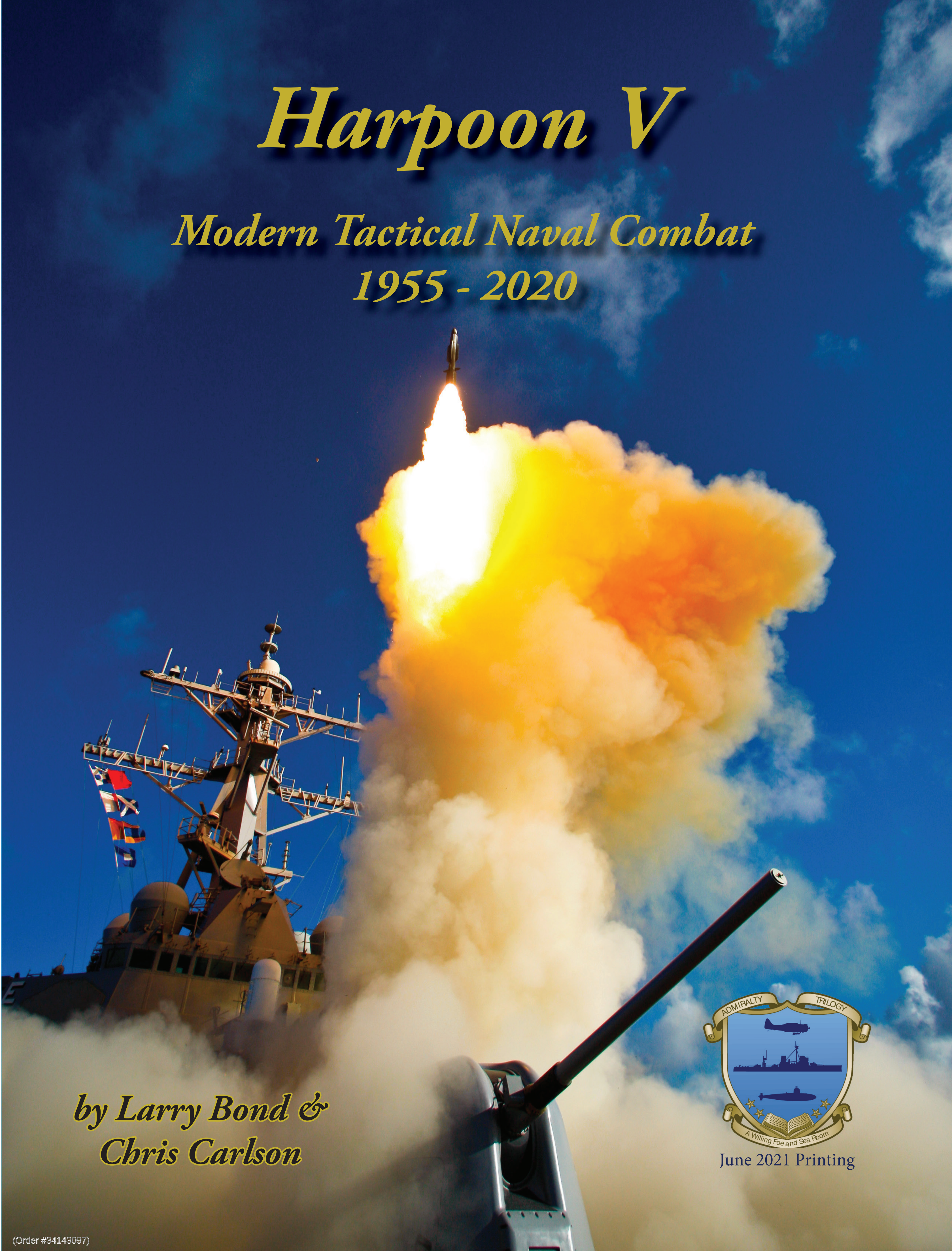
Harpoon V

Modern Tactical Naval Combat 1955 - 2020



by Larry Bond & Chris Carlson

ADMIRALTY TRILOGY

A Willing Foe and Sea Room

June 2021 Printing

Harpoon

Fifth Edition

Modern Tactical Naval Combat from 1955 to the Present Day

designed and edited by

Larry Bond and Chris Carlson

published by

The Admiralty Trilogy Group

This 1 June 2021 printing of *Harpoon V* has been updated to include all changes and corrections through 26 October 2021.

The designers of *Harpoon* are prepared to answer questions about the game system. They can be reached in care of the *Admiralty Trilogy* Group at adtrgroup@aol.com. Visit their website at www.admiraltytrilogy.com.

Cover: USS *Hopper* (DDG 70) launches a Standard Missile SM3 Block IA during exercise Stellar Avenger in July of 2009. It successfully intercepted a sub-scale short-range ballistic missile launched from the Kauai Test Facility at the Pacific Missile Range Facility, Barking Sands, Kauai, Hawaii. (US Navy)

"A willing foe, and sea room..." US Navy daily toast for Friday

Dedicated to Jeanne and Katy

The Co-Designers

Larry Bond is a writer and game designer. A former US Navy surface warfare officer, he lives in Virginia, outside Washington, DC.

Chris Carlson is an accomplished naval analyst, game designer, and writer. A retired Navy Captain, he lives in the (partially) frozen wasteland of Minnesota (not in July!).

Foreword by the late Admiral Sir John Woodward.

Interior illustrations by Jeff Theriault, Larry Bond and Chris Carlson

Acknowledgments

The authors would like to thank John Aclin, Sean Babbitt, Jim Baker, Roger Besaw, Dave Brady, Chang Lei, Jackie Conlon, Dwin Craig, Adrian Davis, Andy Doty, Frank Dunn, John Frazer, John Goetke, Cdr. James Goldrick, RAN, Peter Grining, Steve Hall, Mike Harris, Scott Hartman, Steve Heusten, Doug Houseman, Pat Hreachmack, Jerry Jazbeck, Pete Keller, Floyd D. Kennedy, Ed Kettler, Pat Larkin, Paul Mansfield, Francis Marliere, Kevin Martell, Alex Ramos, Mark Ratner, Chip Sayers, Dave Schueler, Pat Slocomb, Steve Thorne, Jeff Theriault, Dave Vencil, Paul Vebber, Alan Wotherspoon, Chris Weuve, Jay Wissmann, and Rob Wubbenhorst for their help in developing the game.

We would also like to thank the US Navy, the Royal Navy, the Italian Navy, the Federal German Navy, the French Navy, and the Japanese Maritime Self Defense Force for their kind assistance.

Special thanks to Dr. Dave Markov, Dr. Norman Friedman and Mr. A.D. Baker III

In Remembrance

Sam Baker, Tom Clancy, John Gresham, Greg Lyle, Gary "Mo" Morgan, Terry Skye, Bruce Spaulding

Finally, we would like to thank the many naval wargamers whose constructive criticisms of previous editions and versions of *Harpoon* have made this improved version possible.

Harpoon was published in its original edition by Adventure Games Incorporated in 1980. A second edition, titled *Harpoon II*, was published in 1983. The third edition was published in 1987 by Game Designers' Workshop. The fourth edition, *Harpoon*^{4}, was first published by Clash of Arms in 1996. A second printing of the 4th edition, titled "*Harpoon*$^{4.1}$," including all errata and rules clarifications since the 4th edition's appearance, was published in November of 2001.

This new edition of *Harpoon* is published by the Admiralty Trilogy Group, and includes all errata and rule modifications that have appeared in *The Naval SITREP* since 2001, plus many more updates and changes.

If you have been playing the earlier 4th edition, much of it will be familiar. Unlike *H*$^{4.1}$, however, we have not marked the changes with a shaded bar in the margin, mostly because it would be a major pain.

Many thanks to Sean Babbitt, Jim Baker, Andy Doty, Peter Grining, Pat Hreachmack, Francis Marliere, Kevin Martell, Dave Schueler, Steve Thorne, Paul Vebber, Chris Weuve, and Jay Wissmann for their careful reading and unmerciless questioning of the draft for this new edition.

As always, please contact us with questions or suggestions at adtrgroup@aol.com.

May 2020

This June 2021 reprinting of the rules includes all the errata, official changes, clarifications, and updates that have been made since its initial release. Many thanks Tom Niedzinski and to editors Chang Lei, Peter Grining, and Francis Marliere for their valuable contributions.

June 2021

Designers' Notes

This new edition of *Harpoon* is long overdue. The first edition came out in 1980, the second in 1983, the third in 1987, and the fourth followed it in 2001. Almost twenty years later, we're just getting around to the fifth edition. In addition to covering the last twenty years of naval warfare developments, by developing games for other eras, we've gotten smarter about the differences. And I don't have to detail the massive increase in the information that's become available.

This edition adds overarching elements like command and control as well as rules for new weapons systems, like ballistic missiles and unmanned vehicles. Every part of the game has been exhaustively reviewed and revised, sometimes more than once. Some of these "new" changes have actually been in the works for years, and have been extensively playtested. But sometimes the tests revealed problems, and we had to start again.

We hope you'll enjoy it, and if you've dealt with us in our earlier editions, you know we listen to suggestions, fix errors, and do our best to support the game as a living, adapting model of naval warfare. Have fun, and we still always answer our mail.

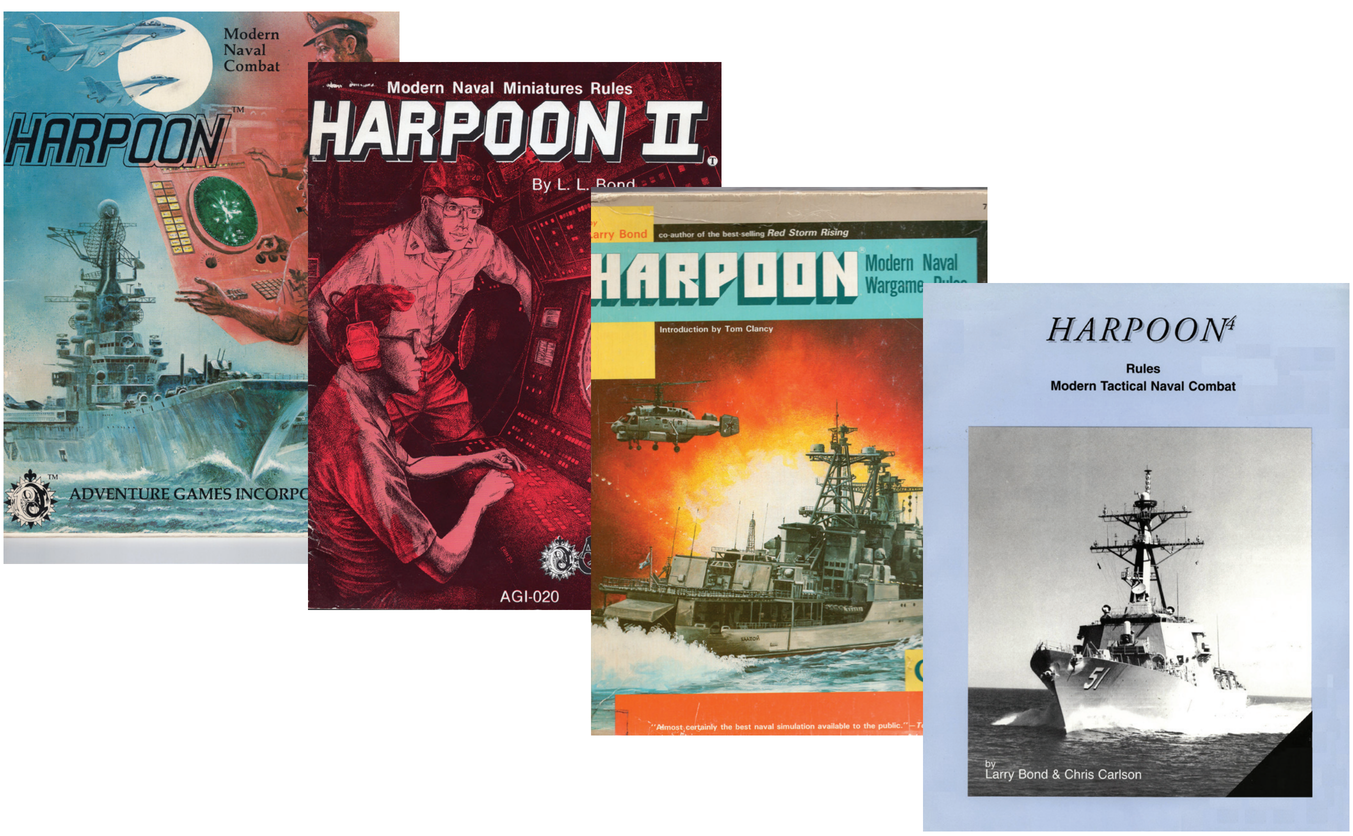
Larry Bond

I first became aware of *Harpoon* back in August 1981 when I spotted an ad for the game in that month's edition of the US Naval Institute's *Proceedings*. Being a First Class Midshipman at the University of Minnesota NROTC Unit and a fanatical wargamer, I rushed down to the nearest hobby shop and picked up a copy. From that point on, naval wargaming for me was never the same.

In retrospect, the first edition was pretty crude, but it had the distinct advantage of being very playable. On top of that, then-Lt. Bond was very easy to approach with questions and suggestions to improve the system. After a few letters and the odd phone call, I convinced Larry to give me a day of his Christmas leave in Minnesota to meet with myself, another 1st Class Midshipman (Michael Harris), and the Commanding Officer (CO) of the NROTC Unit. Two hours later, I had the CO's permission and some cash to start a formal wargaming group to help other interested Midshipmen learn about naval tactics-and I've been along for the ride ever since.

If you are new to modern naval wargaming, I hope this fifth edition is as much a revelation as the first was to myself and that band of Midshipmen. If you are a seasoned veteran, I think you'll be pleased with the improvements that have been made. And in keeping with the tradition that the first edition set, please feel free to ask questions and make suggestions; it's the best way for all of us to get smarter on such a complex and intricate subject.

Chris Carlson



Foreword

The *Harpoon* game system is a most accurate and realistic naval simulation. While some other simulations may be superior in detail, or flexibility of platform capability, or realism, or speed, none yet surpass it in its ability to cope with the "big picture" with free play on both sides simultaneously. Even as a computer enthusiast, I have to admit that this last point, "free play" by both sides with a computer, has still not yet been achieved.

Harpoon is particularly valuable, bearing in mind the sheer complexity of maritime warfare, for the way its designers have taken this complex and technical topic and identified the important bits, abstracting or frankly ignoring the less important. While there are many things that have to be considered and done to deploy weapons properly, not every detail needs to be taken into account. The officers and crew of a warship, because of years of training, know how to perform the various actions necessary to fight their ship. The important questions are more concerned with when and in what order should these actions be taken so that the ship can accomplish its mission. This is the difference between modeling a process and modeling a decision. This is the essence of *Harpoon*.

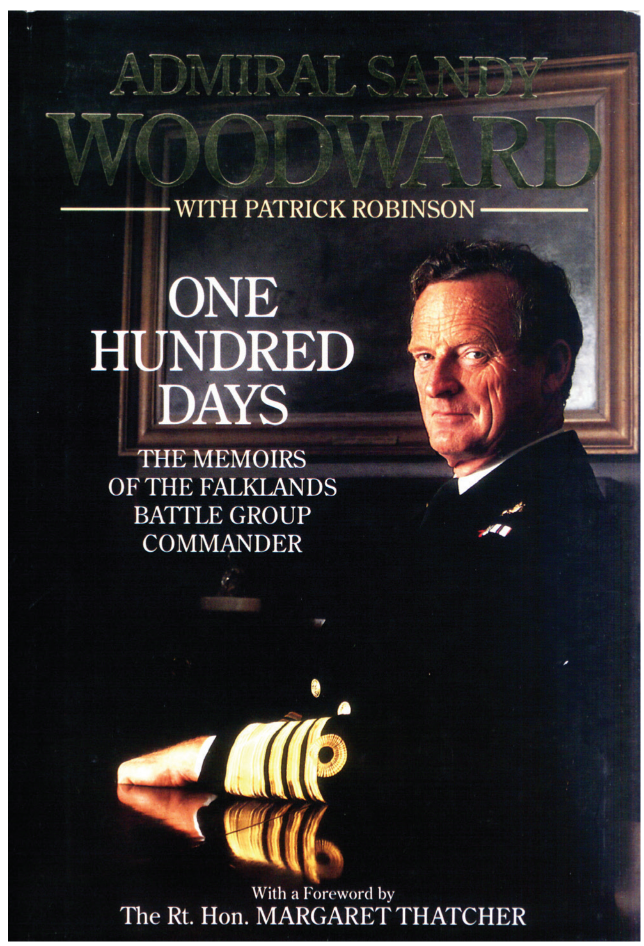
Harpoon properly places the player in the position of a naval commander, often one of senior rank, which normally would be achieved only after decades of successful service. There is no possible way to give a gamer, looking perhaps for an afternoon's entertainment, all the knowledge that is needed to command a ship or a task force. Instead, the game focuses on the decisions that the commander has to make under a specific set of circumstances. By presenting the players with the same resources and information, it forces them to make trade-offs and lets them see the results in the game. Weighing the potential results of an action against the possible risks lies at the heart of decision-making in warfare. *Harpoon* can considerably help the gamer gain some valuable insights into this area, lacking only the real stress of career or life-threatening decisions.

For the junior professional, *Harpoon* contains a wealth of information on maritime hardware and the ways in which it can be used. It matters less that the facts and figures provided are precisely accurate and more that their comparative values are reasonably fair. This has been achieved - and where it is not in line with the hard experience of the player, it can readily be adjusted. This flexibility allows *Harpoon* to track the developments of the new and confusing era ushered in by the disappearance of the Superpower confrontation. It also allows *Harpoon* to track, indeed experiment with the possibilities of emergent and developing technologies, such as stealth, standoff weapons, microprocessors, communications, and the whole range of technical progress today and tomorrow.

In a single sentence, *Harpoon* allows a surprisingly realistic taste of command at sea in war - with the ultimate advantage that you will not have to swim for it if you get it wrong.

Sandy W.

Admiral Sir John "Sandy" Woodward
Twickenham, England
September 1996



Admiral Sir John Woodward 1932 - 2013

From *Naval SITREP* issue 45, October 2013

Admiral Sir John Forster ("Sandy") Woodward, GBE, KCB, passed away on the 4th of August, 2013. I'll let you read about his life and illustrious career online, or better, in *One Hundred Days*, his excellent account of the Falklands campaign and the problems he faced as its commander. I always hoped he'd write another book, because his first one was so good.

I was privileged to correspond with Sandy on many occasions. He'd read some of my books, and he knew and supported *Harpoon* in the UK.

Although he'd read my stuff, he was not a fan of it, or perhaps the genre in general. He managed to praise and criticize my work at the same time, saying that "I had the military stuff pretty much down" but that the "white hats" were too well-organized. After I read *One Hundred Days,* I understood exactly what he meant, and I've tried to keep that guidance in mind.

He was tremendously accessible, especially after email became widely available. He kindly consented to write a foreword for our *South Atlantic War* supplement for *Harpoon* (as well as one for the fourth edition rules), and even answered a few questions.

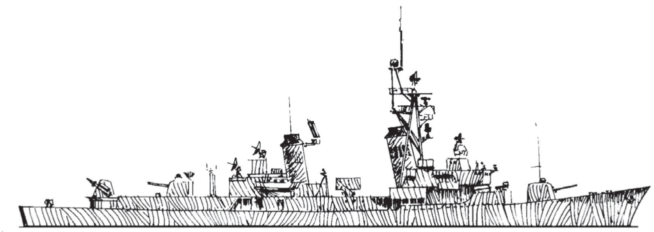
We were having trouble with one ASW scenario in *South Atlantic War*, because we wanted to know if the British helicopters would have had Sting Ray. It was widely known that Sting Ray torpedoes were rushed to the area to supplement the older Mk44 and Mk46 torpedoes, but we didn't know how many had been sent, or when, or what platforms carried them.

So I emailed Sandy, and he replied the next day, apologizing and saying that he couldn't remember! He then rattled on for a few more paragraphs, brilliantly summarizing the RN's ASW campaign in the Falklands. We stole as much of that as we could for the supplement.

In answering another question, he confessed that on May 21st, after the first massive round of Argentine air attacks, he was "ready to pack it in." But wisdom cautioned against making important decisions late at night, and he decided to hang on for one more day. When he saw that the Argentines had "shot their bolt," he knew they would ultimately succeed.

Sandy Woodward's contribution to the history and traditions of the Royal Navy is as important as those of Fisher, Beatty, Ramsay and Cunningham. Such men cannot be replaced, and must be remembered.

Larry Bond



US *Adams*-class DDG

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Russian Project 1134B *Petropavlosk* [Kara] class CG

Subject & Table Index

Naming Warships

Most warships of corvette size and larger are named - for people, places, virtues, events, animals, even plants or minerals. The process of naming a ship is called "commissioning," and is equivalent to baptizing a baby. The ceremony, loaded with tradition, "brings the ship to life."

A common - far too common - error in referring to ships is to say "the USS *Iwo Jima*." This is like to referring to one of your friends as "the Jeff" or "the Mary." A ship's name is its name, and the language used should reflect that. It helps to remember that a prefix like "USS" or "HMS" is equivalent to "Mr." in front of a name, or more properly "Ms." It is a formal mode of address.

Although many august sources, and many in the US Navy itself use "the," it is incorrect.

With that out of the way, we can describe how a ship's name is used in print. There is a system that we try to follow.

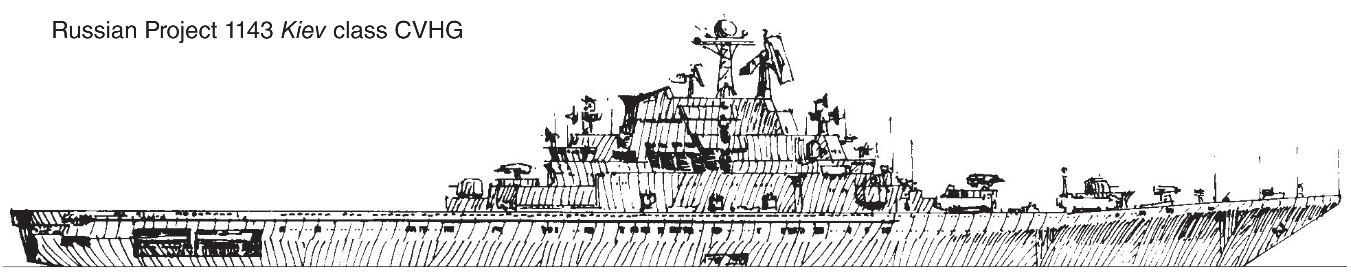
A ship's name, *Iwo Jima*, is italicized. Some classes are named for the first ship of the class, for example, *Spruance*. Other classes may be named after a category, like the British "County" or "Duke" classes. These class names are not italicized, because they are not the actual name of a ship.

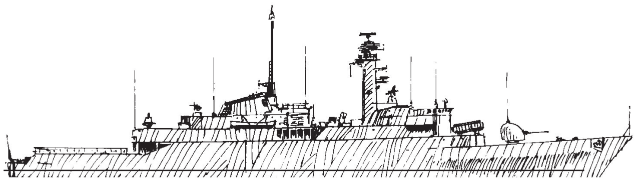
Similarly, the NATO code names of Russian or Chinese vessels are not italicized. In other words, *Petropavlosk* is a unit of the Kara class. Some folks like to capitalize it as "KARA" but it can make text look too blocky.

This can get tricky. Some commissioned ships do not have names. We now know that most Soviet subs were assigned random hull numbers. Since they are commissioned vessels, the hull number is their "name" and should be italicized. For example, the Soviet Typhoon (NATO code name) class includes the units *TK-208* and *TK-12*.

One other convention: We now know the names of almost all Soviet/Russian equipment, but the NATO code names are still in common use. If we use the Russian name of a piece of equipment, we will accompany it with the NATO designation in square brackets. For example, we could refer to the Project 971 *Bars* [Akula] class sub. The NATO designations appear in brackets only to distinguish them from the Russian designation.

Russian Project 1143 *Kiev* class CVHG





British Type 21 (*Amazon*)-class FF

Chapter One - Introduction

1.1 Background. *Harpoon* simulates modern naval warfare. It covers air, surface, and subsurface engagements at the tactical (i.e., individual unit) level. The rules allow a player with little or no experience in naval combat to understand the basic principles of modern naval warfare, and to use those principles to expand their knowledge.

Harpoon shows the player what kind of decisions must be made by a ship or battle group commander when they fight a modern sea battle. It shows what information the commander has, and how they use it to make those decisions. Most importantly, it allows the player to make those decisions and to see their results in a simulated combat setting.

These rules assume an understanding of elementary terms (which have readily available dictionary definitions) like cruiser, destroyer, sonar, or radar. Anything beyond these basics is explained in the appropriate rules section.

As a player becomes more experienced with *Harpoon*, and does some reading, they may discover that a rule is too simple. Change the rule. We had to ruthlessly simplify many aspects of naval warfare to make the game both manually playable and easy to learn. *Harpoon* has a modular design which allows new sections of the rules to be added or changed with a minimum of fuss. New weapons systems can also be added easily.

