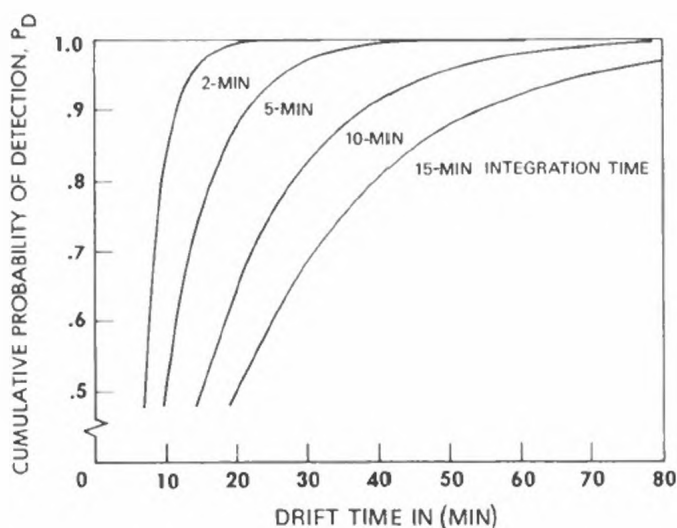
(U) Drift time is a function of the kind of passive sensor, the number of signal integration periods, and the length of the integration. Figure A-6 shows a plot of cumulative probability of detection (P_D) per sprint/drift cycle as a function of number of signal integration periods (N) per drift period. The point of diminishing returns is reached after about four integrations. The equation shown in Figure A-6 assumes that the P_D for a single glimpse, or integration period, is 0.5.



(U) Figure A-6. PROBABILITY OF DETECTION AS A FUNCTION OF INTEGRATION PERIODS

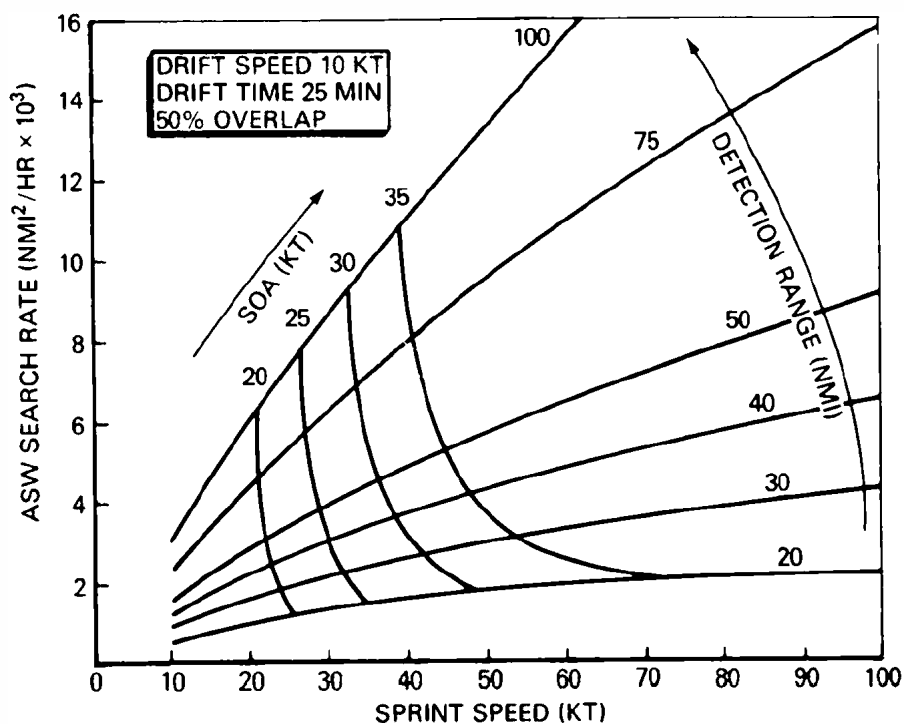
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(U) Figure A-7 shows the cumulative probability of detection per sprint/drift cycle plotted as a function of drift time for various signal integration times. The values plotted range from an optimistic 2 minutes to a pessimistic 15 minutes, with 5 minutes as the best estimate for the postulated 1995 capability. The plot also assumes a 5-minute array stabilization time at the beginning of the drift period prior to the start of the first valid signal integration period. The plot shows that for a drift time of 25 minutes, with the 5-minute integration time curve, a P_D of 0.9 or higher is possible.



(U) Figure A-7. EFFECT OF INTEGRATION TIME

(U) Several factors must be considered in selecting an appropriate sprint speed. Figure A-8 shows the effect of range and SOA on one of those factors, the search rate. A constant drift ($V_D = 10$ kt; overlap = 50 percent; $t_D = 25$ min) is assumed throughout. An increase in effective detection range has a greater effect on search rate than an increase in sprint speed for the range of SOAs of interest, 30 kt or less.



(U) Figure A-8. SEARCH RATE AS A FUNCTION OF SPRINT SPEED

(U) A second factor consists of the limitations imposed by the postulated ASW sensors. Table A-1 lists the ASW search sensors considered for future combatants together with those factors that are considered operationally limiting. The subsequent discussion will focus on the:

- depressor-towed-array survival limit (which places an upper bound on V_s if the array is streamed),
- depressor-towed-array handling time (which adds to the total cycle time if the array is reeled in and out for every sprint cycle),
- remote-linear-array handling time (which adds to the total cycle time in terms of recovering the array),
- speed restrictions while APRAP sensors are deployed (which require a high V_s in order to achieve a moderately high SOA).

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(U) Table A-1. ASW SEARCH SENSOR LIMITATIONS

SENSOR	ATTACHMENT	SENSOR DEPLOYED		TOTAL DEPLOY- MENT TIME PER CYCLE* (min)
		MAXIMUM SEARCH SPEED (kt)	MAXIMUM SPRINT SPEED (kt)	
ACTIVE/PASSIVE Depressor Towed Array	Tethered	15	50	20-75
LINEAR ARRAY				
Recoverable	Remote	NA	NA	40-75
Expendable	Remote	NA	NA	5-10
APRAP	Tethered	0	0	20-30

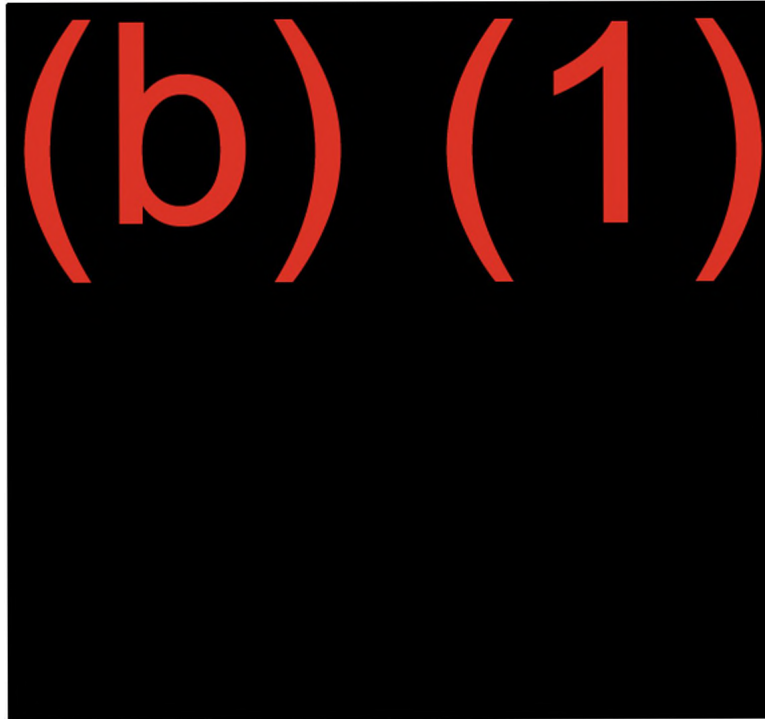
* Deployment time includes both reeling out and in times.

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(U) The greatest impact of the 50-kt survival speed limitation, however, is the limitation it places on maneuverability in emergency situations, e.g., repositioning for an incoming missile or air attack (given sufficient warning). This impact is examined further in the discussion of AAW in Section 2.2 of this chapter.

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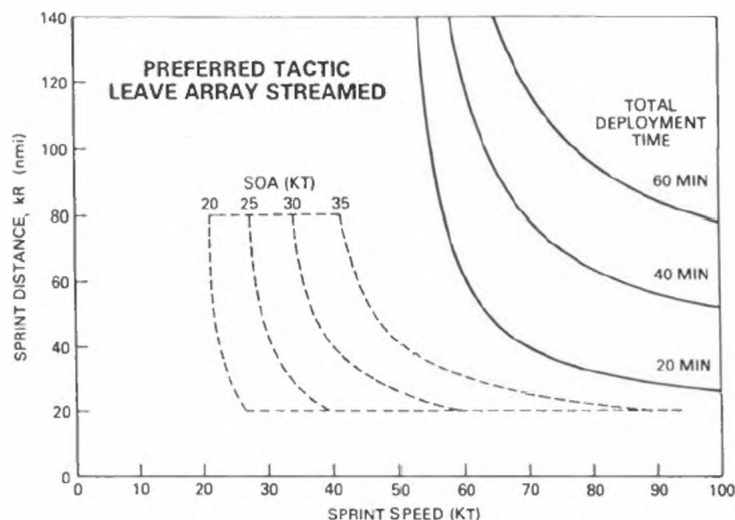


~~(C)~~ Figure A-9. SPRINT SPEED AS A FUNCTION OF DETECTION RANGE (U)

(U) Another limitation to sprint speed is the total time that must be expended in deploying the depressor towed array (reeling it out and in) per sprint/drift cycle. The most optimistic projection is 20 minutes (10 min to reel out and 10 min to reel in); the most pessimistic projection is 75 minutes (30 min to reel out and 45 min to reel in).

(U) These two limitations—the survival limit and array handling time—were analyzed to determine whether it is preferable to allow the array to stream during the sprint period or to reel it in. The results of this analysis are given in Figure A-10 in the form of indifference curves for various total deployment time conditions. The plot shows the sprint distance per cycle as a function of the sprint speed for various deployment times. For each deployment time indicated, the curve represents the condition of indifference between leaving the array streamed or reeling it in for the sprint period. In the area below and to the left of each curve, the preferred tactic is to leave the array streamed for the entire sprint/drift cycle, while, conversely, in the area above and to the right of each curve, the preferred tactic is to reel in the array for the sprint period and then reel it out again for the drift period. As shown, the best tactic for the SOA of most interest (up to 30 kt) is to let the depressor array continue to stream during the sprint period.

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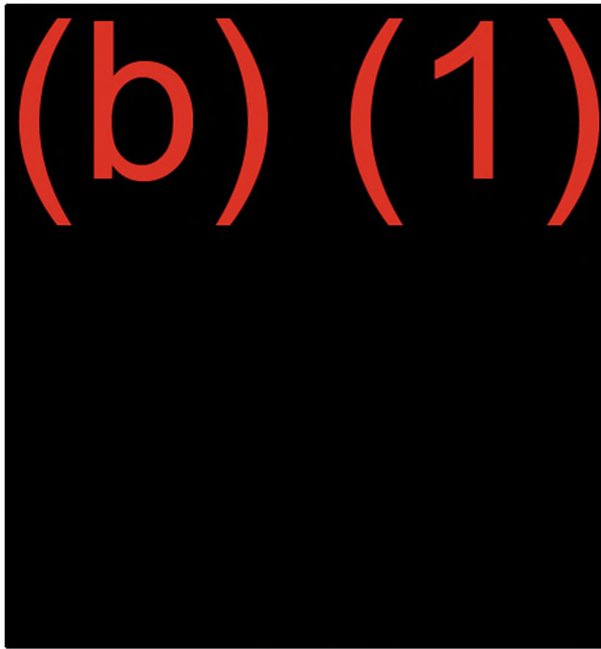


(U) Figure A-10. INDIFFERENCE CURVES FOR DEPLOYMENT OF TOWED ARRAY

(U) With respect to the remote linear array, a range of deployment values was considered for the recoverable array from 40 minutes (20 min out and 20 min in) under the most optimistic conditions to 75 minutes (30 min out and 45 min in) under the most pessimistic conditions. The great advantage of remote sensors is that they permit high-speed platforms to retain their speed and mobility while prosecuting a target. However, in the protection of moving forces, this tactical advantage is outweighed by the handling-time limitation as well as the logistic problems associated with the need for rapid refurbishing, rerigging, and turnaround to keep up with a moving force. The recoverable, remote sensor is best utilized in fixed-area sanitization or barrier (choke-point) operation, where frequent handling is not required. While expendable remote sensors eliminate the time problems involved in handling, the cost involved in using such sensors for an extended moving-force protection operation would be prohibitive.

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~~(C)~~ Figure A-11. SPRINT/DRIFT PARAMETRICS
FOR APRAP (U)

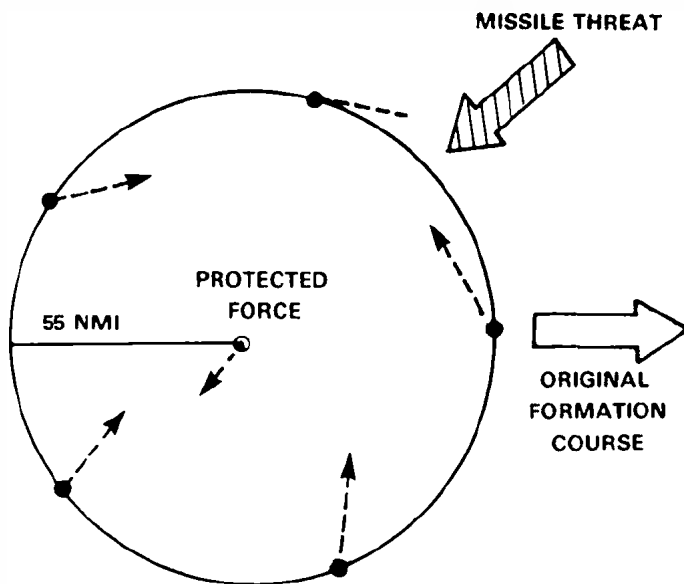
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2.2 Antiair Warfare Operations

(U) The effect of speed on the protecting force is not limited to its ASW activities. The contribution of speed to the force's capability in AAW area defense must also be examined. In the basic situation examined, the protected force is proceeding at a 25-kt SOA on an easterly course under Atlantic environmental conditions. The formation is being protected by a force of five ANVs arranged in a circular ASW disposition with radius of about 55 nmi. Assuming that the force is warned of an incoming missile threat from the northeast, the ANVs maneuver at best speed to maximize their AAW, area-defense firepower while the formation turns and heads directly away from the missile threat. The tactical situation is illustrated in Figure A-12.

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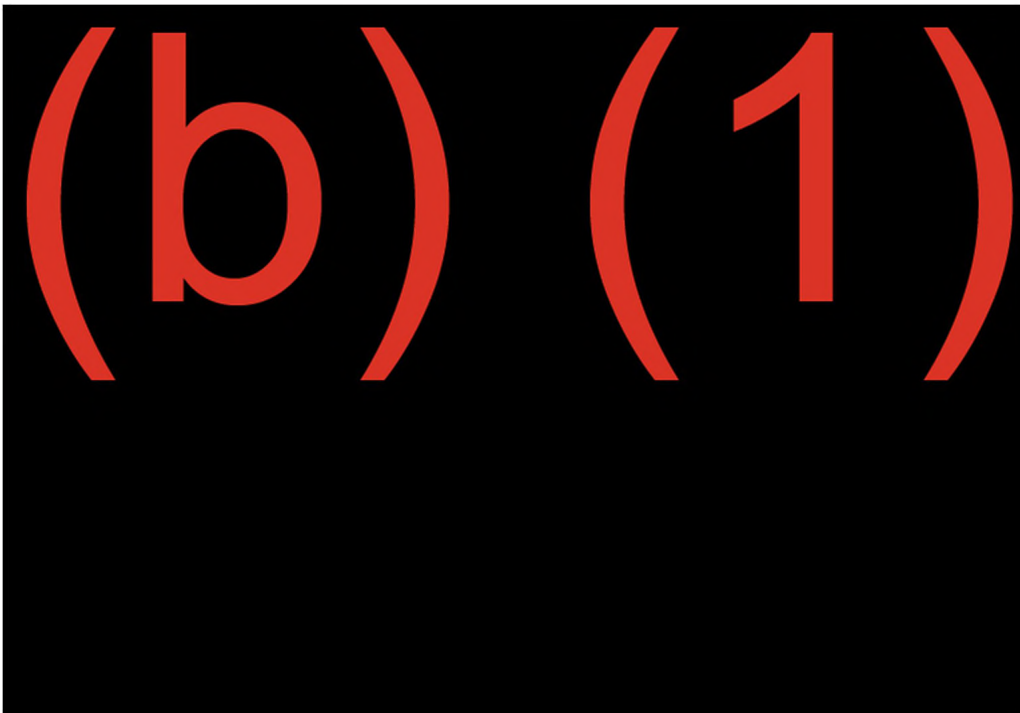
(U) Figure A-12. AAW AREA DEFENSE FROM ASW DISPOSITION

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~~(C)~~ Figure A-13. SPEED IN AN AAW AREA DEFENSE OPERATION (U)

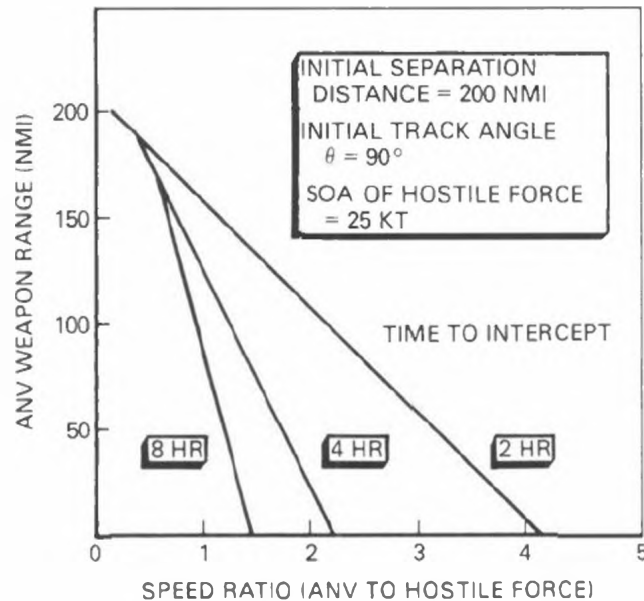
3. SPEED IN THE COMBAT SUITE

(U) Sections 1 and 2 of this chapter assessed the impact of speed on the platforms involved—first the *protected* force and then the *protecting* force. In this section the utility of speed in the combat suite of a moving force is examined.

(U) In any engagement situation, four important variables affect the outcome for both the target and the attacker. The speed of each platform is the primary one, and the others are surveillance range (including that for contributing external sources), weapon range, and weapon response time (measured from detection to weapon launch). In the context of this discussion, the term “combat suite” encompasses all the associated subsystems that contribute to accomplishment of the assigned military mission; that includes such subsystems as sensors; weapon systems; tactical data systems; fire-control computers; command, control, and communications (C³) systems; identification, friend or foe (IFF); and navigation. The concept of “putting speed into the combat suite” refers to the ability to use superior sensor detection range, weapon range, or response time as a substitute for, or a hedge against, limited platform speed. Several numerical examples are given in Reference A-1 to illustrate the point; however, this is *not* a rigorous treatment of the subject.

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(U) The first example assumes a situation in which an ANV is assigned to intercept and attack (or pose a deterring threat to) a hostile surface force proceeding on a steady course at a 25-kt SOA. The initial separation is 200 nmi and the target course is perpendicular to the initial bearing (track angle $\theta = 90^\circ$). Figure A-14 indicates the nature of the trade-off for a potential ANV in pursuit in this situation.



(U) Figure A-14. TRADE-OFF BETWEEN WEAPON RANGE AND PLATFORM SPEED

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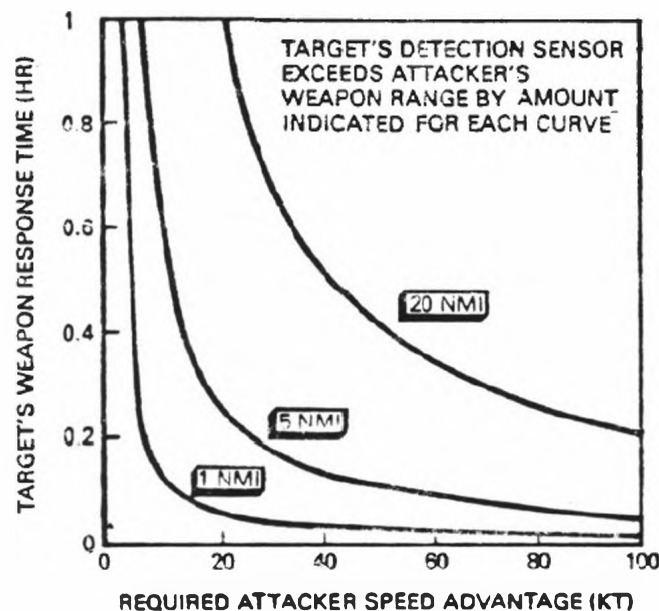
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(U) While this example is specific, some generalization is possible by proper scaling. By analogy, similar inferences can be drawn regarding sensor range versus platform speed. In this case, the mission is to achieve and maintain trail on a target, and hence, the trailing range of the sensor becomes analogous to the weapon range of the preceding example.

(U) The second example illustrates a situation in which an attacker uses a speed advantage to compensate for a limited weapon range. In this case, the attacker takes advantage of the target's long weapon response time by attempting to close at high speed and launch its own weapon before the target can launch one.

(U) Figure A-15 shows that when the target's sensor detection range exceeds the attacker's weapon range by 20 nmi, even an attacker speed advantage as great as 100 kt would be insufficient to prevent successful counterattack by the target if the target's weapon response time is less than 12 minutes; modern tactical weapons systems have much shorter response times.

(U) For the 5-nmi range difference case, a relative velocity of 100 kt requires the target to have a response time of 3 minutes or less in order to carry out a successful counterattack. In the third case, the 1-nmi range difference, the target must have weapon response time of approximately 1 minute or less, when the attacker's speed advantage is 40 kt or greater. Thus, a speed advantage must be large in order to ensure having the first shot unless the attacker's weapon range is comparable to, or greater than the target's detection range. Because of this sensitivity to detection range difference, improving weapon ranges seems to have a greater



(U) Figure A-15. TRADE-OFF BETWEEN TARGET RESPONSE TIME AND ATTACKER SPEED

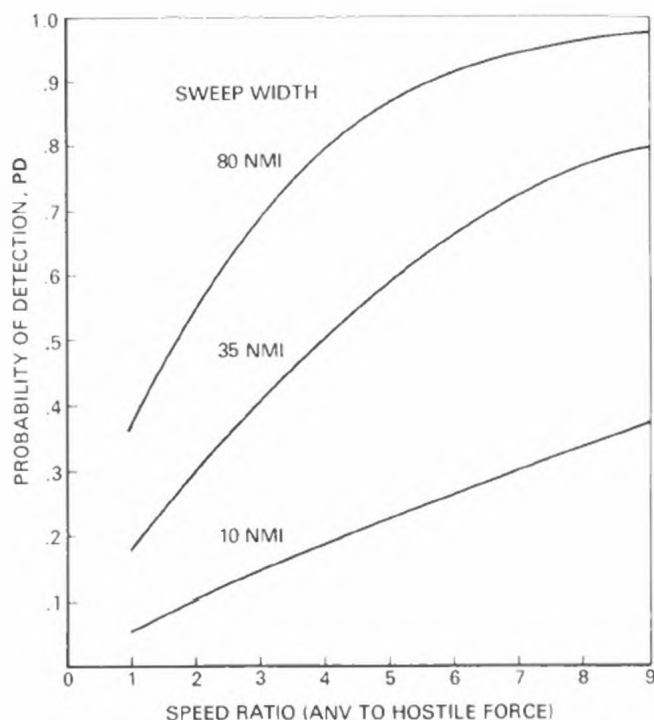
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payoff than does increasing platform speed. However, after the weapon has been launched, the attacker's speed may be greatly advantageous in degrading the accuracy of an attacker's weapon. This application of speed has been addressed previously.

(U) The third example given in Reference A-1 illustrates the trade-off between the detection range capability and the speed of the ANV (Figure A-16). In this situation, the ANV receives intermittent information on the location of the hostile force and closes on its last known position. As it does, the area of uncertainty increases as a function of the speed of the hostile force and the time required for the ANV in pursuit to reach this position.

(U) The simple case assumes a "cookie-cutter" sensor with constant sweep width. The probability of detection within the swath is unity; outside, it is zero. The ANV cuts a swath through the area of uncertainty and, in doing so, passes through the last known position of the hostile force.

(U) As shown in Figure A-16, a speed ratio (ANV to hostile force) of 4.0 with a 10-nmi sweep width results in the same P_D as a 35-nmi sweep width and a speed ratio of 1.0. The slopes increase with increasing sweep width, indicating that there is greater return in effectiveness (P_D) from an increased sensor range than from a comparable increase in speed ratio.



(U) Figure A-16. TRADE-OFF BETWEEN SENSOR RANGE AND PLATFORM SPEED

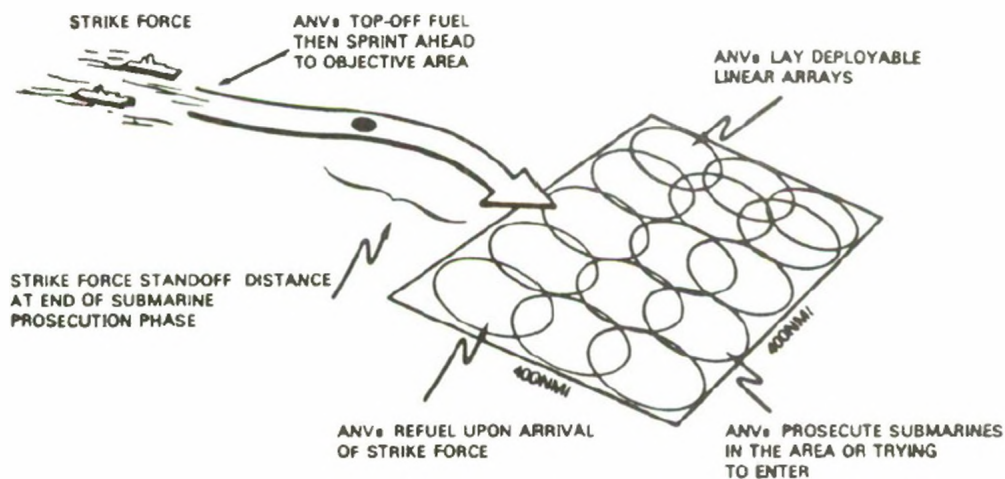
IV. FIXED-AREA OPERATIONS

(U) Fixed-area operations, by definition, are those in which the scene of action (or the intended objective area) is a fixed geographic area or point. The ANV may be in the area or proceeding to the area, depending on the specific nature of the operation. The four types of fixed-area operations examined are

- area clearance,
- crisis response,
- Sound Surveillance System (SOSUS) contact prosecution, and
- barrier operation.

I. AREA CLEARANCE

(U) Area clearance operations assume that there is a need to “sweep out” a large ocean area (approximately 400 nmi²) to be used as a safe operating haven for a carrier strike force. Figure A-17 shows the concept of operations for surface combatant ANVs.



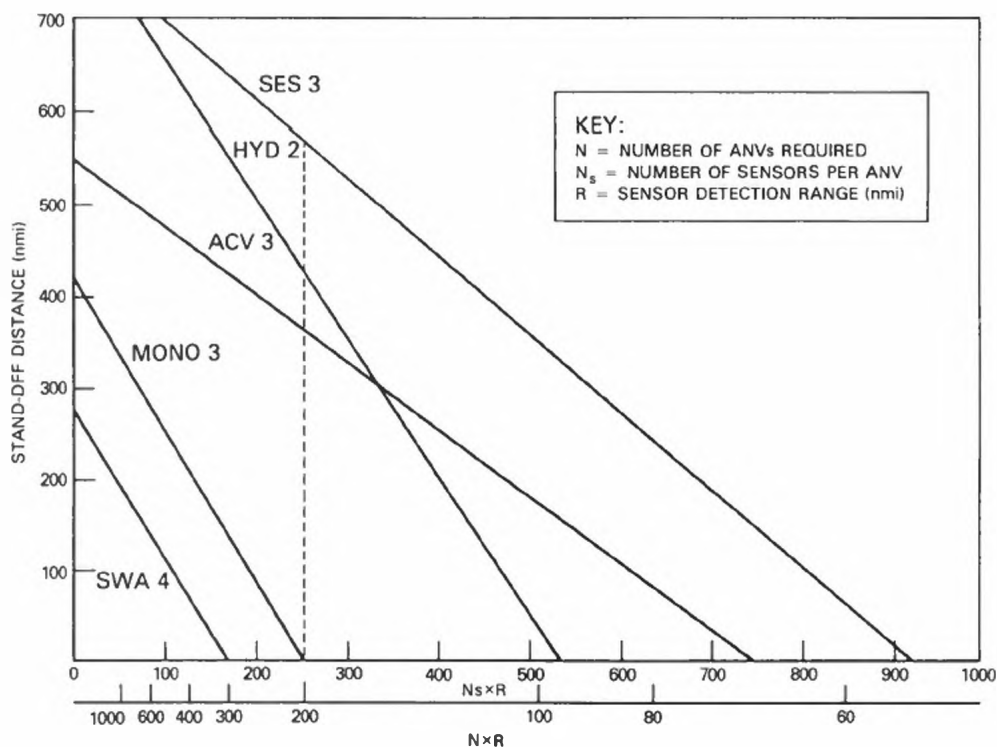
(U) Figure A-17. AREA CLEARANCE OPERATION

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(U) A strike force in transit dispatches a number of ANVs to sprint ahead and sweep a forward area. While the ANVs transit to the operating area and sweep it, the strike force continues its advance. When the ANVs have completed clearing the area of enemy submarines, the strike force is at a given standoff distance from the sanitized area. The ANVs then reduce speed and monitor the deployed sensor field until the strike force arrives.

(U) The measure of ANV performance is the standoff distance at the end of the sanitization phase; the greater this distance, the better the performance of the ANVs. Figure A-18 shows the standoff distance plotted as a function of the product of the number of sensors (deployable linear arrays) and the passive sonar detection range. A second scale is provided for the product of the number of ANVs and the detection range.

(U) For Atlantic conditions, with a sensor detection range of 40 nmi and five ANVs, the SES 3 can provide a standoff distance of about 660 nmi; HYD 2, about 430 nmi; and ACV 3, about 360 nmi. The relatively slower displacement ships, MONO 3 and SWA 4, and all of the 1000-tonne group could not feasibly provide the same standoff distance with just five ANVs.

