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SOVIET SHIP VULNERABILITY DESIGN DEFICIENCIES AND ADVANTAGES (U)

(A SUPPLEMENT TO THE FINAL REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON SURFACE NAVAL WARFARE)

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SOVIET SHIP VULNERABILITY

DESIGN DEFICIENCIES AND ADVANTAGES

(A supplement to the Final Report of the
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SOVIET SHIP VULNERABILITY
DESIGN DEFICIENCIES AND ADVANTAGES

(A Supplement to the Final Report
of the Defense Science Board
Task Force on Surface Naval Warfare)

April 1976

(U) This Supplement was prepared by one of our members, Mr. Reuven Leopold, to address the relative vulnerabilities of Soviet and U.S. warships. Our conclusions and recommendations, based on this analysis, discussions with Navy personnel and our own deliberations are contained in the Final Report.

[redacted] In the following paragraphs, first Soviet design deficiencies are discussed, then the advantages of Soviet shipbuilding practices are summarized.

- Principle design deficiencies are:
  - little blast protection
  - inadequate high shock protection
  - inferior structural design practices
  - vulnerable exposed topside magazines susceptible to mass detonation
  - vulnerability to fire
  - susceptability to flooding damage
- Principle advantages are:
  - redundancy in fire control systems, sensors, modes
  - dispersed, man-in-the-loop command systems
  - redundant and dispersed weapon systems
  - probably well armored command and control spaces and magazines in newer ships

(U) These statements are expanded in this Supplement.

1. Soviet Vulnerability Design Deficiencies

1.1 Soviet Ships are Provided with Little Blast Protection

[redacted] Major reasons for the conclusion that Soviet ships are not designed to resist blast are:

- Detailed photographic analysis of recent Soviet ships indicates that they are provided with numerous superstructure expansion joints. Typical photos of Soviet expansion joints, in this case on the KARA class CLGM, are provided in Figure 1.1-1.

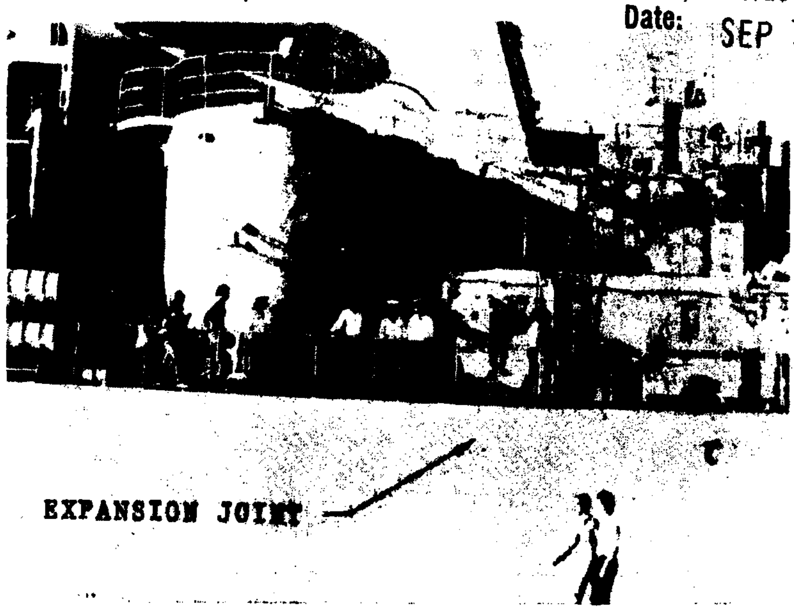


Figure 1.1-1 Soviet Expansion Joint on KARA (U)

To resist air blast, lateral shear must be adequately transferred into the hull structure through transverse bulkheads. Use of expansion joints makes lateral shear transfer clearly impractical unless shear planes are provided to carry loads immediately forward and aft of the joint into the hull. Soviet superstructures are also characterized by discontinuity in the various vertical planes. Blast configured houses usually present a 'blocky' appearance due to a desire to avoid pockets and blast reflection. No older Soviet surface combatants investigated by U.S. Navy analysts have an adequately 'hard' mounted superstructure (a structure aligning with support below). Superstructure ends on these ships were often mounted on doubler plates or only lightly supported by hull structure below.