Units are expressed in real-world terms: knots, meters, kilograms, degrees. We were forced to use damage points to quantify a ship's ability to resist damage, but the formulas to convert any ship to this system are included in Annex Z (included with the annex book). It also has other useful values for metric conversion and converting the game to different scales.

In designing *Harpoon*, we had to make some assumptions about the way that units interact to produce what we considered a realistic result. These assumptions underlie the game and strongly influence the way it should be played.

1. The hardest part of naval warfare is finding your opponent. This had been so throughout history, and the proliferation of sensors has not simplified the initial detection process.

2. A modern ship is relatively easy to cripple. In WW II, a ship could suffer several shell or bomb hits without its fighting efficiency being reduced. A modern ship has many fragile systems, and far less armor. Modern weapons also have greater explosive effect, pound for pound. A single solid hit will often cause enough damage to make a ship ineffective (a "mission kill").

3. Reactions today must be much faster than in WW II. The threat approaches not at the 300 knots of a WW II plane, but the 600-plus knots of a jet plane, or the 1200-plus knots of a supersonic antiship cruise missile.

Finally, all information used in this game has been drawn from unclassified sources listed in the Bibliography. The information in this game is as accurate and up-to-date as possible, but data like weapon kill probabilities and exact ranges can vary widely from source to source. Even prestigious books like *Combat Fleets of the World* and *Jane's Fighting Ships* must sometimes publish best guesses on a weapon's or a sensor's performance. Data on the physical features of a ship or aircraft or missile are easier to come by. Performance information is suspect in any case because it is based for the most part on test firings made under ideal conditions. There is only a small body of combat data by which to judge effectiveness.

Modern game designers must accept that when the systems they describe are actually used for the first time, some will do very well, most will perform a little below advertised performance, and a few will prove to be utter failures. There is no way to predict which will be which.

1.2 Scope. *Harpoon* simulates surface, submarine, and air attacks on naval units, aircraft, and some land units. They cover surface gunnery, cruise missiles, surface to air missiles, ballistic missiles, and electronic and antisubmarine warfare.

The rules do not cover amphibious assaults, towing, or underway replenishment, because they are not tactical evolutions.

1.3 Players. *Harpoon* requires at least two players, but works better with at least three players, one of whom is the referee.

A referee in *Harpoon* sets up the scenario and passes information to the players before and during the game. They observe what happens and enforce the rules. They determine what each side can detect and reveal it to the other when it is detected. When the scenario is over, they can recount the action to both sides, telling them the close calls they had, the near misses, and the brilliant moves they managed to pull off.

1.4 Scales. *Harpoon* uses more than one scale to compress distance and time.

- **Turns**. Two different game turns are used. The Intermediate Turn represents thirty minutes. The Tactical Turn is three minutes.
- **Distance**. Distance is measured in nautical miles (nmi), the standard unit of distance at sea. One nautical mile is about 2000 yards, or 6000 feet, just a little more than the 5280 feet of a standard (statute) mile.

Harpoon uses a variable distance scale, but typical scales are one inch equals one nautical mile, or one inch equals two nautical miles. Since distance is in miles, other scales are possible: ten inches to the nautical mile for close in ASW actions, or one inch equals five nautical miles for long-distance air battles.

For close-in measurement, players can use thousands of yards ("kiloyards" or "kyds"). One nmi = 2 kyds.

- **Altitude**. Height above sea level is measured in meters, and also as altitude bands, described in section 4.5.
- **Depth**. Depths are described in terms of depth bands, and are explained in section 3.2.1.

• **Speed**. Speeds are written in knots (kts; nautical miles per hour). A ship's or airplane's speed in knots divided by two gives the distance the platform moves in one 30-minute Intermediate Turn. The speed in knots divided by 20 gives the distance moved in one 3-minute Tactical Turn.

1.5 Materials. To play, you need:

• Rules book
• One twenty-sided die (D20)
• Two ten-sided dice (D10). A die roll of zero is always read as a 10. Rolled as percentile dice, an "00" is read as 100.
• Two six-sided dice (D6)
• Blank forms. These are available as a free downloadable .pdf on our website.
• A flat playing area approximately four by eight feet. A larger area can be useful. The game does not need a hex map or board.
• A tape measure. Distances are measured from bridge to bridge of the ships in question.
• A protractor.
• Graph paper to plot submarine movement.
• A calculator is highly recommended.
• Pens and pencils.
• Miniature ships (or counters) representing the units in the game.

1.6 Organization. The rules book describes the game concepts and rules. The Data Annex books contains detailed data about selected naval vessels, aircraft, weapons, and sensors.

A free Quickstart booklet available at our website summarizes the rules and provides an introductory game scenario. By playing the example scenario, players will learn the game system, and begin to learn naval tactics.

1.7 Game Pieces. Miniature ship models in 1/2400, 1/3000, 1/4800, or 1/6000 scale are ideal for *Harpoon*. Aircraft can be represented by miniatures or cardboard counters. Submarine miniatures are usually unnecessary. Missiles can be represented by cardboard counters or other plastic playing pieces.

It is also possible to play *Harpoon* directly on graph paper or a map, dispensing with ship models altogether.

Standing Orders

Standing orders are not only an integral part of naval command, but a great way to speed game play. By having both sides issue standing orders, the players can plot movement over long periods of time and quickly bring their forces together.

Standing orders remain in effect until canceled or expired. Every captain issues Standing Night Orders to the Officer of the Deck before he retires for the evening. A good admiral will issue standing orders before a battle, telling his captains what he plans to do.

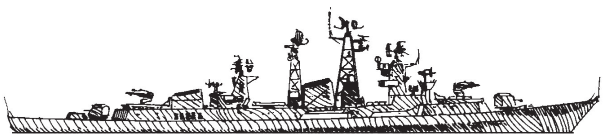
For example, one side on barrier patrol might issue the following standing orders: "Patrol a 20 nmi track running NW/SE at 15 knots until you detect an enemy. All sensors are passive." The other side could order, "Ships will steam in two columns on course 090° at 20 knots, zigzagging 30° to either side of base course every 20 minutes. Continue movement until 0900. Air search radars will radiate once during each 10 minute-period (random interval), all other sensors passive." The orders could be much more complicated, including both aircraft and ships, laying out search or attack plans.

By writing out these orders, the players are forced to think through their plan of battle. They can consider all the elements: Where will they most likely encounter the enemy? What should they do with their aircraft? Is there a submarine threat? What course should they follow? Have they considered the effects of the environment on movement and detection?

Independently written, the players can then cooperate in plotting their forces' movement, seeing where and how their units encounter each other. This information can then be used to set up the battle. Alternatively, the orders can be turned over to a referee, who interprets and executes them, reporting back to the appropriate commander about detections.

If there are several players on one side, and one has been appointed commander, he should issue standing orders to cover what they will do in case of attack, how they maneuver, and accomplish their mission.

A little prior planning will improve both the speed and the quality of the game.



Russian Project 61 [Kashin] DDG

Chapter Two - Game Mechanics

Harpoon simulates reality. Its rules describe, within limits, how naval warfare works in the real world. They encourage the players to use tactics that would work in real naval warfare. As it is with reality, common sense is a valuable asset with *Harpoon*. Rules or rules interpretations that seem silly should be changed or ignored. The game should feel real to its players.

Scenarios can be run by a referee (an independent person who applies the rules and presents information to each side), or by the players themselves.

2.1 Size Classes. Many rules are based on the size of the units involved. Ships and planes are grouped into size classes.

For ships, the rules will refer to either a letter (e.g., "Size Class A") or a description (e.g., "Large"). The classes are:

Ship Size Classes

Size Class	*Standard Displacement*	*Size Description*
A	18001+	Large
B	5501- 18000	Medium
C	1501 - 5500	Small
D	351 - 1500	Small
E	101 - 350	VSmall
F	21- 100	VSmall
G	≤20	Stealthy/VSmall*

Size Classes F and G are called "Small Craft" by some rules.

(*)Size Class G vessels have a Stealthy radar signature, but are otherwise described as "Very Small," e.g., for maneuvering and visual detection.

• Surfaced submarines are treated as one size smaller for visual and radar detection. For example, a submarine that has a Size Class of B/Medium has a Signature of Small. Small subs will have a VSmall Signature, but VSmall submarines will still have a Signature of VSmall. Any sub may have its Signature further reduced if it has been fitted with stealth features.

• Aircraft use the same size descriptions, although their size class is based on their physical size, not their displacement.

• Radar signatures use the same names as the size classes, and in many cases will be the same, but if special shaping or materials are used, its radar signature may be much different. For example, a US B-2 Spirit has a Large Size class, and a Stealthy radar signature. This can be true of ships and missiles as well as aircraft.

2.2 Preparation for Play. After a scenario has been chosen, the players need a Ship Reference Sheet for each of their ships and an Air Mission Form for each aircraft or group of aircraft. The ships and aircraft to be used are listed in the scenario. The master copies of the Ship Reference Sheet and the Air Mission Form can be printed for personal use.

Using the information from the scenario, players prepare Ship Reference Sheets and Air Mission Forms by copying data from the Data Annex Book to blank forms. These forms then hold all the information each player needs to use his ships and aircraft during the scenario.

2.2.1 Filling Out the Ship Reference Sheet. Make one copy of the Ship Reference Sheet for each ship or submarine being used in the scenario being played. Using the information for the ship in Annex A, fill out the sheet. This will speed up play and reduce page flipping once the game begins.

Consult Annex A and find the listing for each ship in the scenario under its nationality and class name. The listing provides information general to all ships of that class. Exceptions for individual ships of the class are listed in the Remarks.

• *Basic Data*. The initial portion of the ship listing provides basic data about statistics and performance. Enter on the Ship Reference Sheet the ship's name, class, type, displacement (in tons), speed (in knots), propulsion system, crew, total mounts and number of aircraft carried.

A weapons "mount" is defined as one weapon installed on a ship. It may be a single-barreled 20mm gun, or an auto-loading ASW rocket launcher, or a multi-celled vertical-launch missile system.

• *Damage and Speed Breakdown*. Transfer the damage and speed breakdown figures from the Annex A entry to the appropriate section of the Ship Reference Sheet.

The *Admiralty Trilogy* game system uses "damage points" to measure the damage inflicted on a ship. Different weapons do different amounts of damage. Ships can absorb damage based on their displacement, type and construction. Annex Z provides the complete procedure for calculating a ship's damage points.

Special features of the ship's construction, such as unusual materials, can raise or lower a ship's damage point rating. For informational purposes, these Damage Modifiers will be listed in the Remarks for a ship in Annex A, but the modifier is already factored into the damage point value.

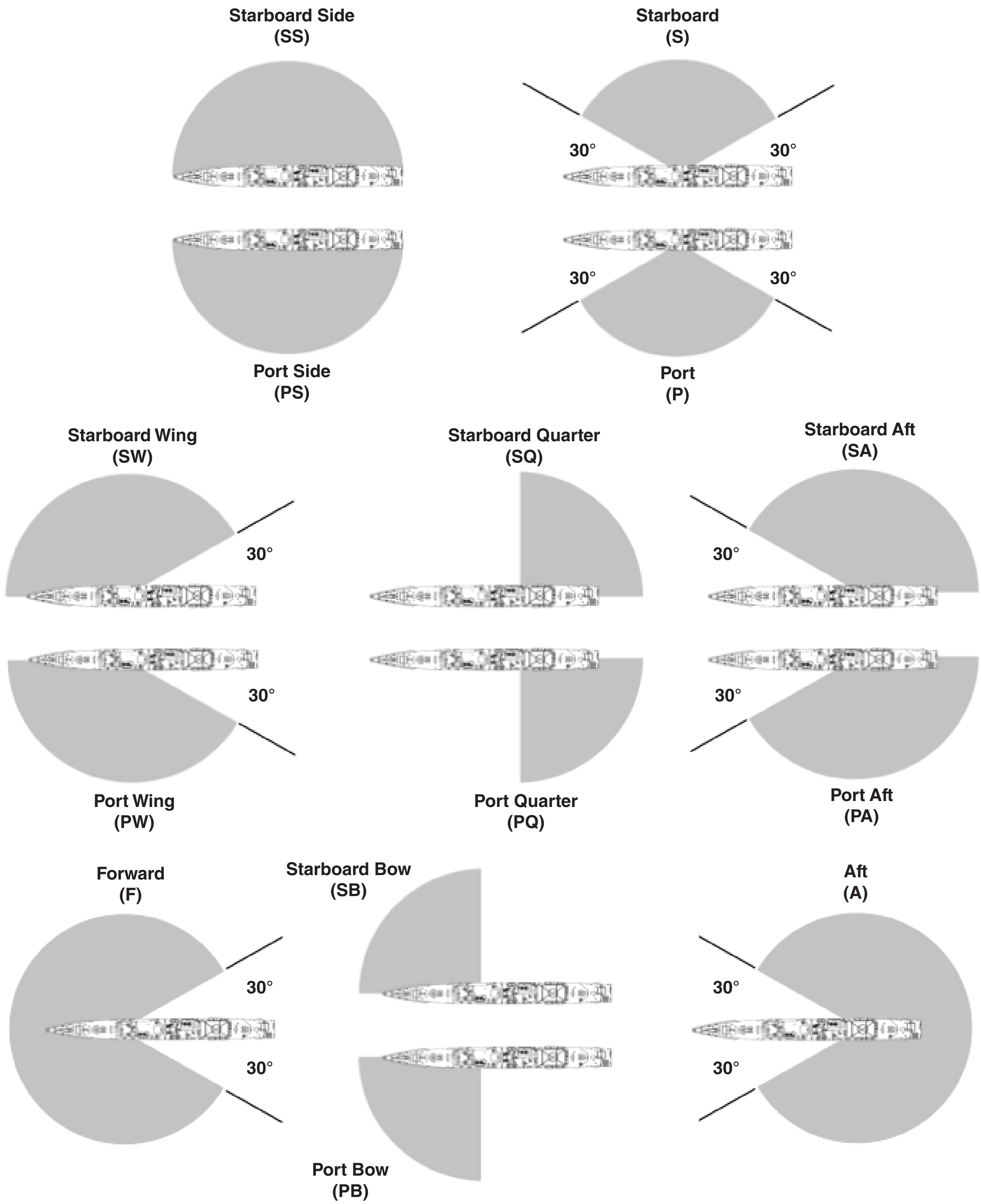
• *Radars*. Find the Sensors section of the ship listing and enter the name of every sensor marked J (in the right margin) in the Radar section of the Ship Reference Sheet. Then turn to Annex J, find each radar type and transfer its statistics to the proper line of the Ship Reference Sheet.

• *Sonars*. Return to the Sensors section of the ship listing and enter the name of every sensor marked K (in the right margin) or in the Sonar section of the Ship Reference Sheet. Then turn to Annex K, find each sonar type and transfer its statistics to the proper line of the Ship Reference Sheet.

• *Weapons*. Find the Weapons section of the ship listing and read each weapon line, noting its annex letter (in bold in the right of each line).

Weapons are listed showing firing arc, number of barrels/rails/tubes per mount, the number of mounts on the ship, the

Shipboard Firing Arcs



Weapons Data Line Example

Annex with data on the weapon

A(8)1 Mk29 NATO Sea Sparrow w/8 RIM-7M//2 Mk91 **D**

Missiles/salvoes per mount
Name of ammunition
Number of weapon directors
Weapon director name

Launcher Name
Number of mounts the ship carries
Number of tubes per mount - eight in this case
Weapon Arc. The single mount is sited aft, with a blind zone forward

weapon name, the ammunition available per mount, the rate of fire and if the weapon has a director. The Weapons Data Line Example above shows this format.

Copy the name of the weapon in the appropriate section of the Ship Reference Sheet. Then turn to Annex C (for guns), D (for missiles), E (for Antisubmarine Warfare (ASW) systems), or F (for torpedoes), find each weapon and transfer its statistics to the proper lines of the Ship Reference Sheet. The name of a missile may either be found as the name of the mount (e.g., "Sea Wolf") or as the Ammunition (e.g., the Mk29 NATO Sea Sparrow launcher can fire either RIM-7F, RIM-7H, or RIM-7M missiles).

Be sure to copy down all the weapons that the mount can fire, depending on the scenario. Some mounts may be able to launch more than one kind or class of weapon. For example, submarine torpedo tubes can fire not only many types of torpedoes (Annex F), but also submerged-launch missiles like Harpoon (Annex D). The American Mk41 VLS can fire surface-to-air missiles, surface-to-surface missiles (both Annex D), and ASW standoff missiles (Annex E).

Embarked aircraft are copied down in the Aircraft and Helicopters portion of the Ship Reference Sheet.

If more than one mount is present, the mounts are equally split between the available arcs. Similarly, if more than one director is present, they are split between the available arcs.

Some weapons, like catapults or aircraft, do not require an arc. Others have a predefined arc and cannot pivot. This includes such things as depth charges, which are dropped from the stern. These will be discussed in the rules for their use.

• *Remarks*. Find the Remarks section of the ship listing and note anything which applies to the specific ship being written up and transfer that data to the Remarks section of the Ship Reference Sheet. This could include changes to the weapon and sensor fit.

• *Weapon Firing Arcs.* Each weapon mount has an arc of fire. A weapon may not be able to shoot because part of the ship's structure blocks its fire. The arc which can be used by each weapon mount is shown in the ship listing in Annex A. If a target is not within the firing arc of a weapon, that weapon cannot fire at that target.

The forms discussed in Chapter 2 are available as fillable .pdfs downloadable from the ATG website.

All the arcs defined in *Harpoon* are shown in the Shipboard Firing Arcs diagram on the page 2-2. Each arc has an abbreviation, which is used on the weapons line. For example, "F" is a weapon mounted forward, which has a blind zone aft.

A slash (/) splits the arcs of multiple mounts: P/S(1)2 indicates that there are two single mounts, one firing into the Port Arc and one into the Starboard Arc.

Some weapons can fire into more than one arc. An ampersand (&) combines arcs: P&S(1)2 indicates that there are two mounts, single barrel each, firing into both the Port Arc and the Starboard Arc.

Director arcs will only be listed if they are different from the weapons arc.

The parentheses contain the number of tubes, barrels, or rails each mount has.

2.2.2 Filling Out the Air Mission Form. Each type of aircraft that will operate alone should have its own card for each type of mission they will fly. A fighter that will fly both intercept and strike missions will need two cards.

Check Annex B (in the Data Annex Book) and find the aircraft listing for an aircraft in the scenario under its nationality and name. The listing provides information about the aircraft. Exceptions for variants of the aircraft are listed in the Remarks.

After copying the information about the aircraft's performance and equipment, refer to the different Annexes to find detailed information about the aircraft's sensors (radar, sonar, etc.) and installed weapons, like an internal gun.

Next, refer to the Ordnance section of the Annex B listing and choose the weapons that the aircraft will carry on that particular mission. Go to the appropriate annex to get information about the weapons performance, and also its weight.

At the bottom of the Air Mission Form, add any drop tanks to the internal fuel to find the total range the aircraft has in this particular loadout. Also, total up the weight of all external stores to make sure it is not more than the aircraft can carry. This information will be used to calculate the aircraft's endurance (section 4.7) and its Maneuver Rating (see 9.1).

2.3 Turn Sequence. *Harpoon* is played in turns. Until the opposing sides find each other, the players should use 30-minute Intermediate Turns. These allow aircraft and ships to move long distances when there are no reactions or decisions to be made.

Naval warfare often consists of hours of boredom as two sides search for each other or move into position. The Intermediate Turn compresses this time, speeding play and allowing the two sides to close quickly in real time.

Once an enemy has been detected, the game uses 3-minute Tactical Turns.

The procedure for both turns is similar; the difference is in the distance moved. All players do the same thing (as allowed by a phase) at the same time. Players plot their actions at the same time; they reveal their orders and move their vessels at the same time; they fire their weapons at the same time.

2.3.1 Time Representation. Turns should be recorded in units of real time. For example, the first Intermediate Turn of a scenario might be at time 0100 (zero one-hundred hours on the twenty-four hour clock). The next would be thirty minutes later, at time 0130, the one after at 0200 and so on.

If two units moved into detection range during the 0130 Intermediate Turn and the movement is backed up, the first Tactical Turn would be 0130, then 0133 and so on. Instead, if the action is continued after the 0130 move in Tactical Turns, the next turn will begin at 0200 (when the next Intermediate Turn would normally begin), then 0203 and so on.

2.3.2 Intermediate Turn Sequence. Intermediate Turns last 30 minutes. No combat is allowed, only movement and detection.

Unless units start the game directly in contact (i.e., within sensor range of each other) they should start out moving in Intermediate Turns. If, at the end of any Intermediate Turns' Detection Check Phase, one unit has moved within detection range of another, the action is stopped. The units' movement is backed up to their positions at the start of the Intermediate Turn. The action then continues in Tactical Turns, to allow for detection.

A player can invoke Tactical Turns any time during the Intermediate Turn. Although time is passing in 30-minute steps, a player can always react to a threat or a change in the situation. See section 2.3.4 Transitioning Between Turns.

Game play can alternate between Intermediate and Tactical Turns. For example, if a submarine moves into detection range, it switches to Tactical Turns. It successfully detects the opposing force and performs a few actions, changing depth and speed, for instance. The other side has not detected the sub and cannot until it gets much closer. The sub player could then go back to Intermediate Turns, with the order that if it loses contact, it can invoke a Tactical Turn to react.

This feature is especially useful in refereed actions, where the other side may never know it has been detected. If there are many groups of units all moving independently, only those holding contact need go to Tactical Turns, while the rest continue using 30-minute segments. Once the units using Tactical Turns are done with their interaction, they rejoin the Intermediate Turn time scale.

The players perform these steps each Intermediate Turn:

• *Plotting Phase*. Players write down (log) movement and other orders. Orders can be phrased as a simple movement order or as an order to move until some specific time or condition is met. For example, a player might order Sub1 in the diagram on page 2-5 to move toward unit R4 at 30 knots until it is 60 nmi away. If it takes less than a full 30-minute Intermediate Turn to reach the spot, it will not keep going, but will stop at the appropriate point. The player may want to invoke Tactical Turns at that time, or continue to move in Intermediate Turns.

• *Movement Phase.* Units move a distance equal to 30 minutes of travel, and aircraft launches and landings take place. Some units may not move for exactly 30 minutes. For example, if a helicopter is on five-minute alert and is ordered to take off at the beginning of an Intermediate Turn, then it will take off and move a distance equal to 25 minutes' flight. Alternately, in one Intermediate Turn the player may order it to take off at the beginning of the next Turn, so that it flies for a full 30 minutes.

• *Detection Phase.* Players examine their units' sensors to see which ones are relevant and see if they are within detection range of a hostile unit. If they are, players should then start using Tactical Turns.

2.3.3 Tactical Turn Sequence. Tactical Turns last 3 minutes. Air units can use this turn if they are not dogfighting. The following phases are executed by the players simultaneously each Tactical Turn.

• *Plotting Phase.* Players write down (log) movement, planned fire and other orders for their forces. These can be phrased as an order to move until some specific time or condition is met. Players may plan fire for the coming Planned Fire Phase only against known (detected) targets.

• *Movement Phase*. All units move a distance equal to 3 minutes of travel. Aircraft launches and landings take place. Ships and subs that strike mines have the damage inflicted in this phase. Missiles and torpedoes that reach their target in this phase are resolved and if they hit, inflict damage in this phase.

• *Planned Fire Phase*. All weapons ordered to fire in the Plotting Phase are fired simultaneously.

AAM attacks, Antisurface gunfire, ASW mortar and depth charge attacks are made in this phase and resolved immediately.

Surface-to-surface missiles launched in this phase will not move until the next Tactical Turn, since this Turn's Movement Phase has already passed.

Using weapons may change a unit's detectability. This takes effect immediately and affects the chance of them being spotted in the Detection Phase.

• *Detection Phase*. Players exchange visual, radar, sonar, Electronic Support (ES), data links, and other sensor information. Units attempt to detect ships, missiles and aircraft. A unit can react only to detected threats, even though the controlling player may be aware of others.

• *Reaction Fire Phase.* Shipboard weapons which have not been used so far this turn may fire at either newly detected threats or against previously known targets.

Guns fired in the Reaction Fire Phase against surface targets halve the damage they inflict, except damage from Autonomous guns is not halved.

Surface-to-surface missiles and non-homing torpedoes cannot be launched in the Reaction Fire Phase of a Tactical Turn. They require setup time before launch.

Homing torpedoes fired in the Reaction Fire Phase do not move until the next Turn's Movement Phase. Also, their rate of fire is halved. For instance, a sub that could normally fire four torpedoes per Tactical Turn can only fire two.

ASW mortar and depth charge attacks made in this phase are resolved immediately.

• *Resolution Phase:* Fire and flooding criticals are resolved. Damage control die rolls are made as needed.

2.3.4 Transitioning Between Turns. A modern naval battle mixes unending tedium with frantic action. In the May 1982 attack on HMS *Sheffield*, although the Argentine search for the British took several hours, the time from missile launch to impact was less than three minutes.