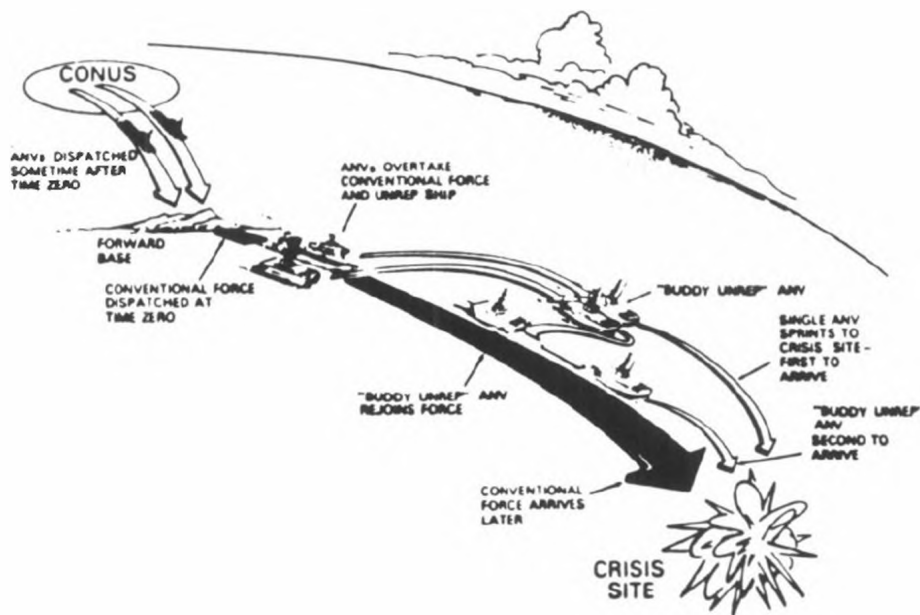


(U) Figure A-18. SURFACE ANV REQUIREMENTS FOR AREA CLEARANCE (ATLANTIC OCEAN ENVIRONMENT)

2. CRISIS RESPONSE

(U) The crisis response operation assumes that an urgent need exists for assistance at long range from the United States or one of its overseas bases and that the need can best be met by naval surface forces. The analysis seeks to measure how quickly a surface ANV can be on the scene at the crisis site, given that the distance to the crisis site exceeds the one-way transit range of the ANV. An underway replenishment (UNREP) concept called the "buddy-UNREP" is postulated in order to extend the range capability and facilitate the high-speed transit capability of the ANV.

(U) It is assumed that upon the National Command Authority (NCA) decision to render assistance (time zero), a designated logistic support force is dispatched from the forward base. As shown in Figure A-19, sometime after time zero, two high-speed ANVs leave the continental United States (CONUS) for the forward base. Upon their arrival, the ANVs top-off their fuel, take on any special medical stores or material required for the crisis, and then wait for the appropriate time to leave the forward base. In the analysis, the departure from the forward base is determined in order that the high-speed ANVs overtake and rendezvous with the conventional force at the appropriate time and distance. After refueling has been completed at a conventional UNREP ship with the force, the ANVs detach and sprint ahead at their best range speed. At a given time, the ANV designated as the "buddy-

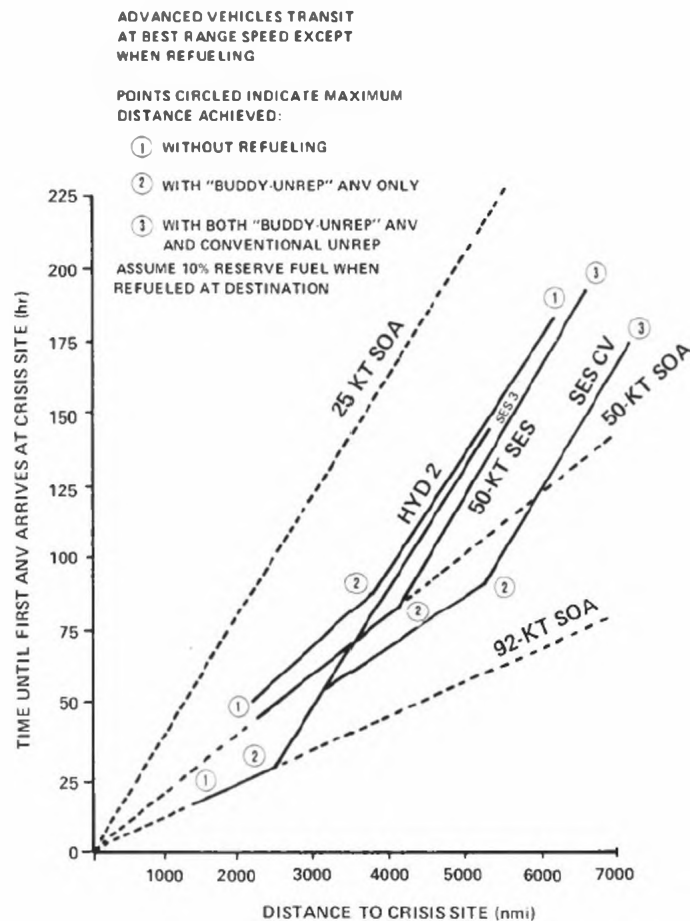


(U) Figure A-19. LONG-RANGE CRISIS RESPONSE

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UNREP" tops off the other ANV with fuel, after which the refueled ANV sprints to the crisis site and the "buddy-UNREP" ANV rejoins the conventional force still en route to the crisis site. The "buddy-UNREP" ANV stays with the conventional force until a specified time (again, determined by the analysis), when it detaches and proceeds independently to the crisis location. When the "buddy-UNREP" ANV arrives at the crisis location, it again refuels the first ANV, providing it with sufficient fuel until the conventional force arrives. It is assumed that neither ANV is below 10 per cent fuel upon refueling at destination.

(U) Figure A-20 shows the time until the first ANV reaches the crisis site as a function of the distance to the crisis site from forward base. The plot for each ANV shows that as the distance to the crisis increases, different refueling schemes are required. The maximum ranges achievable under three such operational approaches are shown: first, the maximum range without refueling; second, the



(U) Figure A-20. CRISIS RESPONSE CAPABILITY

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maximum range using only a "buddy-UNREP" ANV; and third, the maximum range achievable utilizing both a "buddy-UNREP" ANV and a conventional UNREP, as shown in Figure A-19.

(U) Table A-2 shows the time of response for various ANVs in reaching a crisis 5000 nmi from the forward base.

(U) Table A-2. TIME OF RESPONSE FOR CRISIS 5000 NMI AWAY

VEHICLE	SPEED (kt)	HOURS
SES 3	92	128
50-kt SES	50	121
HYD 2	45	134
SES CV	58	86
SES CVN	65	77
CONVENTIONAL FORCE UNREP	25	200

3. SOSUS CONTACT PROSECUTION

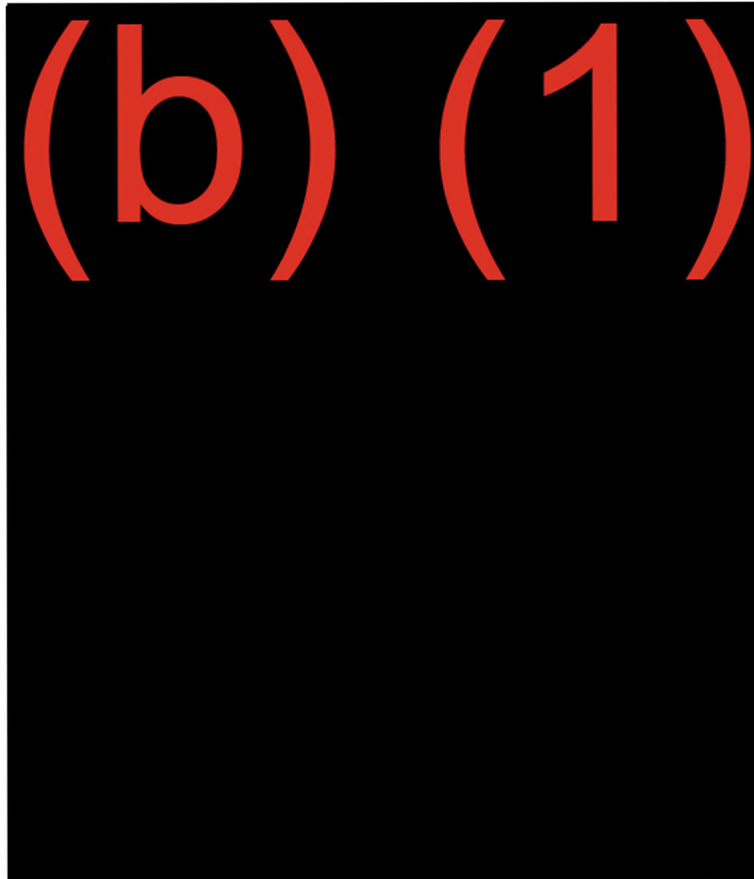
(U) The prosecution of SOSUS is examined as a function of vehicle speed and distance. In this operation the ANV receives information regarding a SOSUS detection of an enemy submarine, proceeds at best transit speed to the datum, and drops a deployable linear array in the center of the SOSUS probability area (SPA) in an attempt to redetect the enemy submarine previously detected by SOSUS. Since the enemy submarine is assumed to be transiting at its best quiet speed, 10 kt, the SPA is still treated as a fixed geographic area that grows in size as time passes.

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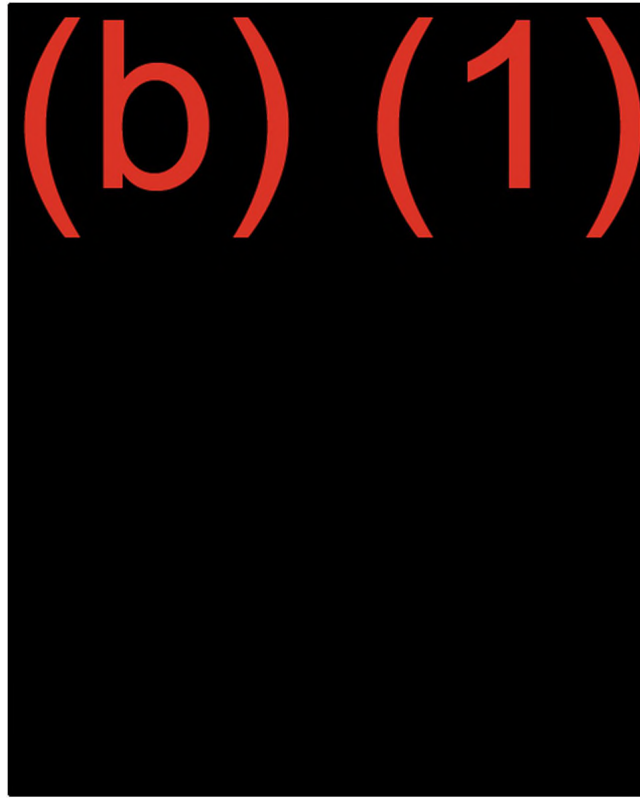
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~~(C)~~ Figure A-21. SOSUS RESPONSE (U)

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~~(C)~~ Figure A-22. EFFECT OF SPA SIZE IN SOSUS
CONTACT PROSECUTION (U)

4. BARRIER OPERATIONS

(U) The objective of ASW barrier operations is to deny passage to enemy submarines attempting to transit through straits. This choke-point control barrier, under steady-state conditions, involves ANVs monitoring fixed, long-range, passive sensors (usually remote linear arrays) and then responding when an enemy submarine is detected. The preferred method of localization and kill once an enemy submarine has been detected and classified is through use of embarked aircraft [light airborne multipurpose vehicles (LAMPS) Mk-XX or vertical/short takeoff and landing (V/STOL)] or other assigned patrol aircraft. The analysis shows that ANV platform speed does not have a significant impact in this operation; combat system parameters are the dominant factor in the calculation of effectiveness.

V. TRANSIT-RELATED OPERATIONS

(U) Reference A-1 examined the utility of speed in transit in terms of

- transit to station, which affects the number of vehicles necessary to maintain one on station;
- a sustained logistics support operation as a function of the productivity of the supply pipeline of goods; and
- transportation economics as a function of the associated value of time in transit.

I. TRANSIT FACTOR

(U) The transit factor is one of the components of the overall availability factor and is defined as

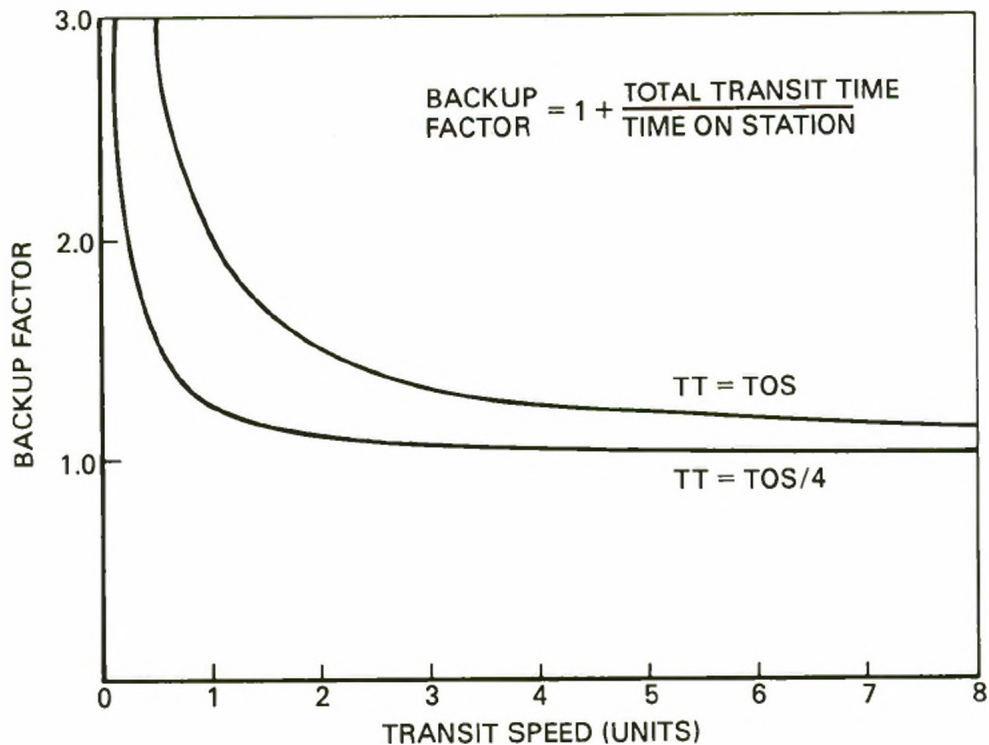
$$TF = \frac{\text{Time in Operating Area}}{\text{time in operating area} + \text{total transit time}}$$

The inverse of TF is the number of operational vehicles required as a backup in the pipeline to keep one on station. If replenishment is considered to occur only at base such that time in the operating area equals the time on station, then

$$\text{backup factor} = 1 + \frac{\text{total transit time}}{\text{time on station}}$$

Figure A-23 plots this expression for two cases: the upper curve represents the case of transit time (TT) equal to time on station (TOS) and the lower curve, transit time equal to one-fourth of the time on station (TOS/4). These curves show that at about speed ratio, changes in the unit transit speed greatly affect the backup factor. For the upper curve, doubling the transit speed (going from a speed ratio of 1 to 2) causes a 25 percent reduction in number of units required to keep one unit on station, and transit time is a significant part of time on station. In the lower curve, where time on station is four times greater, the effect of doubling transit speed only results in about a 10 percent reduction in the backup factor. For both curves, speed increases beyond a speed ratio of three or four provide only marginal return.

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(U) Figure A-23. IMPACT OF TRANSIT SPEED ON BACKUP FACTOR

(U) For any given transit distance, the backup factor is reduced by increasing the product of time on station and transit speed. The overall change in force-level requirements that results from increasing transit speed is also affected when platform endurance is independent of speed. When endurance is relatively independent of speed, increased transit speed will result in reduced force-level requirements. When platform endurance is a dependent function of speed, the overall effect of increased speed is not immediately apparent. In addition, other factors such as fuel consumption rates and capacities must be taken into account with specific concepts.

2. LOGISTICS SUPPORT

(U) The sustained logistics support is basically a pipeline of goods linking a supply point and a demand point, wherein a large amount of the material is en route at any given time. Productivity is the essential measure of effectiveness and is expressed in terms of ton-miles per unit time. Productivity is usually expressed by

$$\text{Productivity} = (\text{Payload}) (\text{Speed}).$$

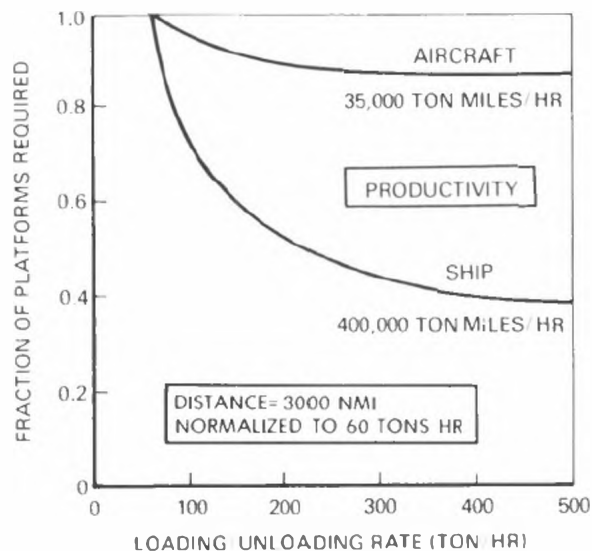
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(U) The number of platforms required to fill a specific pipeline demand is determined not only by a vehicle's productivity but also by loading and unloading rates as well. Where the number of platforms is a critical consideration, increased speed can be important in reducing requirements, particularly for pipelines over long distances.

(U) Figure A-24 shows the effect of loading and unloading rates on the fraction of platforms required (compared to the base case) to fill a pipeline for given productivities. Curves are shown for two representative productivities:

- 35,000 ton-miles/hr, typical of the C-5A aircraft (70 tons of payload x 500 kt), and
- 400,000 ton-miles/hr, which approximates a merchant ship (20,000 tons of cargo x 20 kt).

The curves are normalized to an unloading rate of 60 tons/hr (approximate rate for a C-5A) and represent a transit distance of 3,000 nmi. The relative number of platforms for a given productivity level decreases as the loading and unloading rates increase. Also, for each productivity curve, increasing the loading and unloading rates beyond specific points produces diminishing returns in terms of reducing the required number of platforms.



(U) Figure A-24. IMPACT OF LOADING AND UNLOADING RATES

3. AMPHIBIOUS ASSAULT LANDING OPERATION

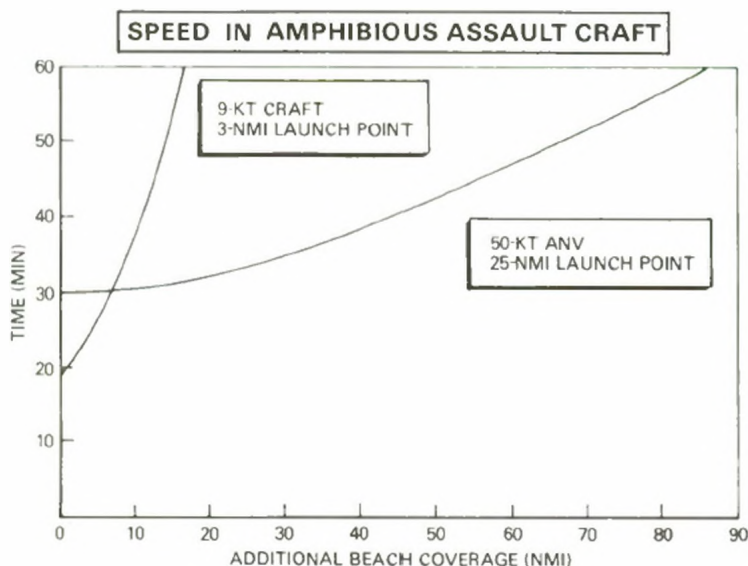
(U) The ship-to-shore movement in an amphibious assault is a special kind of transit-related operation in which speed is important. The effectiveness of the system or vehicles providing the ship-to-shore movement is defined in terms of the rate at which combat power is built up ashore—in short, the productivity of the assault landing craft involved.

(U) The Future Assault Craft Study (Reference A-7) conducted by the Center for Naval Analyses (CNA) and the “Concepts 85” Study (Reference A-8) conducted by the Naval Coastal Systems Laboratory conclude that high speed in the assault craft offers the commander of an amphibious operation the following qualitative advantages over conventional craft:

- The full capability of the helicopter assault ship (LHA) can be better exploited. The LHA carries both landing craft and helicopters. The comparatively short-range, low-speed landing craft is not operationally compatible with the long-range helicopter.
- A more flexible selection of landing sites within a much larger arc is possible from a given launch position. Because conventional landing craft must be launched no more than 3-4 nmi from their destination, only a short section of beach is accessible. A higher-speed (and longer-range) craft can land along a much larger arc of beach.
- Greater flexibility is possible in positioning lift ships in the amphibious operating area. Conventional craft must be launched close to the beach, which severely restricts the commander's choice of position for his lift ships. High speed allows the craft to be launched from a greater distance, which reduces the threat posed to the lift ships by shore-based weapons.
- The chance of tactical surprise is increased. When the lift ships must come close to shore to launch conventional assault craft, tactical surprise is virtually impossible. High speed permits assault craft to be launched from farther out, enabling the assault force to maintain the tactical element of surprise until the amphibious landing craft reach the beach.
- Speed in reinforcing forces ashore or redeploying forces already ashore better meets tactical requirements. High speed provides for a faster and better response in meeting the needs created by changes in the tactical situation.

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(U) Several of these qualitative advantages relate to the ability to stand off over the horizon with high-speed assault craft. Figure A-25 compares the beach coverage available and the time required from the two departure points: 3 nmi for a 9-kt, conventional, landing craft and 25 nmi for a 50-kt ANV.



(U) Figure A-25. EFFECT OF SPEED IN AMPHIBIOUS ASSAULT CRAFT

4. ECONOMICS OF TRANSPORTATION

(U) The third case, the economics of transportation, deals primarily with peacetime and commercial considerations and, hence, is of less relevance to military vehicles. The economics of transportation illuminates the utility of speed through the costs associated with time in transit. The time-dependent factors are the hourly operating costs of the platform and the inventory value of the goods in transit. These costs increase with time and, hence, are reduced by higher transit speeds. However, since higher transit speeds increase costs related to propulsion and energy consumption, there are fundamental trade-offs between time-dependent and energy costs. In general, an optimum vehicle for transporting cargo of a given value can be defined by a combination of time-dependent operating costs and the vehicle speed.

VI. SPECIAL-PURPOSE OPERATIONS

(U) Two operations that were outside moving force, fixed area, and transit-related operations and were categorized as special-purpose operations are:

- mine countermeasures (MCM) and
- defense against sea-launched ballistic missiles (SLBMS).

1. MINE COUNTERMEASURES

(U) In general, speed is a consideration in mine-sweeping because it has an impact on sweep rate, search rate, and other productivity-type measures. As the ANVCE Project evolved, only one vehicle concept was selected for the MCM mission. The small-waterplane-area, twin-hull (SWATH) vehicle concept was chosen for an MCM point design in order to exploit its large deck area, which is air capable, and its stability in heavy seas, which is suitable for motion-sensitive, deep-submergence, sweep gear. Platform speed was a minor consideration in the requirements specified by CNA in connection with its ongoing SWATH effort. Accordingly, the operational need for speed was not looked at in this particular kind of operation by the ANVCE Project.

2. DEFENSE AGAINST SLBMs

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(U) In summary, defense operations against SLBM-equipped submarines does not generate a requirement for very high speed in surface ANVs.

VII. CONCLUSIONS

1. GENERAL

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2. SURFACE VEHICLES

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- [REDACTED]

3. AIR VEHICLES

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APPENDIX B
THREAT ELEMENTS

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I. INTRODUCTION

(U) This appendix identifies and describes the Soviet threat against which advanced naval surface and air vehicles will perform. It treats first the Soviet submarine forces that will face the advanced naval vehicles (ANVs) operating in an antisubmarine warfare (ASW) role; then antisurface-ship warfare (ASUW) threat posed by Soviet forces; and finally, the Soviet forces that affect antiair warfare (AAW) operations.

B-1

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II. ANTISUBMARINE WARFARE ELEMENTS

1. INTRODUCTION

(U) This section identifies elements of the Soviet threat that could directly or indirectly affect the performance requirements of advanced naval surface vehicles performing ASW tasks. These threat elements are grouped into two categories. The first category considers the elements of the submarine platform and its performance capabilities that may have an impact on ANV ASW requirements. This category includes such issues as submarine speed and quieting. The second category considers the elements of the submarine weapon and sensor threat, such as torpedo speed and cruise missile range, that may have an impact of ASW requirements.

2. SUBMARINE PLATFORM THREAT ELEMENTS

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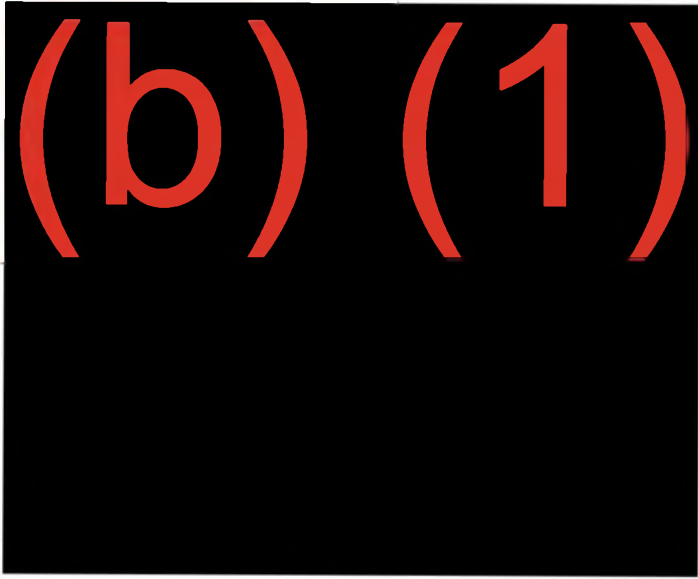
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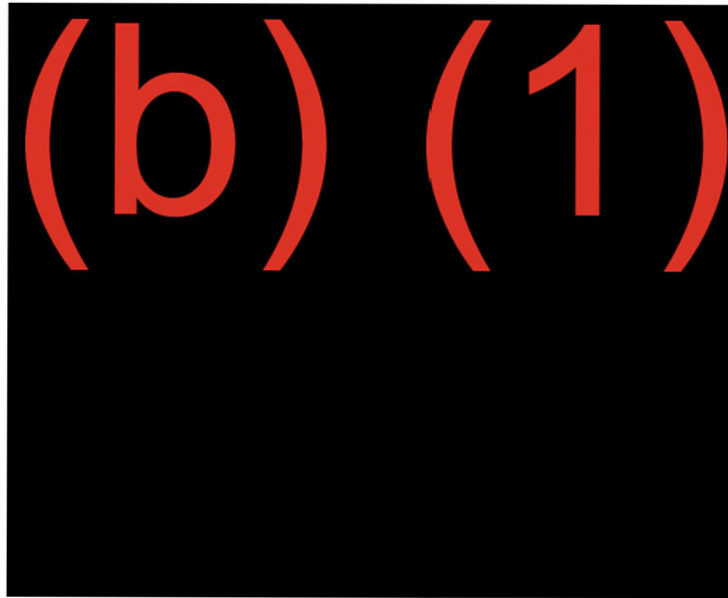


~~(S)~~ Figure B-1. GP SUBMARINE FORCE LEVELS
BY WEAPONS (U)

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~~(S)~~ Figure B-2. GP SUBMARINE FORCE LEVELS
BY PROPULSION (U)

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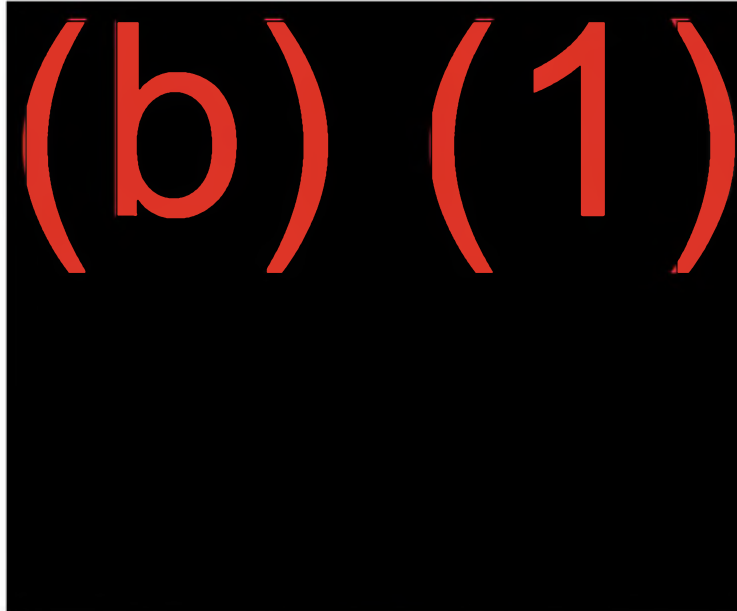
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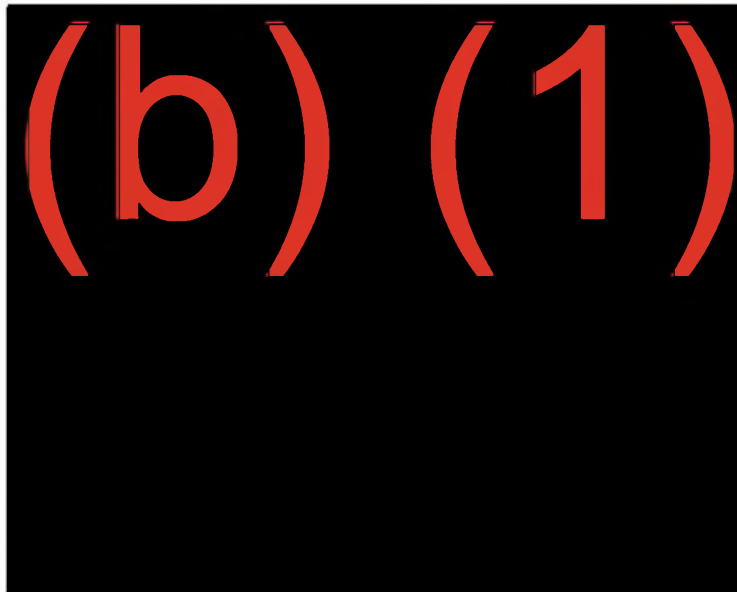
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~~(S)~~ Figure B-3. GP SUBMARINE FORCE LEVELS
BY SPEED (U)



~~(S)~~ Figure B-4. GP SUBMARINE FORCE LEVELS
BY LIMITING DEPTH (U)

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3. SUBMARINE WEAPON AND SENSOR THREAT ELEMENTS

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These elements are examined in the following paragraphs.