- The Soviets use lightweight bulb plates for construction purposes. Members of this type provide little plastic resistance for withstanding short but intense air blast dynamic loads. Bulb plates are incompatible with the development of full moment-bearing fixed end connections due to the virtual impossibility of adequately supporting the narrow flanges of bulb-plate beams with brackets.

- Photographic analysis of Soviet vessels does not present the visual impression of super-heavy masts and yardarms presented by those found on similar U.S. Navy blast protected ships, such as the LCC-19.

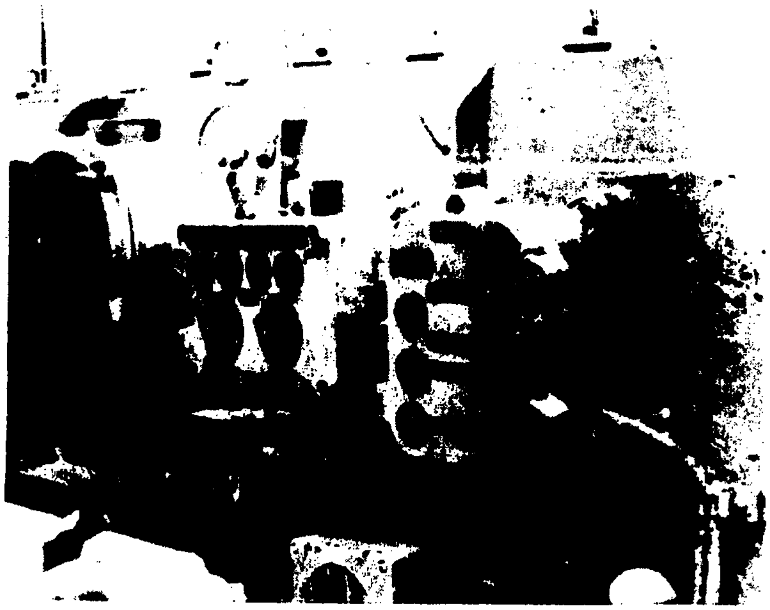
- Soviet radar antennas have very large exposed surfaces which are very vulnerable to blast-induced damage. Soviet gunnery-associated fire control radars use open solid dishes which can be expected to be highly vulnerable to blast-induced loads, as dishes must withstand intense drag loads over their entire cross section.

THUS THE CONCLUSION THAT SOVIET SHIPS HAVE LITTLE BLAST PROTECTION.

1.1.2 Soviet Ships are Not Provided with Substantial Hi-Shock Protection

Detailed analysis of Soviet combatants compromised to the U.S. Navy indicates that these vessels are not provided with substantial Hi-Shock protection. More importantly, analysis of more recent vessels and major conversions, including material observed on a recent KANIN Class DDG conversion, indicates no change to 1950 style design practices.

A typical soft mount utilized by older Soviet combatants for small equipment is depicted in Figure 1.1-2.



OSD 3.3(b)(4), (8)
Navy 3.3(b)(4)

Figure 1.1-2 Soviet Soft Mount Spring

This is unsatisfactory as a shock mount because of its ability to transmit high loads, and also due to the ease with which it would bottom-out during any shock excursion.

[redacted]

Furthermore, substantial analysis of Soviet structural design techniques leads to the conclusion that basic structural design practices are inadequate for combatant type Naval vessels. Thus, even if local foundations were theoretically capable of withstanding local loads, overall structural inadequacies would probably lead to major system failures after a shock event.

THUS THE CONCLUSION THAT SOVIET SHIPS DO NOT HAVE HI-SHOCK PROTECTION.

1.1.3 Soviet Ships Have Inferior Structural Design Practices

[redacted]

Soviet ships, however, have substantial detail design deficiencies throughout their hull girders, as follows:

- The Soviets use unstable bulb-plates for longitudinal beams that will trip when severely axially loaded, as shown in Figure 1.1-3.

Navy 3.3(b)(4)

OSD 3.3(b)(4),(8)

Figure 1.1-3 Soviet Bulb Plate Beam

- Soviet connections of members at intersections or in way of stanchions experiencing tension will fail under combat-induced loads, see Figure 1.1-4.