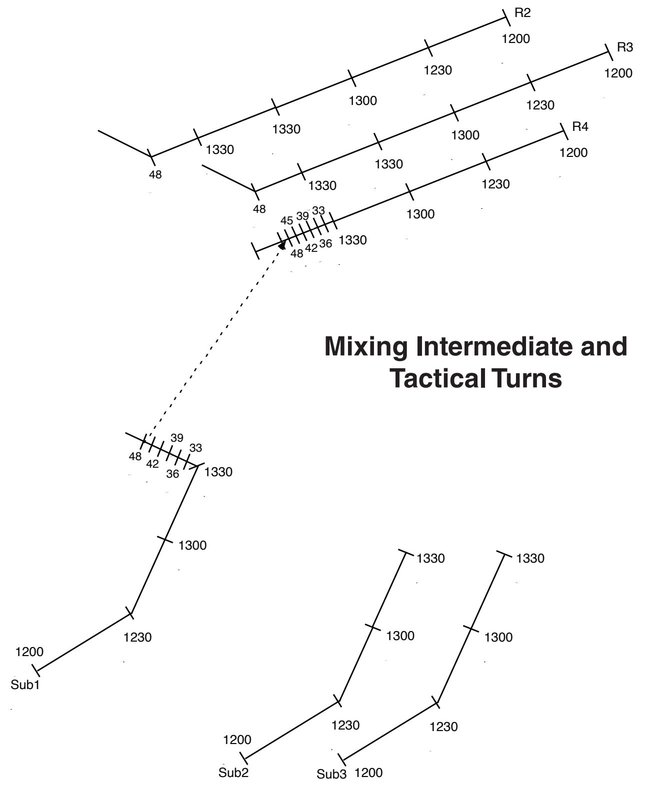
Bond's Laws of Wargaming

1) Turns take the same time to play whether they are 30 seconds, 3 minutes, 30 minutes, or 8 hours. Use long-duration turns to speed up play.

2) The fewer units there are to move, the better. Move associated units as groups, move distant units multiple turns, and eliminate units which are effectively out of play.

3) Press your players for their overall plans - not just their next move, but what they intend to do for the next hour or two. This forces them to take a longer view, and means they have a clearer idea of what to do turn by turn.

4) The time a player takes each turn rises geometrically as the number of options increase.



Mixing Intermediate and Tactical Turns

Players can invoke Tactical Turns any time they wish, in either the Plotting or the Detection Phases of an Intermediate Turn. The next (Tactical) Turn will start in the Plotting Phase.

Example: A game starts at 1200 hours (12:00 noon). The players move in 30-minute Intermediate turns, at 1200, 1230, and 1300. In the Detection phase of the 1300 turn, one player's submarine has approached an enemy task group and the sub player wants to attack. If the movement for the 1300 Intermediate Turn has brought them too close together, the movement can be backed up to the two sides' positions at 1300. Alternately, if the sides are not too close, Tactical Turns can be invoked at the end of the 1300 turn, using the two sides' positions at 1330.

Turn Sequence Summary

Intermediate (30 min)	*Tactical (3 min)*
Plotting	Plotting
Movement	Movement
Detection	Planned Fire
	Detection
	Reaction Fire
	Resolution

Once the interaction is resolved then the players can revert to Intermediate Turns, if they wish.

2.4 Plotting Movement. Players secretly plot the intended movement of their units during the Plotting Phase of each turn (Intermediate or Tactical) on the Log Sheet (*Harpoon* Form 3). An accurate plot is the sign of a well-run formation.

There should be one Log Sheet for each vessel or group of aircraft. During their Plotting Phase, the players order any weapons fire, aircraft to launch or land, and other naval evolutions. Be sure to include any changes in emitter status.

Plotting is not required for guided missiles or torpedoes after they are launched. They move automatically at their rated speed toward a target assigned at the time of launch.

Surface ship orders require speed and direction. Aircraft movement plots must include altitude. Submarine plots must include depth.

The speed of the unit for the turn is stated in knots.

Courses are plotted in degrees(°). North is 000°, East is 090°, South is 180° and West is 270°. North is always "true" north (to the North Pole) as opposed to magnetic north; the two are not the same. The compass rose shows the cardinal directions and their degree equivalents.

A protractor is very useful in measuring bearings. The playing surface should have north clearly marked.

The amount of climb or dive for the aircraft is stated in meters. If the aircraft's climb or dive carries it into a new altitude band, that arrival in the new level should be noted. Depth change for the submarine is stated as an order to move into a new level and the arrival in that level.

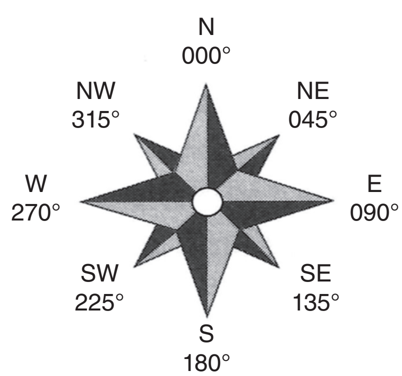
2.5 Plotting Orders for Unmanned Systems. Drones, Unmanned air, surface, and underwater vehicles can be used as extensions of the controlling platform. But while they can perform many of the same functions as their manned counterparts, command and control (C2) limitations make them slow to react. There are three types of unmanned vehicle control systems:

• *Human-in-the-Loop* (HITL): The vehicle is under the control of a remote operator throughout its entire mission. At least one human being is always in control.

• *Semi-autonomous*: The vehicle can execute pre-planned maneuvers and mission functions but remains under human supervision. If the situation warrants it, a human operator has the ability to take over direct control of the vehicle.

• *Autonomous*: The vehicle is capable of executing pre-planned maneuvers and mission functions without the need for human intervention. Human operators, however, can add new mission requirements to the vehicle in response to contacts detected by the vehicle's sensors.

In *Harpoon*, an unmanned vehicle is either in an autonomous mode, or in a HITL mode.



The Compass Rose

Unmanned vehicles in HITL mode use Tactical Turns for movement, detection, and combat, although they cannot execute attacks in the Reaction Fire Phase. Vehicles in autonomous mode will only use Intermediate Turns for movement and detection. It takes one Tactical Turn to switch an unmanned vehicle over from autonomous mode to HITL mode.

Each platform or ground control element can only control one unmanned vehicle at a time. Switching between vehicles takes one Tactical Turn, and the vehicle has to be within range of the control link. The control element for HITL mode is limited to the operation of a single vehicle, while autonomous control systems can handle up to three vehicles.

Unmanned vehicles can have two different types of control link: line-of-sight (LOS) and satellite. The LOS range, in nautical miles, will be listed in the appropriate annex entry, as will the presence of a satellite receiver. LOS distance can be checked using the Radar line of Sight table on page 5-3.

Only one control link can be used at a time.

Note: Satellite bandwidth is not a platform or even a theater asset; it's a national asset with many competing priorities. Scenario designers should be mindful that there could be times where limited bandwidth would be available for unmanned system operations. While this would be frustrating for players, it is a real-world constraint.

For unmanned underwater vehicles (UUV), communications with a human operator can be through an acoustic modem, as well as LOS and satellite methods. An acoustic modem is low-power, covert, very short-ranged (4 nmi), and has limited data rate. Steering commands and basic sensor information (UUV position, bearing, and possibly range to a single contact) for that Tactical Turn can be exchanged, but no large data uploads (such as track histories for multiple contacts) or video. To exchange data of any volume, a LOS or satellite link is necessary. To use this, a UUV must come to periscope depth, raise a mast and establish contact for at least one Tactical Turn.

A player can command a UUV to come to periscope depth and establish radio/satellite communications, but this is an overt acoustic signal that is as detectable as a lower medium frequency (LMF) active sonar (base range of 5 nmi) and can reach a UUV up to 20 nmi away. After receiving the signal, a UUV will take 2D6 Tactical Turns to establish radio/satellite communications.

2.5.1 Loss of Command. If an unmanned vehicle loses contact with its control element (usually because the control link is being jammed) one of two things will occur. If the vehicle is under HITL mode, it will automatically shift to autonomous mode and either move away from the jammer until it regains contact, or it can be pre-programmed to return to base or the launching platform. If both the control link and satellite navigation are jammed simultaneously, or if the vehicle only has a HITL mode, the vehicle will wander aimlessly until it exhausts its fuel.

2.5.2 Mission Plotting. All unmanned vehicles can carry different sensor payloads, and some can carry ordnance. The annex entry for each vehicle will list the sensor options, as well as any available weapons. Sensor and weapons payloads are selected during mission planning and cannot be changed once the vehicle is launched.

A Primer on Tactics

Knowing that a deadly opponent is somewhere on the empty, open sea can be very daunting, leaving a player with the feeling that there's nowhere to start, and no way to find the enemy before he finds you. There are several general rules:

First, know the rules. Specifically, know how sensors interact and how the environment affects them. Know how detectable you are, not just in general but in knots and miles and meters. That tells you what part of the air and ocean you have to control. If you don't control it, your opponent gets a free shot.

Example: I saw a player commanding a surface force, in a known submarine area, roar his formation along at 30 knots (maximum possible speed). I mentioned that his sonar might be "somewhat degraded," i.e., stone blind, but he continued on. A Russian sub a good distance away heard the commotion, maneuvered at speed (without interference) into position, then fired a spread that sank three ships without warning.

Second, don't hunker down. Many players head for their destination with all radars and sonars off, hoping they won't be found. EMCON (emission control) is a good idea, but it's only a tool. Some players have even kept their radars off after they've been detected and attacked. Besides being radar-blind, it also hands the initiative over to the enemy.

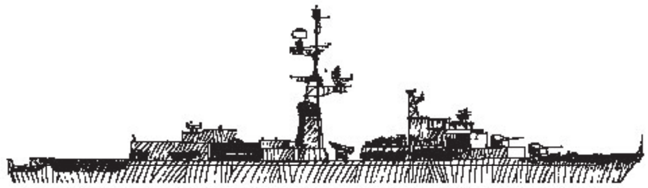
The answer is to search proactively for the enemy, but in a way that does not reveal your forces or intentions. The third rule is to use off-ship sensors, like helicopters or unmanned vehicles for search as much as possible. They are fast, in relation to a surface ship, well-equipped with sensors, and a medium-sized formation can easily field half a dozen machines. Spread out in a scouting front, or running in pairs down a threat axis, they can passively search large areas quickly without exposing a surface force.

Subs should be operated passively, obviously, but players think that at some point, it's OK to stop being passive and use active sonar or periscope radar. Real submariners very rarely go active, and when they fire a weapon or perform some other noisy evolution, they already have a plan to "clear datum" and regain their concealment.

Carriers can be a handful. Just managing an air group and launching a strike can keep an air boss busy, and I recommend appointing a player as air boss. A carrier is also a primary target for the other side, which tends to force the carrier's owner into a defensive mindset. Carriers are offensive weapons, even when they are defending themselves. Everyone thinks of setting up Combat Air Patrol (CAP), but how about sending a few fighters out on offensive sweeps along the threat axis? If you can narrow down a window in time when the enemy might launch a strike, a few fighters can not only find the strike, but bloody it and break it up well beyond CAP radius.

Ships must be mutually supporting. AAW ships must defend the ASW frigates, who screen the formation from subs. Similarly, attackers must exploit those vulnerabilities, sending subs against the heavy ships while aircraft and missiles attack the vulnerable frigates.

Finally, mass your firepower. Remember that the missile attacks can be blunted by jamming, SAMs and point defense weapons. A halfhearted attack wastes weapons to no effect. Hold nothing back. There is no such thing as a "reserve" in modern tactical naval combat.



French *Tourville*-class DDG

Chapter Three - Ship & Sub Movement

Ships, submarines, and aircraft move in the Movement Phase of the Intermediate and Tactical Turns. Missiles and torpedoes move only in Tactical Turns.

3.0.1 Proportional Movement. Miniatures may move several inches on the playing surface in the course of a single Movement Phase. If their paths cross, it may be hard to tell if two units pass close to each other. This is important if there is a chance of two ships colliding, ramming, torpedo attacks, or other special situations.

To see how closely two units approach each other, move the involved units first in small steps. The standard Tactical Turn of three minutes is broken down into three one-minute segments, each step being one-third the length of a regular move.

In the example below, a very fast unit will cross the path of a slower one. At the end of the Turn they are far apart, but how close did they come? The diagram on the right shows how to move the units in smaller steps. Unit A reaches the intersection first, and is clear by about a minute by the time unit B arrives. At 35 knots, this is an interval of over 1000 yards, so there is no risk of collision. Players may wish to measure the distance at each step to see if they come within collision distance (see 3.3).

Any player may invoke proportional movement to resolve a potential movement conflict after all movement for a Turn has been plotted.

If the players wish, they may use intervals of less than one minute for proportional movement. If one or both of the units are at high speed, a one-minute interval may not show their positions clearly enough. In that case, use 30 seconds, or some other convenient time period.

Proportional movement can also be used in an Intermediate Turn, with the moves at intervals of five, ten, or fifteen minutes, as desires. The goal is the exact measurement of the distances between units with the fewest steps.

3.0.2 The Three-Minute Rule. A useful trick when figuring distance is the "Three-Minute Rule." Take a unit's speed in knots and add two zeros on the end. This is how far it travels in yards in three minutes. For example, a destroyer moving at 15 knots covers 1500 yards in three minutes. It also works for aircraft, but there are usually more zeros to keep track of. A fighter flying at 600 knots will cover 60,000 yards, or 30 nmi, in a three-minute period.

3.1 Ship Movement. Ships and subs have a maximum speed listed in Annex A, which can be reduced by damage.

As it accumulates damage, a ship's speed is automatically reduced. Each 25% of its maximum damage reduces its speed by 25%, until it reaches 90% damage, when its speed is zero (it is "dead in the water").

The break points for each damage percentage are included in each ship's listing in Annex A.

3.1.1 Speed Change. Vessels have limits on how fast they can change their speed. The amount of acceleration or deceleration depends on the ship's size and whether it has controllable pitch propellers ("CPP" on the table). Any ship with CPP will have it listed along with the propulsion type in Annex A, e.g., "Diesel/CPP."

The Ship Speed Change table lists the acceleration and deceleration limits for each size class for a Tactical Turn.

Submarines running silent can only accelerate/decelerate up to 50% of the listed amount. Any greater acceleration/deceleration will increase their noise level (cavitation passive sonar modifier, see 5.4.6.5).

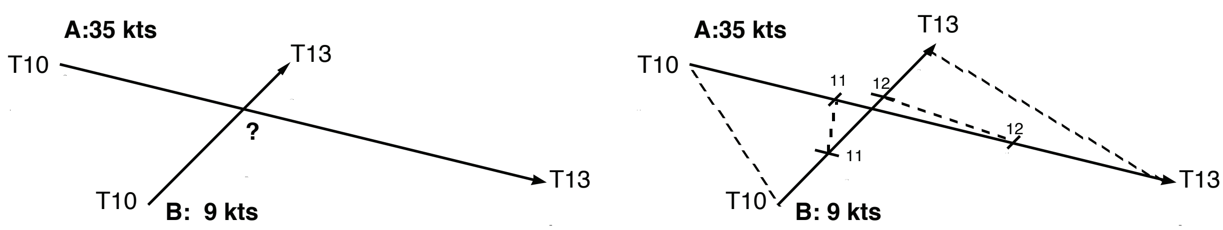
Speed changes ordered in the Plotting Phase of a Tactical Turn happen immediately. For example, if a Fast A-sized ship at 20 knots is ordered to increase speed to 30, its acceleration of 6 knots means that it will move at a speed of 26 knots in the upcoming Movement Phase.

Players can ignore acceleration and deceleration in movement for Intermediate Turns.

3.1.2 Crash Back. Ships can slow much faster than the normal limits by performing a "crash back." The propellers are reversed and the deceleration rate is doubled. There is a 5% chance that this maneuver will cause an Engineering critical hit (ignore the fire part). A crash back can be ordered in the Movement phase, and the speed reduction will take effect before a collision.

All ships cavitate while performing a crash back. See section 5.4.6.5.

Proportional Movement



Unit A arrives at intersection at time T11, Unit B arrives at time T12.

Ship Turning Distance

Warship Size Class	Distance with Stand Rudder (yds)	Speed Loss per 45° turn (kts)	Distance with Hard Rudder (yds)	Speed Loss per 45° turn (kts)
A	400	2	300	3
B	300	2	200	3
C	300	1	200	2
D, E	200	1	100	2
Slow F, G	100	1	50	2
Fast F, G	100	0.5	50	1
Subm Sub*	300	1	200	2

Merchant & Auxiliaries Size Class	Distance with Stand Rudder (yds)	Speed Loss per 45° turn (kts)	Distance with Hard Rudder (yds)	Speed Loss per 45° turn (kts)
A	400	4	300	5
B, C	300	3	200	4
D, E	200	2	100	3
F, G	100	1	50	2

• All values are for a single 45° turn.
• Move the required distance (the "advance") first, then turn the ship up to 45°.
• Ships with waterjet propulsion turn as one size class smaller, and can turn 60° at a time instead of 45°.
* Surfaced submarines maneuver based on their Size Class, e.g., a C/Small sub uses the "C" line when it maneuvers on the surface.

Ship Speed Change

Warship Size Class	Accel per Tac Turn from 0 - 75% Max. Speed	Accel from 76 - 100% Max. Speed	Deceleration per Tac Turn Any Speed
Slow A	4 kts	2 kts	6 kts
Fast A	6 kts	3 kts	9 kts
B	10 kts	5 kts	12 kts
B w/CPP	15 kts	8 kts	18 kts
C - E	12 kts	6 kts	15 kts
C- E w/CPP	18 kts	9 kts	18 kts
Slow F, G	15 kts	8 kts	18 kts
Fast F, G	25 kts	12 kts	30 kts

Merchant & Auxiliaries Size Class	Accel per Tac Turn from 0 - 75% Max Speed	Accel per Tac Turn from 76 - 100% Max Speed	Deceleration per Tac Turn Any Speed
A	4 kts	3 kts	8 kts
B	6 kts	3 kts	10 kts
C- E	8 kts	4 kts	12 kts
F, G	12 kts	6 kts	15 kts

• *Note:* Merchant passenger liners, because of their engine power and high speeds, are treated as combatants for acceleration/deceleration purposes.
• "Slow" Size Class A ships have undamaged maximum speeds less than 25 knots. There is no distinction between fast and slow ships for Size classes B through E.
• "Slow" small craft (Size Class F and G) have undamaged maximum speeds less than 25 knots.
• Coasting to a stop halves the deceleration rate.
• Changing course 45° or more in a Tactical Turn halves the acceleration rate.
• Astern acceleration is half the ahead rate.
• Ships with waterjets accelerate and decelerate as per vessels with controllable pitch propellers (CPP) for size classes B through E, and as Fast Small Craft (Size Class F and G).
• Submarines running silent can only accelerate/decelerate up to 50% of the listed amount. Any greater acceleration/deceleration will increase their noise level (cavitation passive sonar modifier, see 5.4.6.5).

3.1.3 Astern. Maximum speed astern for any surface ship is half maximum forward speed. Submarines may not move astern. A ship moving astern has a 50% chance of total loss of a deployed towed body (sonar or decoy) in each Tactical Turn of astern movement. It also has a 10% chance of its propeller(s) being fouled by the sonar cable (treated as an Engineering critical hit).

3.1.4 Course Changes and Turning. Ships need a minimum distance to turn. Called "advance," it is the distance the ship moves along its original course as the rudder takes effect.

Even if a ship has moved in a straight line for several turns, the player must still move it the stated distance in a straight line before changing course. Advance is the distance the ship moves along its original course line *after* the rudder is put over. If a player knows one or more turns ahead of time that he will need to turn in a particular spot and there is enough maneuvering room, he can order the turn beforehand by entering it on his log sheet, and the ship can then be allowed to make a turn immediately at the start of its movement.

In most cases, such as maneuvering in open water, advance distances will not be an issue. At other times, such as at slow speed or in restricted waters, the exact amount needed will be very important.

The Ship Turning Distance table lists the advance for each ship by size class for both a Standard and Hard rudder. Most turns are made with Standard rudder, but in emergency situations it can turn a little tighter by "putting it over to the stops." There is a risk of the rudder jamming, though, 5% (5 or less on a D100). If it does jam, treat it as a Rudder Critical Hit. The ship continues to circle in that direction until the Critical Hit is fixed.

The player can roll a 25% chance in the Resolution Phase of every Tactical Turn following the jam (including the turn it occurred in) to attempt to free it.

Unless otherwise plotted, all turns are assumed to use Standard rudder.

Surfaced submarines are rated for turning distance by their size class.

Example: A frigate (Size class D/Small) moves at 30 knots. It needs 200 yards before it can turn. The player moves the ship the required distance, then pivots it up to 45°. He can spend the rest of his movement going on his new course, or he can move another 200 yards and turn again.

Ships also lose speed when they turn, because of the drag of the rudder and hull as the ship turns. The amount of loss per 45° turn is shown on the Ship Turning Distance table. In most cases, the speed lost will be regained during the Tactical Turn, unless the ship is moving slowly or makes several changes. The Ship Speed Change table (page 3-2) shows the amount a ship can accelerate in one three-minute Tactical Turn. For example, a Size class B/Medium destroyer, moving at its top speed of 35 knots, makes a 45° turn with standard rudder. This causes a speed loss of 2 knots, while it can accelerate 2 knots in a Tactical Turn (five knots, halved because it is turning). If the total speed loss from the ship's turns in a Tactical Turn exceeds the acceleration for the ship in the same turn, reduce its speed immediately by the difference.

3.1.5 Effects of Weather. As the action of wind and weather increases the wave height, a ship pitches and rolls. If the weather is severe enough, the ship starts to "pound," part of its length leaving the water as a trough passes and then crashing into the next wave. The shock can damage sonar domes and steering gear and even buckle hull plates in severe cases. It also means a rough ride for the crew.

As the sea state increases, ships must slow down to prevent pounding. If the weather gets rough enough, they must "heave to," turning to keep their bows to the wind and slowing to bare steerageway (3-5 knots). Combined with a strong wind pushing the ships, they are essentially stationary.

Check the Sea State/Speed table to see how fast a ship can go in a given sea state. An "M" means that the ship can move at maximum speed. A fraction - 3/4, 1/2, or 1/4 means that the ship may move at no more than that much of its undamaged maximum speed. An "H" means the ship must heave to.

Surfaced submarines, because most of their bulk is submerged, are treated as one size class larger than their listed size, e.g., a Russian Project 641 [Foxtrot] is a Size class C/Small, but would use the B/Medium column on the table. Submerged subs are not affected at all.

Sea State/Speed

Sea	*Ship Size Class*				
State	*A*	*B*	*C*	*D-E*	*F - G*
0, 1	M	M	M	M	M
2	M	M	M	M	M
3	M	M	M	M	3/4
4	M	M	M	3/4	1/2
5	M	M	3/4	1/2	1/4
6	3/4	3/4	1/2	1/2	H
7	1/2	1/2	1/2	1/4	H
8	1/4	1/4	1/4	H	H
9	H	H	H	H	H

M = Maximum speed, no restrictions
H = Ship must heave to or be sunk

3.1.6 Evasive Steering. Ships can attempt to throw off a gunner's aim, or break the lock of a homing weapon by maneuvering evasively. This entails a rapid and significant change in course or the steering of irregular courses, that is, chasing salvoes. Evasive maneuvering is factored into the probability of hit tables for homing weapons, but for gunnery attacks this requires a little more explanation.

By turning toward the shell splashes from the last enemy salvo, a ship can throw off the enemy's gunfire corrections. It isn't foolproof, but it helps. Of course, the rapid, unexpected turns throw off the maneuvering ship's gunners as well (except for light guns, 65mm or less), and ships steering evasively cannot fire torpedoes.

Rather than try to plot every twist and turn of a ship in the water, a ship that wants to maneuver evasively just plots it as "evasive maneuvering" and declares it at the start of the Movement Phase. The ship is actually moving at its ordered speed, but covers only 75% of the distance it normally would. The distance lost is due to steering to the left and right of the base course as it dodges shellfire.

A ship must move at 20 knots or more to steer evasively. Speeds slower than that do not give the ship enough maneuverability. Only ships of size class B or smaller can steer evasively. Size class A ships are not maneuverable enough to use the tactic effectively. Ships with rudder or bridge critical hits cannot use evasive steering.

The modifiers for evasive steering for both the target and the shooter are listed with the gunfire hit chance modifiers in section 8.3 surface gunnery.

Light guns (65mm and smaller), due to their high rate of fire, do not suffer a penalty when firing at a target that is steering evasively.

3.1.7 Impulse Movement. High-speed craft with small-caliber, rapid-firing weapons can't use the standard 3-minute Tactical Turn. Two ships approaching each other at 25 knots cover 5,000 yards in a 3-minute turn, much greater than many light weapons' effective range. The combined speed of two opposing craft could be as great as 70 knots.

Closure rates this high are not a problem with larger warships because their weapons are much longer-ranged. They will not move completely in and out of weapons range in a single move.

The Impulse Movement table substitutes impulse movement for the Movement Phase and Planned Fire Phase. Every vessel moves the same distance in each impulse, but faster ships will get more moves each turn than slow ones, which also allows them to react to slower ships' actions during the turn.

Using Impulse movement will slow play, so it should only be used if absolutely necessary. While players can always invoke Impulse movement, in general it should not be used unless both sides are armed with light weapons of 65mm or less, have speeds over 20 knots, and are close to firing range.

If these three tests are not met, players can use standard 3-minute Tactical Turns with no loss of accuracy (or shot opportunities). Also, some ships can use impulse movement while the rest can move for three minutes normally.