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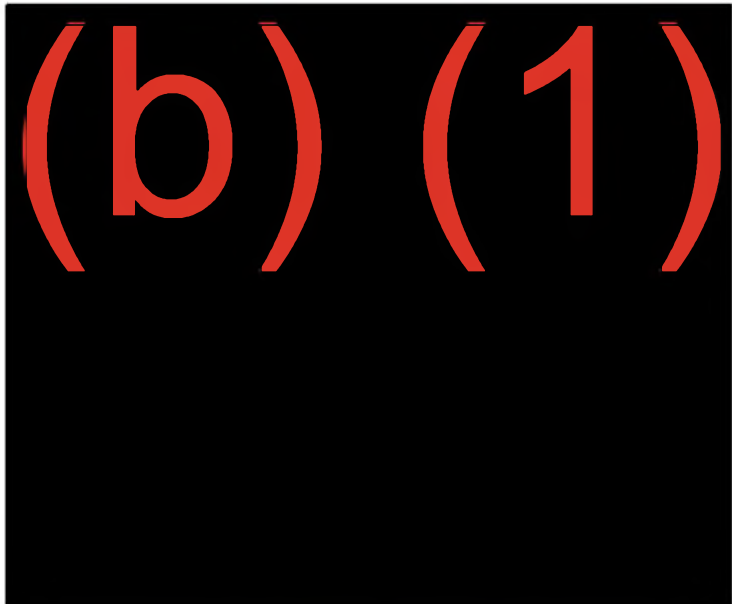
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~~(S)~~ Figure B-5. TORPEDO RANGE AT MAXIMUM
SPEED BY IOC (U)

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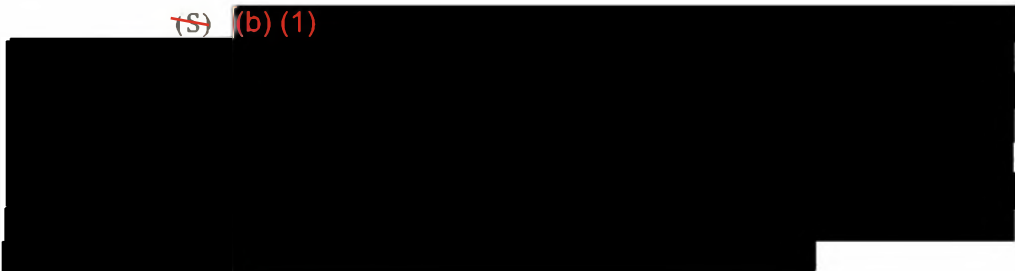


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~~(S)~~ Figure B-6. TORPEDO SPEEDS BY IOC (U)

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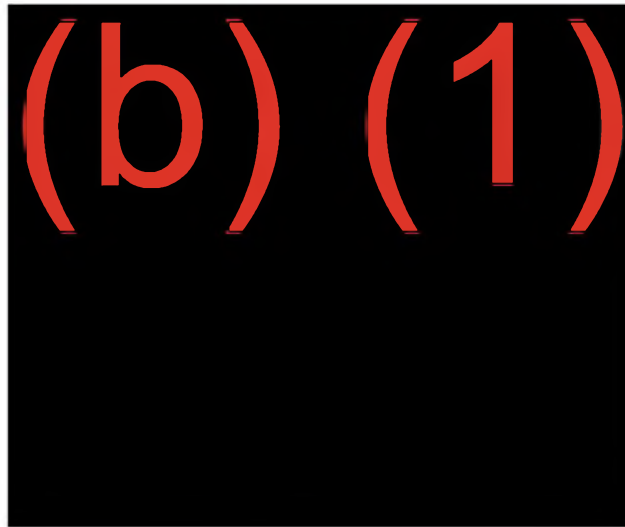
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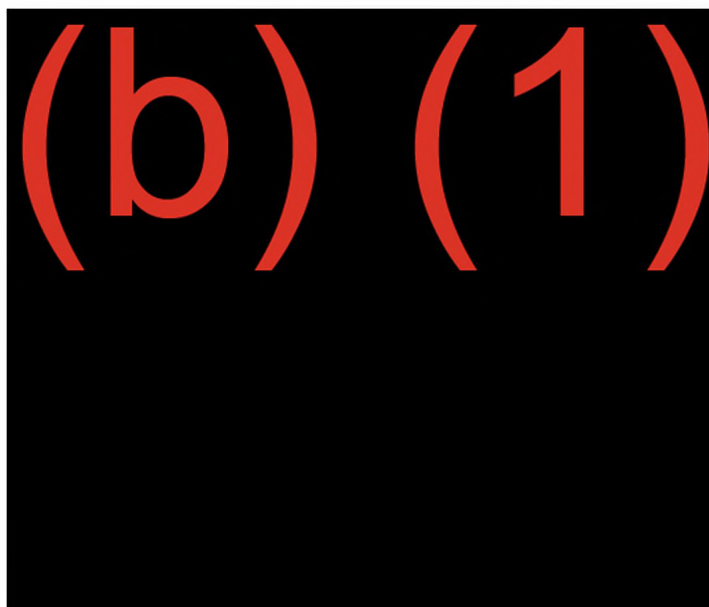
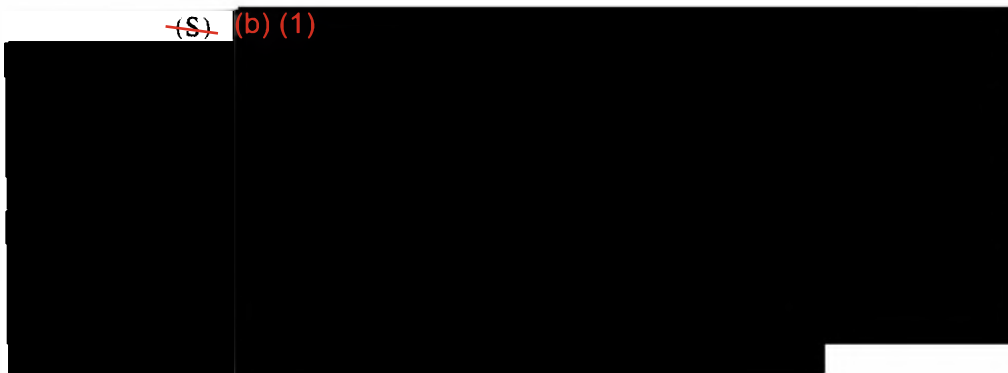


(b) (1)

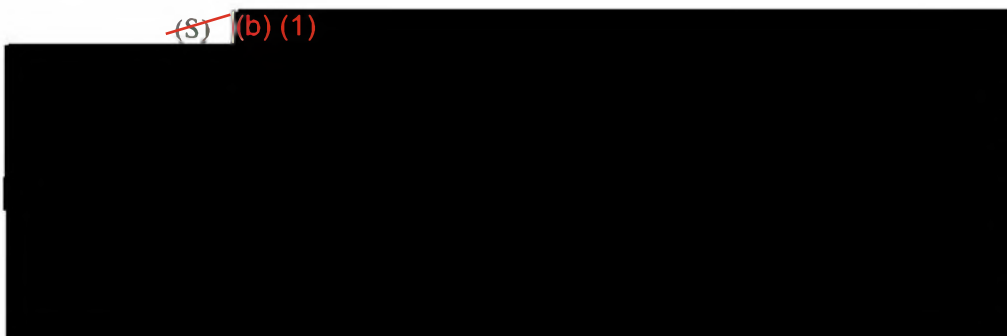


~~(S)~~ Figure B-7. SUBMARINE-LAUNCHED CRUISE-MISSILE
RANGE BY IOC (U)

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~~(S)~~ Figure B-8. GP SUBMARINE FORCE LEVELS
BY TOWED-ARRAY CAPABILITY (U)



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(b) (1)



B-12
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III. ANTISURFACE-SHIP WARFARE ELEMENTS

I. INTRODUCTION

(U) This section identifies elements of the Soviet threat that may directly or indirectly affect the performance requirements of advanced naval surface vehicles performing ASUW tasks. These threat elements are grouped into four categories: first, Soviet surface platform characteristics and capabilities; second, the anti-ship weapon performance; third, sensors that Soviet ships may employ for surface ship targeting; and fourth, Soviet air defense capabilities.

2. PLATFORM THREAT ELEMENTS

(U) The Soviet surface forces are composed of a variety of combatant platforms ranging from aircraft carriers to auxiliaries. They may be categorized into principal surface combatants (PSCs) (aircraft carriers, cruisers, destroyers, and frigates) and minor surface combatants (MSCs) (patrol combatants and coastal patrol craft). The following platform elements of Soviet principal and minor surface combatants have a potential impact on the ASUW capabilities of advanced naval surface vehicles:

- force levels;
- speed;
- size;
- chemical, biological, and radiological (CBR) warfare capabilities;
- redundant systems;
- air-capable platforms;
- surface-to-surface missile (SSM) platforms;
- antiship surface-to-air missile (SAM) platforms;

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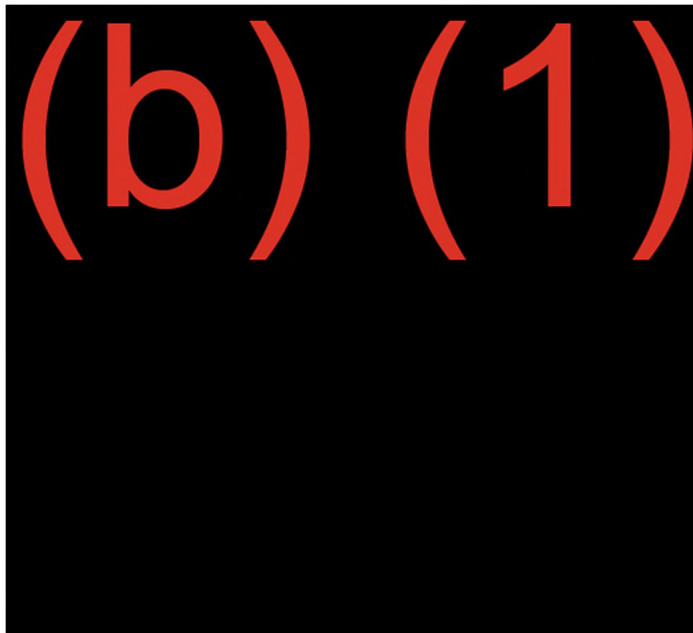
- large-caliber naval gunfire platforms;
- torpedo platforms;
- close-in weapon system (CIWS) platforms; and
- high-energy laser (HEL) platforms.

These threat elements are discussed in the following paragraphs.

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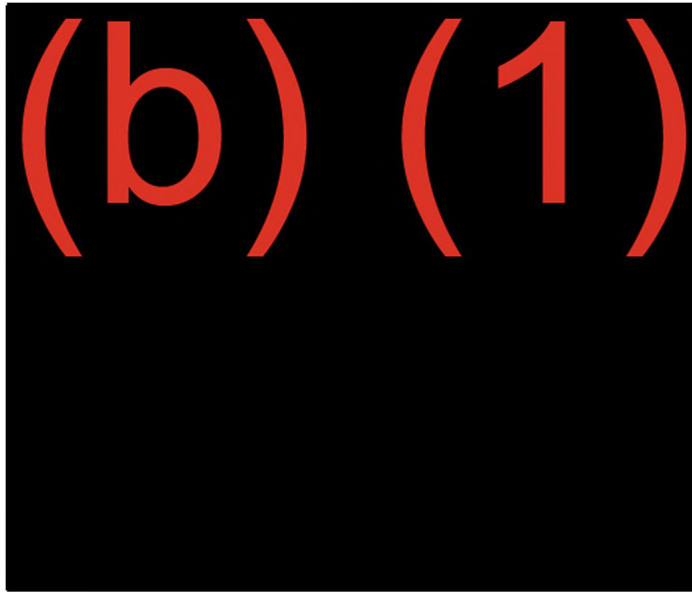


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~~(S)~~ Figure B-9. PSC FORCE LEVELS (U)

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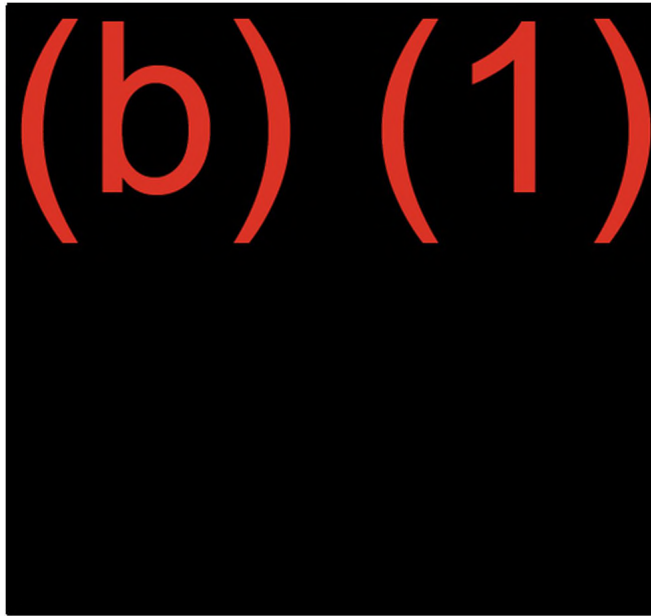
~~(S)~~ Figure B-10. MSC FORCE LEVELS (U)

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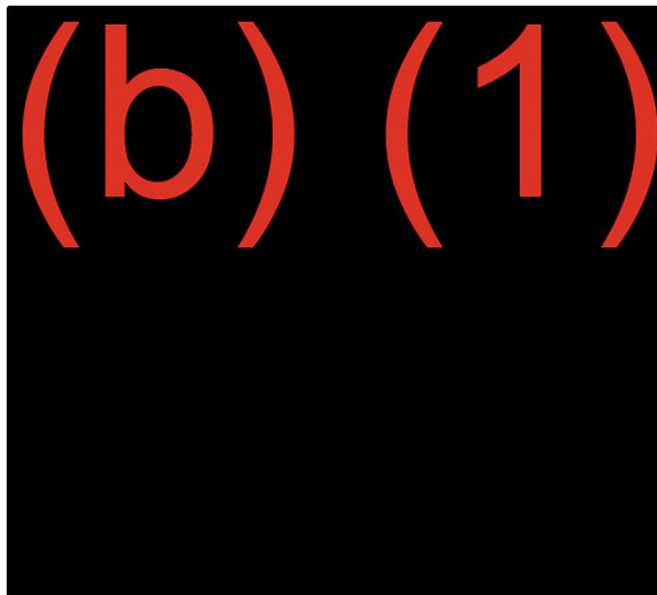
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~~(S)~~ Figure B-11. PSC FORCE LEVELS BY
FULL-LOAD DISPLACEMENT (U)



~~(S)~~ Figure B-12. MSC FORCE LEVELS
BY SPEED (U)

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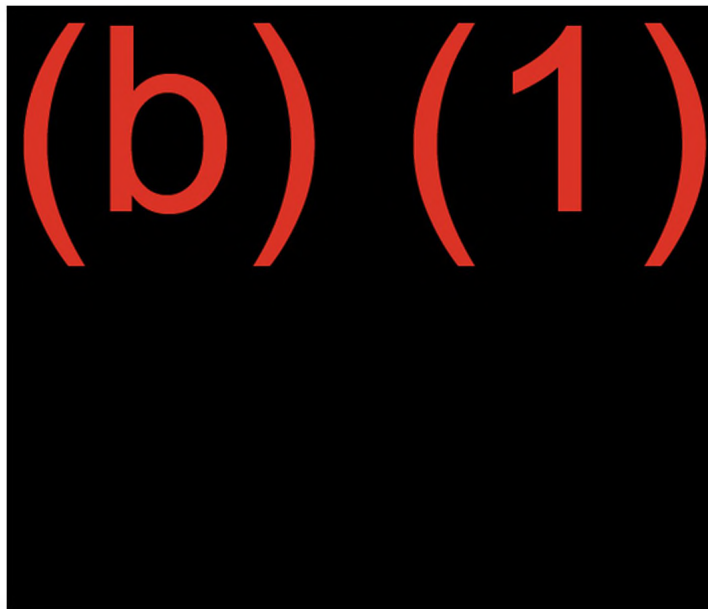
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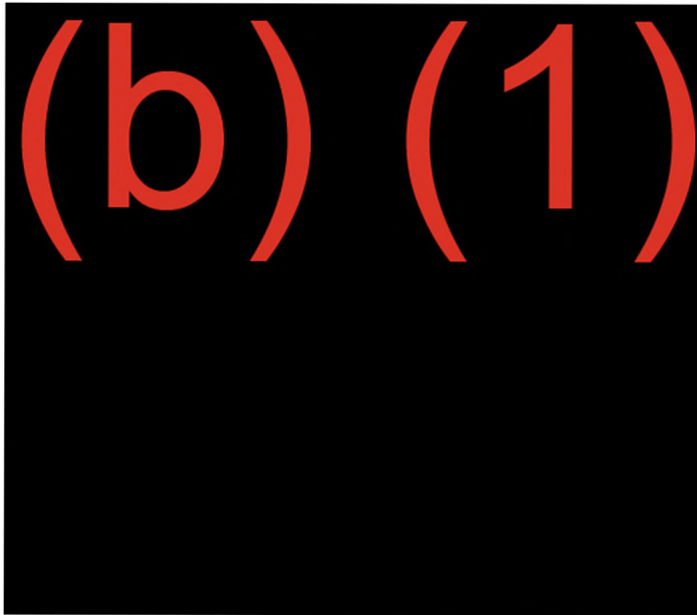
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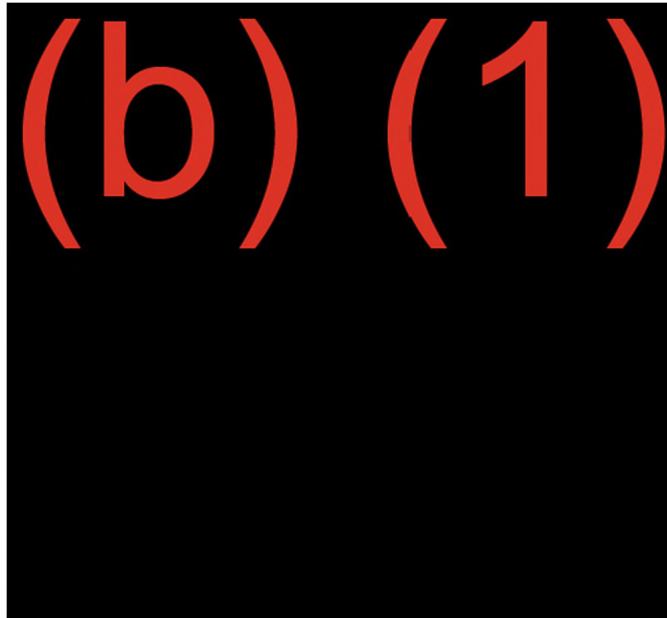
~~(S)~~ Figure B-13. AIR-CAPABLE PSC FORCE LEVELS (U)



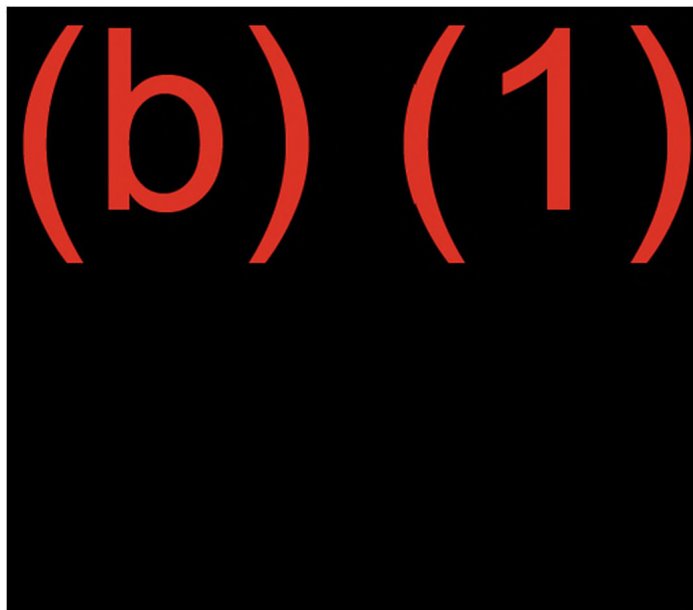
~~(S)~~ Figure B-14. AIR-CAPABLE MSC FORCE LEVELS (U)



* Projected PSCs that may possibly be equipped with SSMs [CV-P-II, CG-X-II, and CG(N)-P-IV] are not shown.



~~(S)~~ Figure B-15. SSM-EQUIPPED PSC FORCE LEVELS (U)

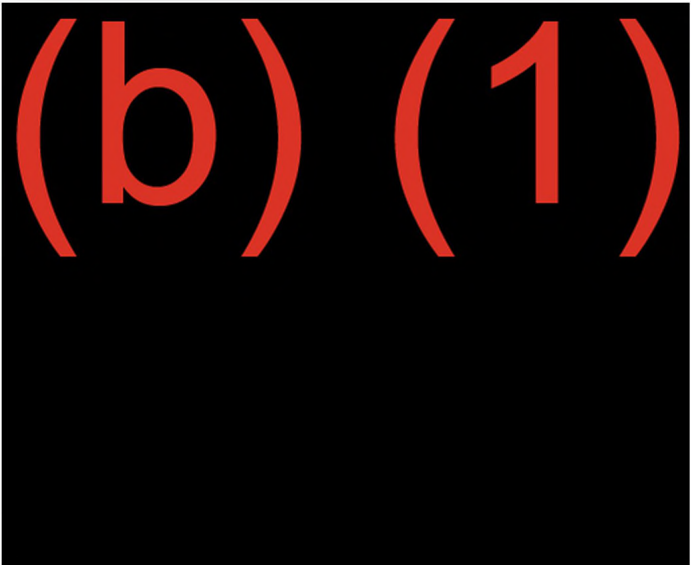


~~(S)~~ Figure B-16. SSM-EQUIPPED MSC FORCE LEVELS (U)

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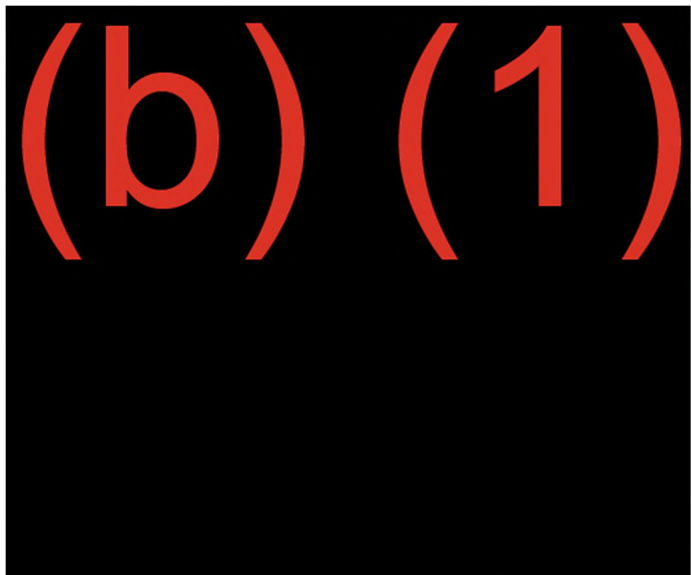


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~~(S)~~ Figure B-17. SAM-EQUIPPED PSC FORCE LEVELS (U)

(b) (1)



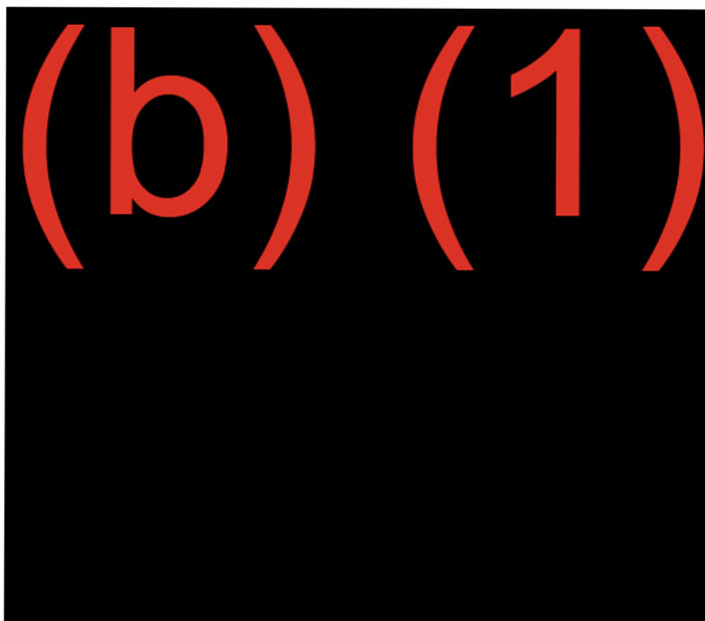
~~(S)~~ Figure B-18. SAM-EQUIPPED MSC FORCE LEVELS (U)

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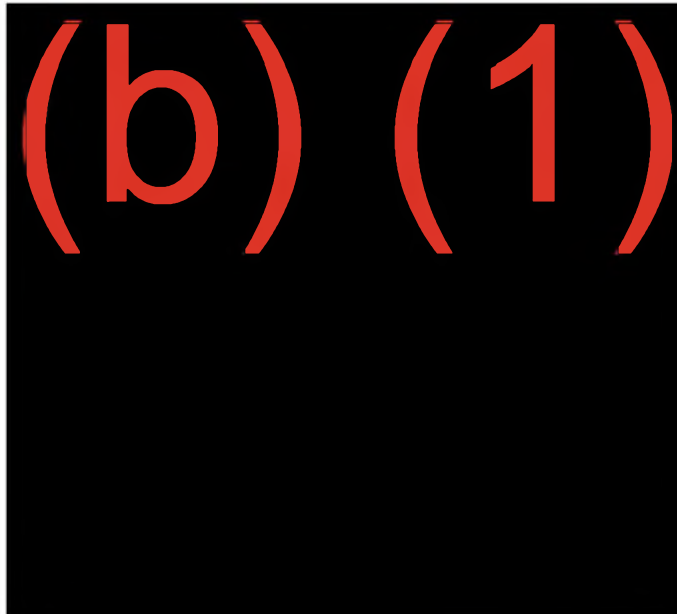
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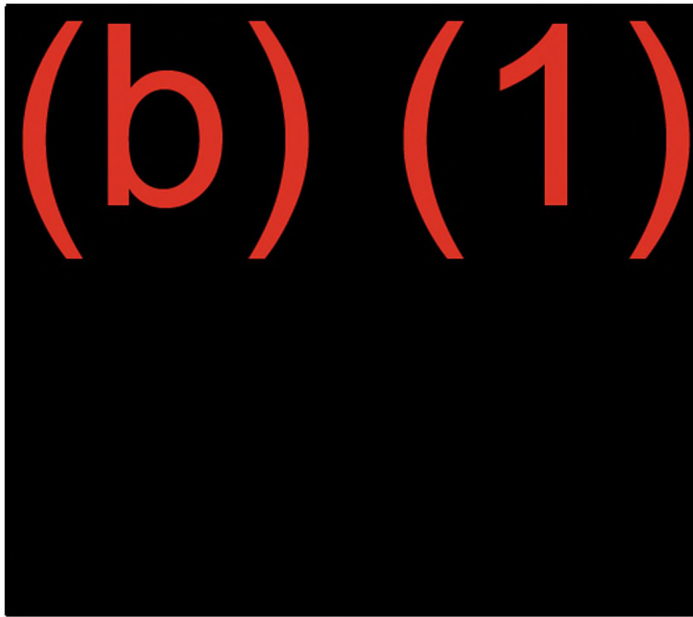


~~(S)~~ Figure B-19. NGF PSC FORCE LEVELS (U)

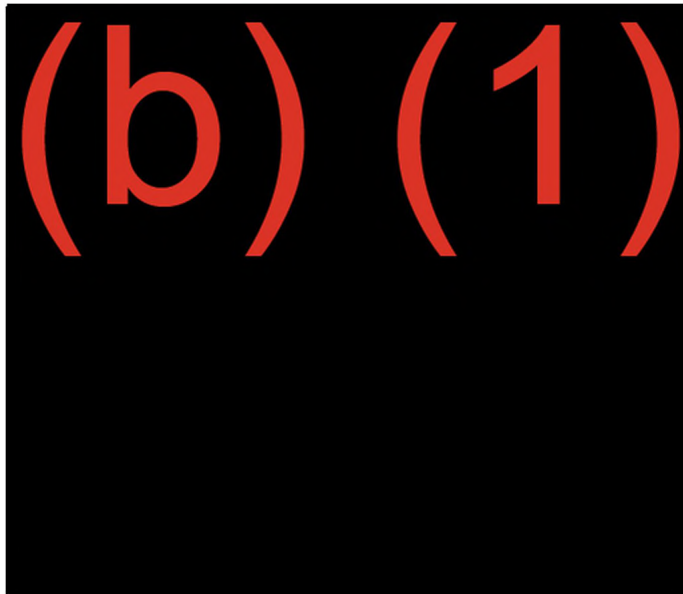


~~(S)~~ Figure B-20. NGF MSC FORCE LEVELS (U)





~~(S)~~ Figure B-21. TORPEDO-EQUIPPED PSC
FORCE LEVELS (U)



~~(S)~~ Figure B-22. TORPEDO-EQUIPPED MSC
FORCE LEVELS (U)

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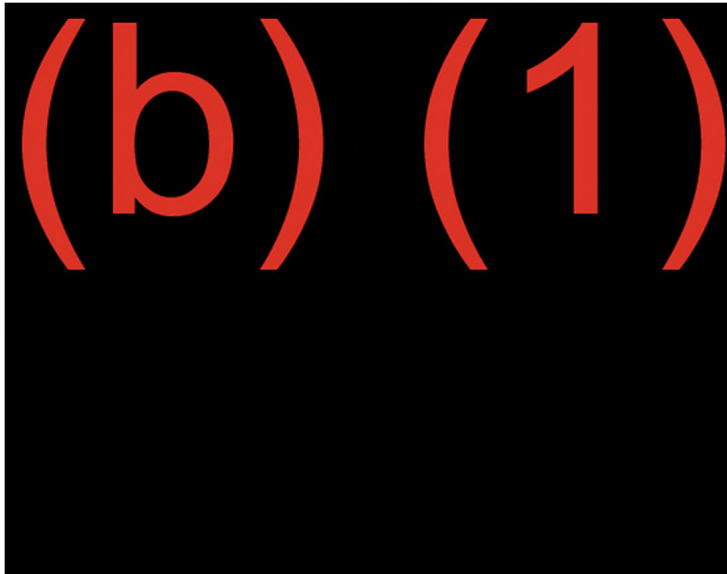
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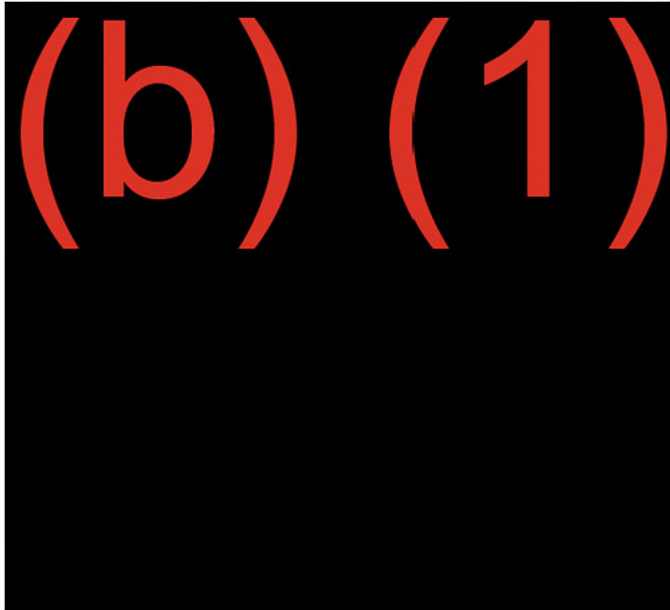
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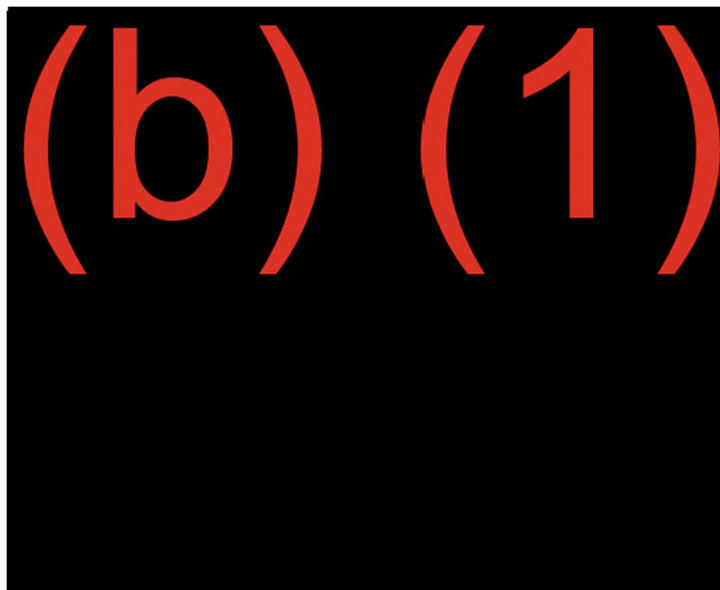
(b) (1)



~~(S)~~ Figure B-23. CIWS-EQUIPPED PSC FORCE
LEVELS (U)



~~(S)~~ Figure B-24. CIWS-EQUIPPED MSC
FORCE LEVELS (U)



~~(S)~~ Figure B-25. FORCE LEVELS OF PSCs
WITH HEL SYSTEMS (U)

3. ANTISHIP WEAPON THREAT ELEMENTS

(U) Several antiship weapon elements of the Soviet threat can have an effect on the ability of advanced naval surface vehicles to conduct ASUW tasks. The antiship weapons of Soviet surface combatants include V/STOL aircraft with tactical air-to-surface missiles (TASMs), long-range and short-range SSMs, SAMs in an antiship role, large-caliber naval guns, and antiship torpedoes.