- Soviets often have very large openings in strength decks; longitudinal material in way of these openings required to resist hull-bending loads is concentrated in narrow strakes; often riveted doubler or welded insert plates are utilized to provide the required cross-sectional area. A typical example is shown in Figure 1.1-5.

- Soviet ships are not developed with emphasis on longitudinal material continuity. Cuts are sudden, and the longitudinal girder lines are discontinuous. Soviet ships do not utilize longitudinal (HOVGAARD) bulkheads aft.

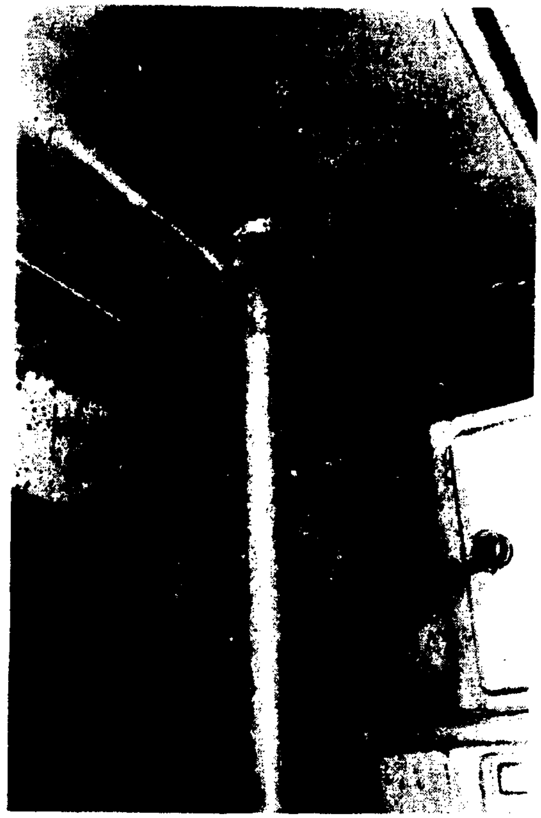


Figure 1.1-4 Soviet Stanchion Connection ~~(S)~~

Figure 1.1-5 Soviet Hull Girder Doublers ~~(S)~~

Navy 3.3(b)(4)

OSD 3.3(b)(4), (8)

- The very tight spaces developed by Soviet arrangement designers force the frequent cutting of hull structure to remove even modest-sized machinery components. This results in, for ships which have experienced years of operational service, the possibility of structural defects, stress concentrations, and weaknesses. These will combine and further constitute a degradation of potential basic hull structural integrity.

[redacted]

The lack of good structural detailing practices may ensure that local damage is translated into catastrophic flooding due to sequential bulkhead failure from a local hit. Poor structural detail design practices may lead to excessively large damage radius from otherwise low level magnitudes of attack. This is especially important as the primary damage mechanism of internal explosions is blast.

Concentration of hull girder material locally means that small weapons may almost totally degrade hull girder strength while inflicting only local damage if they are 'smart'. Riveted doublers are also less able to resist sudden damage induced loads than welded structures which can deform plastically.

SOVIET STRUCTURAL DETAIL DESIGN PRACTICES THEREFORE INCREASE OVERALL SHIP VULNERABILITY.

1.1.4 Soviet Ships are Characterized by Numerous Exposed Topside Magazines, Each Potentially Susceptible to Mass Detonation

Recent Soviet surface combatants oi destroyer size are characterized by numerous exposed topside weapons systems such as:

- Quintuple 21" torpedo tubes
- Cannister mounts for surface-to-surface or
- surface-ASW missiles
- RBU ASW rocket launchers
- Medium caliber gun mounts
- CIWS weapons systems
- SAM alunchers

Typical locations of exposed ordnance of a KARA Class CLGM is depicted in Figure 1.1-6.