Impulse Movement

Speed (Kts)	*1*	*2*	*3*	*4*	*5*	*6*	*Comp*
1 - 7							x
8 - 14			x				x
15 - 22		x			x		x
23 - 29	x		x		x		x
30 - 37	x	x		x	x		x
38 - 44	x	x	x	x	x		x
45 - 52	x	x	x	x	x	x	x

When using Impulse Movement, execute the Plotting Phase normally. During the Movement Phase, look on the Impulse table and find the row that includes each ship's speed. The "x" shows which impulses it can move in. If an "x" appears, the vessel can move 750 yards in that impulse.

If the ship's speed is less than the maximum for that bracket, one of the "x" movements will be less than a full move. That partial move is made in a special seventh "comp" (completion) impulse.

Example: An Iranian speedboat is moving at 38 knots. It moves 750 yds in each of the first five impulses, no movement in the sixth and then gets "nudged" forward 50 more yards in the comp impulse. The Impulse Breakdown table to the right shows how many full impulses and the distance remaining for a partial move for speeds from one to fifty-two knots.

Vessels must follow all standard rules about advance before making a turn. For example, a fast F-size small craft like a Boghammar must move 100 yards in a straight line before it can make a 45° turn.

Impulse Breakdown

Speed kts	*Yds per Tac Turn*	*Full Impulses*	*Remaining Distance (yds)*
1	100		100
2	200		200
3	300		300
4	400		400
5	500		500
6	600		600
7	700		700
8	800	1	50
9	900	1	150
10	1000	1	250
11	1100	1	350
12	1200	1	450
13	1300	1	550
14	1400	1	650
15	1500	2	0
16	1600	2	100
17	1700	2	200
18	1800	2	300
19	1900	2	400
20	2000	2	500
21	2100	2	600
22	2200	2	700
23	2300	3	50
24	2400	3	150
25	2500	3	250
26	2600	3	350
27	2700	3	450
28	2800	3	550
29	2900	3	650
30	3000	4	0
31	3100	4	100
32	3200	4	200
33	3300	4	300
34	3400	4	400
35	3500	4	500
36	3600	4	600
37	3700	4	700
38	3800	5	50
39	3900	5	150
40	4000	5	250
41	4100	5	350
42	4200	5	450
43	4300	5	550
44	4400	5	650
45	4500	6	0
46	4600	6	100
47	4700	6	200
48	4800	6	300
49	4900	6	400
50	5000	6	500
51	5100	6	600
52	5200	6	700

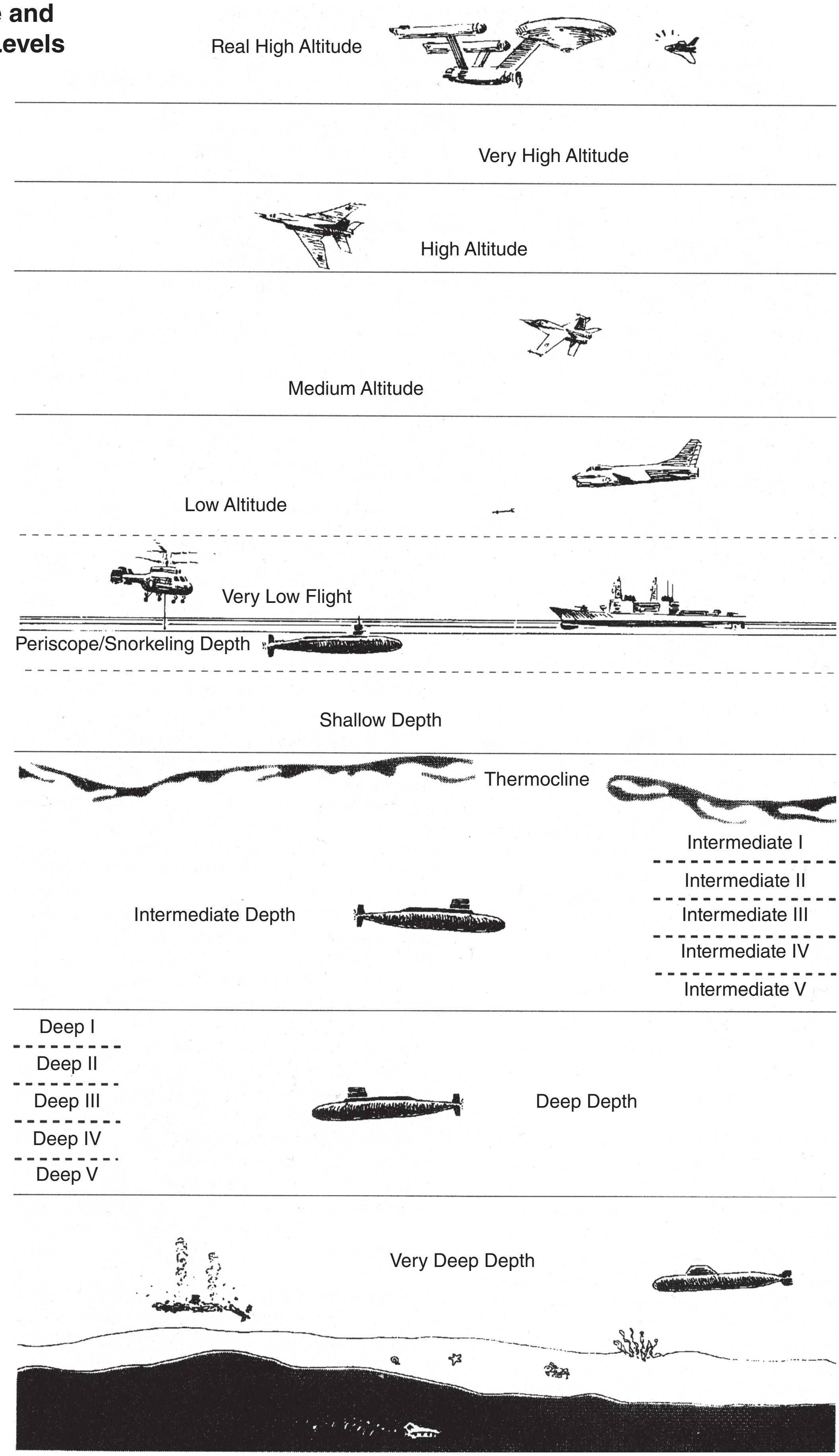
After any impulse move, any player can declare that his unit is firing its weapons at any valid target. *Each light weapon (65mm or less) can be fired twice each turn, but not in consecutive impulses. Because they fire twice, their damage is halved.*

Larger weapons over 65mm can only be fired once. Their damage is not halved.

A player can choose to fire one weapon and hold the rest for a later impulse, or fire them all at once.

All fire is resolved normally, and damage effects applied immediately, before the next impulse.

Altitude and Depth Levels



If a player chooses not to fire in an Impulse at a target, and later does not have a target, he has lost his chance to fire that turn. (In other words, you take the chances you get).

After an Impulse Move Phase is finished, the standard turn resumes with the Detection Phase and then the Reaction Fire Phase.

Ships firing torpedoes may not turn for at least three impulses before the weapon is fired. Torpedoes can be fired in the third and any later impulse. As with torpedoes fired in standard turns, they will not move until the next Tactical Turn. Resolve any torpedo hits made during impulse movement before the next impulse begins.

3.2 Submarine Movement. Submarines maneuver on the surface like surface ships. Because most of a sub is still below the water, even when it is surfaced, it has a very deep draft. When operating in shoal water, treat a submarine as one size class larger than the listed value.

3.2.1 Depths and Depth Changes. Large, Medium, and Small Submarines cannot submerge in water less than 20 fathoms (36 meters). VSmall subs can submerge in 10 fathoms (18 meters).

Submarines can change depth, moving between specific depth zones. These are Surfaced, Shallow Depth, Intermediate Depth (I - V), Deep Depth (I - V) and Very Deep. The illustration on page 3-5 shows the different depth zones. The player must record which zone the sub is in.

The Submarine Depth Bands table lists the exact depth for each band.

Submarine Depth Bands

Depth Band	Depth Limits (m)
Periscope/Snorkeling	0 - 25
Shallow	26 - 50
Intermediate I	51 - 100
Intermediate II	101 - 200
Intermediate III	201 - 300
Intermediate IV	301 - 400
Intermediate V	401 - 500
Deep I	501 - 600
Deep II	601 - 750
Deep III	751 - 900
Deep IV	901 - 1050
Deep V	1051 - 1200+
Very Deep	1201+

A submarine can change depth by plotting the desired zone as a movement order on the Log Sheet. Depending on the sub's speed, it may take several Tactical Turns to reach the ordered depth. The Submarine Speed/Depth Change table lists the number of zones, up to Shallow, a sub can change at each speed.

Submarine Speed/Depth Change

Sub Speed (kts)	1-5	6-10	11-20	21-30	31+
Depth Change (# of zones)	1	2	3	5	8

Example: A submarine at 25 knots at Shallow Depth can dive as deep as Intermediate Depth Zone V.

Submarines can perform an *Emergency Blow*, which allows them to rise as if they were moving one speed level higher. Subs moving at 31 or more knots do not benefit from an Emergency Blow since they are limited by drag on the hull from changing depth any faster. Subs performing an Emergency Blow must change depth upward at least three zones and are cavitating (see 5.4.6.5). They are a Loud contact for passive sonar detection.

The sea surface is not considered a depth level for subs changing depth. Once a sub is in the Shallow band, it may surface, but this is a separate operation.

• *Surface*. To surface, a submarine must be at Periscope/Snorkeling or Shallow Depth at the start of the Turn. It takes three minutes (one Tactical Turn) for a sub to surface. It may use its maximum surface speed the Movement Phase of the Turn it surfaces. Surfaced diesel-electric submarines are treated as "snorkeling" for passive sonar detection, since they are using their diesel engines.

To submerge also takes three minutes. The sub's player must plot whether the sub is to submerge to Periscope/Snorkeling Depth or Shallow depth. It may use its maximum submerged speed the turn after it submerges. While submerging, it is detected and attacked as a surface target, and is limited to its surface speed.

• *Periscope/Snorkeling (P/S) Depth*. The sub is very close to the sea surface. Periscope/Snorkeling Depth is a special part of the Shallow depth level where special rules apply for detection (the sub can extend a mast, but is easier to detect).

The submarine can use its periscope, snorkel, periscope radar, or sensor masts. It may fire submerged-launch missiles and mast-mounted SAMs. A submarine may not extend a snorkel, periscope, or any other mast if its speed is greater than 15 kts. If all masts are retracted, it may move at its maximum submerged speed.

Sub players entering the Shallow Depth band must declare whether they are at Shallow or Periscope/Snorkeling Depth. The sub may move from P/S to Shallow or from Shallow to P/S in one Tactical Turn by ordering it in the Plotting Phase.

A submarine at P/S depth during daytime is visible as a dark shadow in the water and can be seen by aircraft in daylight (two row reduction on the Air to Surface Visibility table). A sub at P/S depth moving 8 knots or more leaves a visible wake on the surface. They are spotted as surface craft.

There is a risk of collision between submarines at P/S and surface ships (see 3.3).

• *Shallow Depth*. The submarine is above the thermocline, but less detectable than at Periscope depth. It may fire submerged-launch missiles. It may not use its periscope or other mast-mounted sensors.

• *Intermediate Depth*. Intermediate Depth is divided into five zones, I, II, III, IV and V.

• *Deep Depth*. This is the maximum safe depth for most submarines. This level is used to evade detection or weapons launched against it.

Deep Depth is divided into five zones, I, II, III, IV and V. The sub can move between zones (maximum depth allowing).

• *Very Deep Depth*. The submarine is at a depth greater than Deep. Only submarines specifically allowed to operate at this depth in their ship listings in Annex A may move to Very Deep Depth.

3.2.2 Submerged Submarine Movement. Undetected submarines move in reference to an arbitrary fixed point on the playing surface. The submerged submarine is plotted on a piece of graph paper (recommended scale is 10 squares/inch with each square representing 500 yards). A sub's starting point may be randomly determined or mutually agreed upon. The submarine player will keep track of the other's ships and will notify his opponent when the sub is detected. Detected but submerged submarines are represented by a counter and moved normally. If contact is lost, remove the counter, or leave it at the last known position ("datum").

3.2.3 Crash Dive. Some submarines are fitted with special ballast tanks that allow them to dive very quickly. If a surfaced sub knows it has been detected, it may order a crash dive during the Reaction Fire Phase. It may not fire or take any other action during the phase. It is still detected and attacked as a surface ship in that Reaction Fire phase, but at the beginning of the next turn, it is submerged at Intermediate Depth I.

In some locations, water depth may prevent a sub from crash diving.

If a submarine is able to make a crash dive, it will say so in the remarks section of its Annex A listing.

3.2.4 Diesel Submarine Battery Endurance. A diesel (or "conventional") sub actually uses diesel-electric propulsion. While surfaced, or while using its snorkel mast, it runs on diesel engines and it can devote part of its diesel power to charging batteries. It is noisy and easier to detect when it uses its diesel engines. When submerged, it uses electric motors, which are virtually noiseless.

The batteries can deliver a low-level current, enough for creeping speeds, for days at a time. On the other hand, if the sub moves at full speed, that same charge will only last about an hour. Each diesel sub in the game has a battery endurance, given in "charge units". This is the number of hours its batteries will last at five knots. At higher speeds, the consumption rate rises quickly.

To find out how much of the battery was depleted in an Intermediate or Tactical Turn, calculate the submarine's average speed during the time in question and then reference it with the Battery Discharge Rate table. The result is the number of charge units that have been expended.

Older Technology: Most subs built before 1970 have older battery technology, and their discharge rate for speeds of 10 or greater knots is twice the values for the newer batteries. A few subs built before 1970 had the new technology, and a few built after 1970 still had the old stuff. Subs in service before 1970 should use the pre-1970 column on the table, unless there is a note in the Battery Rating, e.g., the German Klasse 205 class entered service in 1967, but uses the new technology, so its rating is "114 (new)".

Example: A Type 209 submarine, with 122 (out of 200 (new)) charge units in her battery, is trying to gain a firing position on a 12-knot merchant ship. To do this, the submarine must run at 16 knots for one Intermediate Turn (depleting its battery by 38 units), and then at 12 knots for another Intermediate Turn (depleting by another 16 units) that leaves the battery with 68 charge units as the submarine sets up its attack. During the final approach, the submarine spends seven Tactical Turns at 5 knots that consumes another 1.4 units of charge, leaving the battery at 66.6 charge units.

A sub can recharge its batteries while surfaced or at Periscope/snorkeling depth with the snort mast (snorkel) raised. If it moves at 50% or less of full speed, it can recharge at the full rate. If it moves above half speed, the charging rate is halved.

Lithium-ion batteries charge at twice the rate (x2) below.

Example: After a successful attack on the merchant, the Type 209 comes to P/S depth, raises her snorkel and ES masts and one of the periscopes and starts a battery charge. The sub's battery has 66 units (33%), and the captain decides to move at half speed. After two hours, the ES system detects a radar from a maritime patrol aircraft. The sub's CO secures snorkeling and takes the boat deep. During those two hours, four Intermediate Turns, the submarine added 40 charge units, leaving the battery at 106.

3.2.5 Air-Independent Power. A variety of relatively new technologies are allowing diesel-electric submarines to operate for extended periods of time by using an alternative power source for slow-speed operation. If the submarine travels at a speed of 6 knots or less, an AIP system can meet all the hotel (lighting, ventilation, heat, etc.) and propulsion power requirements without having to draw energy from the battery. While not as flexible or powerful as nuclear propulsion, AIP subs are a lot cheaper.

Mature AIP technologies include fuel cells, Stirling engines, closed-cycle diesels and small steam plants. In Annex A, submarines with air-independent power systems will be listed as "AIP-Electric" and will have the "SSP" ship type designator.

Battery Discharge Rates

Speed	*(units/Int Turn)*		*(units/Tac Turn)*	
knots	*pre-1970*	*1970+*	*pre-1970*	*1970+*
4	2	2	0.2	0.2
5	2	2	0.2	0.2
6	3	3	0.3	0.3
7	5	5	0.5	0.5
8	6	6	0.6	0.6
9	8	8	0.8	0.8
10	20	10	2	1
11	24	12	2.4	1.2
12	32	16	3.2	1.6
13	38	19	3.8	1.9
14	48	24	4.8	2.4
15	60	30	6	3
16	76	38	7.6	3.8
17	94	47	9.4	4.7
18	122	61	12.2	6.1
19	144	72	14.4	7.2
20	168	84	16.8	8.4
21	196	98	19.6	9.8
22	240	120	24	12
23	294	147	29.4	14.7
24	328	164	32.8	16.4
25	384	192	38.4	19.2

Battery Charge Rate

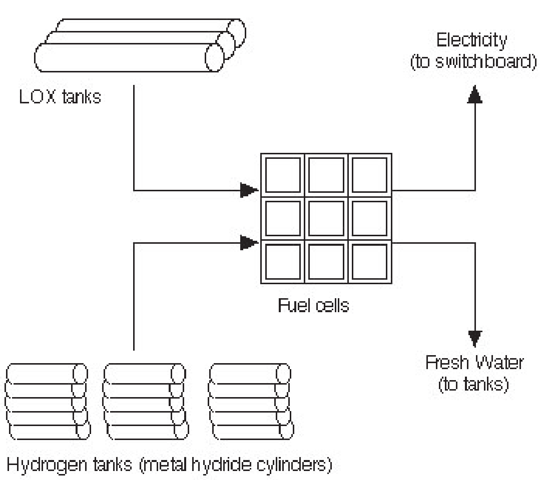
Battery Level	*0-70%*	*71-100%*
Charge Rate (units/Int Turn)	*10*	*5*

Air-Independent Power (AIP)

Submarines with diesel-electric propulsion plants have limited submerged endurance because they have to depend on electrochemical storage batteries as their main source of energy. Since electric propulsion motors draw power proportional to the cube of the submarine's speed, subs that can creep for days at five knots may only be able to sprint for an hour or two on the same charge. Of course, no submarine commander would let his battery go "flat" in combat, so his actual sprint endurance is much less than that. Once a submarine's batteries are depleted, it must snorkel to recharge them. It has to surface or come to periscope depth to do this, and the submarine becomes far more vulnerable to detection by passive sonars, radars and infrared sensors. At the same time, its own sonar is less effective.

Several approaches have been pursued to reduce this vulnerability, but all involve, in one form or another, an Air-Independent Power (AIP) system. This is an alternative power supply that uses liquid oxygen stored in cryogenic tanks. The fuel can be standard diesel fuel or even gaseous hydrogen, but all AIP designs use a form of combustion that requires an oxygen source. The main advantage of AIP is that it can significantly extend slow speed endurance, but it has little effect when the submarine operates at high speed. For the most part, the various AIP systems all offer roughly the same increase in slow speed endurance. At speeds ≤5 knots, an AIP system can improve submerged endurance by **a factor of five**. Thus, instead of having a submerged endurance of four days, an AIP equipped submarine can stay submerged for 20 days. As the submarine's speed increases, however, the AIP system cannot meet the demands of the propulsion motor and the battery begins to provide the bulk of the power. At high speeds (20 knots or more), an AIP system will provide less than 10% of the necessary power to the main propulsion motor and has virtually no impact on the submarine's endurance.

Since a sub spends about 75% of its time patrolling, mixed with only a few bursts of high speed, AIP systems can offer enhanced submerged endurance, as long as the sub doesn't have to go fast or very far. This makes it ideal for coastal subs.



Schematic of Fuel Cell Operation

Air-independent power systems can provide up to 3 charge units per Intermediate Turn. The total power potential of an AIP system is 2,400 charge units. After these are depleted, the sub must return to port to replenish its fuel and oxygen tanks.

Example: A Swedish *Götland* (A-19) class is equipped with a Stirling engine AIP system. If it were to travel at 4 knots, the battery could sustain this speed for 200 Intermediate Turns (100 hours) or 4.2 days. With the AIP system, the Götland can now sustain a 4-knot speed for 700 hours (100 from the battery and 600 from the AIP system) or a hair over four weeks. If the *Götland*, however, were to run at 9 knots, the submarine's propulsion system can only draw 3 of the 8 charge units needed from the AIP system; the remaining 5 charge units would have to come from the battery. This discharge rate would deplete a fully charged battery in 40 Intermediate Turns, or 20 hours. And while the AIP system can still provide the necessary power to keep the boat moving, albeit slowly, there will be little left to charge the battery.

3.3 Collisions and Ramming. Whenever two ships not engaged in towing, assisting with damage control, or underway replenishment pass too close to one another, there is a risk of collision.

The distance is 250 yards for vessels of size class A - E, and 100 yards for small craft (size class F and G). If larger vessels and small craft are both involved, use 100 yards.

Surfaced subs or at periscope depth risk colliding with surface ships if they pass too close. Use a sub's size class (A - G) and not its signature when resolving collisions.

Submerged submarines cannot collide with other subs unless they are both at periscope depth and one submarine declares that it is attempting to ram the other vessel.

Because of their superior speed and maneuverability, aircraft do not collide with ships. Exceptions include hovering helicopters (see 4.3), aircraft attempting a suicide attack, or those that crash while landing on an aircraft carrier (see 4.6.4). These cases are handled in separate rules sections.

If one vessel is trying to ram, it must be ordered in the Plotting Phase, with the target vessel designated. During the Movement Phase, the ramming player is allowed to change his course as needed to intercept the target. He can order an increase in speed in the Plotting Phase within normal acceleration limits, but he cannot change speed during the Movement Phase. If the ramming vessel moves within the collision distance of its target, then resolve it as an attempted ram.

3.3.1 Collision Resolution. To find out whether the ships actually collide, roll 2D10. For an accidental collision, each player involved can roll one D10 to help spread the blame around. In an attempted ram, the attacker rolls both dice. Apply the following modifiers to the 2D10 roll:

Accidental Collision:

- Low Visibility (≤20%): +2
- Per ship with an unrepaired Bridge Critical hit: +2
- Per ship with an unrepaired Rudder critical hit: +2
- Per Small size ship involved (Size class D or less): -1
- Per Large size ship involved (Size class A): +1
- Per Ship over 20 knots: +1
- Both ships are in formation and one suffers a casualty that affects its mobility: +2 (i.e., a casualty affecting a ship's speed or rudder control leaves little time for other ships to react).

Attempted Ram:

• Deliberate attempt to ram: +2

• Target is a submerged submarine: +1 (visually detected by the attacker)

• Target has an unrepaired Bridge Critical Hit: +2 (not applicable if target is DIW)

• Rammer has an unrepaired Bridge Critical Hit: Ramming is prohibited

• Target has a unrepaired Rudder casualty: +2 (not applicable if target is DIW)

• Rammer has a unrepaired Rudder casualty: -6

• Target is dead in the water (DIW): +4

• Speed Modifier (Divide target's speed by striking ship's speed) (not applicable if target is DIW):

Ratio	*Modifier*
<0.10	+4
0.25	+3
0.50	+2
0.75	+1
1.00	+0
1.25	-1
1.50	-2
1.75	-3
2.00+	-4

If the results of the die roll, including modifiers, is 16 or more, then a collision has occurred.

Example: USS *Des Moines* attempts to ram a Kashin class destroyer. The Russian ship has suffered a bridge critical hit in the previous turn. *Des Moines* is a Size Class B ship at 30 knots, and the Kashin is a Size Class C ship at 20 knots. The applicable modifiers are:

Des Moines attempting to ram: +2

The Kashin has an unrepaired bridge critical hit: +2

Speed ratio (20 kts/30 kts) = 0.67: +1 (the speed ratio is more than 0.5, but less than 0.75, use 0.75)

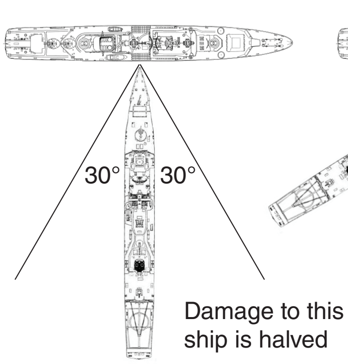
Total die roll modifiers: +5

The US player rolls both D10s and gets a "6" and an "8." When combined with the modifiers, the total is 19 and the attempted ram is successful.

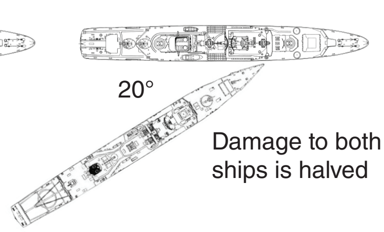
3.3.2 Collision Damage. The damage depends on the angle between the two ships and their relative size.

• *Glancing:* If each ship presents a narrow aspect to the other vessel (see the Aspect Diagram on page 10-2), whether bow or stern, then it is a glancing collision. The ships' sides will scrape against each other and they will continue on their ordered courses and speeds. Both ships halve any damage.

Bow-on Collision



Glancing Collision



• *Quarter:* If one of the ships presents a bow or stern quarter aspect to the other, then both ships suffer normal damage and both have their speeds reduced 25% by the force of the impact.

• *Size:* If there is a size class difference between the ships, increase the speed reduction 25% per size class if the other ship is larger; reduce the speed penalty 25% for every two size classes if the other ship is smaller.