(U) The following elements of the Soviet antiship weapon and sensor threat have a potential impact on the requirements for advanced naval surface vehicles conducting ASUW tasks:

- V/STOL aircraft force levels;
- antiship combat radius of V/STOL aircraft;
- range of ship-launched SSMs;
- range of SAMs in an antiship role;
- range of naval gunfire;
- accuracy of naval gunfire;
- warheads of naval gunfire;
- torpedo range;
- torpedo speed;
- torpedo guidance and homing;
- torpedo radiated noise; and
- torpedo warheads.

These threat elements are discussed below.

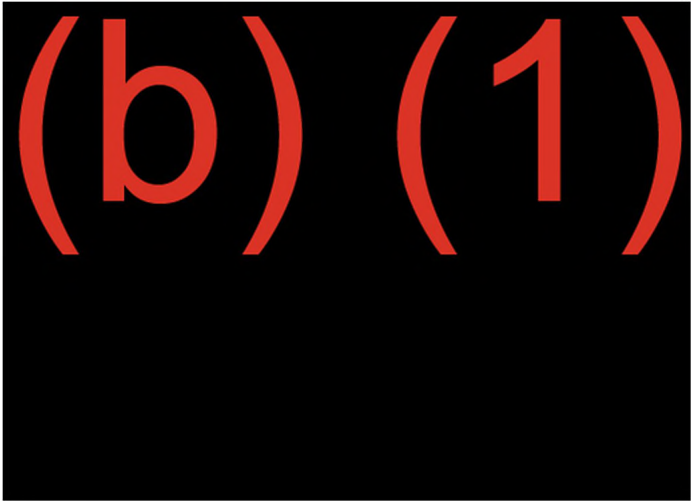
(U) The V/STOL aircraft force levels and their antiship combat radius are examined in Section 2.2 of Chapter IV; the range of ship-launched SSMs is treated in Section 3.1 of Chapter IV.

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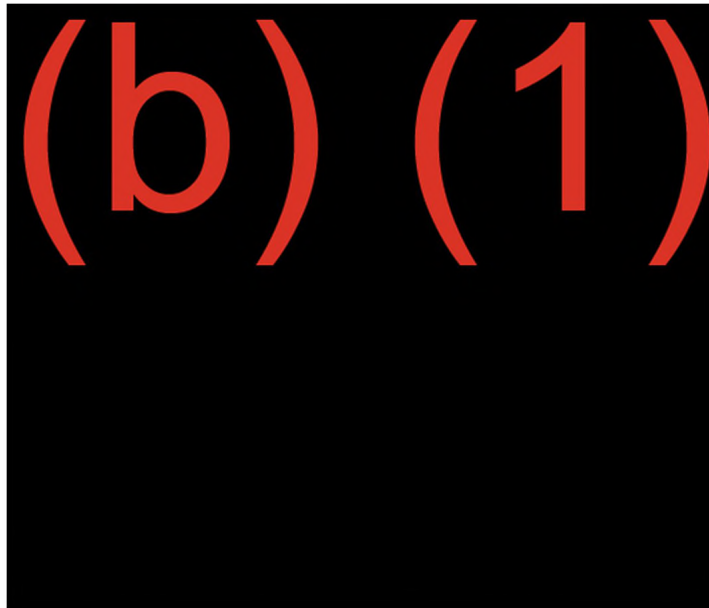
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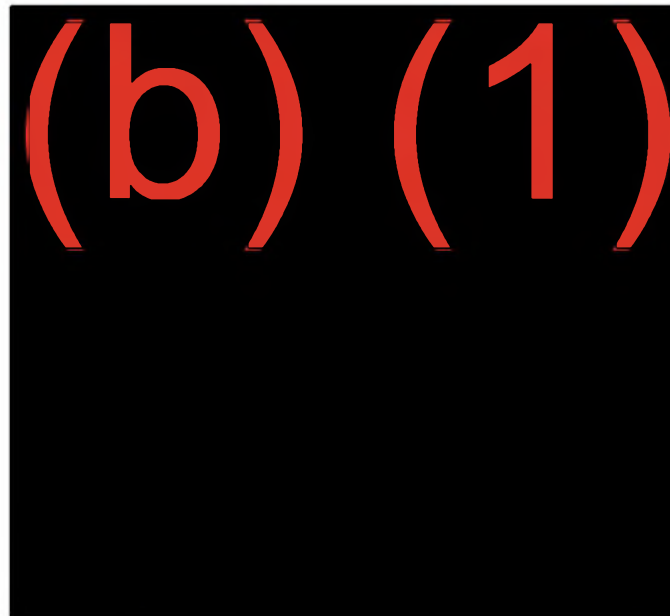
(b) (1)



~~(S)~~ Figure B-26. ANTISHIP RANGE OF SAM
SYSTEMS BY IOC (U)



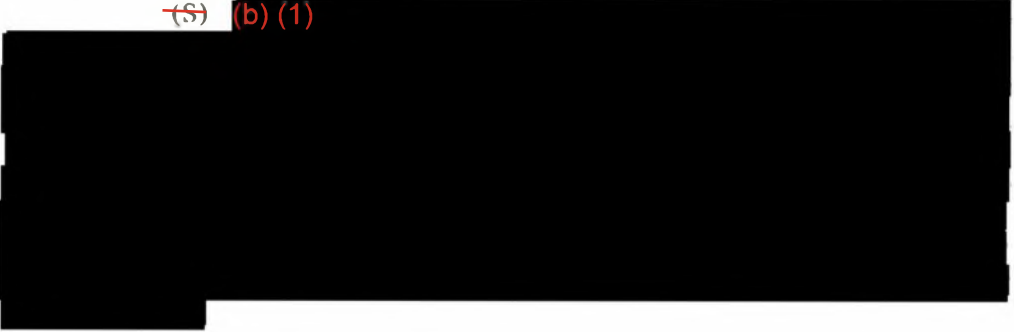
~~(S)~~ Figure B-27. SAM-EQUIPPED PSCs BY SAM ANTISHIP RANGE (U)



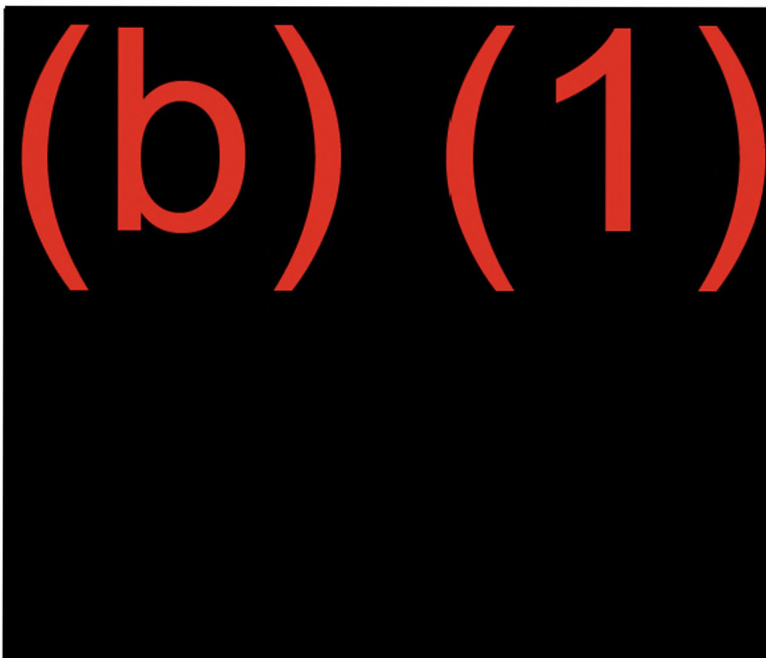
~~(S)~~ Figure B-28. SAM-EQUIPPED MSCs BY SAM ANTISHIP RANGE (U)

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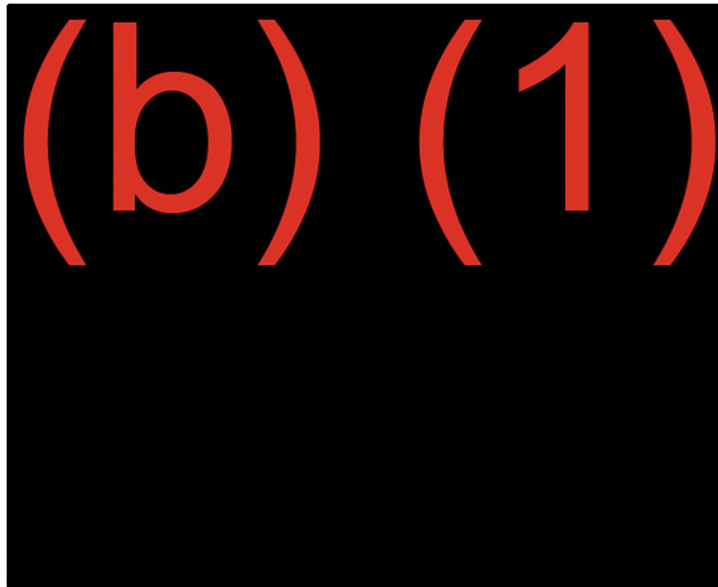
(b) (1)



~~(S)~~ Figure B-29. RANGE OF NAVAL GUNS BY IOC (U)

B-29

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~~(S)~~ Figure B-30. NGF-EQUIPPED FORCE LEVELS
BY GUN RANGE (U)

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4. ANTISHIP SENSOR THREAT ELEMENTS

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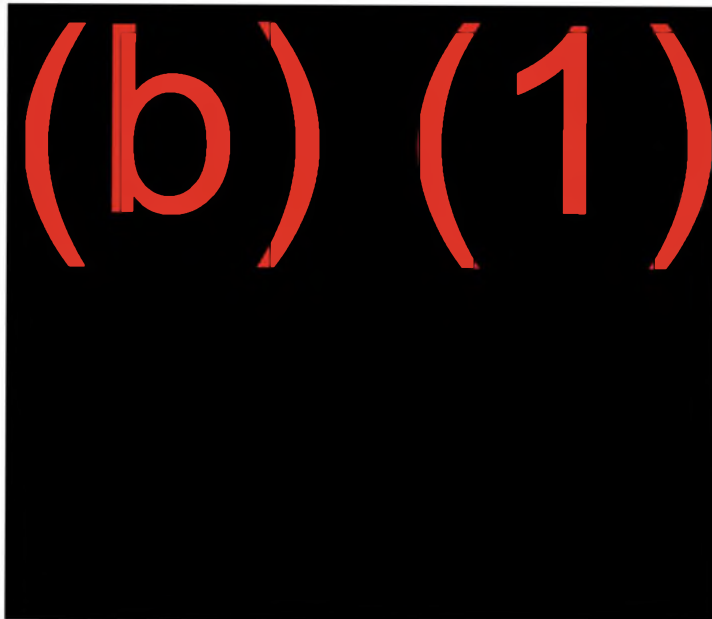
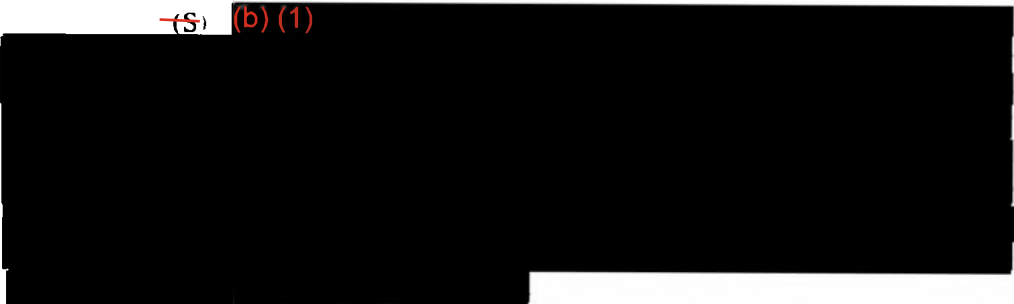
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These threat elements are discussed below.

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~~(S)~~ Figure B-31. SEA-BASED AIRCRAFT
FORCE LEVELS (U)

B-31

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~~(S)~~ (b) (1)



(b) (1)

~~(S)~~ Figure B-32. COMBAT RADIUS OF SEA-BASED
HELICOPTERS BY IOC (U)

(b) (1)

~~(S)~~ Figure B-33. CRUISE SPEED OF SEA-BASED
HELICOPTERS BY IOC (U)

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(U) The threat elements associated SOSS are discussed in Section 3 of Chapter II.

B-33

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IV. ANTIAIR WARFARE ELEMENTS

1. INTRODUCTION

(U) This section identifies elements of the Soviet threat that could directly or indirectly affect the performance requirements of advanced naval surface vehicles performing AAW tasks. Although Soviet aircraft have an impact on the AAW effectiveness of ANVs, surface combatants and submarines also can have an impact because they are able to launch cruise missiles and, in the case of some surface combatants, V/STOL aircraft. The weapon threat that must be countered in AAW includes cruise missiles and antiship SAMs. The diverse flight profiles and launching platforms of cruise missiles present a varied AAW threat.

2. PLATFORM THREAT ELEMENTS

(U) Aircraft, surface combatants, and submarines may all have implications for the ANV performance in the AAW mission area. The air platforms that may be used in an antiship role have AAW implications and consist of land-based bombers with air-to-surface missiles (ASMs), sea-based V/STOL aircraft, and land-based fighter/bomber aircraft. Surface combatants that have AAW implications range from large air-capable combatants to patrol boats and include aircraft carriers, SSM-equipped combatants, and SAM-equipped combatants. Cruise missile submarines also may have implications for AAW because of their cruise missile payload.

2.1 Land-Based ASM Bombers

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These elements are examined in the following paragraphs.

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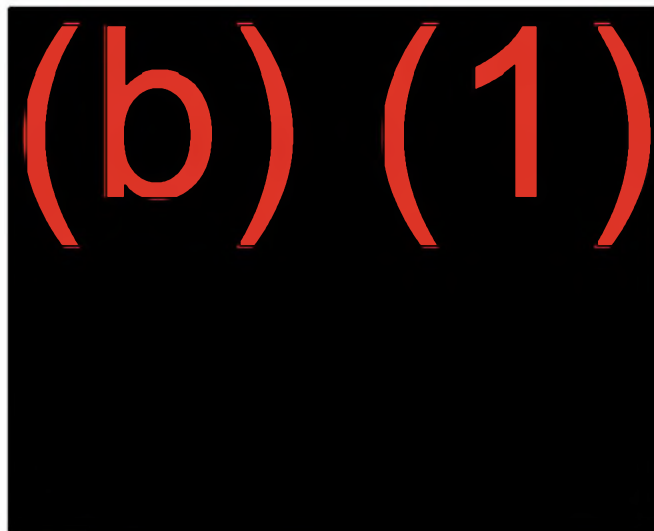
(b) (1)

~~(S)~~ Figure B-34. SNA ASM BOMBER FORCE LEVELS (U)

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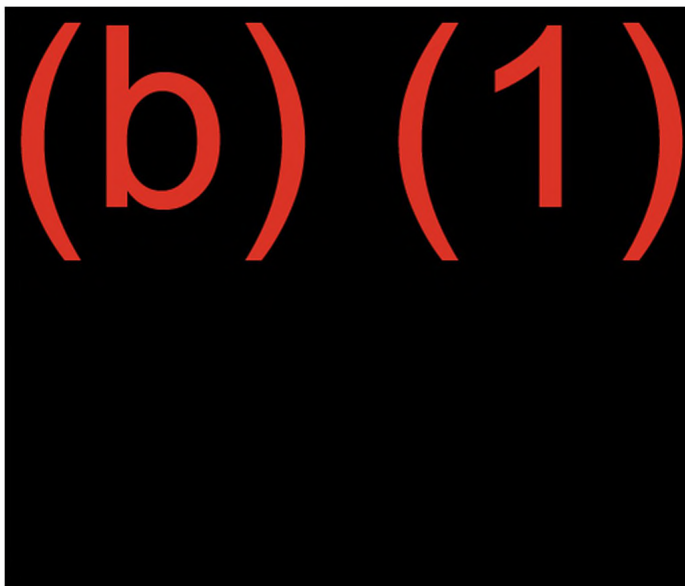
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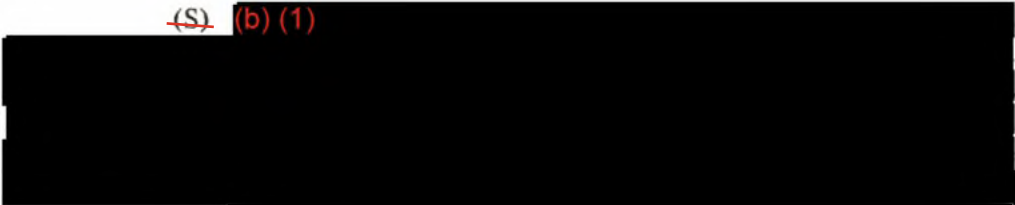
~~(S)~~ Figure B-35. MAXIMUM SPEED OF SNA ASM BOMBERS BY IOC (U)

(b) (1)

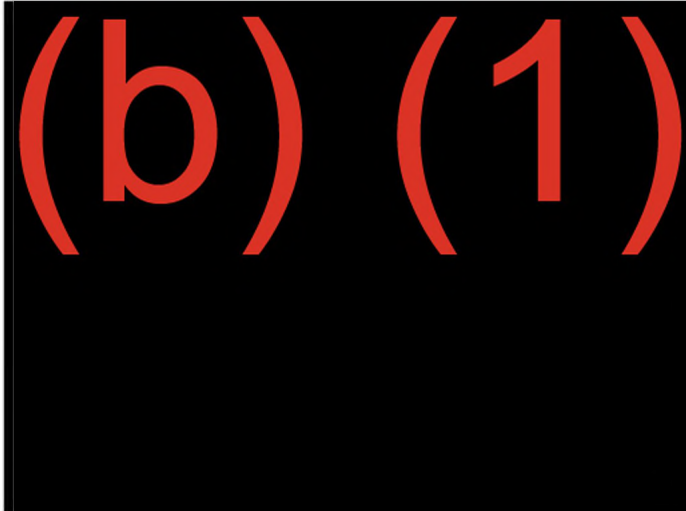
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~~(S)~~ Figure B-36. SNA ASM BOMBER FORCE LEVELS BY SPEED (U)

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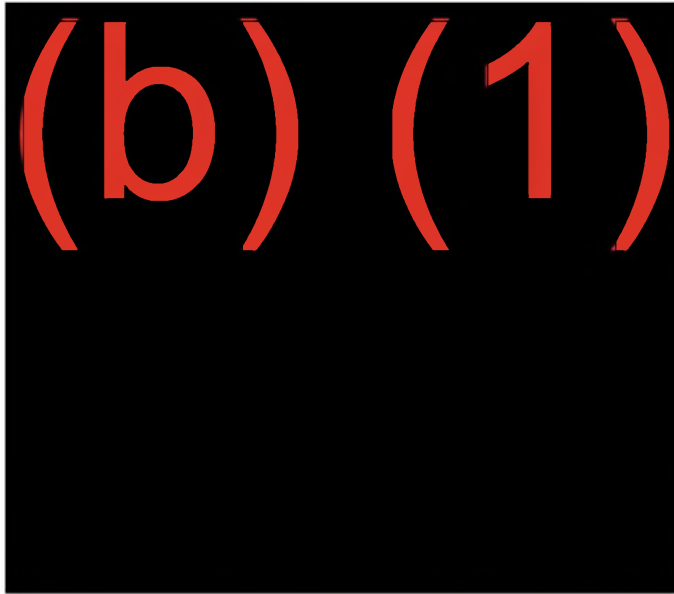


(b) (1)



~~(S)~~ Figure B-37. COMBAT RADIUS OF SNA ASM
BOMBERS BY IOC (U)

(b) (1)



~~(S)~~ Figure B-38. SNA ASM BOMBER FORCE LEVELS
BY COMBAT RADIUS (U)

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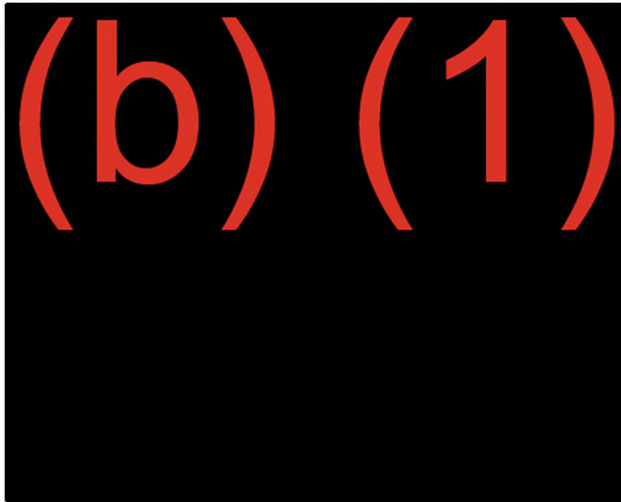
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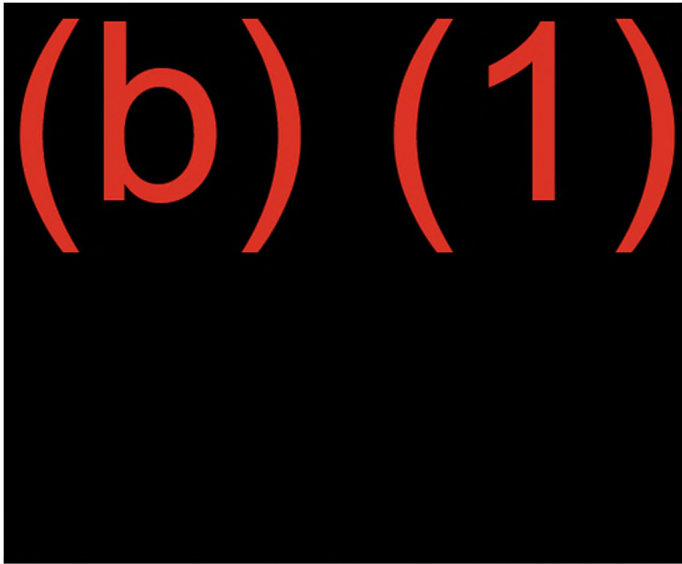
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~~(S)~~ Figure B-39. MISSILE PAYLOAD OF SNA ASM BOMBERS BY IOC (U)

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~~(S)~~ Figure B-40. SNA ASM BOMBER FORCE LEVELS BY MISSILE PAYLOAD (U)

B-39

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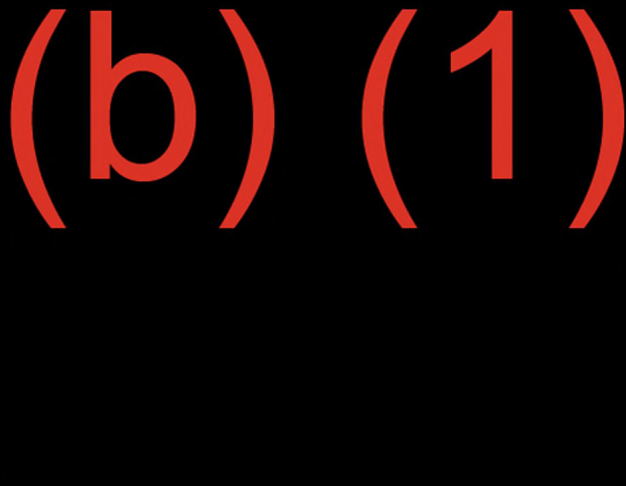
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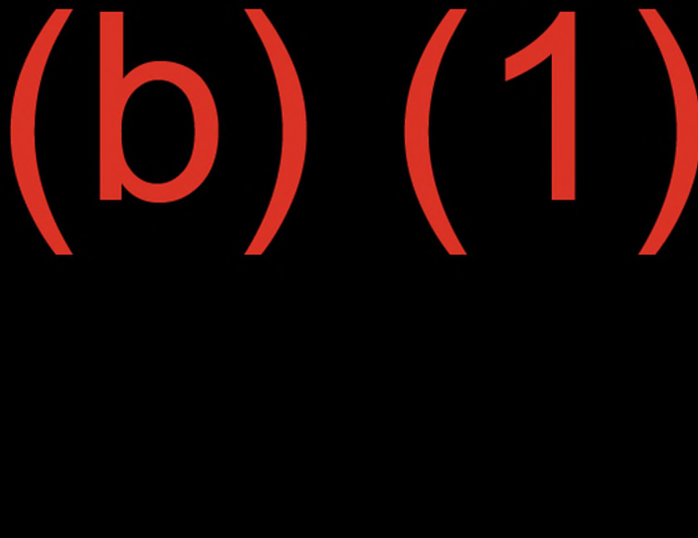
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~~(S)~~ Figure B-39. MISSILE PAYLOAD OF SNA ASM BOMBERS BY IOC (U)

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~~(S)~~ Figure B-40. SNA ASM BOMBER FORCE LEVELS BY MISSILE PAYLOAD (U)

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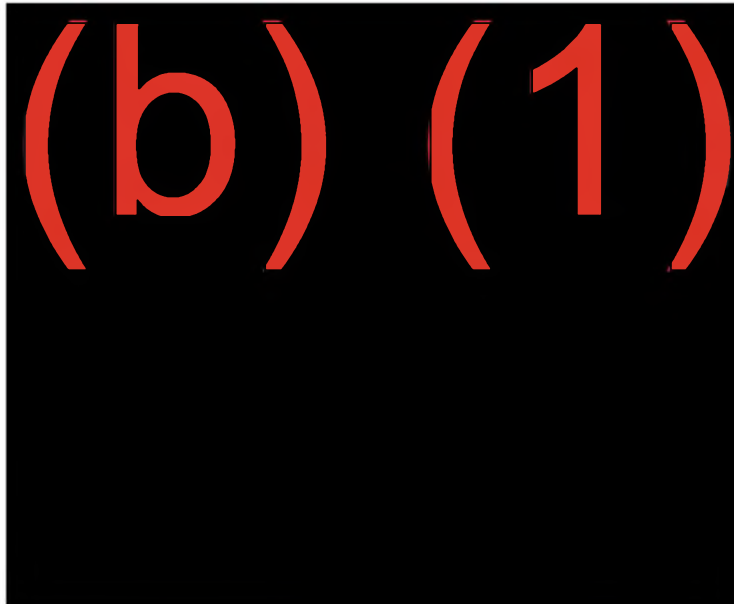
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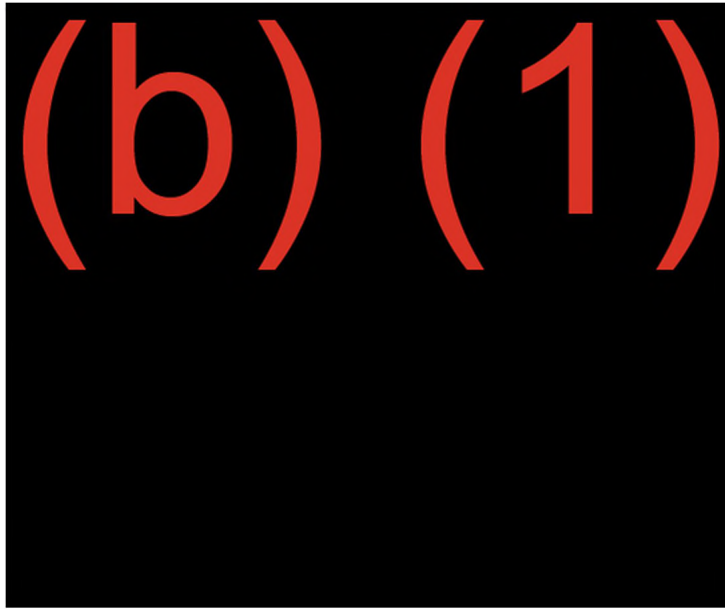
~~(S)~~ Figure B-41. SNA ASM BOMBER FORCE LEVELS
BY SELF-DEFENSE WEAPONS (U)

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~~(S)~~ Figure B-42. TOTAL SNA ASM BOMBER LAUNCH
RAILS (U)

2.2 Sea-Based V/STOL Aircraft

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These threat elements are examined in the following paragraphs.

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(b) (1)

~~(S)~~ Figure B-43. V/STOL AIRCRAFT FORCE
LEVELS (U)

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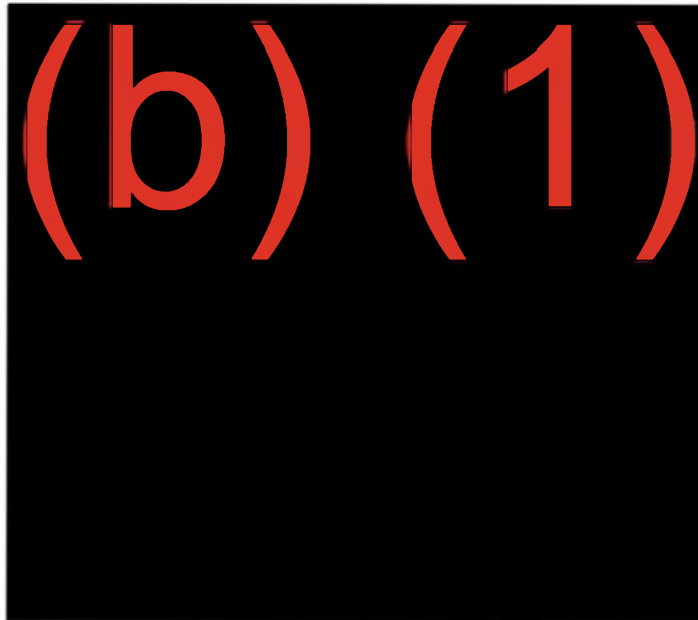
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~~(S)~~ Figure B-48. V/STOL AIRCRAFT
TASM LAUNCH RAILS (U)

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2.3 Land-Based Fighter/Bomber Aircraft

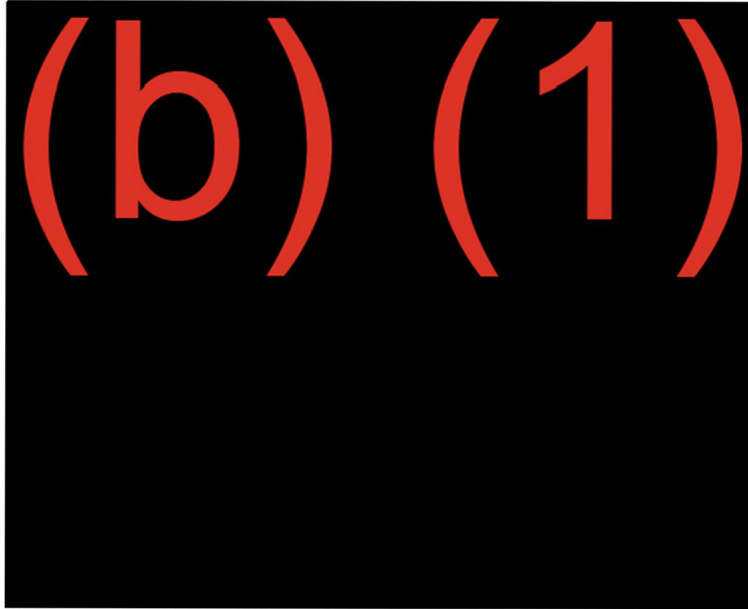
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(b) (1)



~~(S)~~ Figure B-49. FORCE LEVELS OF LAND-BASED SNA
FIGHTER/BOMBER AIRCRAFT (U)

2.4 Surface Combatants

(U) Several aspects of the Soviet threat to surface ships may have an impact on the AAW capabilities of ANVs by virtue of their sea-based V/STOL aircraft, SSMs, and antiship-capable SAMs. They are:

- number of aircraft carriers,
- number of SSM platforms,
- number of antiship SAM platforms,
- type of SSMs,
- number of launch tubes per platform,
- number of reloads per platform, and
- total number of launch tubes.