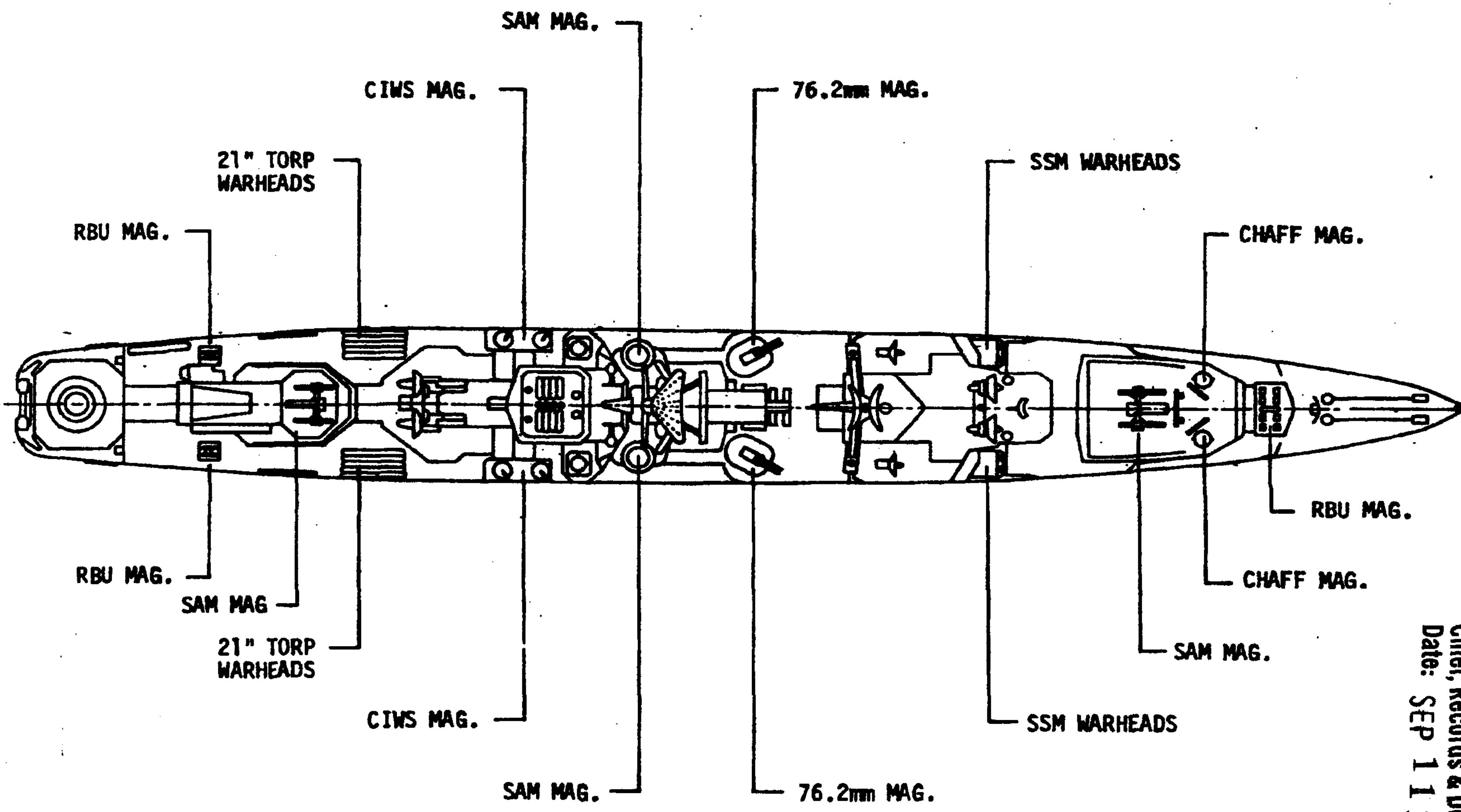


FIGURE 1.1-6: KARA EXPOSED ORDNANCE (S)

As a statistical result of this practice, exposed warheads form a relatively large percentage of overall exposed area from above or athwartships as seen by an approaching warhead. They are therefore exposed to damage and mass detonation.

Mass detonations of ordnance can be caused by the impact on embarked munitions of shaped charge jets or of large, high-velocity, fragments. Indications are that shaped charge jets will almost always induce mass detonation, while WW II damage reports indicate that large, fast fragments possibly may cause a detonation. It is also important to note the difference between detonation and deflagration, which is a low order phenomenon with less significance to the probability of ship loss.