Example: A cruiser (Size Class B) collides with a destroyer (Size Class C) at a quarter angle. Since the cruiser is one size class larger than the destroyer, the destroyer's speed is reduced to 50% of its ordered speed. However, as the destroyer is only one size class smaller, the cruiser's speed is still reduced by 25%. If it had been a corvette (Size class D), the cruisers speed would not be reduced at all.

• *Bow-on:* if one ship presents a broad aspect to the other, then the other vessel (which will have a narrow aspect), makes a bow-on ram - also known as a "T-bone" collision. The vessel striking with its bow has its damage reduced by half, but its maximum speed is permanently reduced by 25% because of the drag caused from the damaged bow, in addition to any other damage suffered.

If the striking ship inflicts enough damage to sink the other vessel outright, then it has literally cut the unfortunate vessel in two and the striking ship's speed is reduced by 25%. Otherwise, the pair will rapidly slow until they are both DIW (use double the normal deceleration rate of the largest ship). They will move along the larger ship's course, or in the direction of the faster ship if they are the same size class.

The ships will remain joined until one sinks or until the striking vessel backs down for one turn at any speed, which will automatically pull it clear.

• *Damage Points:* In a collision, each ship inflicts damage on the other based on its size. A bigger ship inflicts much more damage on another vessel than a smaller ship.

If any civilian vessels are involved, double their damage points before calculating the damage.

Each player rolls 3D10 (read as a value between 3% and 30%) and uses any of the applicable modifiers below:

• Armor: For each five points of belt armor, reduce the percent damage inflicted by 1%.

Special case: If it is not a glancing collision, and the striking vessel has a reinforced bow (e.g., icebreaker), then the ship struck cannot have its damage reduced by the armor modifier.

• Speed: Add 1% to the damage percentage for both ships for each five knots of relative speed. To determine the relative speed, in the case of a glancing blow, add the two speeds if the two bows are pointed toward each other, subtract the lower from the higher if the bows are pointed in the same direction. For a quarter collision, follow the same procedure for a glancing blow but multiply the sum by 0.75. Use the striking vessel's speed if it is a bow-on collision.

The final value (die roll plus armor and speed modifiers) is the percent of the ship's original damage points that is applied to the other vessel. If any critical hits result, they are rolled on the Underwater Attacks column of the Critical Hit Table. The first Critical Hit, if any, is automatically a Flooding critical. Damage results are applied immediately, during the Movement Phase.

Example: An *O.H. Perry*-class (long hull) frigate successfully rams a Krivak I-class frigate in the side. It will be a bow-on ram for the US ship. Their relative speed was 15 knots. Perry's damage point rating is 172; the Krivak's is 162. *Perry*'s player rolls 3D10 and gets a 12, The Krivak's player rolls 3D10 and gets a 22.

Perry inflicts 12%+3% (for speed) of 172 or 26 damage points on the Krivak. The Russian inflicts 22%+3% (for speed) of 162 points or 40 points, halved to 20 points on the American frigate because the *Perry* rammed with its bow.

3.4 Grounding. If a ship is within 2 kyds of shore and it is not in a harbor or channel, it is in "shoal water," and there is a chance of running aground. The exact width of shoal water may vary from scenario to scenario.

Measure the distance from each ship to the nearest shoreline. Roll D100 for each 3-minute Tactical Turn that a ship is within 2 kyds of shore.

Grounding Chances

Distance from shore (yds)	*Grounding %*	*Size Class*	*Modifier*
1001-2000	10	A	+20%
501-1000	20	B	+10%
0 - 500	30	C&D	0
		E, F, G	-20%

If a ship runs aground, it takes D6 times its speed in knots as damage points (underwater damage for resolution and criticals). Torpedo protection systems do not protect a ship from grounding damage.

It takes 2D6 Intermediate Turns to free a grounded ship. It cannot be attacked by torpedoes set to run deep (see 14.1.7).

3.5 Torpedo Movement. Once fired, torpedoes travel toward their targets in accordance with the details of their guidance systems. Use markers to show the location of torpedoes on the way to their targets. Information on torpedoes is in Annex F.

• *Speed & Range:* Some torpedoes have two or more speeds with different ranges. The slower speed gives the torpedo a longer range. Either speed may be selected at the time of launch. If the torpedo is wire-guided, the speed may be changed on command by the controlling platform. The torpedo then uses the corresponding range.

If a two-speed torpedo acquires a target, it will automatically shift to high speed.

When launched during the Planned Fire Phase, torpedoes move the full distance allowed by their speed in the following Movement Phase. When launched during the Reaction Fire Phase, they move half that distance the following Movement Phase and their full distance in following Phases.

When a torpedo reaches its maximum range, it stops and sinks without exploding.

• *Course Changes:* Torpedoes can turn any amount as they are being guided toward their target.

• *Depth Changes:* Torpedoes will change depth any amount to intercept a target.

3.6 Getting Underway. This is normally not done during a sea fight, but ships surprised in harbor may be forced to get underway quickly.

Steam-powered ships in port will have some part of their engineering plant shut down, to rest the crew and allow them to perform maintenance. They can be at one of three readiness levels.

The first and lowest level is called "cold iron." In this case a ship is moored to a pier, its boilers completely shut down. Electrical power and other housekeeping services are provided from shore. It takes some time to light a boiler, build up steam, and "warm up" the propulsion plant. If the process is pushed too much, it will wreck the engines. If the crew are not even at their stations, it will take more time before the ship is "ready to answer all bells."

Ships will sometimes have one boiler lit off to provide power. This is called "inport steaming." They are limited to one-quarter maximum speed until the rest of the boilers are lit off.

Nuclear plants are a special case, since the reactor has to be brought on line, which takes more time. Double the amount of time listed in the steam propulsion column if it uses nuclear propulsion.

Ships moored to a buoy or anchored will have their engineering plant fully operational. This is a safety precaution, since if the mooring chain or anchor chain parts, the ship will be adrift.

Times to get underway from cold iron are shown on the Underway Times table. If the ship is at inport steaming, roll on the table, but halve the resulting time.

Other propulsion plants (diesel, gas turbine, AIP-electric, COGAG, etc.) are simpler, but also require some time for preparation, and to get the crews on station.

It will take different amounts of time for ships to get underway, depending on their size and propulsion.

Underway Times

Non-Steam Propulsion		*Steam Propulsion*	
Size Class	*Tac Turns*	*Size Class*	*Minutes*
A & B	D10/2	A & B	2D6*10
C & D	D10/3	C & D	2D6/2*10
E	D10/4	E	2D6/3*10

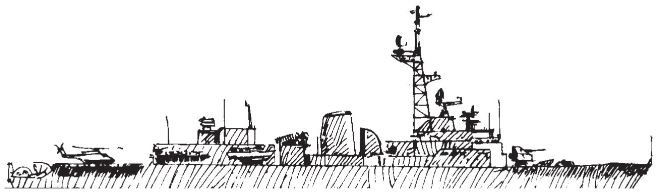
The order to get underway can be issued at the same time as the order to go to general quarters.

3.7 Arrival of Units in the Battle Area. Units outside the battle area become part of the fight when they reach maximum possible detection range from any unit in the battle area.

Because of distances involved, the range at which a unit arrives may not allow it to be placed on the playing surface. Players must be made aware of the unit's existence, however, and once sensors detect the unit, it is placed on the playing surface.

Units which are too far away to be placed, but which have been detected may be reported to players in terms of position, altitude, bearing and speed.

Example: An SS-N-3 Shaddock is fired at maximum range (250 nmi) against USS *Hull*, a *Decatur*-class destroyer. *Hull's* SPS-29 air search radar has a range of 122 nmi against a small-sized contact. The missile is either placed on the playing surface 122 nmi from *Decatur,* or recorded as being detected at that range and then the range is reduced each turn by the missile's speed until it reaches a manageable distance.



French *Georges Leygues*-class DDG

Chapter Four - Air Movement

Plotted aircraft movement should include speed and direction, altitude, altitude changes, turns, and land/launch orders. Aircraft may arrive in, or move out of, the battle area and still be in the game. Record the positions of off-board air units on paper.

4.0.1 Stepped Aircraft Movement. Aircraft rarely fly in a straight line for three minutes in combat. Pilots can react and turn much more quickly than ships, and in a fast-moving air situation, three minutes is a long time.

If an aircraft player wishes, he may "step" through his movement, dividing his three-minute Tactical Turn into as many as six 30-second steps. This allows a player to react to developing situations, but it will slow down the game. Use it sparingly, or experiment first, to understand its effects.

At the beginning of a turn, an aircraft player may declare that he is stepping through his turn. Other aircraft, especially enemy aircraft that might interact with it, must also step through their movement, but planes that will not interact with the stepping player may move normally.

Each stepping aircraft player turns his aircraft as desired, then moves a distance equal to thirty seconds of flight. Once all aircraft have stepped through the movement, play proceeds to the Planned Fire Phase.

During stepped movement, a plane can turn up to 180° each step, unless it is flying VLow/Nap of the Earth (see 4.5 Very Low Flight).

• Aircraft in NOE flight may only change course by up to 90° per step. Any more than that and they crash.

Altitude changes during stepped movement should divide the climb and dive rates listed in the Altitude Change table by the number of steps.

An aircraft may declare a dogfight during stepped movement as well as normal movement, provided all the aircraft involved have completed the same step.

4.1 Dogfight Movement. Aircraft can be plotted as participating in close-in air combat; the plotted order is "dogfight." If an air unit is plotted as dogfighting, and the other aircraft is not dogfighting as well, then the dogfighting aircraft unit is allowed to know what the second aircraft's movement orders are for the next phase. Possible candidates for this are bomber formations and any air unit, which for any reason, chooses to move normally and not maneuver.

4.2 Speeds. Players controlling aircraft must plot them to be flying at one of three throttle settings:

• *Cruise.* The most efficient power setting to cover distance. It is normally about 75% - 80% of the engine's maximum rated power.

• *Full Power.* This is 100% of the rated output of the engine without afterburning. However, they will burn more fuel per mile traveled. Hovering helicopters must use full power.

• *Afterburner* (or "reheat"). Some aircraft, usually high performance jet fighters, are equipped with afterburners. These boost the thrust above full power by dumping fuel into the exhaust nozzle. This burns fuel at ten times the cruise rate.

The exact speed will vary with the aircraft type and the altitude. They are listed in Annex B for each aircraft. A player can change a plane's speed by ordering it in the Plotting Phase. Speed changes take effect immediately.

Aircraft combine these speed settings in the course of executing a mission. A fighter will use full power for a few minutes at takeoff, then throttle back to cruise speed until it nears the target. Near the target, it will accelerate to full power and make its attack. It may also use short bursts of afterburner if it engages in air-to-air combat or to escape the target area more quickly. Finally, it would use cruise speed to return to its base.

• *Minimum speed:* Aircraft must move at least 20% of their Full Military speed for the altitude band, except for VTOL-fixed wing aircraft and helicopters transitioning into (or out of) hover. Hovering helicopters and VTOL-fixed wing aircraft must remain stationary when hovering.

• *Speed of Sound limitations:* Planes carrying more than 60% of their ordnance load externally, including most drop tanks, cannot exceed the speed of sound. This is 660 knots at Low altitude, 650 kts at Medium and 575 knots at High and Very High altitude.

Exception: Some drop tanks (rated "Supersonic") allow the plane to fly faster than Mach 1, and this restriction also does not apply to planes with conformal fuel tanks or ordnance carried semi-recessed.

Planes In Very Low or NOE flight cannot exceed the speed of sound because the supersonic shock wave is reflected off the surface back into the aircraft.

4.3 Hover. A helicopter can hover at Low altitude at zero speed. Its player plots "Hover" as its movement. In the Movement Phase of that turn, the helicopter is hovering.

While hovering, the helicopter is stationary and runs the risk of a collision (see 3.3) as if it were a ship. It is treated as a sea-skimming air target (in VLow flight) or as a surface target, whichever the firer chooses, including while in transition into and out of hover. Its engines are at full power during the hover and the transition into and out of hover.

4.4 Course Changes and Turning. A single plane may change course by any amount in a three-minute Tactical Turn.

4.5 Altitudes and Altitude Changes. Aircraft and missiles can be in one of five altitude bands: Low, Medium, High, Very High and Real High. The Altitude Bands table shows their heights. Manned aircraft should record their exact altitude (normally in hundreds of meters); different rates of climb will carry aircraft through the different altitude bands in different amounts of time. The Altitude Change table shows the rate of climb allowed for various types of aircraft. Missiles or other air units at Very Low altitude are often referred to as sea-skimmers.

• *Speeds when changing Altitude:* When changing between altitude bands, an aircraft must use the slower of the two speeds.

Aircraft climbing more than 50% of maximum rate cannot accelerate at the same time. Aircraft diving more than 50% of the allowed rate can increase their speed by up to 50% (x1.5). This may be more than the listed speed for that altitude; it cannot exceed the fastest speed for that aircraft at any altitude.

4.5.1 Altitude Changes Over Land. Except for mountain ranges, all terrain is in the Low altitude band. Mountains may extend into the Medium or even the High Altitude bands. They will be shown on the scenario map. Failure to avoid them is Bad.

4.5.2 Very Low Flight*.* This is a special flight mode within the Low altitude band over water. Aircraft flying this low are literally skimming the sea surface. Antiship missiles may cruise this low (sea-skimmers) to reduce their detectability, or to evade a ship's defenses.

Aircraft may only fire unguided rockets (see 9.6.7), drop torpedoes (see 9.7.1), and drop retarded ("high-drag") unguided bombs (see 9.6.4) in VLow flight. They may only launch guided weapons that are "rail-launched," which will be listed in the Remarks column in Annex H2 (see 9.6.8). If they attempt to drop standard low-drag bombs, the explosion will destroy the aircraft, regardless of whether or not it hits the target. If they wish, aircraft can "climb" to Low altitude the Tactical Turn they attack to avoid this restriction, but of course they may then be attacked normally.

Fixed wing aircraft have problems in VLow flight because of their high speed and size. The turbulence close to the surface is heavy, and this can cause a plane to change altitude rapidly. Even making a gentle turn increases the risk of suddenly losing altitude.

No manned aircraft can fly at supersonic speeds (660 knots) in Very Low flight, even if its max speed at Low altitude allows it. The shock wave created by a supersonic aircraft will reflect off the sea surface and strike the aircraft, causing it to crash.

There is a chance fixed-wing aircraft will crash in VLow flight. This must be rolled each Tactical Turn. If it crashes, it is before it releases any ordnance or makes an attack. The chance is shown on the Very Low/NOE Crash table.

Very Low/NOE Crash Chance

Speed (kts)	*150 or less*	*151-250-*	*251 350*	*351 450*	*451-550*	*551-650*
Chance of Crash	0%	1%	2%	3%	5%	8%

Modifiers:

+1% per turn (cumulative, up to 5% maximum) if the aircraft is traveling faster than 150 kts.

+2% if the aircraft turns more than 30° in one turn.

+2% if the aircraft is being fired on by AA (gun) fire (including infantry weapons), surface-to-air missiles, or aircraft.

The roll is made in the Movement Phase, based on the plane's movement and attacks on it in that turn.

Example: An Argentine Dagger is attacking a RN Type 42 destroyer in Falkland Sound. The Dagger approaches its target at 725 knots at Low altitude. As it nears Sea Dart engagement range, it drops to Very Low altitude and must immediately slow to 650 knots, since aircraft cannot move at Mach 1 in VLow flight.

The pilot is taking this risk because the Sea Dart missile system has a poor chance of hitting a target in VLow flight.

As the Dagger attacks, it is fired on by the Sea Dart without hits. The ship's AA weapons are also firing, but the +2% modifier for being fired at is only applied once.

The chance of crashing is 10% (8% plus 2% for being fired on).

4.5.3 Nap-of-the-Earth Flight. Aircraft at Low Altitude must fly higher than the tallest listed terrain feature (at least 100 meters), or they can be in Nap of the Earth (NOE) flight, flying at 100 meters altitude or less. This is a special flight condition within the Low altitude band.

Similar to Very Low flight over the water (but with a different altitude limit), this is hazardous, and requires the pilot's full attention. The terrain passing the sides of the aircraft is a blur, and the effect is similar to flying in a tunnel. Although the plane may be flying a straight course, the pilot is constantly making small altitude changes to stay close to the ground.

Aircraft may only fire unguided rockets, rail-launched guided missiles, and drop retarded "dumb" bombs from NOE altitude.

Fixed-wing aircraft in NOE flight have a Maneuver rating of 0.5.

They have a chance of crashing, either into a natural or man-made obstacle. The chance is shown on the Very Low/NOE Crash table.

Aircraft in NOE flight must have some way to steer around and over terrain. This can be by:

• Naked eye (in visibility of 50% or more)

• An imaging infrared system (such as FLIR) in clear weather visibility of 5% or more.

• Night-Vision goggles (NVG) in clear-weather visibility of 10% or more.

Attempts to fly NOE outside these conditions results in a failure to avoid the terrain.

Some aircraft are fitted with radars that allow safe NOE flight, removing the requirement to roll on the Very Low/NOE Crash table (see 5.2.5). These are:

• Terrain-avoidance (TA) radar in clear weather visibility of 30% or more.

• Terrain-following (TF) radar in any visibility.

Terrain-avoidance or terrain-following radar can be detected by ES.

Failure to avoid terrain eliminates the aircraft, due to its interaction with the earth/air interface and its infinite coefficient of friction.

4.6 Aircraft Launching and Landing. Some planes can land and take off from carrier flight decks, helipads, or the sea surface, as well as from land. Launching or landing is a Plotted activity for both the aircraft and the ship involved. Players may order the launch of aircraft in any Turn, Tactical or Intermediate.

To ready the flight deck for launching or recovering aircraft, any aircraft that are parked on deck must be moved out of the way. Respotting the flight deck takes 14+D6 minutes for every 12 aircraft.

4.6.1 Carriers and Flight Decks. An aircraft carrier is any ship with a flight deck. A flight deck may be straight (UK *Invincible*), angled (Russian *Kiev*), or dual (USA *Nimitz*). Flight decks may have catapults to assist in the launch of fixed wing aircraft. A carrier can have arresting gear to capture, stop and hold aircraft which land on the deck. Flight decks are listed in Annex A, as straight, angled, or dual. For example, the *Midway* class has a dual flight deck. Dual decks allow for takeoffs using bow catapults or takeoff positions and landing at the same time.

4.6.2 Helicopter Pads. These allow helicopters and VTOL aircraft to launch and land on a ship. Ships with helicopter pads will have them listed in Annex A. They are identified by location (aft, midships, or forward). The number of mounts is the number of helicopters which can be carried; the number of tubes is the number of helicopters which can be launched or landed at one time. Additional information is given in the remarks section. For example, a *Spruance*-class destroyer is equipped with Aft Pad(1)2; it can launch one helo at a time and can carry two helicopters. Helicopter pads may be fitted with recovery systems (typical types are Bear Trap or RAST) which assist in launching and landing helicopters. Small VTOL-fixed wing aircraft can launch from and land on helicopter pads; they cannot use helicopter recovery systems.

4.6.3 Sea Surface. Seaplanes and float-equipped helicopters can launch from and land on the sea surface, subject to sea state restrictions.

4.6.4 Launching & Recovering Aircraft. Aircraft can be launched or brought safely aboard ships in sea state 3 or less. Ships launching or recovering aircraft must have 30 knots "wind over the deck" during the Tactical Turn they launch aircraft with catapults or recover them with arresting gear. This can be any combination of the ship's speed and the wind, but to use the wind, the ship must be steaming into the wind.

There is a 20% chance per sea state greater than the safe limit that the aircraft will crash on landing or takeoff. The safe sea state for flight ops can be increased by the equipment listed in the Land/Launch Safe Sea State table.

For example, *Iowa* is a Size class A/Large ship. It can launch a helicopter in sea state 5 safely. In sea state 6, the helo would have a 20% chance of crashing while taking off.

4.6.4.1 Catapults and Arresting Gear. Catapults launch aircraft into the air in a short distance. One plane can be launched by a catapult every two minutes. If the launch is aborted, for any reason, the launch sequence must start again from the beginning. At the end of the Movement phase, the aircraft will be moving at 25% of full power speed, at Low altitude, heading in the same direction as the ship.

During landing operations, aircraft are rapidly slowed by

Altitude Bands

Trilogy Altitude Band	*Meters above S/L**	*Feet above S/L**	*Characteristics*
Real High	30001+	98426+	Missiles only. No fixed-wing a/c. No helicopters, seriously.
Very High	15501 - 30000	50854 - 98425	Cruise for jet a/c. No helicopters.
High	7501-15500	24607-50853	Cruise for jet & TP, some IP, RP a/c. No helicopters.
Med	2001-7500	6563-24606	Cruise for jet and IP, RP, TP and helicopters.
Low	0-2000	0-6562	Cruise for IP, RP, TP and helicopters.
Nap of the Earth	0-100*	0-328	Risks for fixed wing. Special mode over land only.
Very Low flight	0-30	0-98	Risks for fixed wing. Special mode over water only.

Note: VLow is used over water and NOE is used over land to fly very close to the surface. The NOE and Very Low altitudes are special-purpose flight conditions by aircraft within the Low altitude band. They are not separate altitude bands.
* NOE altitude is measured above ground level, not sea level.

Contrails occur only at High Altitude.

Altitude Changes

Aircraft Engine Type	*Abbreviation*	*Rate of Climb Multiplier (times Maneuver Rating) per 3 min*	*per 30 sec*	*Rate of Descent (times Maneuver Rating) per 3 min*	*per 30 sec*	*Max Dive Speed*
Piston or Turboprop	RP, IP, TP	900 m	150 m	1800 m	300 m	1.33 Level Speed
Turbojet, Turbofan	TJ, TF					
Man Rtng: 2.0-		1500 m	250 m	2400 m	400 m	1.5 Level Speed
Man Rtng: 2.5+		3000 m	500 m	4500 m	750 m	1.5 Level Speed
Helicopter	--	200 m	33 m	300 m	50 m	1.1 Level speed

These rates apply to aircraft starting at Medium altitude. Double them for Low altitude and halve them at High altitude and above. If the aircraft is fully loaded, halve the climb rate.

Example: The F-16A has a turbofan engine and a lightly loaded Maneuver rating of 4.5. In a three-minute Tactical Turn, starting at Medium Altitude, it can climb 3000 * 4.5 = 13,500 meters, or dive 4500 * 4.5 = 20,250 meters.

All Maneuver Ratings:						
Rocket	RT	5000 m	833 m	7500 m	1250 m	1.5 Level Speed

the arresting gear and brought to a halt on the flight deck. A carrier can land, or recover, one aircraft every minute, or three aircraft every Tactical Turn. Landing aircraft must be at Low altitude and at 25% of its full power speed on the turn the aircraft intends to land. Without arresting gear, only VTOL aircraft or helicopters can land on a ship.

4.6.4.2 Fly-off. Fixed-wing aircraft that do not require catapults to take off can be launched every thirty seconds. The forward catapults, if present, cannot be used and no aircraft can land while an aircraft is flying off. At the end of the Movement phase, the aircraft will be moving at 25% of maximum speed at Low altitude into the wind.

4.6.4.3 Pad Launch. Helicopters and VTOL fixed-wing aircraft can take off vertically from pads. One helicopter or VTOL-fixed wing aircraft may be launched from each spot every three minutes. At the end of the Movement Phase, the aircraft is moving into the wind at 25% of its full power speed at Low altitude.

Land/Launch Safe Sea State

Ships: Carrier aircraft and helicopters may launch from or land on a ship safely in sea state 3 or less.

Sea Surface: Seaplanes, amphibians and float-equipped helicopters may launch from or land on the sea surface in sea state 2 or less.

Modifiers: (modifications are cumulative):

If ship has stabilizers	+1
If ship has dual stabilizers	+2
Note: Stabilizers do not work unless the ship's speed is at least 8 knots.	
If ship is Size class A	+2
If ship is Size class B	+1
If aircraft is medium-sized or larger	+1
If ship has a helo recovery system (Bear Trap, RAST, etc.)+1 (for landing helicopters only)	

4.6.5 Sea Surface Landings and Takeoffs. To land, a seaplane must fly at 25% of its maximum speed at Low altitude into the wind. At the end of the Movement Phase it has landed. Seaplanes must take off into the wind, and at the end of the Movement Phase, are flying at 25% of their full power speed at Low altitude. The safe sea state for landings and takeoffs is Sea State 3.

4.6.6 Swamping. Any aircraft sitting on the sea surface has a 10% chance of being swamped and lost per sea state above 3. This should be rolled every Tactical Turn that the plane is on the sea surface.

Moored aircraft (i.e., to a tender, buoy, or a pier) are exempt. Coastal waters, especially a lee shore, will be calmer than open ocean by one or two sea states. The sheltering effect of a location will be described in the Environment Section of a scenario where it applies.

4.6.7 Ready Times. Aircraft (including UAVs) must be prepared for flight before launch. The Ready Times table shows the times required for certain preparations for an aircraft before it can be launched.

An armed aircraft has bombs or other ordnance loaded on it. Aircraft which have no weaponry (e.g., a Tu-95RT Bear D) need not be armed. A fueled aircraft has its fuel tanks filled. An alerted aircraft has its preflight checks performed and its crew briefed. A crewed aircraft has its flight crew physically on board and prepared to operate the aircraft (UAV crews must be in their control spaces). Aircraft are normally in a fueled, but uncrewed, unalerted, unarmed condition. A ready aircraft is armed (if necessary), fueled, alerted and crewed; considered on +5 status (ready for launch in 5 minutes).