(U) The number of V/STOL aircraft carriers, SSM platforms, and SAM platforms and the type of SSMs on Soviet combatants are discussed in Section 2 of Chapter II.

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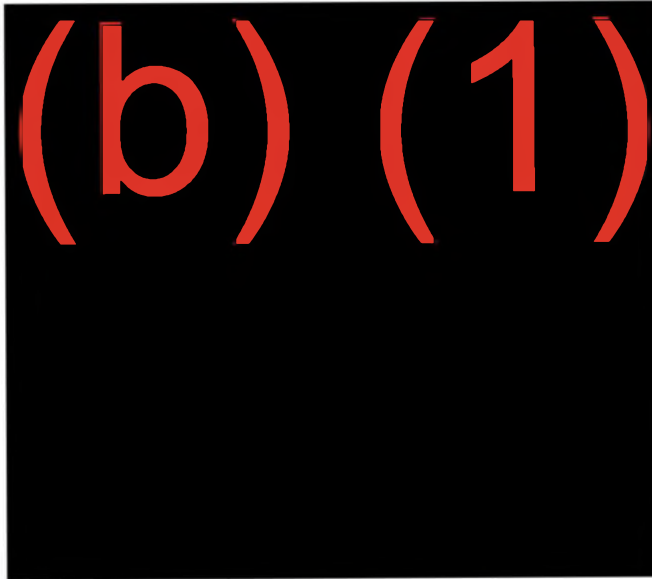
* Projected PSCs that may possibly be equipped with SSMs [CV-P-II, CG-X-II, and CG(N)-P-IV] are not included in this discussion.

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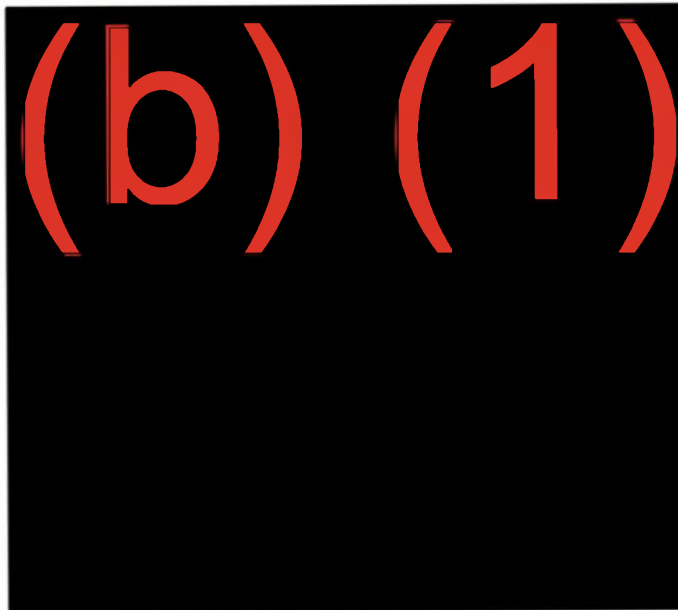
~~(S)~~ Figure B-50. NUMBER OF LAUNCH TUBES ON
SSM-EQUIPPED PSCs (U)

(b) (1)

~~(S)~~ Figure B-51. NUMBER OF LAUNCH TUBES ON
SSM-EQUIPPED MSCs (U)



~~(S)~~ Figure B-52. SSM-EQUIPPED PSC FORCE LEVELS
BY NUMBER OF LAUNCH TUBES (U)



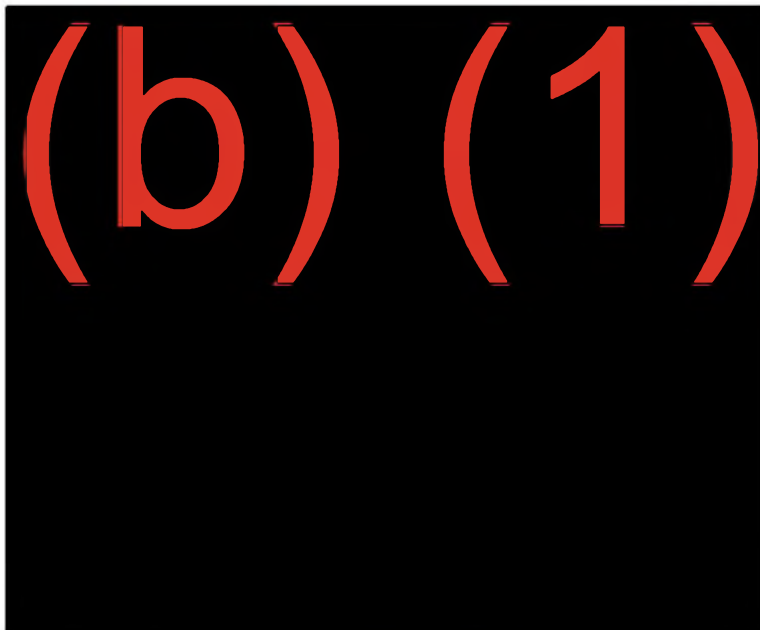
~~(S)~~ Figure B-53. SSM-EQUIPPED MSC FORCE LEVELS
BY NUMBER OF LAUNCH TUBES (U)

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(b) (1)



~~(S)~~ Figure B-54. SSM PSC FORCE LEVELS BY
RELOAD CAPABILITY (U)

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(b) (1)

~~(S)~~ Figure B-55. TOTAL PSC SSM LAUNCH TUBES (U)

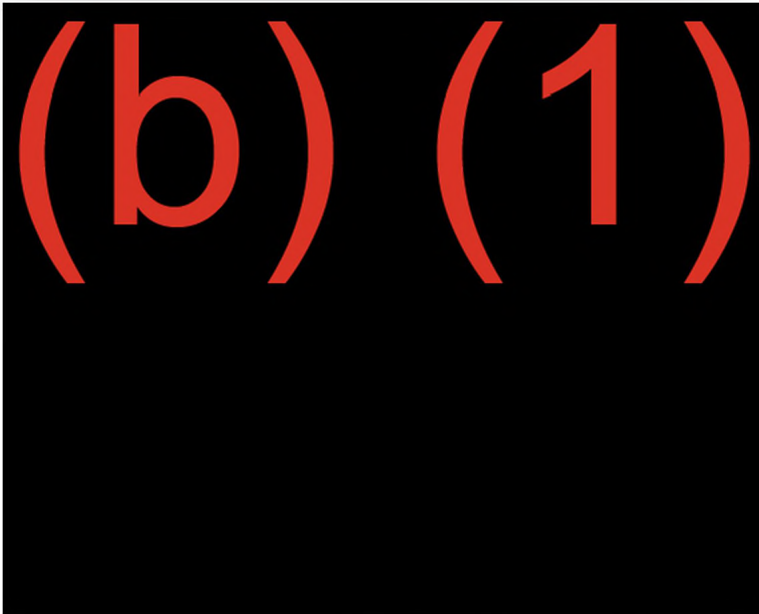
(b) (1)

~~(TS)~~ Figure B-56. TOTAL PSC DEPLOYED SSMs (U)

~~(S)~~ (b) (1)



(b) (1)



~~(S)~~ Figure B-57. TOTAL MSC SSM LAUNCH TUBES (U)

2.5 Submarines

(U) A number of aspects of the Soviet submarine threat may have an impact on the AAW capabilities of ANVs by virtue of the submarine cruise-missile payload. As cruise-missile platforms, submarines offer some advantages over surface ships and aircraft because of their stealth, but they do not carry missile reloads as do some surface ships nor can they conduct repeated attacks that match aircraft sorties. The following elements of the Soviet submarine threat have an impact on the AAW requirements and capabilities of ANVs:

- cruise-missile-equipped submarine force levels,
- type of cruise missiles on submarines,
- number of missile tubes on submarines,
- total submarine launch tubes.

These threat elements are examined in the following paragraphs.

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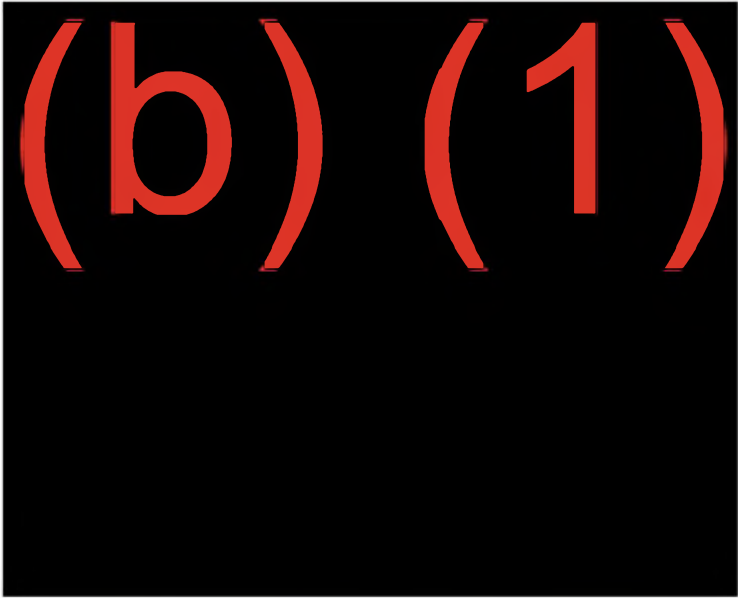
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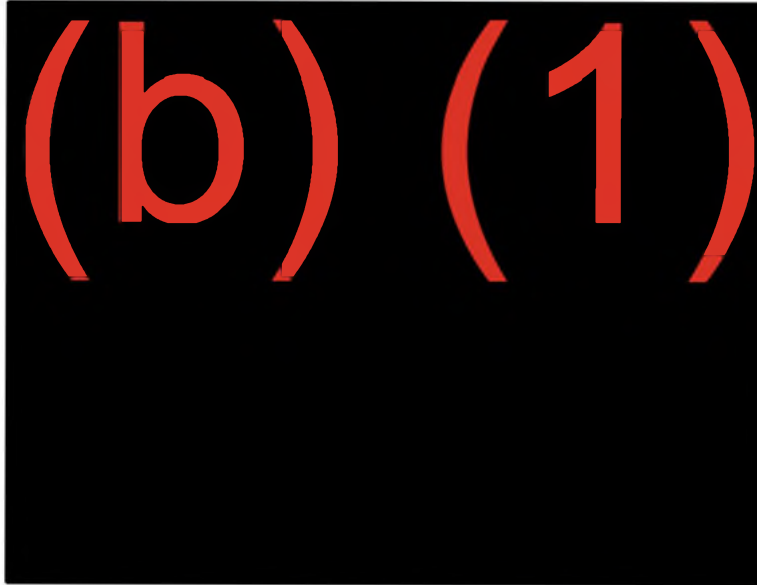
(b) (1)



~~(S)~~ Figure B-58. FORCE LEVELS OF CRUISE
MISSILE-EQUIPPED SUBMARINES (U)

~~(S)~~ (b) (1)





~~(S)~~ Figure B-59. FORCE LEVELS OF CRUISE-MISSILE-EQUIPPED
SUBMARINES BY MISSILE TYPE (U)



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(b) (1)

~~(S)~~ Figure B-60. SUBMARINE CRUISE-MISSILE
PAYLOAD BY IOC (U)

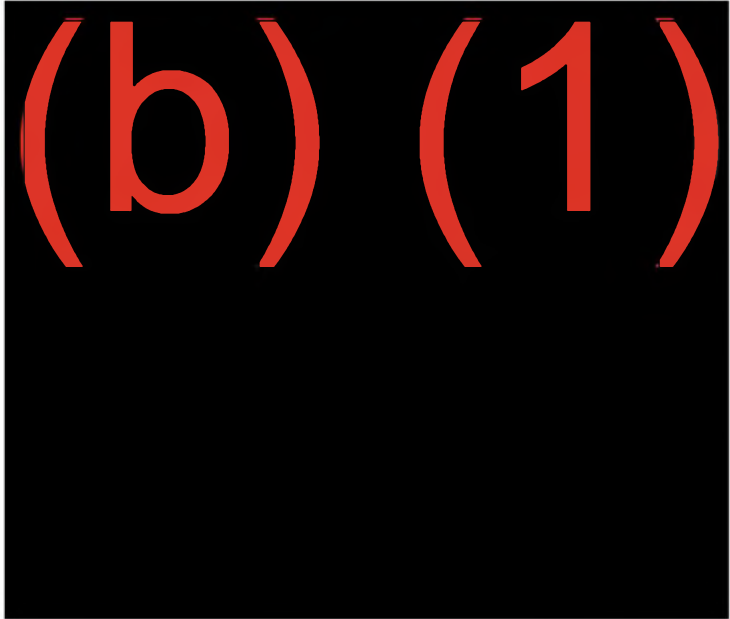
(b) (1)

~~(S)~~ Figure B-61. FORCE LEVELS OF CRUISE-MISSILE-EQUIPPED
SUBMARINES BY PAYLOAD (U)

~~(S)~~ (b) (1)



(b) (1)



~~(S)~~ Figure B-62. TOTAL SUBMARINE SSM LAUNCH
TUBES (U)

3. WEAPON THREAT ELEMENTS

(U) Although ANVs may be able to engage aircraft in some scenarios, in many cases their AAW capabilities will have to be used to counter missiles. The weapon threat that must be engaged in AAW consists of ASCMs launched from air, surface, and submarine platforms and SAMs in an antiship role launched from surface ships. This section identifies and examines those aspects of the Soviet weapon threat that may have implications for the AAW requirements and capabilities of ANVs.

3.1 Cruise Missiles

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~~(S)~~ (b) (1)



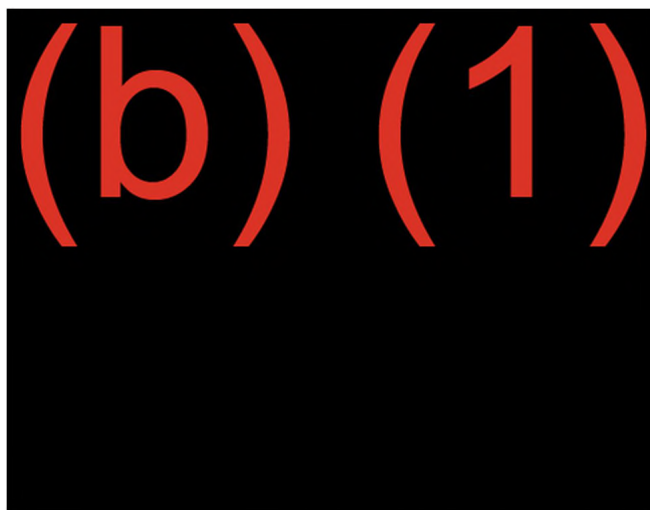
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These performance parameters are discussed below.

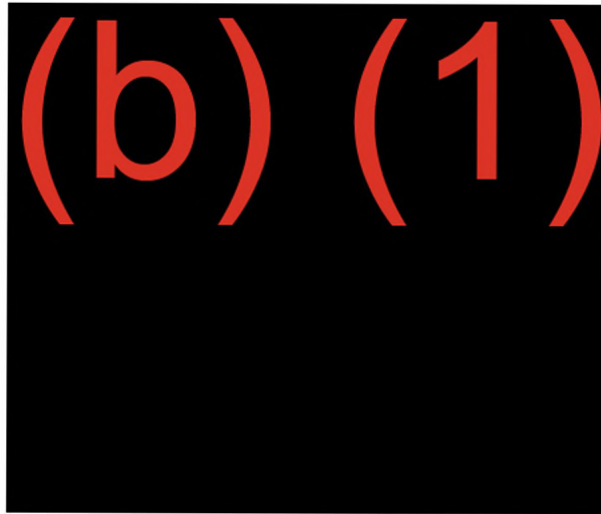
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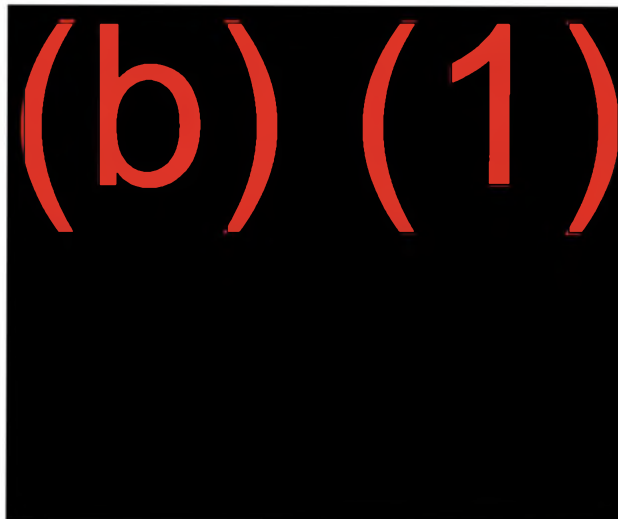
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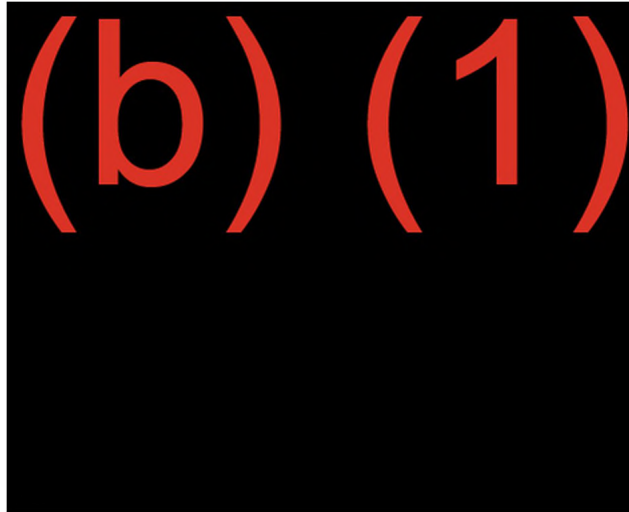
~~(S)~~ Figure B-63. CRUISE SPEED OF LONG-RANGE
SSMs BY IOC (U)



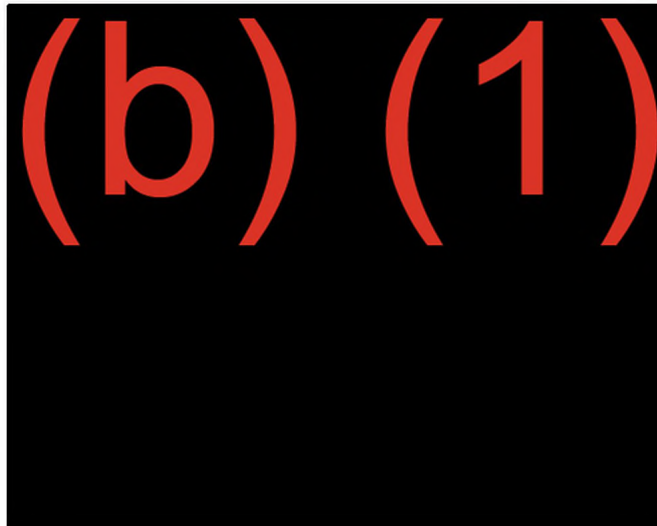
~~(S)~~ Figure B-64. CRUISE SPEED OF SHORT-RANGE
SSMs BY IOC (U)



~~(S)~~ Figure B-65. CRUISE SPEED OF ASMs
BY IOC (U)

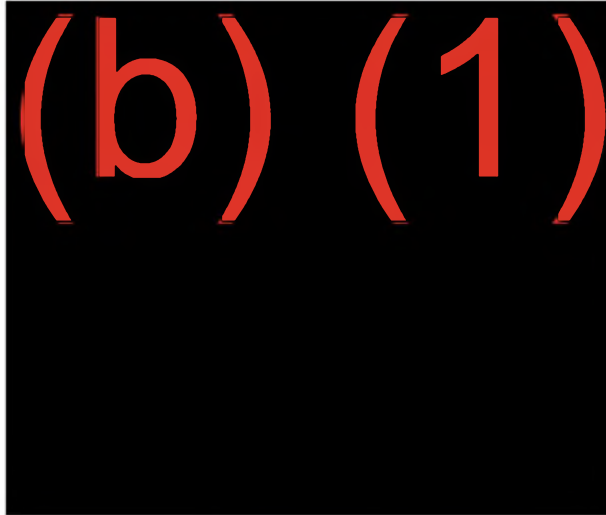


~~(S)~~ Figure B-66. CRUISE SPEED OF TASM_s
BY IOC (U)

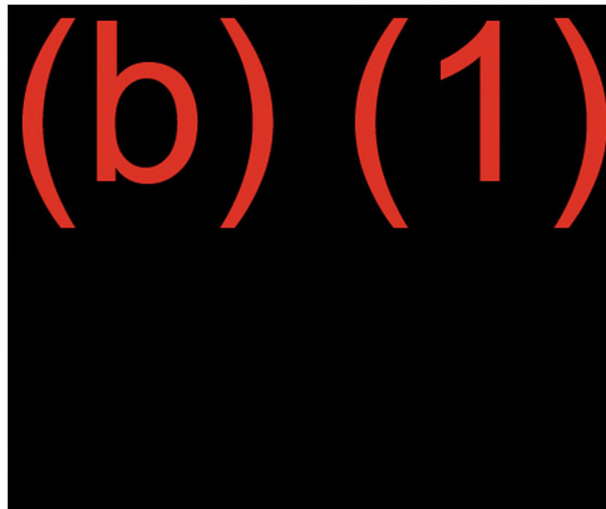


~~(S)~~ Figure B-67. RANGE OF SHORT-RANGE
SSM_s BY IOC (U)

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~~(S)~~ Figure B-68. RANGE OF LONG-RANGE
SSMs BY IOC (U)



~~(S)~~ Figure B-69. RANGE OF ASMs BY IOC (U)

(b) (1)

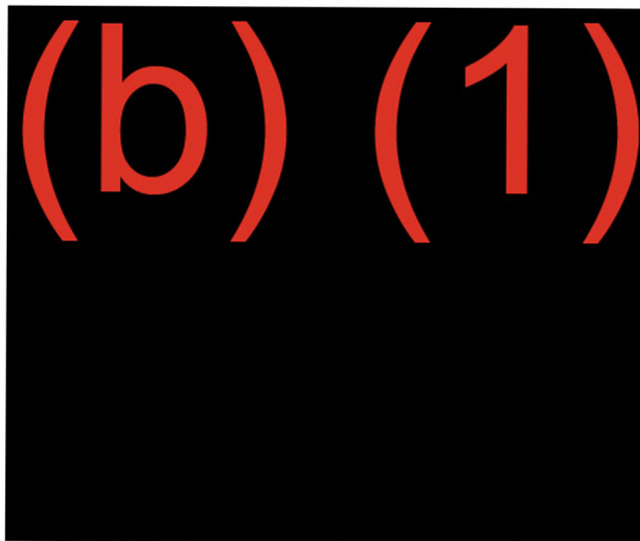
~~(S)~~ Figure B-70. RANGE OF TASM_s BY IOC (U)

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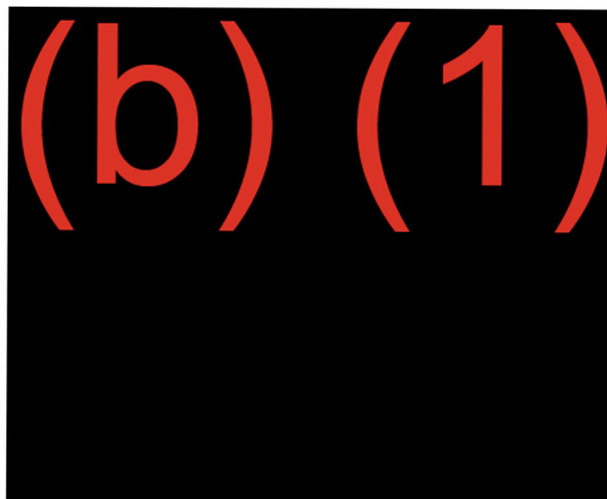
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~~(S)~~ Figure B-71. CRUISE ALTITUDE OF
SHORT-RANGE SSMs BY IOC (U)



~~(S)~~ Figure B-72. CRUISE ALTITUDE OF
LONG-RANGE SSMs BY IOC (U)

(b) (1)

~~(S)~~ Figure B-73. CRUISE ALTITUDE OF
ASMs BY IOC (U)

(b) (1)

~~(S)~~ Figure B-74. CRUISE ALTITUDE OF
TASMs BY IOC (U)

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3.2 Antiship SAMs

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APPENDIX C
POTENTIAL IMPACT OF THREAT ON
U.S. NAVAL OPERATIONAL CAPABILITIES

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I. INTRODUCTION

(U) This appendix examines the potential impact of the projected threat on the U.S. Navy operational capabilities in three warfare mission areas: antisubmarine warfare (ASW), antisurface ship warfare (ASUW), and anti-air warfare (AAW). The threat in each of these areas is described in Appendix B.

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II. ANTISUBMARINE WARFARE

(U) This chapter examines the impact of the threat on U.S. ASW operational capabilities in the context of the ability of U.S. Navy forces using advanced naval vehicles (ANVs) (a) to conduct ASW search; (b) to detect, localize, classify, and track submarines; (c) to engage submarines; and (d) to evade/avoid/disengage from submarines.

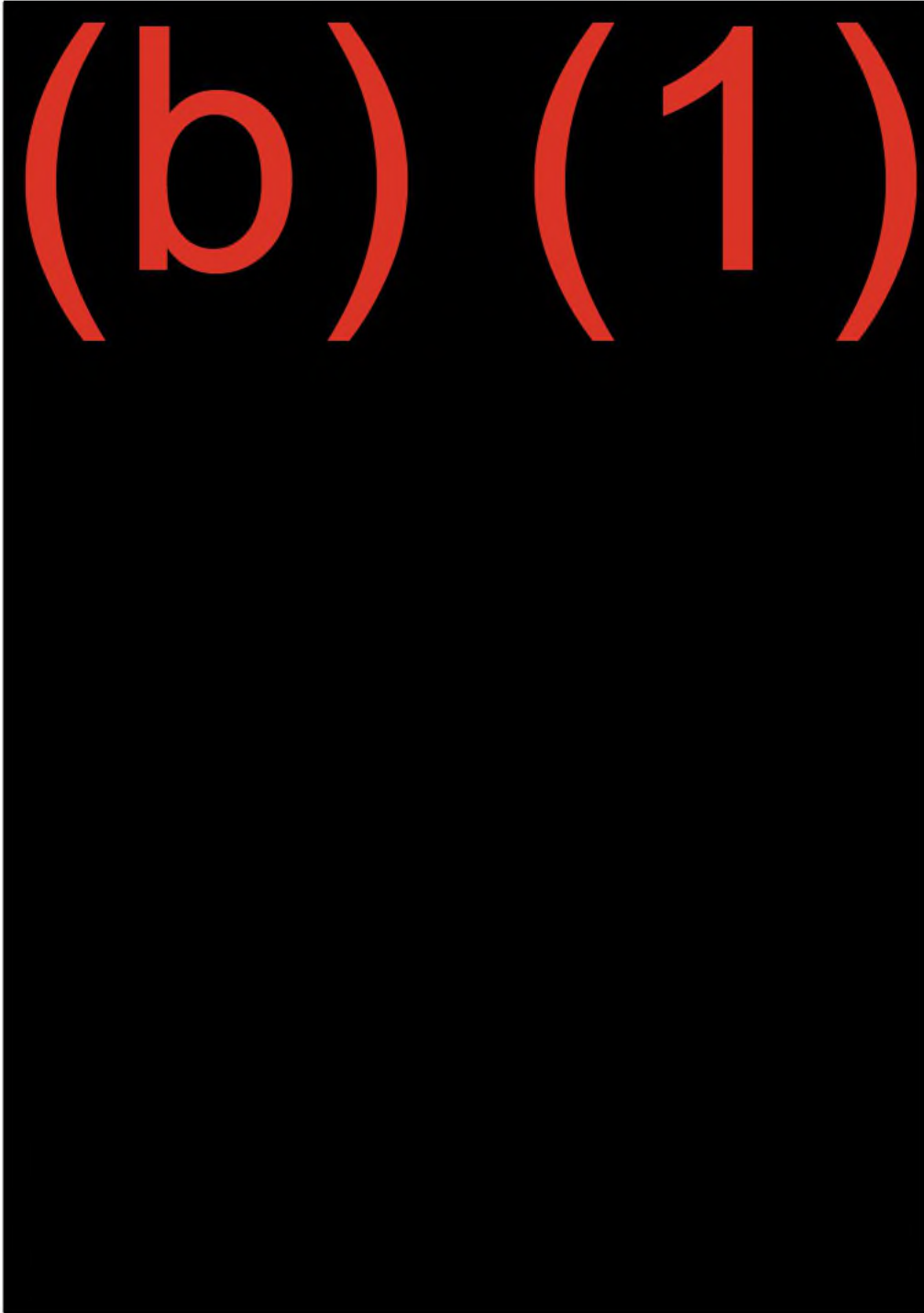
I. ABILITY TO CONDUCT ASW SEARCH

(U) In conducting ASW operations, most of an ANV's time will probably be spent in the search phase. ASW search includes screening operations to protect moving forces from submarine attack, barrier operations to prevent submarines from transiting choke points, and area search operations to clear (sanitize) operating areas for surface ships. Two methods by which search operations can be performed are sprint/drift search and deployed sensor search. This section examines the potential operating impact that the threat may have on ANVs during various search operations and in different search methods.

I.1 Screening Search Requirements

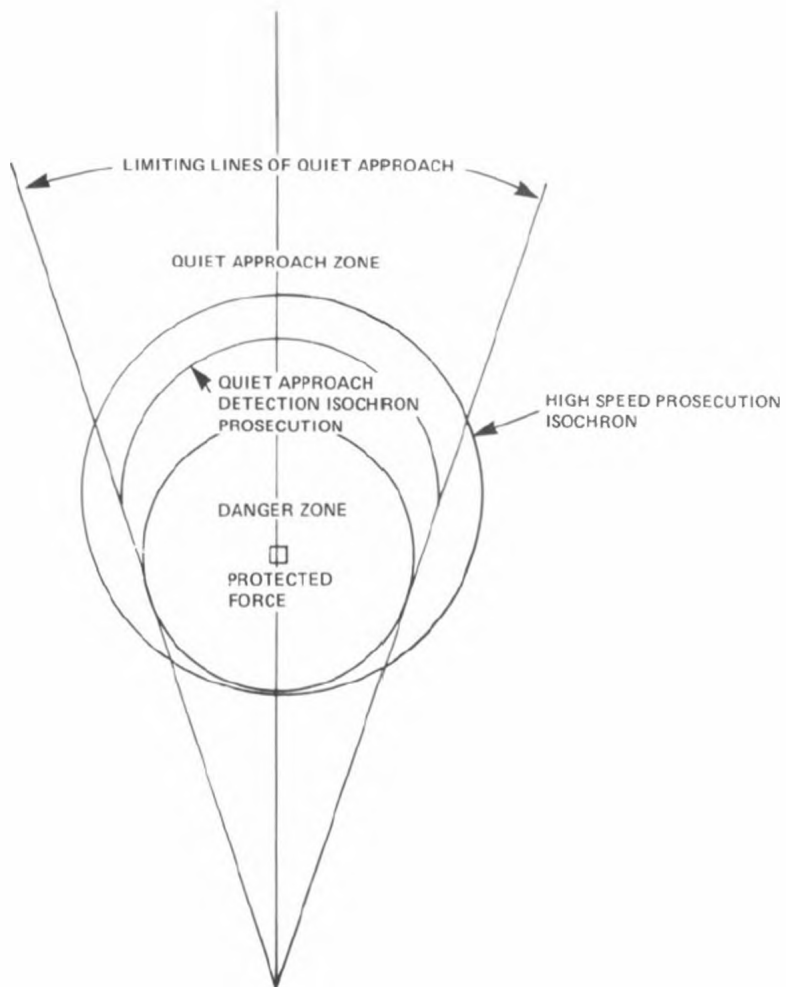
(U) The purpose of an ASW screen is to detect and destroy enemy submarines before they can reach a position from which they can attack a protected force. A screen can employ either active or passive acoustic sensors in a variety of search methods (e.g., sprint/drift search or deployed sensor search) and tactics (e.g., leap frog or zig-zag search tactics). However, regardless of the sensor, method or techniques employed, the basic geometry required for an effective and efficient screen is defined primarily by the enemy threat and by the protected force. The elements of the Soviet threat that have an impact on the screening geometry include the submarine propulsion (nuclear or diesel-electric), type (attack or cruise missile), degree of quieting, type of sensors, speed, weapon range [surface-to-surface missiles (SSMs) and torpedoes], and the Soviet Ocean Reconnaissance System (SOSS). Figure C-1 relates these elements to the potential operational impact that may result. To better understand the impact of the threat upon the screening geometry, it is useful to examine the manner in which the screening geometry is derived.