The probability of any specific shaped charge warhead (without unusual accuracy) impacting on stowed ship-board ordnance is obviously very low. However, modern weaponry, such as 2.75" FFAR or Rockeye HEAT bomblets, can result in numerous hits occurring during an event (i.e. aircraft attack or combat episode) since one aircraft can carry 6-12 Rockeye containers, each containing 247 bomblets, or a similar number of LAU missile launchers, each with 18 FFAR weapons. Thus the potential single hit probability per event is relatively high; furthermore the remarkable penetrating powers of shaped charge cone diameter thickness's of homegenous steel armor, means that even small warheads will penetrate normal destroyer-like structure to reach vital magazine spaces.

Should the local volume of stowed ordnance be sufficiently large relative to overall ship size, mass detonations may conceivably lead to total - and instantaneous - loss of the target ship. Large amounts of stowed ordnance on destroyer type ships are found in 21" torpedo warheads or large surface-to-suface missile warheads; both characteristic weapons on Soviet designs.

[redacted]

Navy 3.3(b)(4)
OSD 3.3(b)(4),(8)

Navy 3.3(b)(4)
OSD 3.3(b)(4),(8)

[redacted]

1.1.5 Soviet Ships Are Vulnerable To Fire

~~(C)~~ Soviet ships are probably far more vulnerable to fire damage than equivalent U.S. Navy combatant designs.

~~(C)~~ Three 1950 vintage designs investigated by U.S. Navy experts (The SKORYY, RIGA and SVERDLOV Classes) were extremely vulnerable to fire as they extensively utilized flammable materials, including flammable cork insulation. The late 1960's vintage KANIN Class DDG, visited by a team of U.S. Navy personnel, utilizes flammable materials in accommodation areas. Observed fire fighting capabilities in the machinery spaces on this vessel were, for all practical purposes, non-existent. Furthermore, the known recent loss of a KASHIN due to fire in the Black Sea confirms the extent of this weakness.

(U) U.S. Navy fire-fighting design practices have been strongly influenced by combat experience, especially the numerous losses due to fire during the early days of WW II.

(U) These losses were feflected in a massive 'strip-ship' campaign and modifications to detail material design practices. Since WW II, if anything, U.S. Navy practice has improved in this regard with improvements becoming especially significant with respect to the combat of fires aboard aircraft carriers.

~~(C)~~ Fire damage is necessarily sequential. Except in special cases, like aircraft carrier hangars, initial fire induced damage is usually less than the blast damaged volume of the target vessel. Thus, prevention of the spread of fires and containment of a casualty induced conflagration must be the primary goal of any shipboard fire fighting system. IN THIS REGARD, SOVIET SHIPS ARE CLEARLY DEFICIENT.

1.1.6 Soviet Ships May Be Susceptible To Flooding Damage

[redacted]

(S) In previous Soviet naval vessels they did not utilize interior 'Damage Control Decks'. Attention to vertical and longitudinal access on these designs was poor.

(S) Vital space watertight boundaries were not provided nor were multiple escapes from manned spaces in case of flooding. Thus, actual damage control capabilities of Soviet ships as compared to equivalent type and similar vintage U.S. Navy designs may be restricted, even though their theoretical capabilities are otherwise equal.

(S) The Soviet are estimated to place less emphasis on unsymmetrical flooding than does the U.S. Navy. Some recent combatants are known to utilize watertight centerline bulkheads in machinery spaces. Redundancy is provided by this separation, while some degree of damaged stability is provided by use of outboard compensating tank spaces, port and starboard, and by provision of generous GM/Beam ratios.

(S) This Soviet design concept provides machinery system viability without side protection systems or excessively long segregated machinery spaces. The Soviets apparently believe that on relatively wide-vessels contact side-hits by U.S. underwater weapons will not destroy the watertight integrity of the centerline bulkhead. Thus, equipment on the opposite side of any hit is probably assumed to survive a combat casualty in operational order.

(S) Lack of freeboard on the MOSKVA class and estimated lack of freeboard on the KIEV suggest that the Soviets place less emphasis on damaged stability than does the U.S. Navy. Combined with convoluted internal access, lack of vital spaces, and tendency to accept unsymmetrical flooding, it becomes reasonable to assume that SOVIET SHIPS MAY BE SUSCEPTIBLE TO FLOODING DAMAGE.