Pilots and aircrew can remain at an Alert +5 status for at most one hour (two Intermediate Turns).

Aircraft Ready Times (Minutes)

A/C Size:	*VSmall*	*Small*	*Med*	*Large*
To Arm				
AAM & gun ammo only	20	30	40	40
Unguided air-to-surface	20	30	40	180
Guided air-to-surface	30	50	60	240
ASW	--	20	40	60
To Fuel:	10	20	30	90
To Alert:	20	40	40	120

To catapult launch: 2 minutes per plane per catapult
Helicopters halve the time to Alert

Aircraft can be fueled and armed simultaneously, using the longest time for ordnance loading or refueling. Once completed, the aircraft can then undergo preflight checks, be manned, and the engines started. This is the time needed to bring the aircraft to alert status. Adding the two gives the total time required to make the aircraft ready.

Aboard an aircraft carrier or other aviation ship, only one 12-plane squadron can be fueled and armed at once. Times can be changed if information on specific aircraft types and ordnance loads is available, as long as all players agree.

4.7 Aircraft Endurance. The distance an aircraft can fly changes depending on its load, the altitude it flies at, and how fast it flies. It can also be extended by carrying extra fuel or refueling inflight from a tanker.

4.7.1 Aircraft Ranges. The maximum range of an aircraft flying at cruise speed is given in Annex B as "cruise range." This is based on internal fuel, with a normal load (less than 80% of max payload), a climb to flight altitude and a reserve.

4.7.2 Increasing Range.

• *Additional fuel.* Annex B lists the number of drop tanks or internal auxiliary tanks a plane can carry and the additional range that each tank gives.

• *Inflight Refueling.* Many planes can be refueled in flight from a dedicated refueler or a plane equipped with a "buddy" refueling pod. See section 4.8 for inflight refueling rules.

If an aircraft runs out of fuel without reaching a base or tanker, it crashes.

4.7.3 Altitude Effects on Range. Piston aircraft need superchargers (IP(S), RP(S)) to cruise at High Altitude. Otherwise they must use full power when flying at High altitude.

Jet Aircraft (TJ, TF), burn 2 nmi of range for each nmi flown at low altitude.

Turboprop (TP) and Turboshaft (TS) aircraft are not affected by either requirement.

4.7.4 Throttle Effects on Range. Flying at other than cruise speed uses more or less fuel.

Full power ("Full Military Power" or FMP) costs 3 times as much for jets (TJ, TF).

FMP costs 1.5 times as much for propeller aircraft (TP, TS, IP, RP).

Afterburner ("Reheat") costs 10 times as much for jets.

Loiter costs .8 times as much for everyone. Loitering planes cannot move from their location.

4.7.5 Load effects on range. Aircraft carrying 80% or more of its maximum payload have their range reduced by 25%.

4.7.6 Strike Mission Planning. Make sure the plane will have enough fuel to reach the target and return.

1) Decide on the plane's route to and from the target. Measure the distance in nmi.

If a jet plane will fly at low altitude, or a prop plane at high altitude, check for altitude effects (4.7.3)

2) Decide what ordnance will be carried. Fully loaded planes have their cruise range reduced by 25%.

3) If the plane will fly part of its route at full power or afterburner, calculate the extra range it costs.

4) Compare this result (the Mission Range) with the Cruise Range in Annex B.

If the Mission Range is less than the Cruise Range, good. If it is not, see if the plane can add drop tanks, which may mean changing the ordnance loadout. If that won't work, consider inflight refueling. If none of these options will work, then it's a suicide mission and the pilot will refuse to fly.

Example: A jet fighter will fly 200 nmi to its target. It will fly 150 nmi cruising at High altitude, then 25 nmi at Low altitude to avoid radar and then the last 25 nmi at full power because it can't avoid that part of the radar coverage. It will return at cruise speed at High altitude.

It's best to break up the route into legs:

Leg 1: Fly 150 nmi High@cruise = 150 nmi

Leg 2: Fly 25 nmi Low@cruise = x2 (altitude) = 50 nmi

Leg 3: Fly 25 nmi Low@FMP = x2 (alt), x3 (FMP) = 150 nmi

Leg 4: Fly 200 nmi back High@cruise = 200 nmi

Mission range: 150 + 50 + 150 + 200 = 550 nmi is required, although the distance there and back is only 400 nmi.

The plane has a Cruise range of 400 nmi, but it can carry two drop tanks, which add 100 nmi each, which means it can now fly the mission.

4.7.7 Combat Air Patrol (CAP) Mission Planning. Planes orbiting on station include not only fighters, but airborne early warning (AEW) aircraft, EW aircraft (EWCAP), planes armed with antisurface ordnance (SuCAP), and ASW aircraft patrolling (for some reason, not called "SUBCAP").

Planes on station increase their time aloft by using a "Loiter" throttle setting. It reduces fuel consumption by 20%, so that a plane that would spend an hour at cruise speed can actually stay up for 75 minutes (60 minutes/.8 = 75). While loitering, a plane doesn't cover any distance.

To find the endurance of a plane at a particular distance from its base, subtract the distance from its base to the CAP station at its cruise speed, double it (the trip there and back), then divide what's left by the 0.8 loiter modifier, and then its cruise speed, to get the time.

The formula is:

R = Range of aircraft with load and drop tanks

r = CAP station distance from base

s = cruise speed at med/high altitude

t = time an aircraft can remain on station at distance r.

CAP time on station t = (R-2r)/.8/s

Example: A fighter with a range of 600 nmi, carrying AAMs and two 100 nmi drop tanks, is patrolling 200 nmi away from its base. It cruises at 400 knots.

1) The total range available is 600 + 100 + 100 = 800

2) It will use 200 nmi of its range flying to its station and another 200 nmi to return, leaving 400 nmi for patrol.

3) Divide 400 by 0.8 = 500 nmi. Divide this by the plane's cruise speed of 400 knots = 1.25 hours or 1 hour and 15 minutes on station. It will spend one hour in transit to and from the station for a total flight time of 2.25 hours.

An airborne station of any type has to be supported by more than one plane. To keep this CAP station occupied continuously over 24 hours, the player will need 24/1.25 = 19.2, or 20 sorties (in this case, always round up).

A "sortie" is one flight by one aircraft. Medium-sized and smaller aircraft can fly two sorties a day, as long as each sortie is no longer than eight hours. Large aircraft can fly one sortie a day.

The number of CAP stations that a player can support depends on how many planes he has available, how far away from their base he places them, and of course how long each plane can stay in the air.

4.7.8 Dogfight Effects on Endurance. Planes in a dogfight are maneuvering violently, and constantly changing their throttle from idle all the way up bursts of full power or afterburner. Most dogfights are very short, but if the exact fuel consumed in a dogfight matters, treat dogfighting aircraft as being at Full Military Power.

If aircraft involved in a dogfight are not maneuvering, then they use their plotted throttle setting. Only maneuvering aircraft use the FMP throttle setting.

4.8 Inflight Refueling. The tanker and receiving aircraft must have compatible equipment to refuel. Most planes use the probe and drogue method, where the tanker trails a hose with a drogue attached and refueling aircraft inserts a probe into it.

While the US Air Force started with the probe and drogue, they later developed a different method, called a "flying boom." This uses a pipe which fits into a receptacle in the receiving aircraft. Some boom aircraft can be fitted with a drogue attachment before takeoff if it needs to refuel probe-equipped aircraft. While so fitted, it cannot use the boom method. Some tanker aircraft carry both systems.

The first Russian widespread inflight refueling aircraft type was the Tu-16Z Badger A. The refueling drogue was

Sample Fuel Offload Values

Receiving Aircraft		*F-14A*	*F-14D*	*F/A-18A/B F/A-18C/D*	*EF-18 F/A-18E/F*	*A-4E*	*A-6E*	*A-7E*	*S-3*
Tanker Aircraft	*kg/nmi*	*3.9*	*3.4*	*4.5*	*5.8*	*2.5*	*4.5*	*2.2*	*2.2*
KA-6D	4.5	1.2	1.3	1.0	0.8	1.8	1.0	2.0	2.0
A-7E w/Buddy Store	2.2	0.6	0.6	0.5	0.4	0.9	0.5	1.0	1.0

KC-135E refueling F-16C by the flying boom method
USAF

KC-130J refueling F-35Bs by the probe & drogue method
USAF

streamed from the wingtip of the tanker aircraft, and the receiving aircraft probe was on its wingtip. This method is not compatible with other Russian aircraft types, and can only be used to refuel other Badger aircraft fitted with wingtip probes. The later Tu-16N Badger A used the now-standard probe & drogue system for Russian aircraft.

Annex B shows whether an aircraft may be refueled in flight and what method it uses. The entry for "Inflight Refuel" will either read "N" for cannot refuel in flight, a "B" for boom, "P" for the probe and drogue method, and "ZA" (*zaprahvsh-chik* or "refueling tanker") for early Badger aircraft.

Western and Soviet aircraft have similar probe & drogue systems, but the two are not compatible.

If the letter is followed by a slash and a number, that is the number of Medium or smaller aircraft it can refuel at the same time. For example, the entry for the Victor K.2 is "P/3P". This means that it can be refueled by probe & drogue and can refuel three Medium or smaller aircraft simultaneously using the drogue method. A tanker can only refuel one Large aircraft at a time. Large aircraft can only be refueled from a tanker's centerline boom or drogue. This is due to aircraft wake interference.

A buddy refuel store can be carried by many planes and will be listed as one of a plane's possible ordnance loads. It may refuel only one aircraft at a time, and they all use the probe & drogue method.

4.8.1 Inflight Refuel Procedure. To find the amount of range a tanker can transfer to another aircraft:

1) Figure out how much fuel (in terms of range) the tanker has available to transfer. A tanker with a Cruise Range of 2000 miles that is 300 nmi from its base needs 300 to return, so it has 1400 nmi of range available for transfer.

2) Find out how much fuel the receiving aircraft need. A fighter 300 nmi from its base has used that much fuel, and can accept that much range from the tanker.

3) Planes burn fuel at different rates, so go to Annex Ba Fuel Offload Factors and cross-index the tanker type with the receiving aircraft type. Multiply the tanker's range by this Offload Factor. That is the amount of range that can be transferred to the receiving aircraft.

Example: A KA-6D accompanies a flight of four F-14As on a mission. At 300 nmi, it will refuel the fighters.

The KA-6D has a 1600 nmi cruise range. It has used 300 nmi, and needs the same amount to get back, so it has 1000 nmi of range available. (By the way, the original cruise range figure includes allowances for takeoff, climb to altitude, forming up, and a reserve.)

The Tomcats need 300 nmi each to top off their tanks.

The offload factor for the KA-6D to the F-14A is 1.2, so the tanker can give the F-14s 1,000 x 1.2 = 1,200 nmi of range. The fighters need 1,200 total, so the tanker has just enough.

If the players want to find out how much range a tanker can give to another aircraft (R), the formula is:

C = Cruise range of the tanker
D = distance from base

R = (C - 2*D) x offload factor for the receiving aircraft.

4.8.2 Inflight Refuel Times. If it matters how long it takes for aircraft to refuel inflight, use the following table.

Inflight Refuel Times
(All times are in 3-minute Tactical Turns)

Aircraft Size	*Hookup*	*Boom Refuel*	*Probe Refuel*	*Buddy Refuel*
Large	2	6	8	--
Small & Medium	1	1	2	3

Add the times for each aircraft to hook up and then refuel. Buddy stores have a much lower transfer rate than dedicated tanker aircraft. The KA-6D is treated as using a buddy store because that's how it was converted from an attack aircraft to a tanker.

Example 1: Refueling a CAP pair from a KA-6D

2 aircraft * (1 Tac Turn for the hookup + 3 Tac Turns to refuel) = 8 Tac Turns total

Example 2: Refueling a flight of four F-111s from a KC-10 (boom method)

4 aircraft * (1 for the hookup + 1 to refuel) = 8 Tac Turns total

Example 3: Tu-16 refueling two Backfires (probe)

2 aircraft * (2 for the hookup + 8 for the refuel) = 20 Tac turns.

Example 4: KC-130J refueling two F-35B (probe)
2 aircraft refueled at same time (1 for the hookup + 2 for the refuel) = 3 Tac turns to refuel both aircraft.

4.9 Helicopter Inflight Refueling. Western helicopters can refuel from any friendly surface ship by approaching the ship at low altitude, matching its course and speed, and dropping a refueling hose, which allows the ship to fill the helicopter's tanks. It takes about fifteen minutes, and brings its fuel up to 100%.

This is a non-combat evolution, and cannot be carried out indefinitely, due to crew fatigue.

4.10 Missile Movement. Ship-launched surface-to-surface missiles are launched in the Fire Phase of a turn, after the Movement Phase has already passed, so the missile will not move until the next Movement Phase. They are not valid targets until a Movement phase has passed. Although they have been launched, they have not yet moved away from their launcher, so any weapon would be unable to separate them from their much larger launch platform. Even submerged-launch missiles are assumed to be still clearing the surface on the phase of launch.

Surface-to-surface missiles and surface-to-air missiles are described in Annex D; air-to-air and air-to-surface missiles in Annex H. Section 7.4 describes different missile guidance types.

Missile counters can be used to show the location of missiles in flight if they will be in the air for more than one turn. Groups of missiles launched at the same time at the same target can be represented by a single counter. This speeds play and denies the other side information on the size of each raid.

Missiles fly at their stated maximum speed during their entire flight. They can change course as much as needed to reach their targets. Once a missile has traveled its maximum range, it has exhausted its fuel supply and it crashes harmlessly.

4.10.1 Missile Trajectories. Guided weapons, including glide bombs, will change altitude en route to their target, or in pursuit of their target.

• Surface-to-Air Missiles (SAMs) can change an unlimited number of altitude bands in one Turn.

• Surface-to-Surface and Air-to-Surface Missiles (SSMs and ASMs) with a *Direct* or *Glide* flight path will spend one turn at their launch altitude (which will be Low if launched from a surface ship), then descend as they approach their target. In the turn they attack, missiles with a direct flight path are at Low altitude.

• *SSMs with a Cruise* flight path fired from subs or ships climb to Low altitude on the turn they are launched, and then climb or descend to their cruise altitude for the remainder of their flight. Missiles cruising above Low altitude will dive on their target in the turn they attack. Missiles in VLow flight may either remain at that altitude, or "pop up" to Low and dive on their target, if they have that option.

• *ASMs with a Cruise* profile fired from aircraft immediately climb or descend to their cruise altitude for the remainder of their flight. Missiles cruising above Low altitude will dive on their target in the turn they attack. Missiles in VLow flight may either remain at that altitude, or "pop up" to Low and dive on their target, if they have that option.

• SSMs and ASMs with a *Ballistic* profile climb to Very high altitude halfway along their flight path, and then dive on their target in the second part of their flight.

4.10.2 Missile Range Modifiers. If an air-to-surface weapon is launched at Low altitude and it has a Direct trajectory, its range is halved (dense air).

AAMs launched outside a dogfight at a closing (±45° of the target's heading), non-maneuvering target have their range doubled if the combined speed of the launching aircraft and the target is 2001 knots or more. If the sum is from 501 - 2000 knots, multiply the range by 1.5.

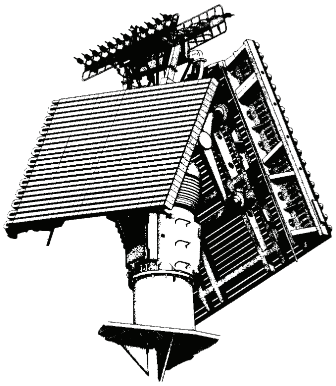
AAMs launched outside a dogfight from Low altitude, or at a receding target (±45° aft of the target), i.e., in a tail chase at any altitude, have their ranges halved. The rear aspect reduces the intercept envelope.

These modifiers stack. A Low-altitude, tail-aspect launch quarters the range. A Low-altitude launch against a closing, 2001+ combined speed target uses the AAM's listed range.

4.10.3 Evasive Maneuvers. Because they are much faster than ships, antiship missiles are not affected by their target's maneuvers.

4.10.4 Waypoints. Some inertially-guided missiles can be programmed before launch to change course at specific locations. These are called "Waypoints"(see 7.4.8). They allow missiles to attack from unexpected directions or steer around known obstacles.

If a missile has waypoint capability, it will be indicated in the Annexes in the Remarks column. Before launch, the controlling player should specify the geographic point(s) where the missile will turn and the new course.



Russian MR-750 Fregat-M2 [Top Plate] radar

Chapter Five - Detection

5.1 Sensor Basics. A typical modern warship receives information from its lookouts and electro-optic sensors (visual), two or three kinds of search radars, at least one sonar, and from electronic intercept equipment (called ES, for "electronic support"). The ship's helicopter may also provide information by using sonobuoys, MAD (Magnetic Anomaly Detection), and radar. Some helicopters are equipped with a dipping sonar.

5.1.1 Active and Passive Sensors. A passive sensor is one that detects energy (such as heat or sound) given off by a contact. It will give direction, but not distance (for example, try to guess the distance of something you hear). An active sensor radiates energy, which is then reflected from the target back to the sensor. Radar is an example, as is a searchlight at night, although the human eye cannot measure the range. Active sensors give direction and range to any contacts, but at a price. Since the sensor is giving off energy, it can be itself detected, which may reveal the ship's location and something about its nature. For example, merchant ships probably do not use active sonar.

5.2 Radar. Radars use pulses of electromagnetic energy (radio waves) to detect and track objects. These pulses are broadcast by an antenna high up on the ship's superstructure. Objects in the pulse's path reflect some of the energy back to the antenna, where the direction of the reflection gives the bearing, and the time the echo takes to travel to the target and back gives the range.

5.2.1 Detection by Radar. There are different procedures for detecting surface, periscope and air contacts:

• *Surface contacts.* Within their detection range, radar detection of surface contacts (except periscopes) is automatic - that is, a 100% chance.

• *Periscopes.* A submarine periscope or mast is a Stealthy-sized radar contact. Two or more extended masts are treated as a VSmall target. Unlike ships, periscopes and other retractable masts are fleeting contacts nestled in the sea clutter return. Raised and lowered quickly, periscopes will be exposed for only a few sweeps of the radar. When attempting to detect a periscope by radar, the detection chance is 25%, except Inverse Synthetic Aperture radars (ISAR) have a 50% chance. This is listed in Annex J in the remarks. Periscopes and submarine masts cannot be detected at all by radar over Sea State 4.

If a periscope or mast is extended for the entire Tactical Turn, it is detected as a regular surface contact of the appropriate size class.

RCS and Stealth

Every ship, plane or any other object has a radar cross section, or RCS, measured in square meters. While described as the area, it is more correctly the strength of its radar return, which has little to do with its physical surface area.

Since the detection range of a radar is directly affected by the RCS, it pays to have as small an RCS as possible. Radar beams do funny things when they strike a surface, especially a metal one. Radar is of course reflected by a smooth surface, but a joint between two pieces of metal only a few millimeters wide may be wide enough to act as a corner reflector, focusing and amplifying the echo. Engine inlets, with their jumble of metal parts and compressor blades, are notorious radar traps. A plane's cockpit is another, with the radar wave coming in through the clear canopy, bouncing around inside, and scattering out again.

By improving tolerances and surfaces, substituting materials, and a few special additions, a plane's RCS can be lowered with little extra cost. For instance, adding a conductive, transparent gold film to a canopy (look at a good color photo of a modern fighter) makes it opaque to radar and dramatically reduces the radar return from the front.

To make a platform fully stealthy requires shaping and special materials. Engine inlets and exhausts can be hidden, surfaces angled, control surfaces positioned so that they do not form right angles, or "corner reflectors." Radar-Absorbent Materials, or RAM, are an exotic mixture of ceramic or resin compounds with a metal component that absorb and diffuse a radar wave as it passes through the material. RAM can be used as a coating to cover a surface, it can line an inlet to reduce interior reflections, and in many other ways to reduce reflected radar energy.

Radar cross sections depend on the platform's angle with respect to the radar wave and with the wave's characteristics, especially its polarization and frequency. This means that a plane that is optimized against low-frequency search radars will not be as stealthy to high-frequency weapons radars. It also means that a plane that is stealthy from one angle may not be stealthy from another. Making a platform stealthy to all radars, from all angles, can be very expensive. Hence the F-117 and B-2 and their high price tags.

It is much more reasonable to take the first, relatively inexpensive step and make a platform "low observable" instead of fully stealthy. The designers of the Rafale, the Eurofighter, and other modern aircraft are taking this approach. Other aircraft, like the F-22, are stealthy, and their costs reflect this.

Stealth applies to ships as well as planes. Many modern vessels have sloped sides and RAM coatings to reduce their cross sections. One ship with this feature is the US *Burke* class, which many sources report has the radar signature of a frigate.

Reducing a platform's radar cross section has a cost. It adds one more factor to an already complex equation, although it can be classed as both an offensive and defensive feature. Adding stealth to a ship may reduce its need for defensive weapons. Adding it to an airplane will make it easier to penetrate a target's defenses, so fewer planes and pilots are needed.

• *Detection of air contacts* is more variable because of their higher speed. Air Search, HF/3D and LAS radar detections are made through the combat system on a ship, AEW aircraft, or land-based SAM system. As an aircraft or missile reaches maximum detection range for that radar, roll on the Combat System Reaction table on page 8-4 for the number of 30-second increments between it coming into detection range, and being recognized as a valid contact the player can react to.

AI and LD/SD radars operate on a higher frequency, and automatically detect elegible air contacts at the range listed in Annex J3 for the contact's Signature.

5.2.2 Size of Contacts. The larger the contact, the farther away a radar can see it. There are five radar contact sizes, called "signatures," and a radar's range for each signature size is given in Annex J.

Example: *Range in nmi*

		Lge	*Med*	*Small*	*Very Small*	*Stealthy*
France	DRBV 22	70	59	42	17	5
USA	SPS-48A	235	165	118	47	14

The French DRBV 22 and US SPS-48 have different ranges, but are both reduced by the same relative percentage. The SPS-48 has a longer range against the same large-size target because of its electronic characteristics: more power, a bigger antenna, or better processing. When checking for the detection range of a radar against a ship or aircraft, refer to Annex A for ships or B for aircraft for their signature, then check the radar annex (Annexes J1 - J3) for the radar's range against that size. Ship and aircraft size classes are covered in section 2.1.

Ships or planes may have a signature smaller than their physical size because of stealth techniques used in their construction. If VSmall or Stealthy aircraft carry external ordnance (except on wingtips or semi-recessed), their radar signature is increased to Small.

Single periscopes and submarine masts are Stealthy-sized contacts and cannot be detected by radar over sea state 4. Two or more extended masts are treated as a VSmall target.

Multiple aircraft in groups are more detectable than individual aircraft. Three or more aircraft flying together are treated as being one size class larger than their listed size. Nine or more aircraft in a group are treated as two size classes larger. For example, three small-sized aircraft would be considered a medium contact for radar detection. A nine-plane group would be a large contact. Regardless of the group's size, detection range cannot exceed the radar's maximum range listed in Annex J.

5.2.3 Radar Information. A detection will tell the detecting player the range and bearing to the contact. If the player tracks a contact for one Tactical Turn, in the Detection phase of the next turn he will know its course and speed.

It is impossible to identify a radar contact from the blip alone. One can deduce something about its size from how far away it was detected, but the size of the blip on the screen is essentially meaningless. The "large" blip could be a Large- or Medium-sized contact, or even several Small contacts. Basically, a blip description of "large" or "small" is the best most radar systems can provide.

Synthetic Aperture Radar (SAR) uses special electronic techniques and computer processing to display images of ground targets. These targets can be bombed as if they were visually spotted in all weather conditions. Inverse Synthetic Aperture Radar (ISAR) uses similar techniques to classify ships by type and class (e.g., *Udaloy* class destroyer). Some radars have Non-cooperative Target Recognition (NCTR) capability - these can identify aircraft by type and class (e.g., MiG-29). Radar with SAR, ISAR and NCTR features are identified in the remarks column of Annex J.

5.2.4 Shipboard Radar Types. The characteristics of shipboard radars are listed in Annex J1. They may perform more than one function:

• *Surface search* (SS) radars are designed to pick up ships and land. They can see air contacts in Very Low (VLow) flight at one-tenth normal range. They can use the radar duct (see 5.2.9.5) to extend their range.

• *Navigation* (Nav) radars are specialized surface search sets designed to pick up ships and land for safe shiphandling. They have limited tactical benefit, as they are stand-alone sensors, and are not tied into the combat system. They can use the radar duct (see 5.2.9.5) to extend their range.