(U) Figure C-2 shows a basic screening geometry. It consists of a quiet approach zone ahead of the protected force and bounded by the limiting lines of quiet approach, a danger zone encompassing the protected force, and high speed and quiet approach prosecution isochrons. (Isochrons are the locus of points from which it takes the same amount of time to reach the danger zone.)



~~(S)~~ Figure C-1. EFFECT OF THREAT ELEMENTS ON SCREENING SEARCH REQUIREMENTS (U)

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(U) Figure C-2. BASIC SCREENING GEOMETRY

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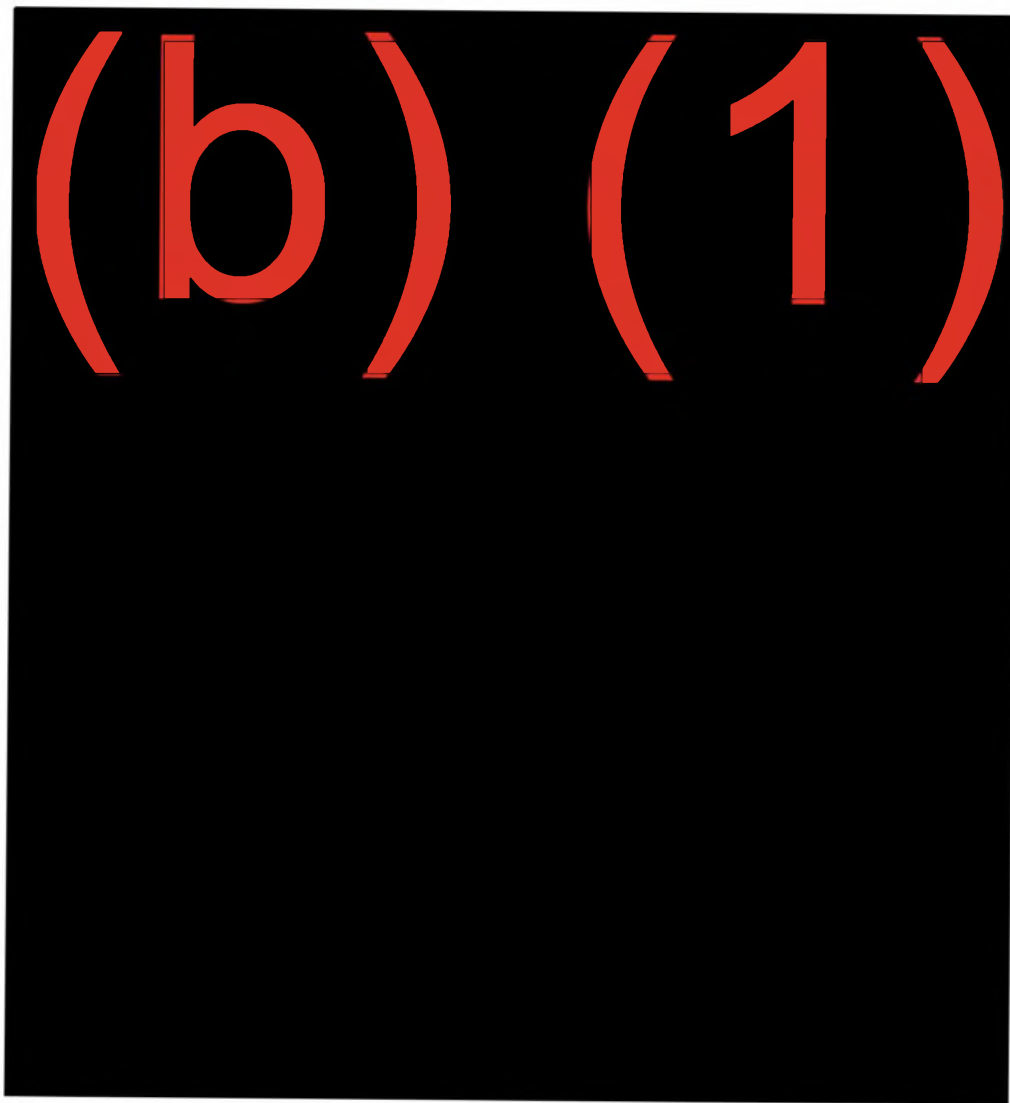


(U) If a submarine limits its approach to the maximum quiet speed, it will be confined to the quiet approach zone as shown in Figure C-2. The quiet approach zone is determined by the speed of advance (SOA) of the protected force and the maximum quiet speed of the submarine. Submarines outside the quiet approach zone must exceed the maximum quiet speed and accept the increased detectability to approach the protected force. As the maximum quiet speed of the submarine increases, so does the size of the quiet approach zone. The increased passive quieting of future Soviet submarines may increase the maximum quiet speed of these submarines. Thus, for a given SOA of a protected force, the size of the quiet approach zone may also increase.

(U) The danger zone contains the protected force and is bounded by a curve that is the locus of points that the submarine must reach in order to fire a weapon at the protected force. For a submarine to conduct an effective attack against surface ships, it must obtain a fire control solution and be within range of its weapons (cruise missiles or torpedoes). Soviet submarines are expected to improve in both ability to obtain a fire control solution [using their own acoustic and electronic support measures (ESM) sensors or external information provided by SOSS] and in the maximum range of weapons systems that result in any increased standoff attack capability. Hence, the size of the danger zone may increase.

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~~(S)~~ Figure C-3. EFFECT OF CHANGING THREAT PARAMETERS
ON SCREENING GEOMETRY (U)

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1.2 Barrier Search Requirements

(U) The purpose of an ASW barrier is to deter or destroy submarines that are attempting to transit a geographical area. In general, barriers exploit geographical choke points such as straits or other confined waters in order to minimize the area that must be searched. The length of the barrier is dictated by the geographical constraints while the width of the barrier is governed by the ability of the ANV to detect and prosecute a transiting submarine. ASW search in barriers can be conducted with deployed sensors or with sprint/drift tactics and can employ either active or passive acoustic sensors.

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1.3 Sprint/Drift Search Capabilities

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~~(S)~~ Figure C-4. EFFECT OF THREAT ELEMENTS ON BARRIER REQUIREMENTS (U)

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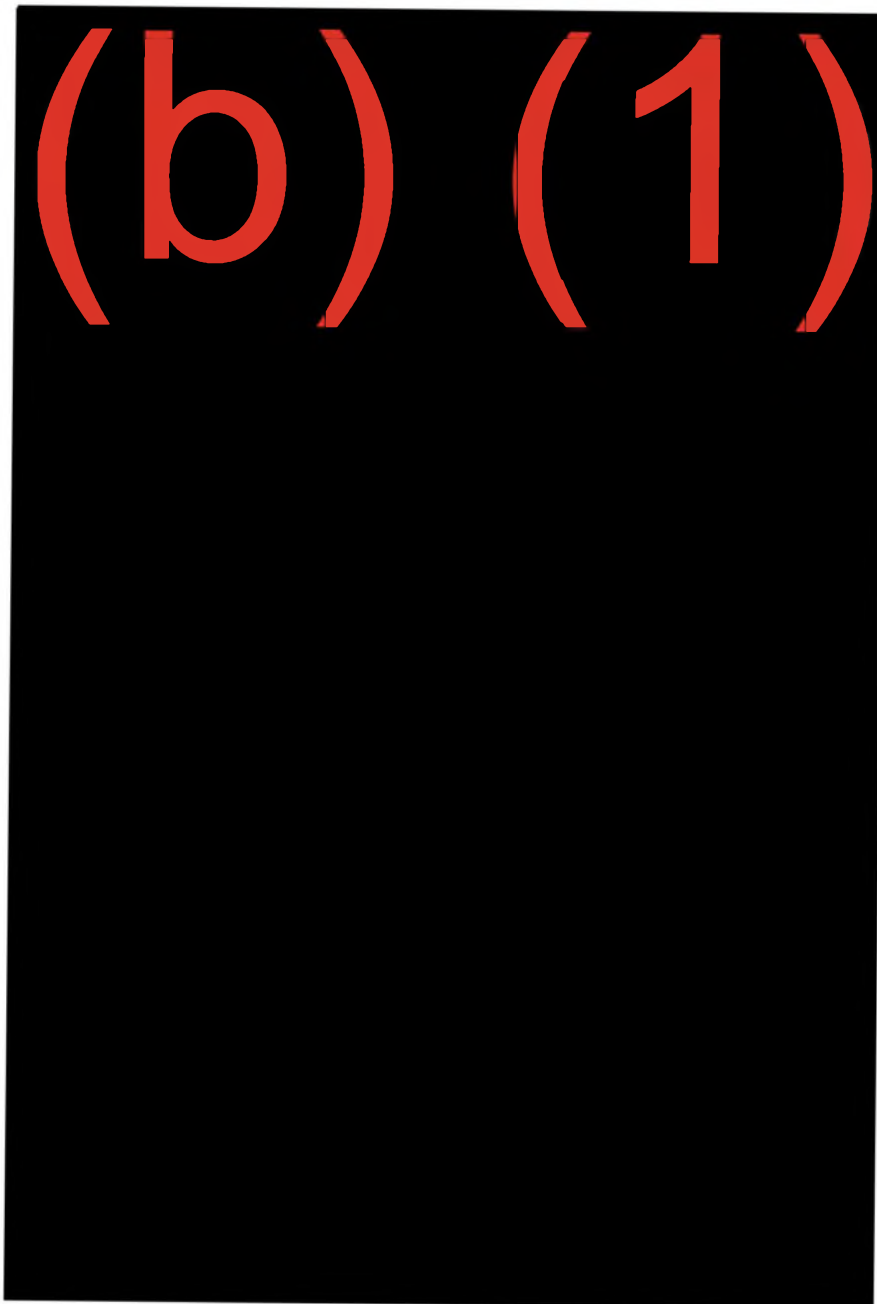
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1.4 Deployed Sensor Search Capability

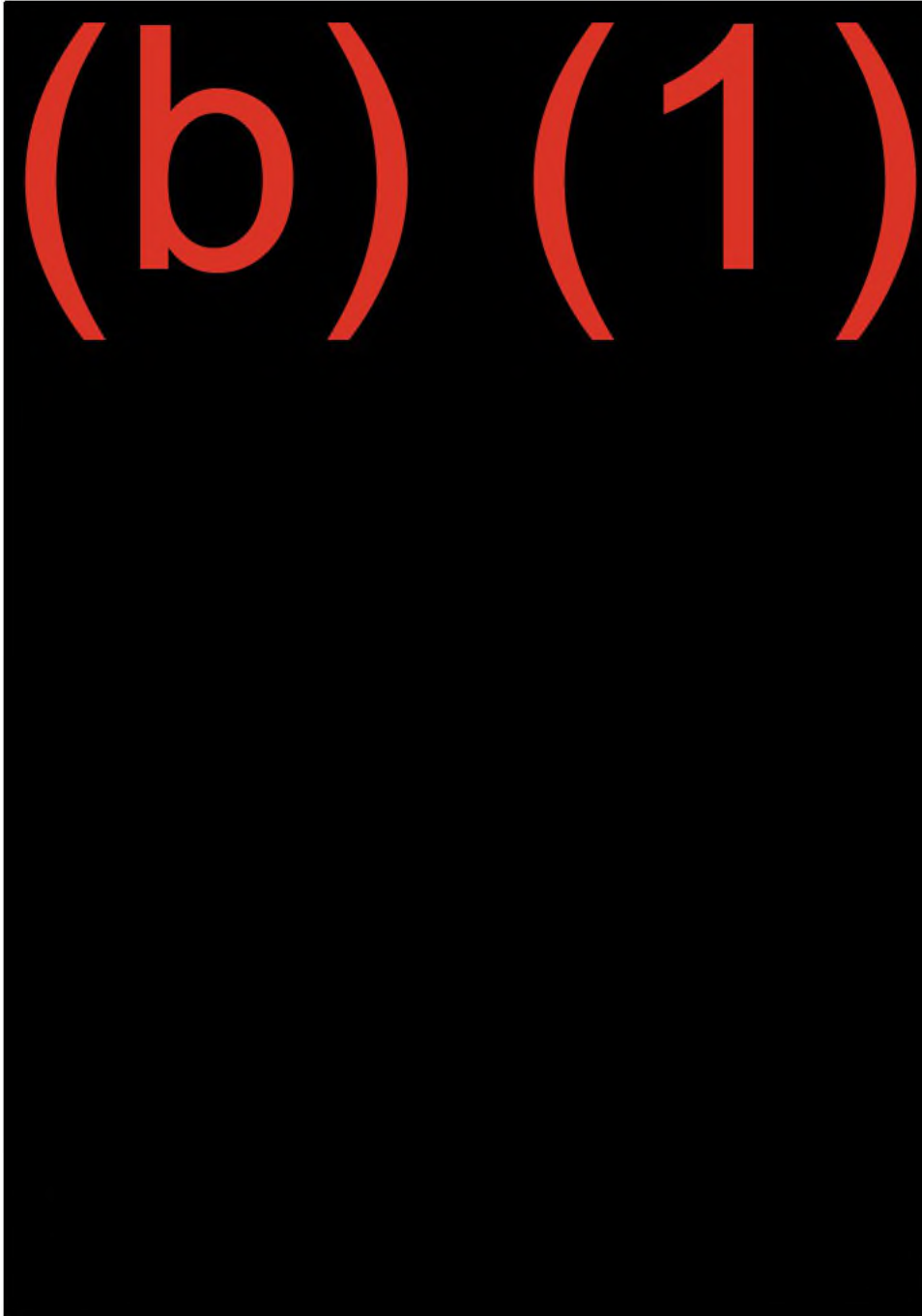
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(U) A number of elements of the Soviet threat have an impact on the ability of ANV concepts to conduct ASW search with deployed sensors. These threat elements and the potential deficiencies that may result in the ability to search with deployed sensors are shown in Figure C-6. Both active and passive quieting of Soviet submarines and the passive detection problems associated with diesel-electric-powered submarines may result in decreased sensor detection ranges and, hence, decreased search rates. As the detection range decreases, less time is available for sensor de-



(S) Figure C-5. EFFECT OF THREAT ELEMENTS ON SPRINT/DRIFT
SEARCH CAPABILITY (U)



~~(S)~~ Figure C-6. EFFECT OF THREAT ELEMENTS ON DEPLOYED SENSOR
SEARCH CAPABILITY (U)

ployment and an increased sensor payload is required. As more sensors are required to search a given area, problems may be encountered in adequately monitoring the sensors.

(U) When helicopters are used to deploy and retrieve sensors, helicopter utilization may exceed the prescribed limit of 80 hours a month if sufficient helicopters are not available. As in the case of vehicles conducting sprint/drift search, vehicles conducting ASW search with deployed sensors may suffer decreased detection opportunities because of greater tactical knowledge on the part of the submarine and, in some cases, increased vulnerability of the ANV which must at times pass through unsearched waters to deploy sensors.

2. ABILITY TO DETECT, LOCALIZE, CLASSIFY, AND TRACK SUBMARINES

(U) The ability of an ANV to detect, localize, classify, and track submarine targets is a vital aspect of ASW. A number of elements of the Soviet threat may have a potential operational impact on these capabilities.

2.1 Detection

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2.2 Localization

(U) The localization of a submarine is initiated after a detection has been made and consists of determining the position of a submarine with sufficient accuracy that the submarine can be effectively prosecuted. In some cases, an ANV may be able to rapidly obtain a fire control solution after a detection (e.g., after detections made with active sensors). In many cases, however (primarily following passive detections), a more time consuming intermediate localization step [such as crossfixing or target motion analysis (TMA)] is necessary both to remove zonal and



~~(S)~~ Figure C-7. EFFECT OF THREAT ELEMENTS ON DETECTION
CAPABILITY (U)

bearing ambiguities. This "rough" localization does not provide a fire control solution. In such cases, it is necessary to reacquire the target with towed or tethered sensors, deployed sensors, or rocket- or aircraft-deployed sensors.

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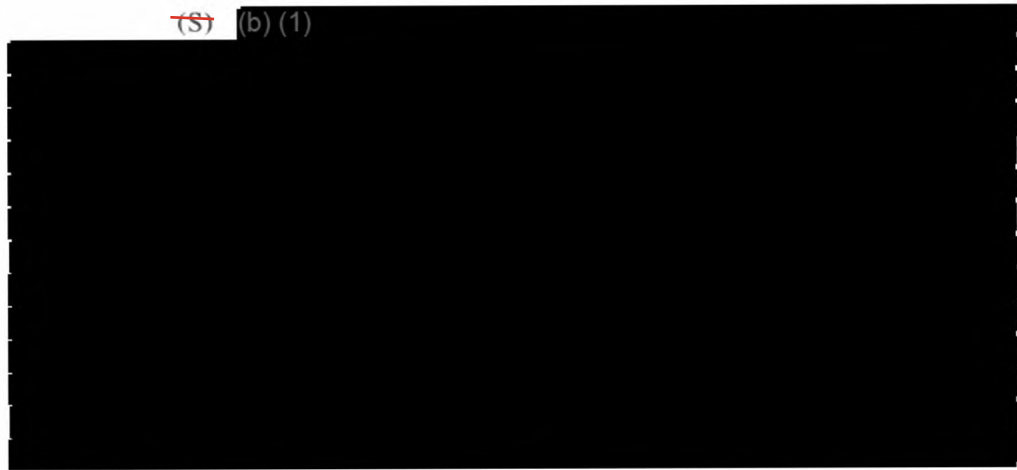


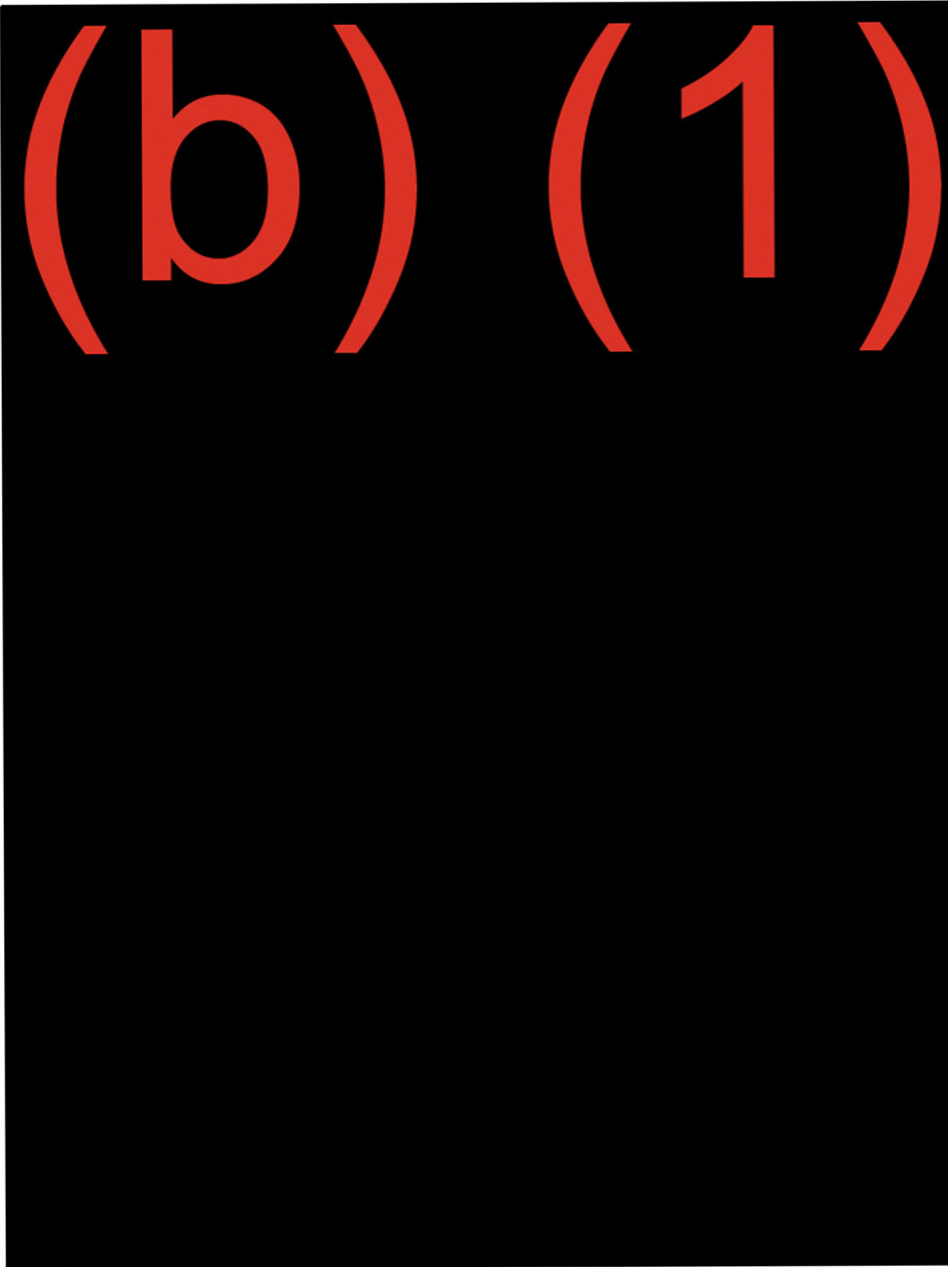
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2.3 Classification

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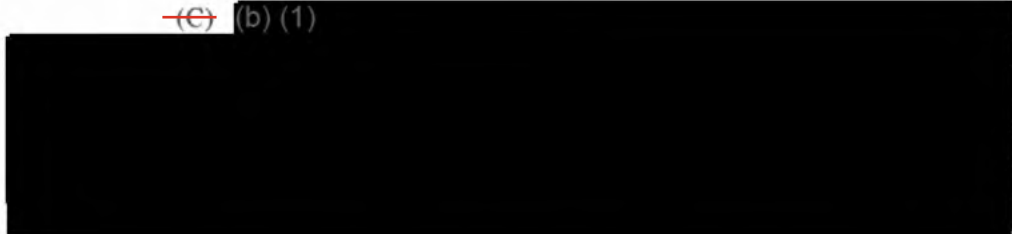
~~(S)~~ Figure C-8. EFFECT OF THREAT ELEMENTS ON LOCALIZATION
CAPABILITY (U)

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2.4 Tracking

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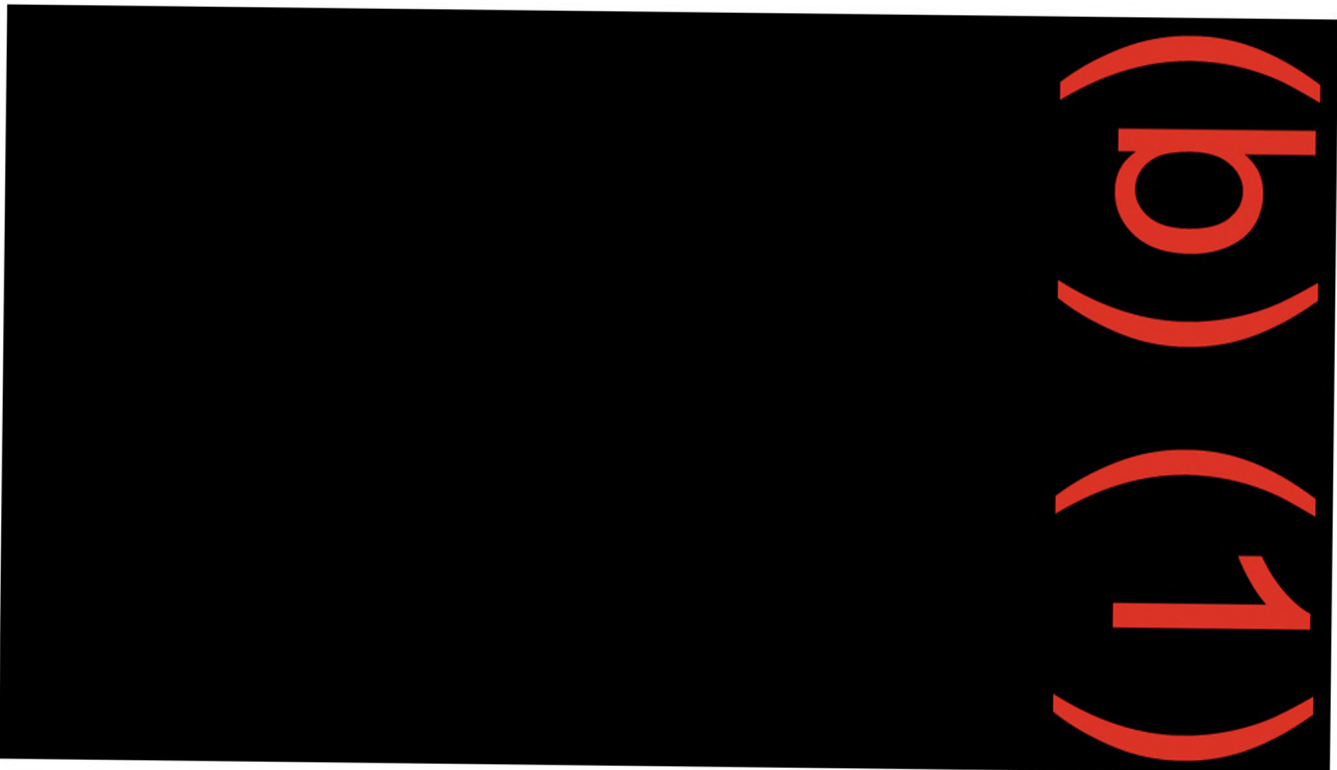
3. ABILITY TO ENGAGE SUBMARINES

(U) The ability to engage a submarine is defined as the ability to conduct an effective attack on a submarine target. While the detection, localization, and classification capabilities discussed in the previous section contribute to the ability to engage, the discussion in this section assumes that a detection has been made, that it is classified as a submarine, and that it is roughly localized. It is then possible to concentrate on those aspects of the Soviet threat that can cause a potential deficiency in (a) the ability of ANVs to close to within weapon range of the submarine target, (b) the ability to initiate an attack, and (c) the ASW weapon effectiveness.

3.1 Ability to Close to Weapon Range

(U) Unless an ANV can close to within range of its ASW weapons, it can not conduct an effective attack against a submarine. However, improvements in submarine speed capability, submarine sensors, and SOSS may reduce the ability of ANVs to close to weapon range of the target as shown in Figure C-1 I. Improved sub-

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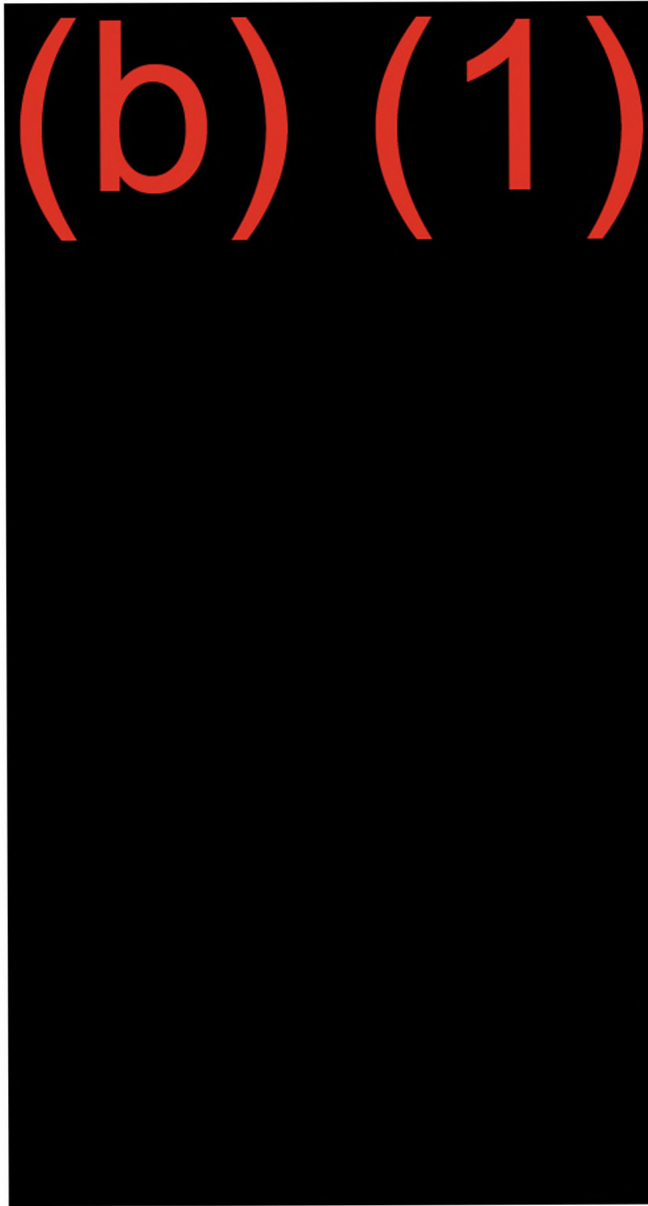
(S) ~~Figure C-9. EFFECT OF THREAT ELEMENTS ON CLASSIFICATION CAPABILITY (U)~~

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~~(S)~~ Figure C-10. EFFECT OF THREAT ELEMENTS ON TRACKING CAPABILITY (U)

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~~(S)~~ Figure C-11. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
CLOSE TO WEAPON RANGE (U)

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marine sensors coupled with SOSS may provide the submarine with better and longer-range alertment when it is being prosecuted as well as with improved tactical knowledge of the situation. The submarine would then be better able to optimize its tactics for evasion or counterattack. In some cases (such as when a submarine is attempting to penetrate a screen), an attempt to evade a prosecuting ANV by out-running it may be inconsistent with the mission of the submarine. In other cases, however, it may be a viable option, given the high-speed capability of Soviet submarines. Unless an ANV has an effective speed advantage, it may require a substantial distance (and time) to close to within weapon range of the submarine providing that the contact is not lost. In any case, it is apparent that ANVs may suffer a reduced ability to close to within weapon range of the submarine.