1.2 Soviet Vulnerability Design Advantages

[redacted]

[redacted] Soviet weapon-fire control systems have redundant capability. Most ships have two directions, and their fire-control systems have a degraded mode of operational capabilities since virtually all forms of gun mounts are provided with secondary local optical-control capability and the surface-to-air systems have a closed-circuit TV system for optical tracking. It should be recognized that in some cases this capability has problably been provided in order to provide fire-control capability in the face of intense electronic countermeasures. However, whatever the reason, the result is fire-control systems which are very difficult to totally destroy by low grade weapons. Using secondary control systems, however, considerably degrades optimum system performance.

[redacted] This fire-control redundancy is especially important because large exposed radar antennas, external radar wave guides, and system interconnect cables are extremely vulnerable to fragment damage. Fragments can be caused by ARM weapons (Shrike or Standard Arm), proximity or contact fused systems where fragments are the primary kill mechanism, and attack systems with a tendency for a high hit point. Provision of redundancy substantially reduces the probability of the ship experiencing a total loss of weapons capability from very low order, simple weapons.

[redacted]

Navy 3.3(b)(4)

OSD 3.3(b)(4),(8)

[redacted]

Soviet command philosophy is apparently quite different from that described for U.S. Navy designs. Soviet destroyer type ships are not known to have large centralized command centers located in their superstructures.

Soviet radar equipment rooms are cramped, small, and dispersed. Data is fed into centralized rooms where it is presented on displays and where all fire control solutions are derived. This data is then fed to a central command station (either the bridge or a small space nearby), where the data is correlated and decisions are made. Indications are that, except for display repeaters, this data is manually correlated and decisions are arrived at, and made, manually.

Navy 3.3(b)(4)

OSD 3.3(b)(4),(8)

[redacted]

The Soviet command posture, as described above, is clearly consistent with a first-strike posture.

1.2.3 Soviet Ships Have Redundant Weapons Systems

Major Soviet surface combatants have redundant weapons system capability. For example, the KARA has the following redundant AAW capability:

- 2 - SA-N-3 Systems (fore and aft)
- 2 - SA-N-4 Systems (port and starboard or fore and aft)
- 2 - 76.2mm Mounts (port and starboard or fore and aft)
- 4 - CIWS Systems (on each quarter or P/S)

all as indicated in Figure 1.2-1.

[redacted]

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NOTE:

- TWO AIR SEARCH RADARS
- TWO SAM GUIDANCE SYSTEM (L-R)
- TWO SAM GUIDANCE SYSTEM (S-R)
- TWO GFCS (M-R) PLUS LOCAL CONTROL
- TWO GFCS (S-R) PLUS LOCAL CONTROL