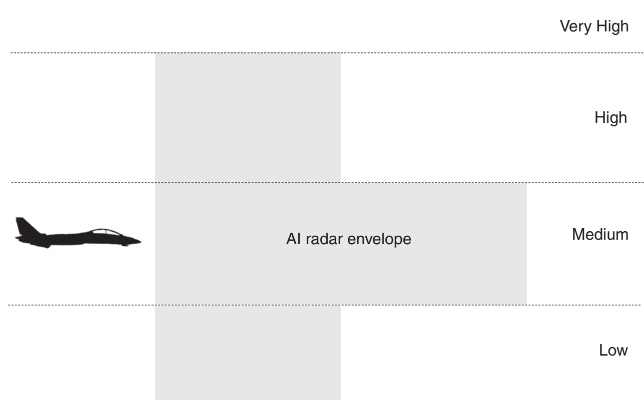
• *Targeting* radars (SS-T) are a type of surface-search radar used by the Soviet Union/Russia. They not only function as a surface search radar optimized to use the surface duct to extend their range over the horizon, but can serve as an extremely precise ES sensors, and have real-time data links that pass the information to other units within 15 nmi fitted with a targeting complex. They can use the radar duct (see 5.2.9.5) to extend their range.

• *Air Search* (AS) radars see air contacts in the Low altitude band or above, except that they have problems with ones in VLow flight, because of the surface clutter.

All air search radars have problems detecting contacts in VLow flight; they suffer high clutter interference (double the Airborne AS, SS, Ship LAS radar clutter value on page 5-5). Because their beam is angled upward, they cannot use the radar duct.

• *Low-Altitude Search* (LAS) radars are designed to detect seaskimminers. They only see contacts in the Low and Medium altitude bands, but detect anything in VLow flight normally because they don't suffer from the same clutter problem that affects air search radars. They can use the radar duct (see 5.2.9.5) to extend their range.

• *Height-Finding* (HF) *Radars* are used to find a target's altitude. They do not search for new contacts. Once cued by another sensor, they can provide the height of any air contact inside their range at any altitude (horizon limited). They suffer the same limitation on seeing VLow air contacts as air search



radars. Because their beam is angled upward, they cannot use the radar duct.

SAM systems need a 3D or HF radar to attack an aircraft more than 15 nmi away. If the radar is lost, the associated SAM is unable to fire beyond the 15 nmi limit.

• *Three-Dimensional Radars (3D).* These are air-search radars that can provide the altitude of an air contact. They suffer the same limitation on seeing VLow air contacts as air search radars. Because their beam is angled upward, they cannot use the radar duct.

SAM systems need a 3D or HF radar to attack an aircraft more than 15 nmi away. If the radar is lost, the associated SAM is unable to fire beyond the 15 nmi limit.

• *Periscope Radars.* A specialized type of surface search radar is mounted on a retractable mast or built into the periscope of modern submarines. It requires that the submarine using it be at periscope depth and have its radar mast or periscope extended.

• Fire Control radars, either for guns (GFC), or missiles (MFC) are specialized, with no search capability.

5.2.5 Airborne Radar Types. Most fighters carry a combined search and fire-control radar in their nose. Other aircraft carry air search or 3D search radars (e.g., E-2C Hawkeye with the APS-125), and a few carry a range-only (RO) radar that has no search capability. An airborne radar's function and performance will be listed in Annex J3.

Most aircraft radars have an arc of 120° centered on the aircraft's heading. Some radars, like the APS-125, have a 360° arc. The arc is listed in Annex J3.

• *Airborne Surface Search Radars (SS)*. These radars will pick up surface contacts and VLow air contacts at one-tenth of normal range. Other than the effects of line of sight, their detection capability is not affected by altitude.

• *Airborne Air Search Radars (AS)*. These radars detect air units in their own altitude band, in the next one higher (at full range) and one lower (at half range).

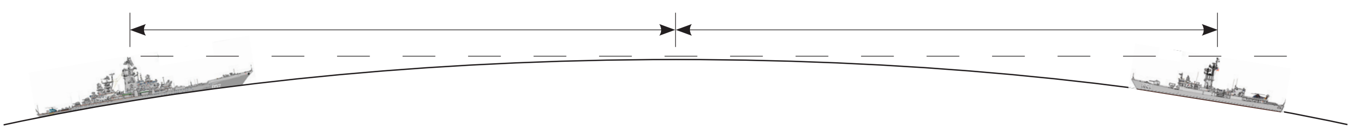
• *Airborne Three-Dimensional Radars (3D).* These are air-search radars that can find out the altitude of an air contact.

• *Air Intercept Radars (AI)*. These Air Search radars feed information to a plane's fire control system. They can detect air targets at the same altitude at full range, and half range one level above and below the radar's altitude. They cannot detect anything two altitude bands above or below them.

• *Look Down/Shoot Down (LD/SD).* These improved AI radars can detect and engage air contacts at full range two altitude bands up and two bands down from the band the aircraft is in.

• *Range Only Radars (RO)*. These have no search capability; they provide range data for a radar computing gunsight.

• *Terrain-Following and Terrain Avoidance Radars (TF, TA)*. These are specialized radars or modes on some radars that allow a plane to fly nap-of-the-earth (see 4.5.3) in poor



Radar Line of Sight

Height (m)	*Obsrv Unit*	*RHigh*	*VHigh*	*High*	*Med*	*Low*	*VLow*	*Horizon*	*Large*	*Med*	*Small*	*VSmall*	*Peris.*
35000	RHigh	835	730	640	575	465	430	415	435	430	425	420	415
20000	VHigh	730	630	540	475	365	325	315	330	325	325	320	315
10000	High	640	540	445	380	275	235	225	240	235	235	230	225
5000	Med	575	475	380	315	205	170	160	175	170	170	165	160
500	Low	465	365	275	205	100	60	50	65	60	60	55	50
30	VLow	430	325	235	170	60	25	12	26	24	22	19	14
0	Horizon	415	315	225	160	50	12	0	14	12	10	7	2
40	Large	435	330	240	175	65	26	14	26	25	23	20	16
30	Medium	430	325	235	170	60	24	12	24	23	21	18	14
20	Small	425	325	235	170	60	22	10	22	21	19	16	12
10	VSmall	420	320	230	165	55	19	7	19	18	16	13	9
1	Peris.	415	315	225	160	50	14	2	14	12	10	8	3

Line of sight distances are in nautical miles. Observer and contact heights are of aircraft or radar antennas in meters.

The detection range of a radar is either the Annex J range for a particular signature or the radar horizon, whichever is shorter.

HFSW radars are limited by their range, not by the radar horizon.

Evaporative Duct High Refraction

Obsrv Unit	*Horizon*	*Large*	*Med*	*Small*	*VSmall*	*Peris.*	*VLow*
Large	35	70	65	60	50	40	70
Medium	30	65	60	55	45	35	65
Small	25	60	55	50	40	30	60
VSmall	20	50	45	40	30	22	50
Peris.	5	35	30	25	20	8	35

Surface Duct RF Trapping

Obsrv Unit	*Horizon*	*Large*	*Med*	*Small*	*VSmall*	*Peris.*	*VLow*
Large	75	145	135	125	110	85	145
Medium	70	135	125	115	100	75	135
Small	55	120	115	100	90	65	120
VSmall	40	105	95	85	70	45	105
Peris.	9	75	65	55	40	17	75

visibility. They will not function in Heavy rain. They have a minimum altitude of more than 30 meters, so will not allow VLow flight over water.

• Side-Looking Air Radars (SLAR) are used for reconnaissance. They have no search capability.

5.2.6 Ground Radar Types. Most have functions similar to shipboard radars. For finding the horizon distance, they have the same height as a medium ship, unless stated otherwise in the scenario.

• *OTH Backscatter* (OTH-B) radars are not real-time search sensors. They are not limited by the horizon, as the radar beam bounces off the ionosphere and can cover large areas, but the information they provide is not precise. They can be used to detect a surface or air unit's presence, but the area of uncertainty varies (see 8.4.3 Ballistic Missile Attacks Against Ships). Information from an OTH-B radar will be provided as part of a scenario setup.

• *High Frequency Surface Wave* (HFSW) radars are specialized coastal surveillance radars that use ionospheric refraction for extended range against ships and aircraft. Any HFSW radars will be described in the scenario setup.

5.2.7 LPI Radars. Low Probability of Intercept is a feature which greatly reduces a radar's chance of being detected by ES (see 5.3). LPI radars will be identified in the remarks column of Annex J.

5.2.8 Radar Line of Sight. The distance units can detect each other is limited by the range to the horizon. This is a function of the height of the two units trying to detect each other, and whether the sensor uses light or infrared (visual) or the electromagnetic spectrum (radar). Visible light and radio waves are both refracted by the Earth's atmosphere, although visible light is not bent as much as radio and radar.

To find the radar horizon, the maximum radar line of sight, consult the Radar Line of Sight table on page 5-3. For example, a Medium ship with a SPS-39 air search radar attempts to detect a bomber at Medium altitude. The radar has a range vs. a Large contact of 160 nmi (listed in Annex J1). Referring to the Radar Line of Sight table, find the searching ship's size class in the left-hand column (as a Medium Ship), and the column for the aircraft's height (at Medium Altitude); at the junction of the row and column, find the value 170. This is the maximum range at which a Medium-altitude contact can be detected by a Medium-sized ship, regardless of the radar's performance. If the same ship was trying to detect a Medium-sized aircraft, the radar's detection range would be 115 nmi (from Annex J1), well inside the radar horizon at Medium altitude, so it would be detected at 115 nmi. If a plane's pilot wished to delay detection, he could drop to Low altitude, where the horizon distance is 60 nmi, and that is the range where it would be possible to detect him.

Land masses between a radar and a potential contact block the line of sight. The radar cannot detect the contact.

5.2.9 Environmental Effects on Radar. A radar's range is reduced by rising sea states, rain, and nearby land masses. These create "clutter," or interference, on a radar display. Clutter values for the effects described here are listed on the Radar Clutter Value table.

Clutter can also come from noise jamming, a form of electronic warfare. This is covered in section 12.5, and is treated the same as clutter from any other source.

5.2.9.1 Sea State Clutter. The detection range of a radar searching for contacts on the sea surface and sea-skimming aircraft is reduced by sea clutter. This effect is caused by the radar beams striking the wave tops and being reflected back. The bigger the waves, the more clutter that appears on the scope.

5.2.9.2 Rain Clutter. Rain reflects radar energy back towards an antenna; the heavier the rainfall, the greater the clutter. If the searching ship is in a rain storm, then the rain clutter value applies regardless of bearing. A squall or rainstorm near the contact affects detection if it is within the radar's maximum range and within ±5° of the contact's bearing.

5.2.9.3 Land Mass Clutter. Nearby land is a much better radar reflector than waves. Ground clutter can cause a significant reduction in a search radar's range. Air search radar beams are angled up, so they are only affected by land clutter if they are attempting to detect contacts at Low altitude.

The amount of ground clutter depends on the type of terrain. Ground clutter is only effective within the radar's maximum range and within ±5° of the target's bearing.

5.2.9.4 Combining Clutter Effects. If there is more than one clutter source, use only the largest value to find the range reduction. The other sources are low enough that they can be ignored without significantly affecting accuracy.

At the beginning of a scenario, note if there is any land or rain present in the setup and environment sections. Also note the sea state. Consult the Radar Clutter Values table on page 5-5 to find the clutter values for each source. During the Detection Phase of each turn, see which clutter sources apply and use the largest value to reduce the radar's performance.

Radars can reject or reduce the effects of clutter. At first, this "clutter resistance" was mainly done by reducing the power in the radar signal, later, by better displays, and then by computer processing. The Clutter Resistance table shows how effective each generation of radar is at suppressing clutter.

Subtract the radar's clutter resistance value from the largest clutter source to find the net clutter value for the radar. Take this value to the Clutter Effects table and cross-index to find the radar range modifier.

Example: A US SPS-10 (a 2nd-generation radar) is attempting to detect a small surface contact against a jungle background and sea state 3. The clutter value for the sea state is 2, and the jungle is 9, so the radar's clutter resistance of 5 is subtracted from the larger value. Using the result of 4 on the Clutter Effects table means the radar's range against a land backdrop is halved.

5.2.9.5 Radar Ducting. Atmospheric refraction bends electromagnetic energy, such as radar waves, as they travel. The Radar Line of Sight table on page 5-3 uses standard atmospheric refraction. However, there are two non-standard, or anomalous cases, that have significant tactical implications for naval vessels.

• The first is the *evaporative duct*. Caused by a rapid change in humidity as height increases above the sea surface, it is often present at sea and can reach a height of 40 meters. Usually, the duct height is 10 - 15 meters, and usable only by Small (C&D size) and VSmall (E-G size) ships, and submarines with a raised periscope/mast radar.

Exception: All Medium (B-size) Russian and Chinese ships with a targeting complex (SS-T) are treated as "Small" ships for employing the evaporative duct with the targeting system. There is a very good reason why the Russians put the radome on top of the bridge, instead of on top of the mast.

In addition, all U.S. ships with the SRS-1 Combat DF 3rd Gen ES are treated as one size class smaller for using the duct.

Radar Clutter Values

Clutter *Type*	*Ship SS, Nav Radars*	*Airborne AS, 3D, SS, Ship AS, 3D, LAS Radars*
Land		
Flat land/Beach	3	6
Flat land w/brush/Lt Woods	6	9
Heavy Woods/Jungle	9	12
Hills/Towns	12	15
Mountains/Cities	14	17
Sea State		
0, 1	0	0
2	1	3
3	2	5
4	4	7
5	6	9
6	8	12
7	12	15
8	15	18
9	18	21
Precipitation		
Drizzle/Lt Fog	0	0
Light Rain/Mod Fog	2	2
Moderate Rain/Heavy Fog	5	5
Heavy Rain	8	8
Torrential Rain	11	11

Ship AS and 3D radars looking at VLow targets suffer twice the clutter of the Airborne AS, SS, Ship LAS column.

Clutter Resistance

Generation	*Resistance Value*
First	2
Second	5
Third	8
Fourth	12
Fifth	15
Sixth	18

Clutter Effects on Range

Net Clutter Value	*Radar Range Modifier*
1	.85
2	.70
3	.60
4	.50
5	.40
6	.35
7	.30
8	.25
9 - 10	.20
11- 12	.15
13 - 14	.10
15 - 16	.05
17 - 18	.03
19 - 20	.01

The evaporative duct enables radar waves to travel farther than the standard atmospheric model. This extends the radar horizon (see the appropriate line-of-sight table) for surface search (SS) and low-altitude search (LAS) radars detecting VLow and surface contacts by more than double.

Weather can have a significant effect on the evaporative duct. Wind speeds greater than 30 knots are too strong to allow a stable duct to form; the air is being mixed too much. Furthermore, if there is too much moisture in the air (precipitation or fog), the presence of sea ice, or heavy cloud cover (broken or solid) it will eliminate the humidity gradient and prevent the formation of a duct.

The presence of a duct will be specified as part of the scenario's environment. Roll D100 for its height. All size classes of the rolled height and smaller may exploit the duct.

Evaporative Duct Height

D100 Roll	*01 - 10*	*11 - 40*	*41 - 80*	*81 - 95*	*96-100*
Usable by Size Class	Peris./ Sub Mast	VSmall	Small	Med	Large

Modifiers:
Fall/Spring months: -15 Winter months: -30
Wind speeds ≤ 10 knots: -20

Example: A Project 956 *Sovremenny* class DDG with a Mineral-M [Band Stand] targeting complex wants to target a hostile medium size contact. The scenario takes place in the fall, and the Russian player rolls D100 to determine the evaporative duct's height. Rolling a 71 and using the -15 Fall modifier yields a final result of 56. Thus all Small, VSmall ships, and submerged submarines with a raised radar mast can use the duct. Medium-size ships cannot. Even though the *Sovremenny* is a Medium size class, the Band Stand's location effectively makes it a small ship for this purpose.

The Mineral-M has a maximum range of 135 nmi against a medium sized target. However, in looking at the Evaporative Duct line-of-sight table, the *Sovremenny* is limited to a maximum range of 55 nmi (Small observer to Medium target).

• The second type of anomalous propagation is the *surface duct*. This is caused by an atmospheric temperature inversion - a layer of warm, dry air flowing over the top of cold, wet air. This duct is much stronger and can reach heights of hundreds of meters, effectively trapping a radar wave and enabling it to travel very long distances. All size classes of ships may use a surface duct. The Surface Duct line-of-sight table illustrates the very long radar horizon of surface search (SS) and low-altitude search (LAS) radars detecting VLow and surface contacts.

The weather effects with surface ducts are very different from the weaker evaporative duct. Wind speeds over 5 knots and cloud cover heavier than scattered (25%) will disrupt the inversion layer. Humidity also plays a role, with drier air tending to form a temperature inversion. A surface duct tends to occur from about three hours before sunset to about three

> Designers' Note: Players do not have to use the clutter rules, but they will not be able to include weather effects on radar or offensive EW jammers.

hours after sunrise. Temperature inversions are also more likely during summer months, locations with warmer water, and along coastal areas.

If weather conditions permit a surface duct, roll D100 to see if one is formed.

Surface Duct Probability

Season	Summer	Spring/Fall	Winter
% Chance	20%	15%	5%

Modifiers:
Within 50 nmi of land: +10%
Hot climate locations: +10%
Cold climate locations: -10%

Example: The Project 956 *Sovremenny* class DDG with a Mineral-M [Band Stand] targeting complex is back, but this time with the aid of a surface duct. Once again it attempts to target a hostile medium size contact.

The Mineral-M has a maximum range of 135 nmi against a medium size target, but with a surface duct, this becomes 115 nmi (Small observer to Medium target)!

Normally, extended radar coverage would be a good thing, however, since the atmospheric conditions that cause the duct are not reliable, it is difficult to predict how strong a duct will be at any given time of day. In addition, as the radar signals are traveling farther than normal, they become vulnerable to jamming and clutter from distant sources.

(Optional Rule) Another problem is if the ducted line-of-sight is greater than the radar's maximum range, then spurious contacts could show up on the display. This is because the radar pulses are no longer properly timed with the radar's electronics and the ranges provided are "ambiguous."

Contacts inside the normal radar ranges will be detected and shown accurately on the radar display, but if the contact is in a duct, and the contact is not greater than twice the normal range, it could be displayed at any distance out to radar's maximum range for that contact's signature.

Radar operators can shift range scales to see if the range changes; this will show if it is an ambiguous contact. Under these circumstances, the contact's range will not be accurately displayed, but the value will be less than the maximum radar range. The bearing reported by the radar is correct.

This rule should only be used if neutral or white shipping are also included in the scenario.

The anomalous propagation effect works both ways. ES horizons are also increased by the same amount. When determining ES system detection range, use the appropriate line-of-sight table as the base range. Any radar that transmits into the Low Altitude band will have some of the RF energy captured in the duct. This can be detected by an ES system. In some cases, particularly with a shallow evaporative duct, large-size ships' surface and air search radars could be detectable at the longer range, even though the ships cannot gain any benefit from the duct itself.

5.3 Electromagnetic Support (ES). All electronic emitters (radar, radio) radiate electromagnetic energy into space. This can be detected by sensitive receivers designed for this purpose, just as a passive sonar can hear an active one. This sensor is called ES (Electronic Support). Ships and planes fitted with ES will have it listed as one of their sensors.

A successful ES detection will reveal the type of emitter (e.g., MR-145, SPS-10), and its bearing from the detecting unit. Cross bearings from two or more units can be used to passively find a contact's location without using radar, but they are less precise. See 6.3 Fire Control Solutions.

Noise jamming (see 12.5) is also detected by ES.

While ES provides a bearing to a transmitting radar, the bearing is not precise, ±5° - 15°, in other words, somewhere in a 10° - 30° arc. Dedicated Russian targeting systems in passive mode have much better bearing resolution: ±0.5°. These values are built into the Passive RF fire control tables, with an obvious bonus for the specialized Russian systems.

Many planes and some ships have a simple form of ES called a Radar Warning Receiver (RWR) that will tell them when they are being attacked by radar-guided weapons. It will not detect search radars.

Generation zero RWRs warn of a radar's presence, but do not give the type, and give a bearing only ±45°. First Generation RWRs also do not give the type, but give a bearing ±20°. Second-generation and later RWRs will identify the type of weapons radar and give an accurate bearing to the source.

The chance of detecting a search radar's emissions with ES is 90% each Tactical Turn. ES detection during an Intermediate Turn is automatic. Weapon and fire-control radars, because of the strength of their signal and their narrow beams, are automatically detected at all times. A director does not emit radiation except when it is guiding a weapon or controlling a weapon's fire. Otherwise, regardless of mode, it cannot be detected. Air intercept radars guiding or controlling weapons are treated as weapons radars.

The maximum range of ES intercept depends on the type of ES receiver and the effective radar horizon. Successive generations of ES receivers have grown more and more sensitive, and can detect radar emissions farther and farther over the horizon because of the atmosphere's refractive properties.

ES Generation	1	2	3	4	5	6
Multiplier	1.1	1.2	1.3	1.4	1.5	1.6

Example: A second generation ES can detect a radar at 1.2 times the horizon distance. A Russian Tu-95RT Bear D, equipped with a 2nd Gen ES, is patrolling at high altitude. It is looking for an American task force made up of small, medium, and large ships. The Radar Line of Sight table on page 5-3 says that High altitude observers can see Large ships at 240 nmi, and Medium and Small ships at 235 nmi. He can expect to detect the American radars at 288 and 282 nmi.

All radars are more detectable in a ducted environment as at least some of the RF energy gets trapped in a duct. Thus, atmospheric ducting effects will also apply to ES system ranges (see 5.2.9.5).

Example: A Russian Project 1241.1M [Tarantul III] missile boat (the Russians call them "rocket cutters") has a Monolit 3rd Gen targeting complex. To find its detection range against a *Burke's* SPY-1 radar, take the 1.3 modifier and add a modifier for the type of radar it is trying to detect, 0.7 for a long range air search radar. The radar horizon between Small (Tarantul) and Medium (*Burke*) size ships, 21 nmi, is multiplied by 1.3 + 0.7, or 2.0, which is 2.0 x 21, or 42 nmi.

If there was an evaporative duct present, then the horizon is 55 nmi, and the modified ES range becomes 2.0 x 55, or 110 nmi.

LPI radars (see 5.2.7) are specifically designed to be difficult for ES to detect. Subtract 1.0 from the multiplier above. A 3rd Gen ES detects an LPI radar at 0.3 (1.3 - 1.0), or 30% of the radar horizon.

5.3.1 Emitter Location Systems (ELS). These aircraft sensors not only detect a radar, but will plot its location, by taking a series of bearings as the aircraft moves. This will provide the location of any ground-based or naval radar. Airborne radars move too quickly for an ELS to develop a fix.

Fifth generation and later ES sets on aircraft are also Emitter Location Systems.

The first emitter detection (Automatic for fire control radars, use normal ES chances for other types) gives a Fair fire control solution. The second emitter detection gives a Good solution for the emitter's location.

An ELS can plot any number of radars at the same time.

5.4 Sonars. There are two methods of sonar detection: active and passive. Passive sonar listens for the noise made by other vessels while active sonar sends out intense sound pulses (commonly referred to as “pinging,” but actually more of a “buh-wAA”) into the water and listens for their return echoes.

A passive sonar tells only the direction (bearing) of the contact (a passive *omnidirectional* sonar will only tell you if something is there), and after some analysis, the type of vessel detected. An active sonar provides bearing and range just like radar. However, broadcasting very loud “pings” into the water makes the searching vessel easier to detect.

5.4.1 Hull-Mounted Sonars. Hull-mounted sonars are fitted on subs and surface ships and come in four configurations; bow-mounted, keel-mounted, deck-mounted, and flank.

• A *bow-mounted* sonar is at the extreme forward portion of the vessel‘s lower bow.

• A *keel* sonar dome is about 25 - 35 feet back from the bow. Both bow- and keel-mounted sonars can be active/passive systems.

• A *deck*-mounted sonar is usually a passive set that was fitted to some submarines. These were located on the upper deck at the forward or after end of the boat.

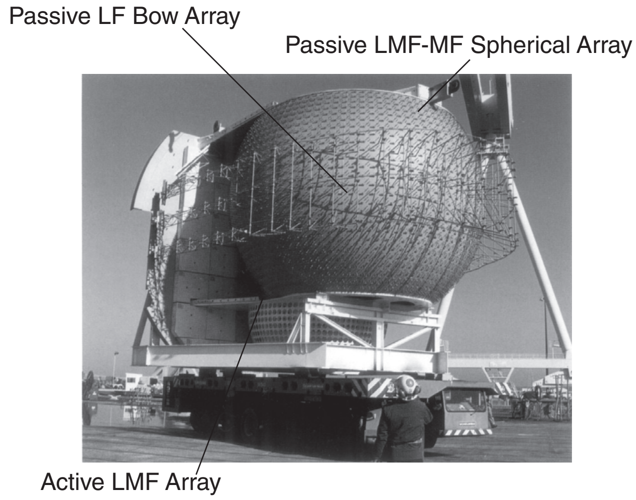
• *Sail*-mounted sonars can be active or passive, and are positioned on a submarine’s sail or fairwater.

• A *flank array* is usually a set of passive hydrophones mounted along the side of the vessel, although some Russian submarines have flank-mounted active arrays. For Gen 1-3 systems, these arrays are not search sensors, but fire control aids, and provide a positive modifier to the Acoustic Fire Control Solution Tables on page 6-4. For Gen 4-6, these arrays are both a search and localization system (see 6.3.4).