3.2 Ability to Initiate Attack

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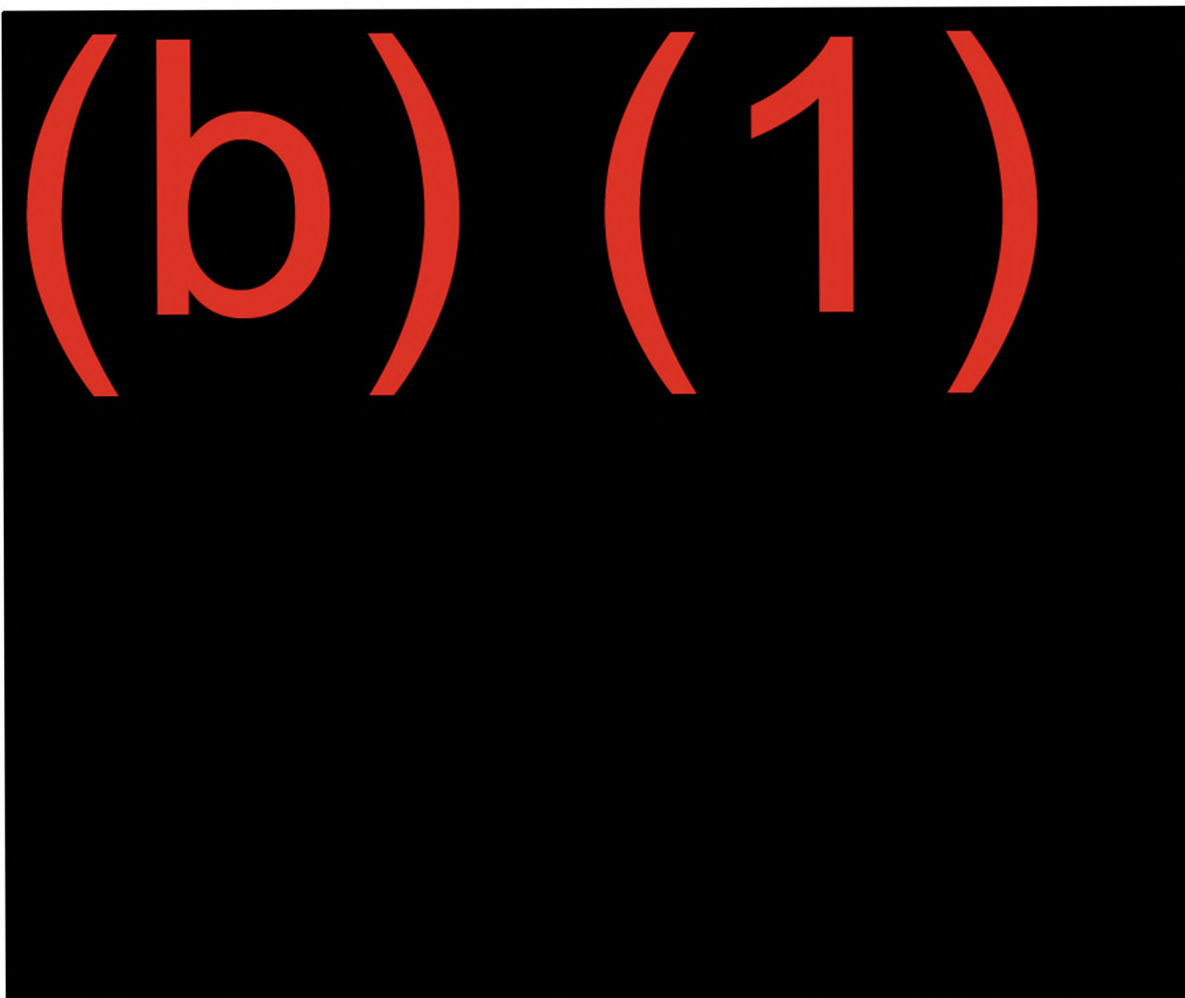


3.3 Weapon Effectiveness

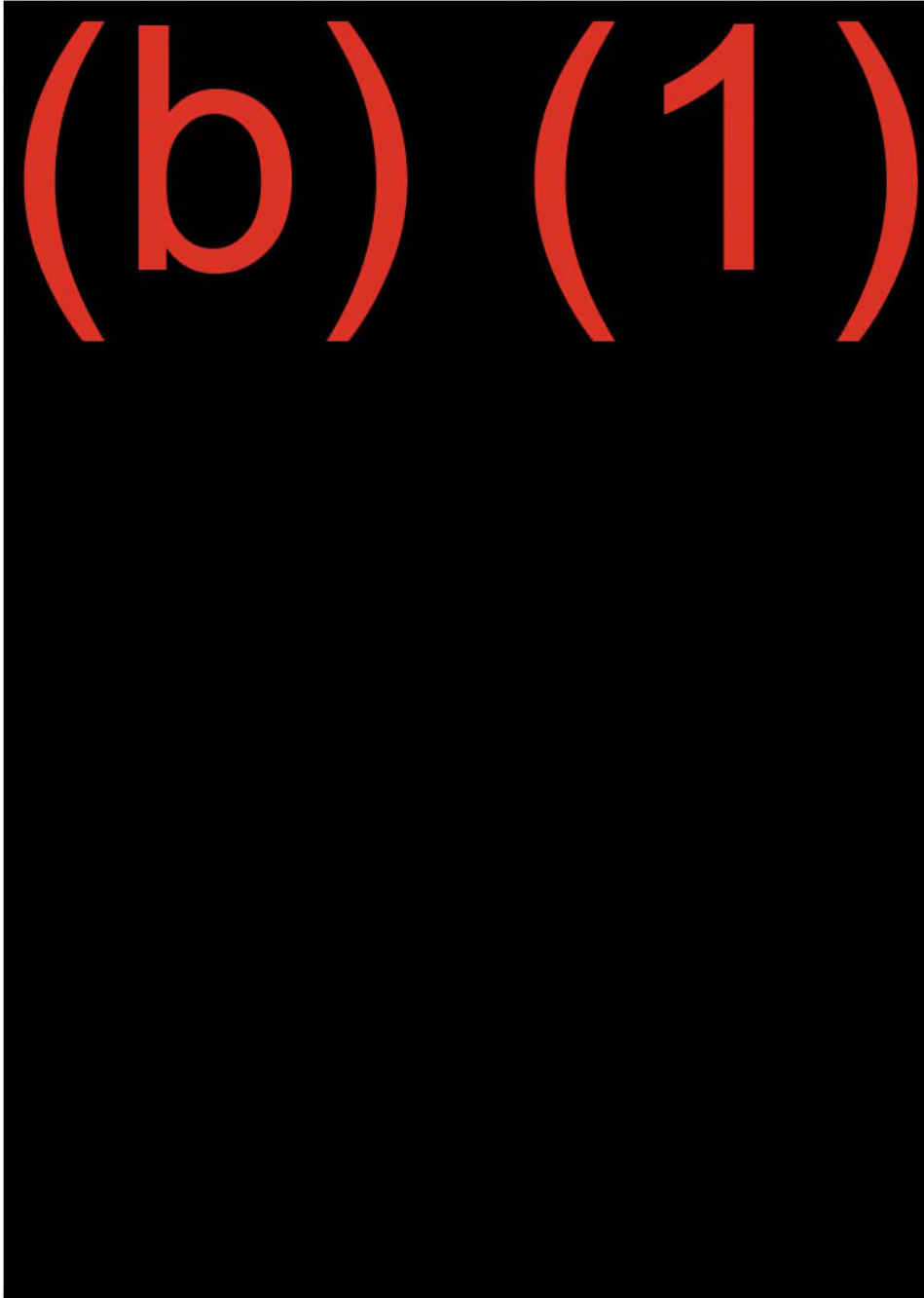
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(U) A number of threat elements have an impact on the effectiveness of lightweight and heavyweight torpedoes including submarine speed, depth, hull construction, and active and passive quieting.



~~(S)~~ Figure C-12. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
INITIATE ATTACK (U)

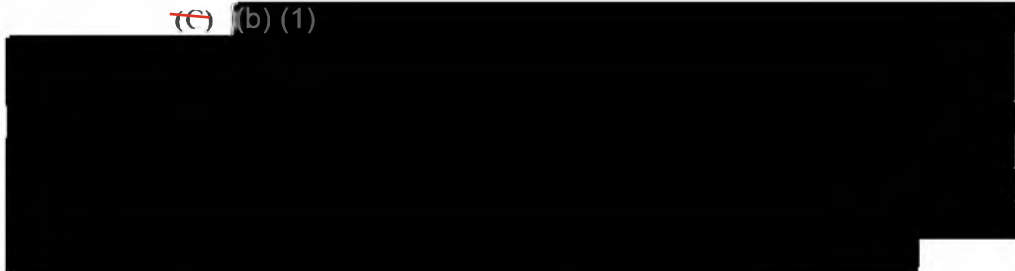


~~(S)~~ Figure C-13. EFFECT OF THREAT ELEMENTS ON WEAPON
EFFECTIVENESS (U)

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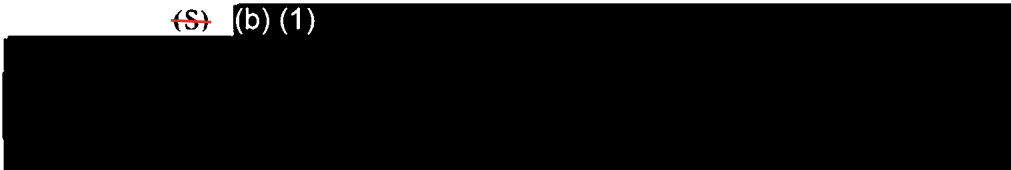


4. ABILITY TO EVADE/AVOID/DISENGAGE

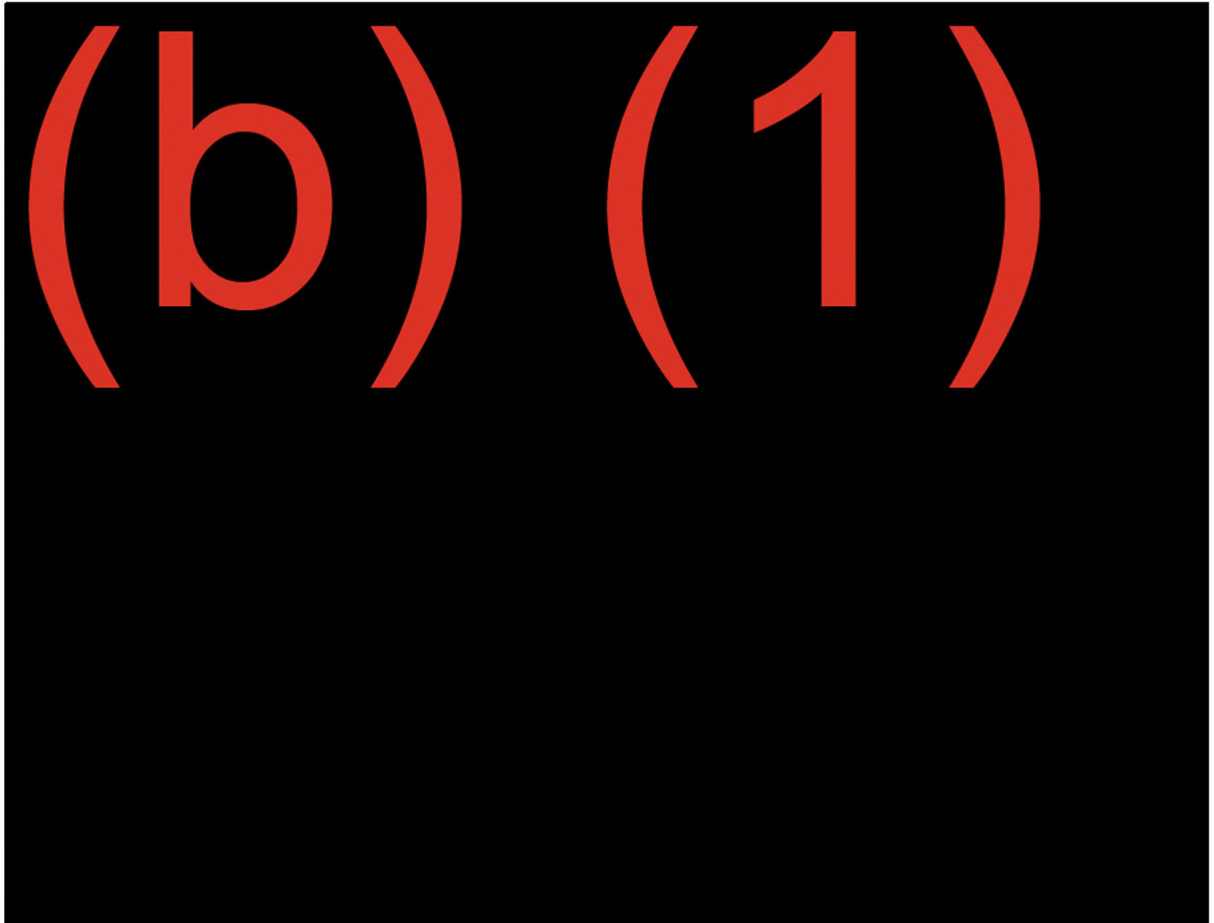
(U) The elements of the Soviet threat discussed in the previous sections may also contribute to the potential operational deficiency in the ability to break off an engagement with a submarine by moving out of range of its weapons and sensors. In addition, the elements of the Soviet torpedo threat may reduce the ability of ANVs to counter a submarine torpedo attack.

(U) To avoid attack by a submarine, an ANV must first move out of range of the submarine's antiship weapons and then break contact by moving out of range of the submarine's sensors. For air vehicles, this is a trivial task. Figure C-14 shows the elements of the Soviet threat which have an impact on this ability. The improvements in Soviet submarine speed, sensor capabilities, and weapon range increase their ability to maintain surface contacts and to close to weapon range.

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~~(S)~~ Figure C-14. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
AVOID ATTACK (U)

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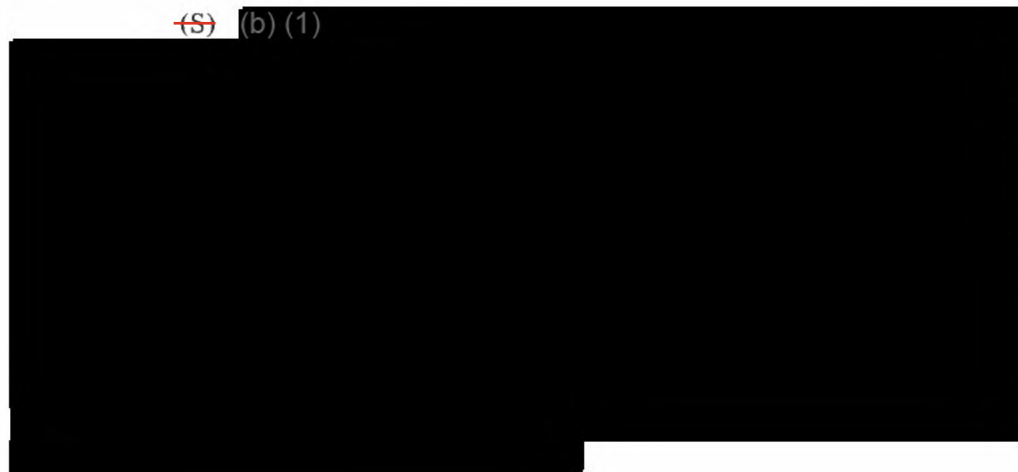
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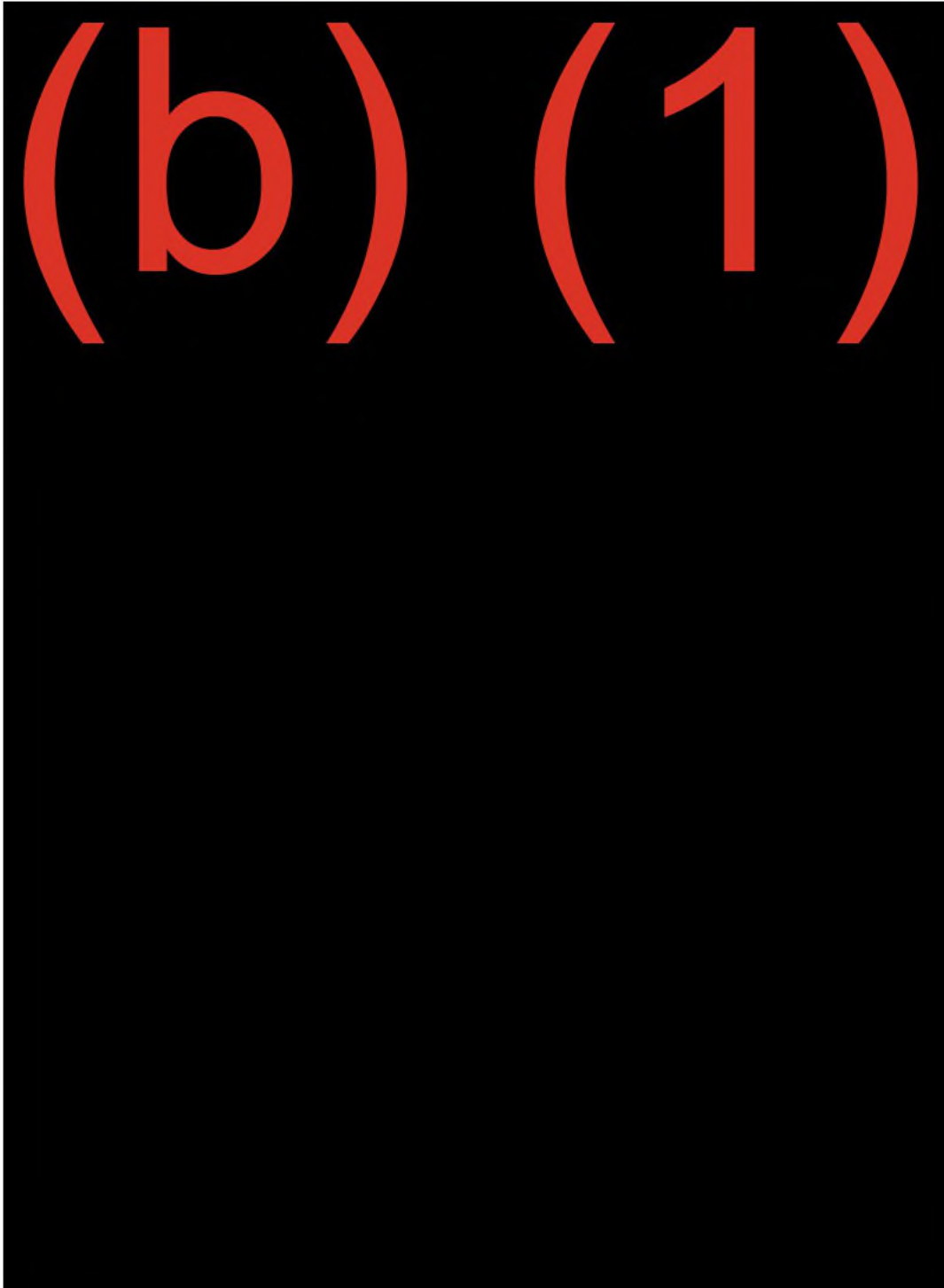
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~~(S)~~ Figure C-15. EFFECT OF THREAT ELEMENTS ON ABILITY TO COUNTER
TORPEDOES (U)

III. ANTISURFACE-SHIP WARFARE

(U) This section examines the potential impact of the threat on the ASUW operational capabilities of ANVs. The impacts are examined in the context of the ability (a) to detect and identify surface targets; (b) to engage surface targets; and (c) to disengage from surface targets.

I. ABILITY TO DETECT AND IDENTIFY SURFACE TARGETS

(U) The ability to detect and identify surface targets is a vital capability for advanced naval surface vehicles conducting ASUW operations. A number of elements of the Soviet threat may contribute to potential operational impact in these areas.

I.1 Detection

(U) The ANVs will have a variety of sensors to use in detecting surface targets. These sensors include radar, sonar, electro-optical (EO) systems, and ESM. In most cases, platform-mounted sensors will be limited to line-of-sight (LOS) detections, with sensors mounted on organic aircraft [such as vertical/short takeoff and landing (V/STOL) aircraft, helicopters, and remotely piloted vehicles (RPVs)] or surface forward observers required for over-the-horizon (OTH) detections. A number of elements of the Soviet threat may have an impact on the ability of advanced naval surface vehicles to detect surface targets. Figure C-16 shows these threat elements as well as the potential operational impact that they imply.

~~(C)~~ (b) (1)



(U) The antiship capabilities of Soviet combatants may inhibit the use of surface platforms as forward observers.

(b) (1)

~~(S)~~ Figure C-16. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
DETECT SURFACE SHIPS (U)

~~(C)~~ (b) (1)



1.2 Identification

(U) Accurate identification of surface ships is a necessary prelude to engagement. They must be identified as either threat or nonthreat platforms and also as a specific type of threat platform. While a variety of sensors can be used to detect surface ships, not all of them may be suitable for identifying surface ships.

(U) A number of elements of the Soviet threat may contribute to a potential operational impact on the ability of ANVs to identify surface contacts. These threat elements are shown in Figure C-17 along with the potential operational impacts that they may imply.

~~(C)~~ (b) (1)



~~(C)~~ (b) (1)



2. ABILITY TO ENGAGE SURFACE TARGETS

(U) The ability to engage surface targets can be defined in general as the ability to conduct an effective attack on them. While the capabilities of an ANV for detection and identification of surface targets contributes to the ability to engage, this section assumes that a surface target has been detected and identified and concentrates on the ability of ANV surface vehicles to close to weapon range, the ability to initiate an attack before they are attacked, the ability of ANV weapons and aircraft to penetrate Soviet air defenses, and the effectiveness of ANV weapon warheads.

(b) (1)

~~(S)~~ Figure C-17. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
IDENTIFY SURFACE SHIPS (U)

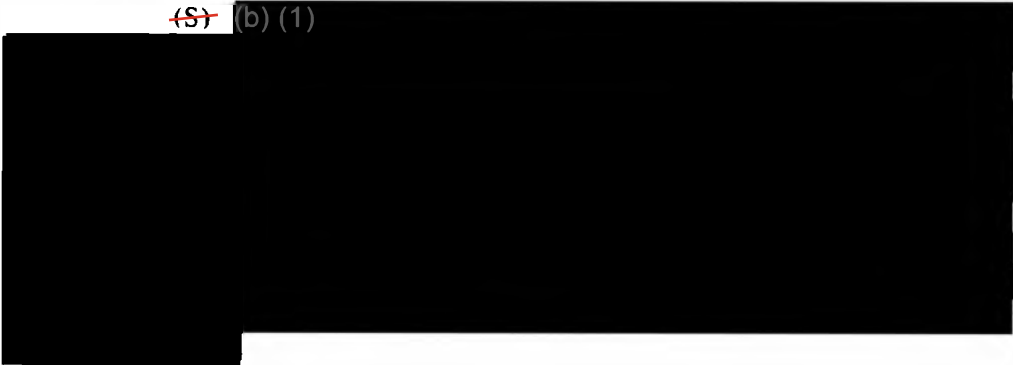
2.1 Ability to Close to Weapon Range

~~(S)~~ (b) (1)



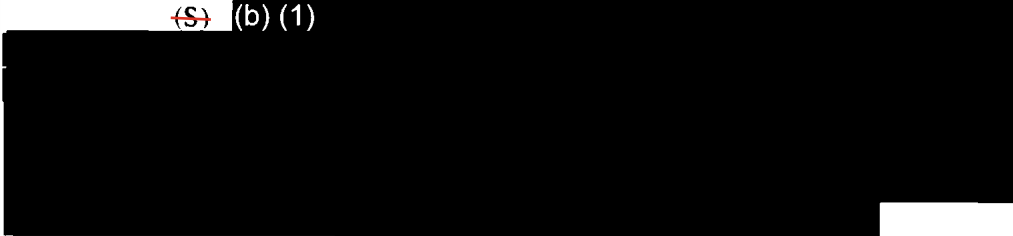
2.2 Ability to Initiate Attack

~~(S)~~ (b) (1)



2.3 Ability to Penetrate Defenses

~~(S)~~ (b) (1)

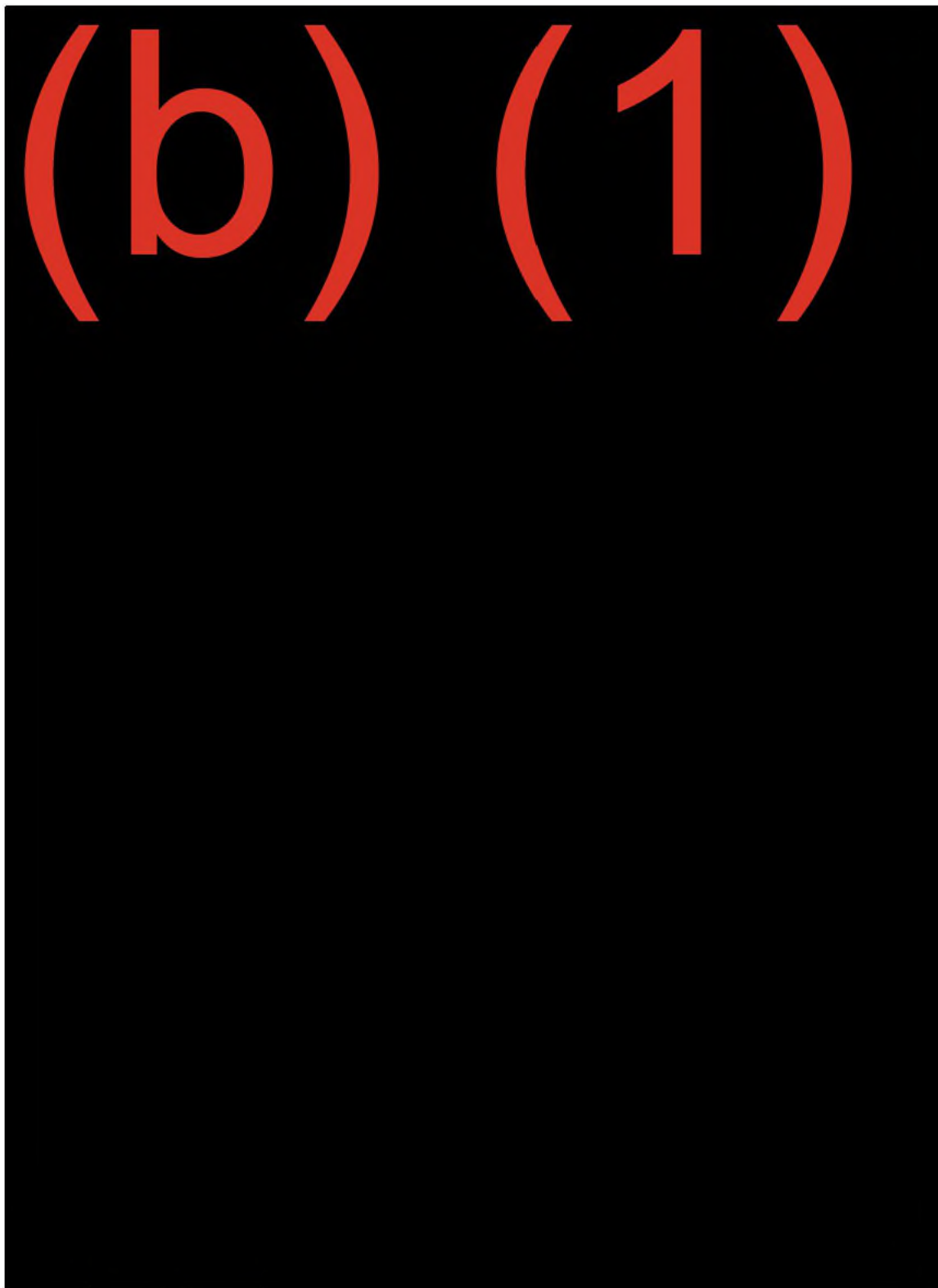


~~(S)~~ (b) (1)



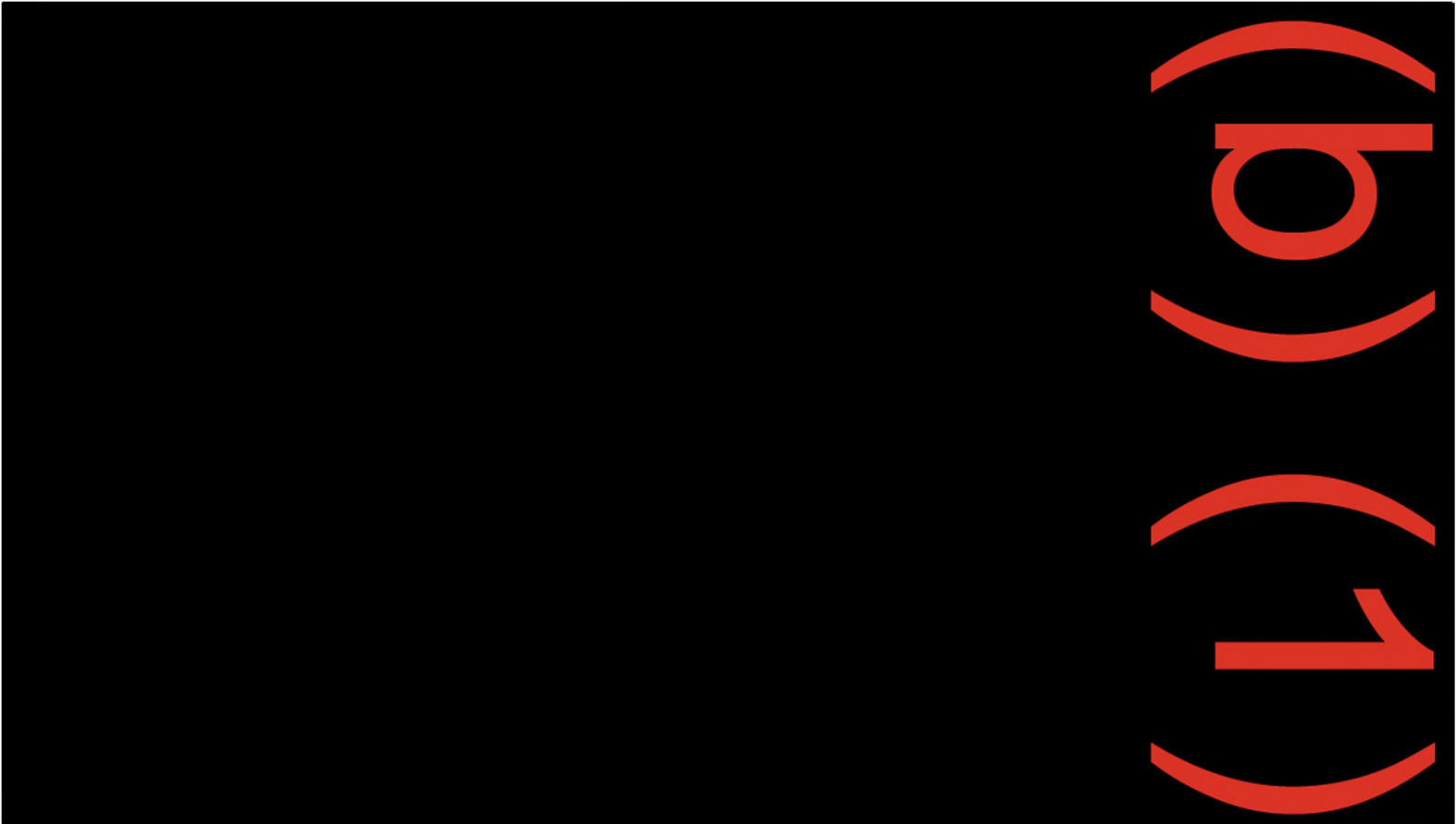


~~(S)~~ Figure C-18. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
CLOSE TO WEAPON RANGE (U)



~~(S)~~ Figure C-19. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
INITIATE ATTACK (U)

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~~(S)~~ Figure C-20. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
PENETRATE V/STOL AIR DEFENSE (U)