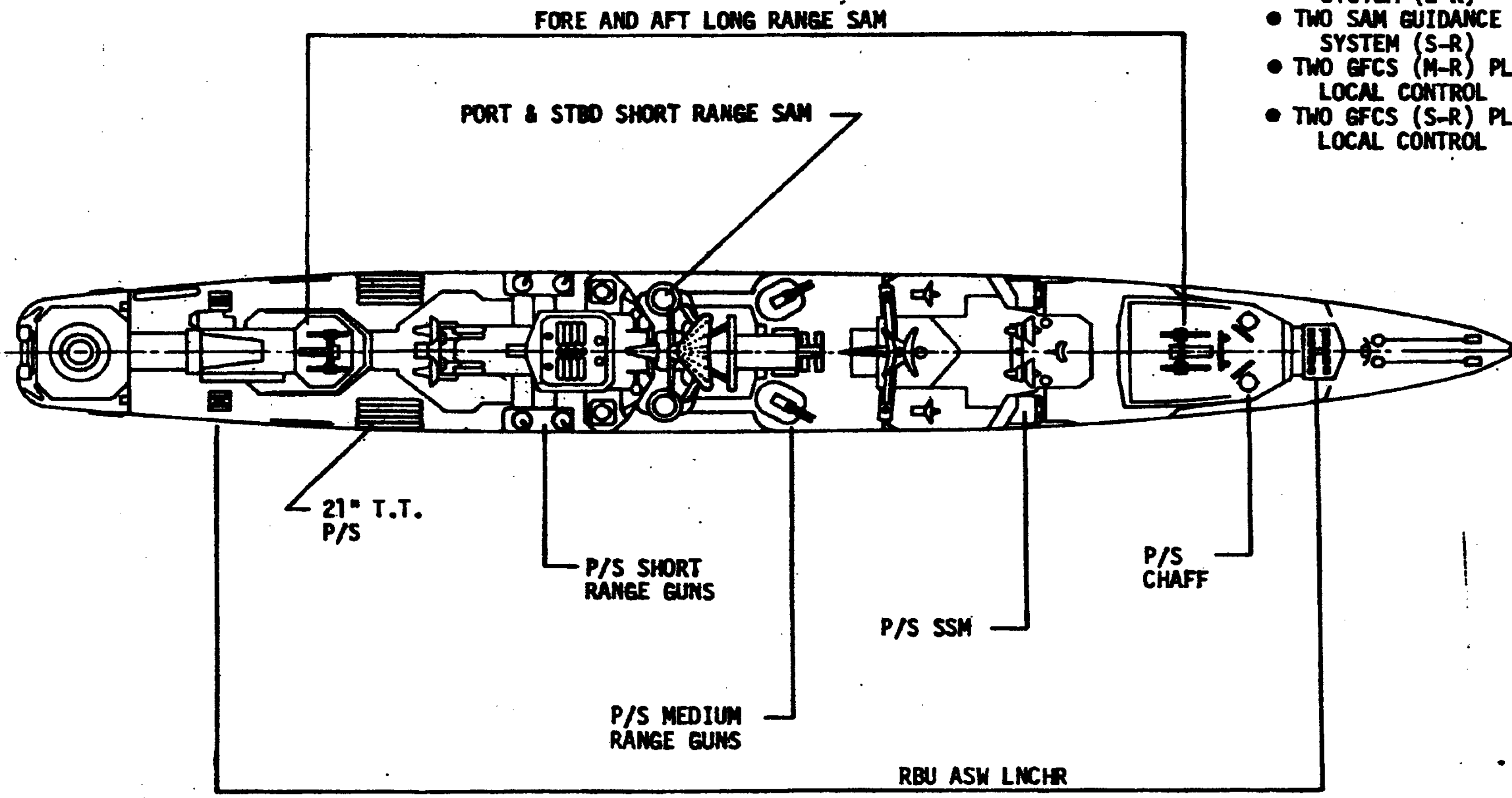

FIGURE 1.2-1: KARA REDUNDANT WEAPONS CAPABILITY (~~S~~)

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However, the extreme susceptibility of the large number of relatively-exposed magazines to mass detonations after hits by even modest-caliber projectiles tends to offset this apparent advantage.

1.2.4 Key Command and Control Spaces and Magazines on Soviet Vessels may be Relatively Well-Armored

There are very strong indirect indications that recent Soviet surface combatants have armor protection over key spaces high in the structure of the ships. This has resulted from detailed weight and stability analysis of recent Soviet combatants which result in grossly over-stable - 'stiff' - ships unless substantial added high weights are provided to balance the designs.

If this is the case, it means that the Soviets have recognized the problem of vulnerability to low-lethality weapons (fragments, aircraft cannon, etc.) and at least partially compensated for the problem by providing armor on a scale well beyond that of modern U.S. Navy practice.

U.S. combatants, except for aircraft carriers, have command and control facilities in aluminum deck-houses whose skin has negligible protective qualities (against fragments or shells equal only to 1/12" thick steel plate).

1.3 Summary

In general, these observations lead to the following overall conclusions:

- It is easier to engage a Soviet Surface Combatant and negate it by sinking, fire, or mass detonation than to degrade its system combat potential.

[redacted]

In any event, it should be recognized that all surface warships are exceedingly vulnerable to certain threats even considering low order conventional weapons; i.e., shells and bombs. This is due to fundamental limitations associated with the overall size and hull girder strength of typical destroyer type vessels.

Navy 3.3(b)(4)

OSD 3.3(b)(4)

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