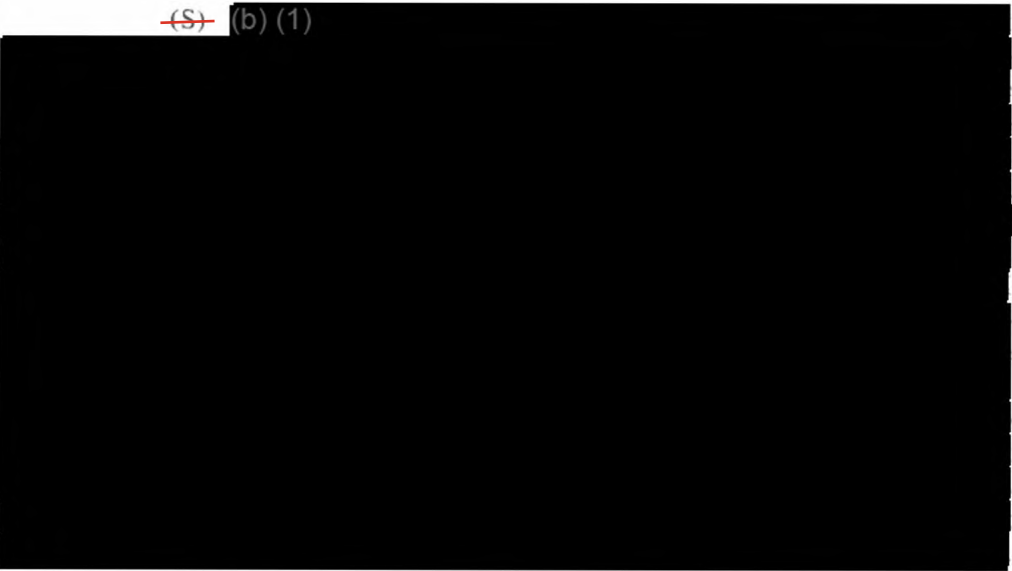
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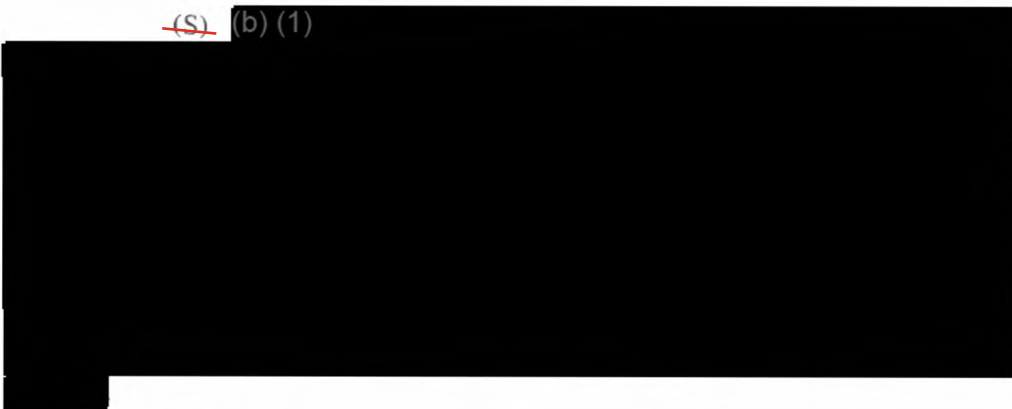
~~(S)~~ (b) (1)



~~(S)~~ (b) (1)



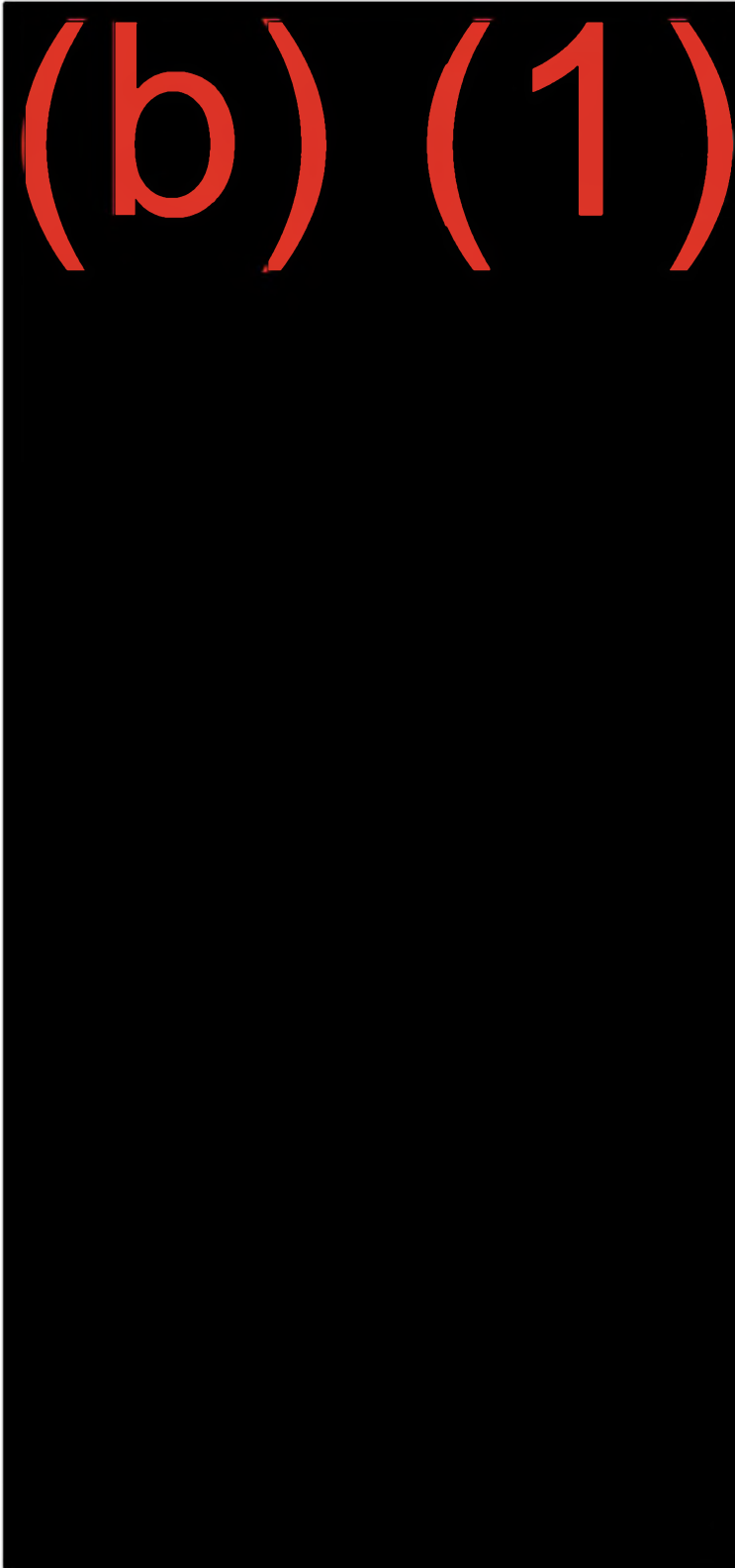
~~(S)~~ (b) (1)



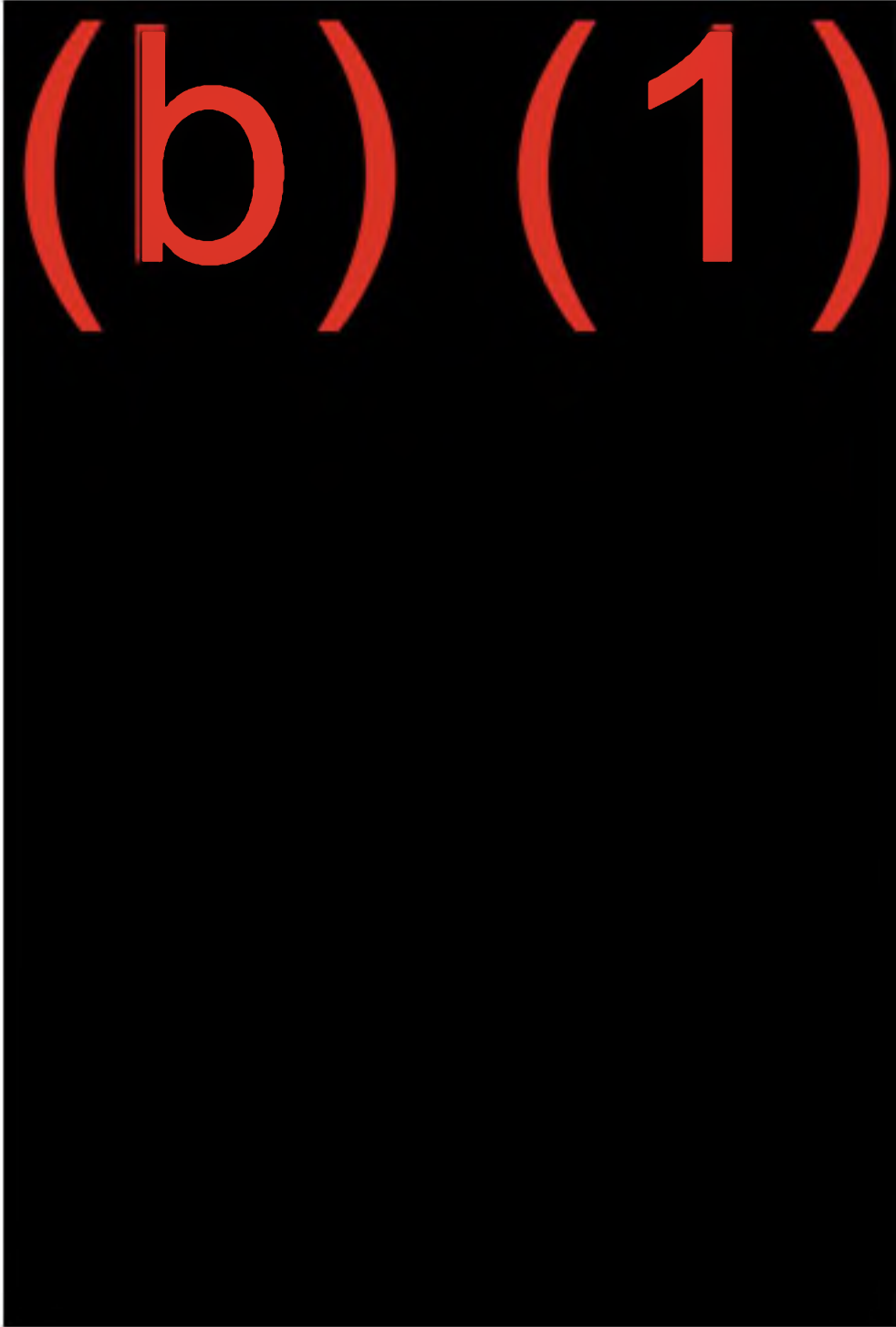
~~(C)~~ (b) (1)



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~~(S)~~ Figure C-21. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
PENETRATE SAM AIR DEFENSES (U)



~~(S)~~ Figure C-22. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
PENETRATE CLOSE-IN DEFENSES (U)

2.4 Warhead Effectiveness

~~(C)~~ (b) (1)

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~~(S)~~ (b) (1)

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3. ABILITY TO DISENGAGE FROM SURFACE SHIPS

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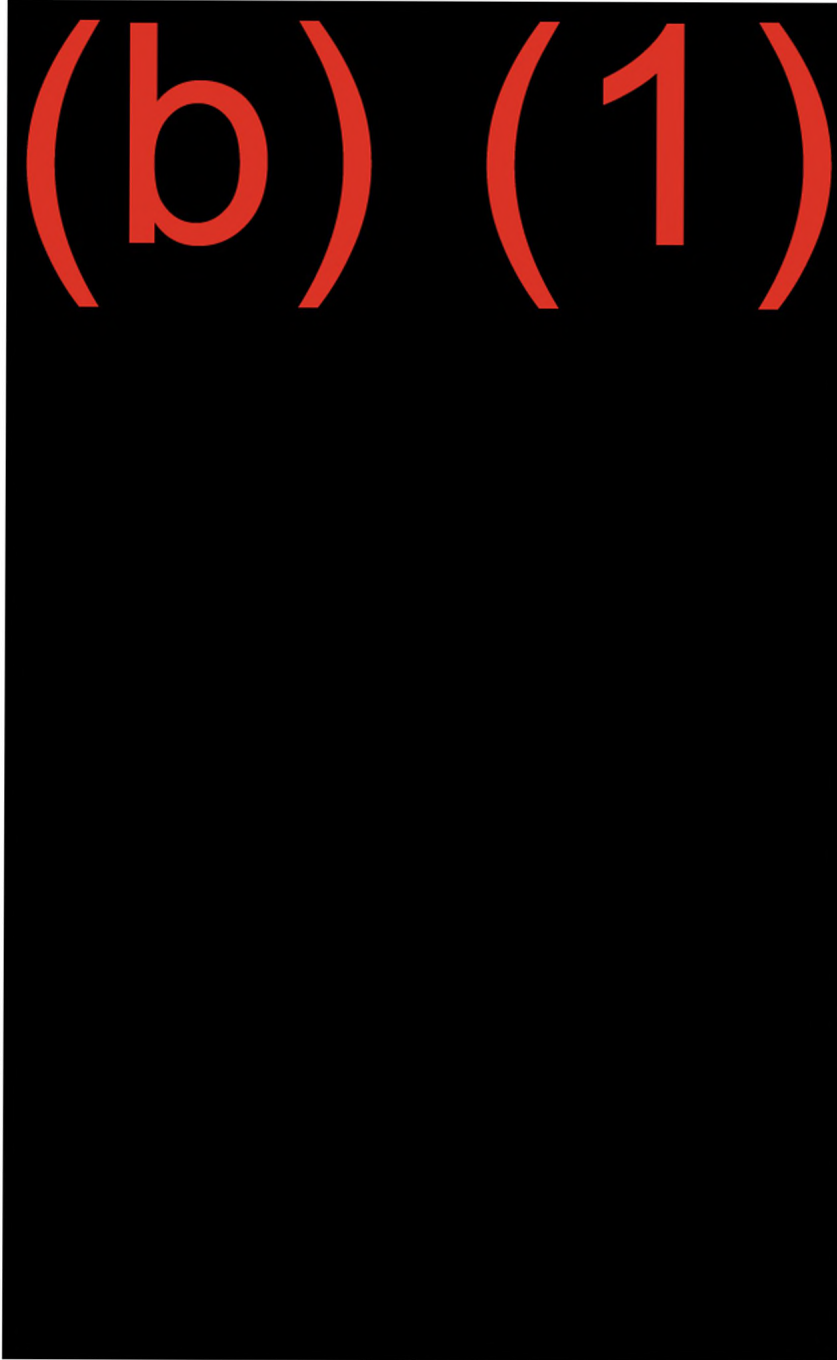
~~(S)~~ (b) (1)

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(U) Figure C-25 shows those elements of the Soviet threat that have an impact on the ability of surface ANVs to counter ship launched antiship torpedoes.

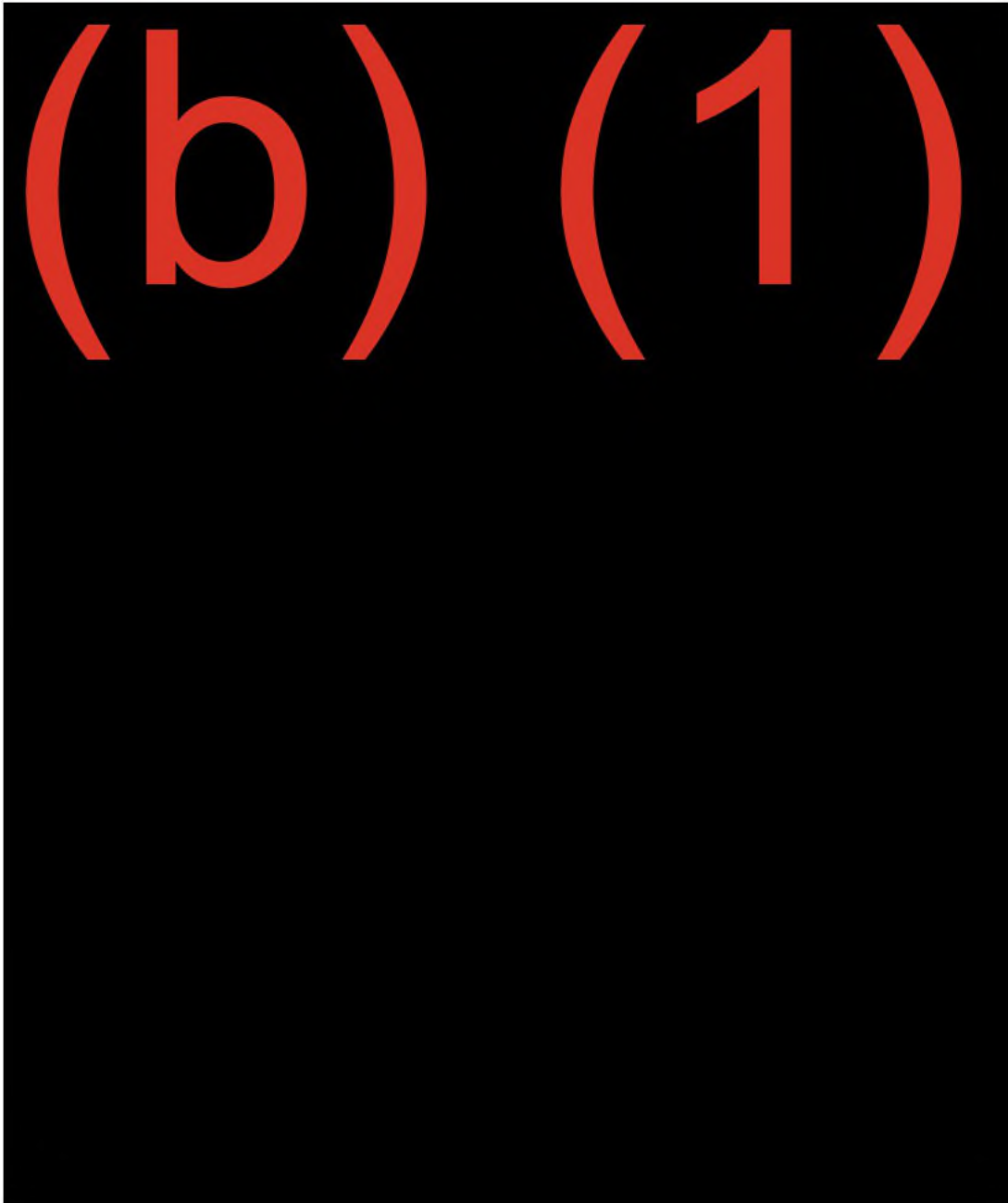
~~(S)~~ (b) (1)

A large rectangular area of text is completely redacted with black ink.

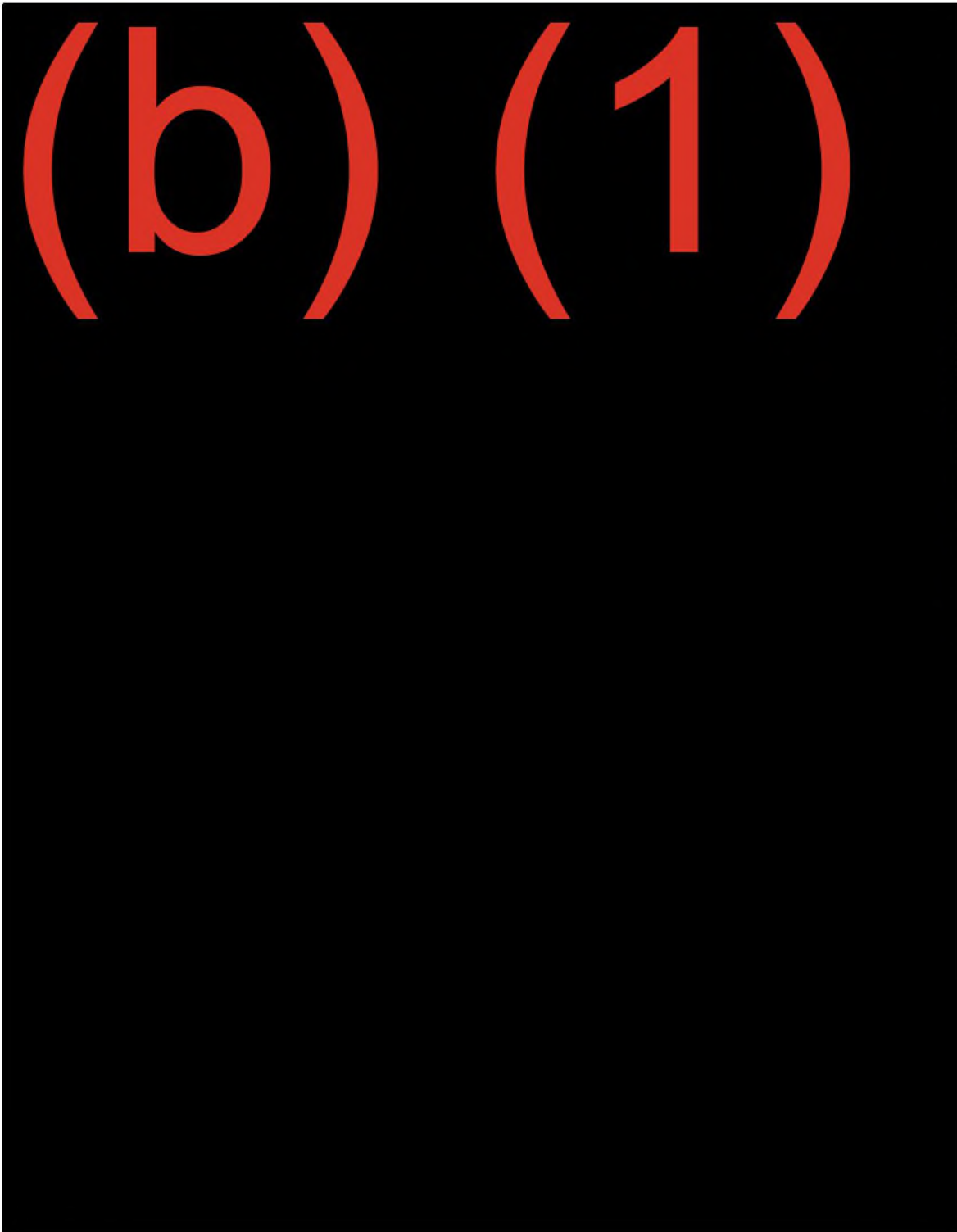


~~(S)~~ Figure C-23. EFFECT OF THREAT ELEMENTS ON WARHEAD EFFECTIVENESS (U)

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~~(S)~~ Figure C-24. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
COUNTER NAVAL GUNFIRE (U)



~~(S)~~ Figure C-25. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
COUNTER TORPEDOES (U)

(b) (1)

~~(S)~~ Figure C-26. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
AVOID ATTACK (U)

IV. ANTIAIR WARFARE

(U) This section examines the potential impact of the threat on U.S. AAW operational capabilities in the context of the ability of ANVs to (a) provide AAW defense; (b) detect, identify, and track air targets; (c) engage air targets with antiair weapons; and (d) provide countermeasures to Soviet weapons.

1. ABILITY TO PROVIDE AAW DEFENSE

(U) AAW defense includes the defense of moving forces, the defense of a geographic area, and self-defense. A number of elements of the Soviet threat may have an impact on the ability of ANVs to provide AAW defense. These elements and the deficiencies that they imply are shown in Figure C-27.

~~(S)~~ (b) (1)



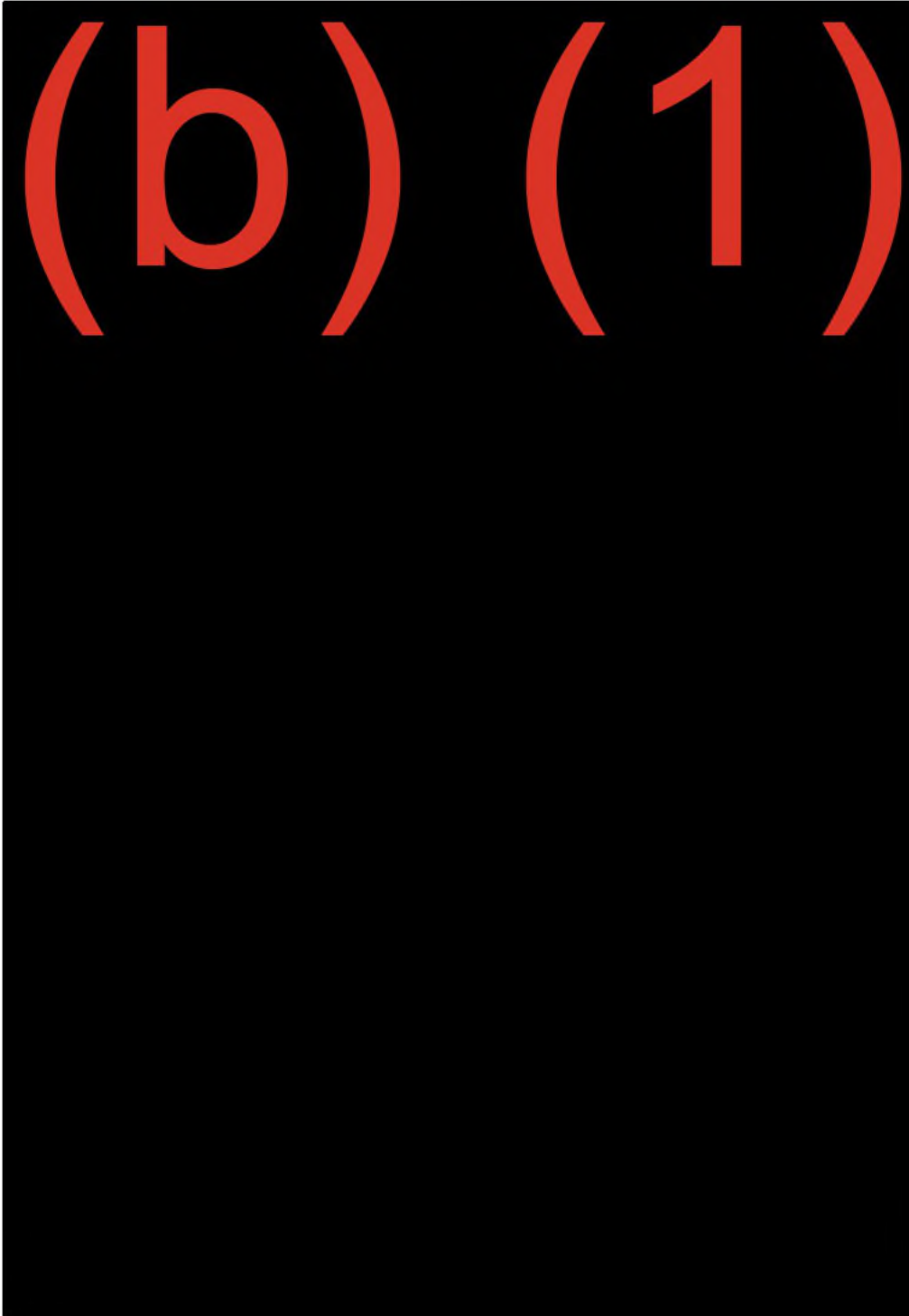
2. ABILITY TO DETECT, IDENTIFY, AND TRACK AIR TARGETS

~~(S)~~ (b) (1)





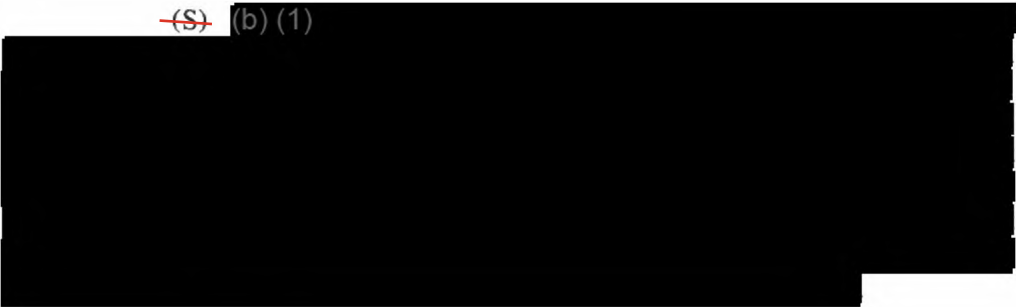
~~(S)~~ Figure C-27. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
PROVIDE AAW DEFENSE (U)



~~(S)~~ Figure C-28. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
DETECT, IDENTIFY, AND TRACK AIR TARGETS (U)

3. THE ABILITY TO ENGAGE AIR TARGETS

~~(S)~~ (b) (1)



~~(S)~~ (b) (1)



~~(S)~~ (b) (1)



4. ABILITY TO PROVIDE COUNTERMEASURES TO SOVIET WEAPONS

~~(S)~~ (b) (1)

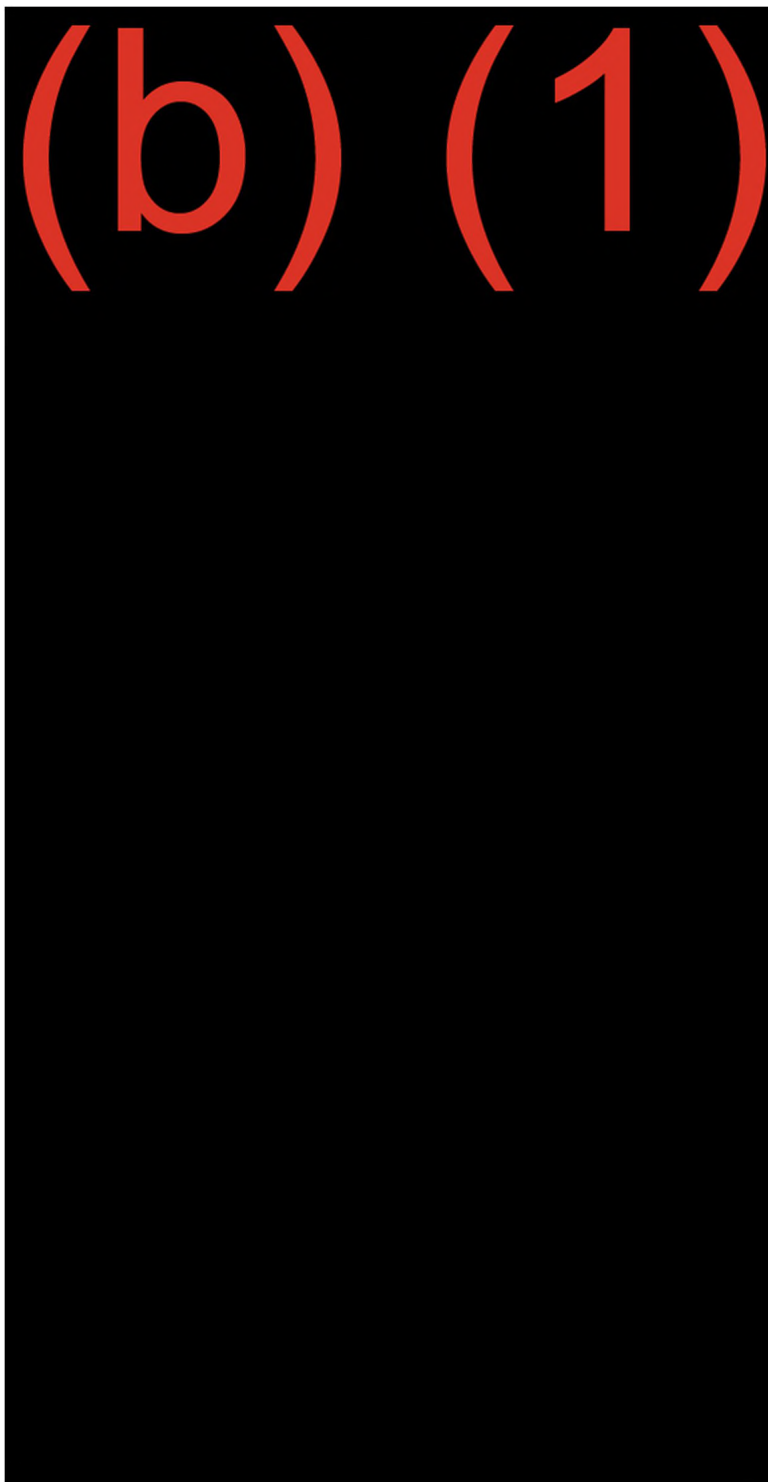


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~~(S)~~ Figure C-29. EFFECT OF THREAT ELEMENTS ON THE OPPORTUNITY
TO ENGAGE AIR TARGETS (U)

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~~(S)~~ Figure C-30. EFFECT OF THREAT ELEMENTS ON ENGAGEMENT
EFFECTIVENESS (U)

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(b) (1)

~~(S)~~ Figure C-31. EFFECT OF THREAT ELEMENTS ON THE ABILITY TO
COUNTERMEASURE WEAPONS (U)

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VOLUME 4
APPENDICES A,B & C



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