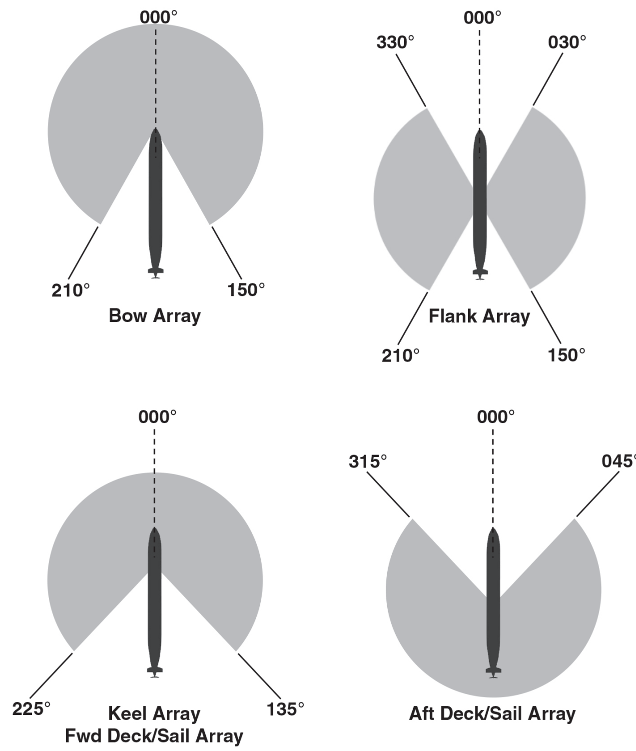
All hull-mounted sonars have blind zones, caused by the noise from the ship’s engines and propellers, or because the ship’s hull is between the sound source and the sonar. They are called “The Baffles,” because the sonar has a baffle to block sound from those directions, and are present even when the ship is dead in the water. The size and shape of the baffles varies with sonar configuration.

Any unit (ship, submarine, or torpedo) within the bearing limits of a baffle cannot be detected by that sonar. The baffles for each type of hull-mounted sonar configuration are shown in the diagram on the right. They are defined relative to the ship’s bow (i.e, ship’s bow = 000°).

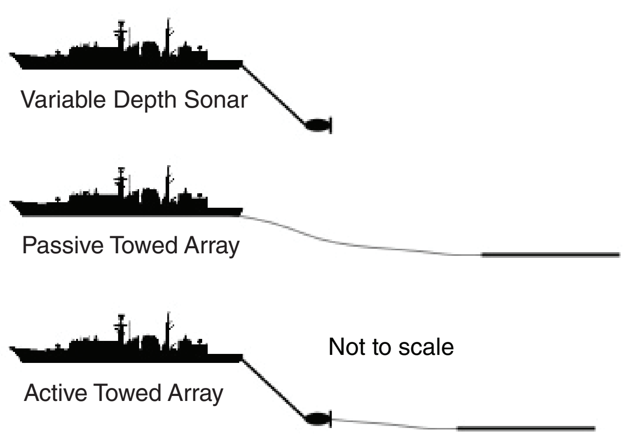
5.4.2 Towed Arrays. These are sonars deployed from the stern of a ship/submarine and are literally towed through the water. There are several types:



BSY-2 Sonar Arrays on USS *Seawolf* (SSN 21) *(US Navy)*



Baffle Zones for Different Sonar Installations



Sonar Frequency Bands in *Harpoon*

Throughout the sonar rules we refer to sonar "frequency bands." A sonar's frequency not only determines its capability, but also the effect the environment has on its performance.

The frequency bands used in *Harpoon* are based on a US Navy scheme and are different from those used by European (and other) sonar manufacturers. For example, Thales, a French multinational defense corporation, refers to their 5 kHz active sonars as "low frequency," but the US Navy concept places these systems squarely in the "medium frequency" category. Many sonar systems in *Harpoon* cover multiple frequency bands. Each sonar will have the bands it operates in listed in Annex K1 or K2, with the band that it uses for active marked with a superscript "a". For example, the Russian MGK-400 Rubikon is an LMF[a]-MF sonar, meaning it can listen in the LMF and MF frequency bands but transmits in the LMF band only.

The reason for multiple passive frequency bands is that one of the bands may be less affected by the environment than the others. For detection purposes, use the band that provides the best possibility of detecting the contact. Usually this is the passive frequency band that provides the longest range.

The sonar frequency bands in *Harpoon* are defined as:

Very High Frequency (VHF): This is 100 kHz or higher, and is typically used by side scan sonars, imaging sonars, and torpedo wake homing seekers, where high resolution and precision is more important than range.

High Frequency (HF): This band is between 10 kHz and 100 kHz, and is used by short-range hull sonars, minehunting sonars, most dipping sonars and active sonobuoys, and torpedo acoustic seekers.

Medium Frequency (MF): This band lies between 1 - 10 kHz and is used by medium-range hull sonars, some dipping sonars and sonobuoys. In *Harpoon*, we break this frequency band into two subgroups:

- MF systems that operate between 5 - 10 kHz.
- Lower Medium Frequency (LMF) systems that operate between 1 - 5 kHz.

This division is necessary because LMF systems can effectively use both bottom bounce and convergence zone propagation paths in all of the world's oceans, but MF systems can only use the convergence zone propagation path in the Mediterranean Sea.

Low Frequency (LF): These operate between 100 Hz and 1 kHz. They include submarine passive hull and flank arrays, passive towed arrays, fixed passive arrays (e.g., SOSUS), and passive sonobuoys. Only a very small number of military active sonars transmit in the LF frequency band, although it is used extensively in civilian applications in the search for undersea petroleum deposits.

Very Low Frequency (VLF): This band lies between 1 Hz and 100 Hz. It is used by passive towed arrays, passive fixed arrays, and sonobuoys. Due to the long wavelengths at these frequencies, sonars that operate in this band are not as affected by the presence of a layer.

• *Variable Depth Sonars* (VDS) systems have an active or active/passive array housed in a streamlined tow body or "fish". This is similar to a hull-mounted sonar, but is on a cable so that it can be lowered below the thermocline, where a submarine may be hiding. Once a VDS is deployed, the ship is limited to 25 knots ("safe operating speed").

• A *Passive Towed* hydrophone array, or more simply a "towed array," is a collection of passive hydrophones inside a polymer hose. By stringing a large number of hydrophones together, the sonar can detect targets at greater ranges than the typical hull array. Unfortunately, this arrangement also makes the array quite long (half a mile or more); It cannot fit on the hull of a ship or submarine, and thus must be towed behind the vessel.

Another advantage of a towed array is that since it is not attached to the hull, own ship's noise doesn't affect it as it would a hull sonar. The base range in Annex K1 takes this into account. Towed arrays are classified as either "Slow Speed" or "High Speed" arrays and are noted in the annex. This is the speed it can be towed at without significantly reducing its detection range because of flow noise. There is no restriction on the speed it can be towed, only at what speed it is effective.

• *Active Towed Arrays* use a towed body with an active sound source along with a passive towed array as the receiver. These systems use an improved hydrophone arrangement, along with advanced signal processing, to resolve the bearing ambiguity problem (see 5.4.2.1 optional rule) without the ship having to maneuver. A ship with an active towed array streamed is limited to 25 knots.

Deploying or retrieving a towed array or VDS takes seven Tactical Turns (21 minutes) and the platform cannot exceed 15 knots while the sonar is being streamed or recovered; once deployed, the ship can increase speed up to the array's safe operating speed. It cannot be used until the array is completely deployed.

Towed sonars can be streamed safely by surface ships in Sea State 5 or lower. In higher sea states, it has a 50% chance each Tactical Turn of being lost. Submerged subs are not limited by sea state.

A surface ship's towed sonar is deployed one depth band below the Layer, either Intermediate I for a Shallow & Moderate layer or Intermediate II for a Deep layer. When determining which sonar modifiers are applicable, always use the depth of the sonar in question. This applies to both hull and towed arrays alike.

Passive VLF sonars are immune to the effects of Shallow and Moderate layers. For Deep layers, reduce the cross-layer loss modifier to -2 (not -5). There is no modifier, good or bad, when a VLF sonar and the contact are on the same side of the layer.

A submarine's towed sonar is always streamed one depth band below the submarine.

If the water depth becomes less than a towed array's streaming depth, the array gets snagged on the ocean floor and is lost. Very embarrassing, not to mention the paperwork.

5.4.2.1 Bearing Ambiguity and Towed Array Stabilization *(optional rule)*. A towed array's construction has a problem: the bearings it provides are ambiguous. The beams of a towed array are cone-shaped, and the sonar cannot tell if the target is on the right or the left-hand side of the beam pattern. When a target is first detected, the sonar operator doesn't know which one of the two bearings is the correct. For most towed arrays, the only way to solve the bearing ambiguity problem is to maneuver the detecting ship and put the target in a radically different beam. This means a course change of between 45° and 135°, port or starboard, to get another angle on the target. Once this course change is completed, and the contact reacquired, the correct right/left bearing can be quickly determined and target tracking can begin. *Note:* the fire control solution process cannot be started without a target track first being established.

The problem with changing course with a deployed towed array is that once you put a kink in it (i.e., the towed array is no longer in a straight line) its bearing information is worthless. After the course change is completed, it takes a while for the array to straighten out. This is called the "array stabilization time" and it depends on the length of the array and the speed of the ship or submarine. Annex K1 lists the towed array length in the remarks section. The Towed Array Stabilization table below shows the time it takes to straighten out, depending on the ship's speed and the length of the array.

Towed Array Stabilization Time (Tactical Turns)

Speed (kts)	*5*	*10*	*15+*
Short Array	2	1	1
Long Array	3	2	1

During the time an array is stabilizing, while the bearing information is unreliable, the players can continue to make classification rolls (see 5.4.6.6).

Seventh generation passive towed arrays, and all active towed arrays, have the ability to resolve bearing ambiguity without the need for a maneuver.

5.4.3 Dipping Sonars. These are deployed from hovering helicopters, flying boats that have landed on the water, and stationary small ASW vessels. The sonars do not move, but they can easily change depth. If the platform moves, the cable snaps and the dipping sonar is lost. Dipping sonars have 360° coverage and thus, do not have any baffle zones.

Once a helicopter is in a hover, or the aircraft/ship is dead-in-the water, the sonar is deployed and can be used in the Detection Phase of the same Tactical Turn. It can either be recovered in the same turn or left deployed for use in the Detection Phase of the next turn.

5.4.4 Sonobuoys. Sonobuoys are small, air-dropped sonars with a radio and a floatation device. The sonar (either a hydrophone or a transducer) of a sonobuoy is on a cable, and can be set to either Shallow or Intermediate II depth. Once deployed, the depth setting cannot be changed.

Sonobuoys have a selectable lifetime, after which a soluble plug dissolves and the buoy sinks. Typically, passive sonobuoys can have lives between one to eight hours, while active sonobuoys have considerably shorter lives, about 30 minutes, due to the greater power requirements of the active sonar transducers. The life of a sonobuoy will be listed in Annex K2.

Most sonobuoys cannot survive in Sea State 6 or rougher seas. However, some Gen 6 and 7 sonobuoys can work in these conditions. If a sonobuoy is capable of operating in Sea State 6, it will be noted in Annex K2.

To deploy a sonobuoy, an plane flies over the intended position at Low or Medium altitude at 325 knots or less, and declares the drop. A buoy dropped outside these restrictions breaks up on impact. It will begin transmitting in the Detection Phase one full Tactical Turn after it is dropped. Sonobuoys also provide 360°coverage; they do not have baffles.

See 5.4.6.3 for sonobuoy detection.

5.4.5 Acoustic Intercept Receivers (AIR). These are passive sonars designed to warn subs that there is an active sonar in the area. They can detect LMF through HF sonars, including active torpedo seekers, and have 360° coverage (no baffle zones). See the sidebar on page 5-8 for details on the different sonar frequencies used in the game.

The range of an AIR depends on the power of the transmitting sonar, its frequency band, and any environmental restrictions. After calculating the active sonar's modified 50% detection range (see 5.4.6.1) multiply the range by the modifier below for the appropriate AIR generation and the frequency band of the transmitting sonar. Active sonars using bottom bounce and convergence zone propagation paths can also be detected, but an AIR is unable to distinguish how the signal arrives; it cannot provide a bearing. If an active sonar is within the detection range of an AIR, it is automatically detected. Once an active sonar is detected, the AIR provides frequency band and varying degrees of bearing information, and sometimes range, depending on the generation of the AIR.

The Acoustic Intercept Receivers table below lists the capabilities of the different AIR generations.

Acoustic Intercept Receivers

Generation	*LMF Range*	*MF Range*	*HF Range*	*Bearing Accuracy*	*Ranging Capability*
1	x3	x3	x2	±20°	No
2	x3	x3	x2	±15°	No
3	x4	x4	x3	±10°	No
4	x4	x4	x3	±5°	No
5	x5	x5	x4	±3°	Yes

• *First* and *second* generation receivers provide only the frequency band of the detected sonar (e.g., "HF").

• *Third* and *fourth* generation AIRs can identify the active sonar by type (e.g., "SQS-26C").

• Fifth generation receivers will provide a range out to a limit of 12 nmi. They receive the wave front curvature bonus of +3 on the Acoustic Fire Control Solution table.

Layer Acoustics

As a sound wave approaches the Layer, part of the wave front is coming in at shallow angles and is bent back up toward the surface, due to the increasing sound velocity. Other parts of the wave front are coming in at steeper angles, and will penetrate the Layer, but are immediately bent downward as the speed of sound begins to decrease rapidly. These two phenomena create the "Shadow Zone," an area of very low signal strength where a submarine can hide. Thus, a ship on the surface might not be able to detect a distant submarine below the Layer, since the sonar beams are refracted upward before they can reach the submarine's depth. As the submarine gets closer to the ship, however, the angle becomes more and more acute and eventually the sonar beam does penetrate the Layer and detection is possible, though, usually at very short ranges. This problem can also affect a sonar system below the Layer trying to detect a target above the Layer.

Passive Sonar Detection Modifiers

Noise Signature

Contact Noise Rating	*Loud*	*Noisy*	*Quiet*	*VQuiet*	*EQuiet*	*Active Sonar*
Modifier	+6	+3	0	-3	-6	+8

Signature Modifiers		
Sub using diesels	+3	Snorkeling or surfaced
Target Cavitating	+4	
Ultra Quiet	-1	Nuclear sub, max speed 3 kts
Ultra Quiet	-2	Conventional sub, max spd 3 kts

Relative Speed Modifier

Contact	*Searcher Speed (kts)*					
Speed (kts)	*0-8*	*9-15*	*16-20*	*21-25*	*26-30*	*30+*
0 - 8	0	-1	-3	-6	-8	Blind
9 - 15	+1	0	-2	-4	-6	Blind
16 - 20	+2	+1	-1	-3	-5	Blind
21 - 25	+3	+2	0	-2	-4	Blind
26 - 30	+4	+3	+1	-1	-3	Blind
30+	+5	+4	+2	0	-2	Blind

Note: High speed towed array reduces the searcher speed by 7 knots.

Environmental Modifiers

Sea State	*0-1*	*2-3*	*4*	*5*	*6*	*7*	*8-9*
Modifier	+1	0	-1	-2	-4	-6	-8

Shipping Traffic	*Moderate*	*Heavy*
Modifier	-1	-2

Rain	*Light*	*Moderate*	*Heavy*	*Torrential*
Modifier	-2	-4	-6	-8

Shallow Water (≤ Int II)	*Sonar Frequency*		
	VLF/LF/LMF	*MF*	*HF*
Modifier	-3	-2	-1

Ice	
MIZ	-3 for LMF - HF -2 for VLF - LF
Pack Ice	-3

Active Sonar Detection Modifiers

Target Strength

Contact Size Class	*Large*	*Med*	*Small*	*VSmall*
Contact Size Class	*A*	*B*	*C - D*	*E - G*
Modifier	+3	+2	+1	-1

Target Strength Modifiers	
Anechoic Coating	-1
Narrow Aspect	-1
Broad Aspect	+1

Relative Speed Modifier

Contact	*Searcher Speed (kts)*					
Speed (kts)	*0-8*	*9-15*	*16-20*	*21-25*	*26-30*	*30+*
0 - 8	0	0	-1	-2	-4	Blind
9 - 15	0	0	0	-1	-3	Blind
16 - 20	+1	0	0	0	-2	Blind
21 - 25	+1	+1	+1	0	-1	Blind
26 - 30	+2	+2	+1	+1	0	Blind
30+	+2	+2	+2	+1	0	Blind

Environmental Modifiers

Sea State	*0-1*	*2-3*	*4*	*5*	*6*	*7*	*8-9*
Modifier	0	-1	-2	-3	-5	-7	-9

Shallow Water (≤ Int II)	*Sonar Frequency*		
	VLF/LF/LMF	*MF*	*HF*
Modifier	-3	-2	-1

Ice	
MIZ	-2
Pack Ice	+3

Ocean Type	*Applicable Environment Modifiers*
Open Ocean	(Sea State + Shipping) or Rain Whichever is greater
Marginal Ice Zone	Sea State + MIZ
Pack Ice	Pack Ice

Layer Modifiers (apply to both the Active and Passive Sonar)

Direct Path - Sonar Above Layer

Contact	*Layer Depth*		
Depth	*Shallow*	*Moderate*	*Deep*
Surface/PD	0	+2	+3
Shallow	-5	+2	+3
Intermediate I	-5	-5	+3
Intermediate II+	-5	-5	-5

Passive VLF capable sonars are immune to the effects of Shallow and Moderate layers. For Deep layers, reduce the negative cross-layer loss modifier to -2 (not -5). There is no modifier, good or bad, when a VLF sonar and contact are on the same side of the layer.

Direct Path - Sonar Below Layer

Contact	*Layer Depth*		
Depth	*Shallow*	*Moderate*	*Deep*
Surface/PD	-5	-5	-5
Shallow	-3	-5	-5
Intermediate I	-2	-2	-5
Intermediate II	-1	-1	-2
Intermediate III	0	0	-1
Intermediate IV+	0	0	0

Layer Depth (m)	*Layer Title*	*Sonars Affected*	*Surface Duct*
25	Shallow	MF/HF	No
50	Moderate	LMF/MF/HF	Weak
100	Deep	VLF/LF/LMF/MF/HF	Strong

Detection Range Modifiers

Modifier Total:	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
Range Mod:	0.05	0.10	0.15	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.0	1.25	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0

Multiply the sonar system's base range from Annex K1 or K2 with the Range Modifier above to find the 50% probability of detection range.

Sonar Range/Probability

Range (nmi) — Probability of Detection

90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%
0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9
0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7
0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6
0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5	2.8	3.0	3.3	3.5	3.8	4.0	4.3	4.5
0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4
0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9	4.2	4.6	4.9	5.3	5.6	6.0	6.3
0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2
0.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.9	6.3	6.8	7.2	7.7	8.1
1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.5	6.1	6.6	7.2	7.7	8.3	8.8	9.4	9.9
1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2	10.8
1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.8	8.5	9.1	9.8	10.4	11.1	11.7
1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9	12.6
1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5
1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4
1.7	2.6	3.4	4.3	5.1	6.0	6.8	7.7	8.5	9.4	10.2	11.1	11.9	12.8	13.6	14.5	15.3
1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2
1.9	2.9	3.8	4.8	5.7	6.7	7.6	8.6	9.5	10.5	11.4	12.4	13.3	14.3	15.2	16.2	17.1
2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
2.1	3.2	4.2	5.3	6.3	7.4	8.4	9.5	10.5	11.6	12.6	13.7	14.7	15.8	16.8	17.9	18.9
2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2	14.3	15.4	16.5	17.6	18.7	19.8
2.3	3.5	4.6	5.8	6.9	8.1	9.2	10.4	11.5	12.7	13.8	15.0	16.1	17.3	18.4	19.6	20.7
2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6
2.5	3.8	5.0	6.3	7.5	8.8	10.0	11.3	12.5	13.8	15.0	16.3	17.5	18.8	20.0	21.3	22.5
2.6	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4
2.7	4.1	5.4	6.8	8.1	9.5	10.8	12.2	13.5	14.9	16.2	17.6	18.9	20.3	21.6	23.0	24.3
2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2
2.9	4.4	5.8	7.3	8.7	10.2	11.6	13.1	14.5	16.0	17.4	18.9	20.3	21.8	23.2	24.7	26.1
3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0

Sonar Range/Probability (continued)

Probability of Detection

Range (nmi)

90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%
3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8
3.4	5.1	6.8	8.5	10.2	11.9	13.6	15.3	17.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6
3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4
3.8	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0	20.9	22.8	24.7	26.6	28.5	30.4	32.3	34.2
4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0
4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0	24.2	26.4	28.6	30.8	33.0	35.2	37.4	39.6
4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0	26.4	28.8	31.2	33.6	36.0	38.4	40.8	43.2
5.2	7.8	10.4	13.0	15.6	18.2	20.8	23.4	26.0	28.6	31.2	33.8	36.4	39.0	41.6	44.2	46.8
5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0	30.8	33.6	36.4	39.2	42.0	44.8	47.6	50.4
6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	42.0	45.0	48.0	51.0	54.0
6.4	9.6	12.8	16.0	19.2	22.4	25.6	28.8	32.0	35.2	38.4	41.6	44.8	48.0	51.2	54.4	57.6
6.8	10.2	13.6	17.0	20.4	23.8	27.2	30.6	34.0	37.4	40.8	44.2	47.6	51.0	54.4	57.8	61.2
7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0	39.6	43.2	46.8	50.4	54.0	57.6	61.2	64.8
7.6	11.4	15.2	19.0	22.8	26.6	30.4	34.2	38.0	41.8	45.6	49.4	53.2	57.0	60.8	64.6	68.4
8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0	44.0	48.0	52.0	56.0	60.0	64.0	68.0	72.0
8.4	12.6	16.8	21.0	25.2	29.4	33.6	37.8	42.0	46.2	50.4	54.6	58.8	63.0	67.2	71.4	75.6
8.8	13.2	17.6	22.0	26.4	30.8	35.2	39.6	44.0	48.4	52.8	57.2	61.6	66.0	70.4	74.8	79.2
9.2	13.8	18.4	23.0	27.6	32.2	36.8	41.4	46.0	50.6	55.2	59.8	64.4	69.0	73.6	78.2	82.8
9.6	14.4	19.2	24.0	28.8	33.6	38.4	43.2	48.0	52.8	57.6	62.4	67.2	72.0	76.8	81.6	86.4
10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0
10.4	15.6	20.8	26.0	31.2	36.4	41.6	46.8	52.0	57.2	62.4	67.6	72.8	78.0	83.2	88.4	93.6
10.8	16.2	21.6	27.0	32.4	37.8	43.2	48.6	54.0	59.4	64.8	70.2	75.6	81.0	86.4	91.8	97.2
11.2	16.8	22.4	28.0	33.6	39.2	44.8	50.4	56.0	61.6	67.2	72.8	78.4	84.0	89.6	95.2	100.8
11.6	17.4	23.2	29.0	34.8	40.6	46.4	52.2	58.0	63.8	69.6	75.4	81.2	87.0	92.8	98.6	104.4
12.0	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0	66.0	72.0	78.0	84.0	90.0	96.0	102.0	108.0
12.4	18.6	24.8	31.0	37.2	43.4	49.6	55.8	62.0	68.2	74.4	80.6	86.8	93.0	99.2	105.4	111.6
12.8	19.2	25.6	32.0	38.4	44.8	51.2	57.6	64.0	70.4	76.8	83.2	89.6	96.0	102.4	108.8	115.2
13.2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0	72.6	79.2	85.8	92.4	99.0	105.6	112.2	118.8
13.6	20.4	27.2	34.0	40.8	47.6	54.4	61.2	68.0	74.8	81.6	88.4	95.2	102.0	108.8	115.6	122.4
14.0	21.0	28.0	35.0	42.0	49.0	56.0	63.0	70.0	77.0	84.0	91.0	98.0	105.0	112.0	119.0	126.0
14.4	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0	79.2	86.4	93.6	100.8	108.0	115.2	122.4	129.6
14.8	22.2	29.6	37.0	44.4	51.8	59.2	66.6	74.0	81.4	88.8	96.2	103.6	111.0	118.4	125.8	133.2
15.2	22.8	30.4	38.0	45.6	53.2	60.8	68.4	76.0	83.6	91.2	98.8	106.4	114.0	121.6	129.2	136.8
15.6	23.4	31.2	39.0	46.8	54.6	62.4	70.2	78.0	85.8	93.6	101.4	109.2	117.0	124.8	132.6	140.4
16.0	24.0	32.0	40.0	48.0	56.0	64.0	72.0	80.0	88.0	96.0	104.0	112.0	120.0	128.0	136.0	144.0
16.4	24.6	32.8	41.0	49.2	57.4	65.6	73.8	82.0	90.2	98.4	106.6	114.8	123.0	131.2	139.4	147.6
16.8	25.2	33.6	42.0	50.4	58.8	67.2	75.6	84.0	92.4	100.8	109.2	117.6	126.0	134.4	142.8	151.2
17.2	25.8	34.4	43.0	51.6	60.2	68.8	77.4	86.0	94.6	103.2	111.8	120.4	129.0	137.6	146.2	154.8
17.6	26.4	35.2	44.0	52.8	61.6	70.4	79.2	88.0	96.8	105.6	114.4	123.2	132.0	140.8	149.6	158.4
18.0	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0	99.0	108.0	117.0	126.0	135.0	144.0	153.0	162.0
18.4	27.6	36.8	46.0	55.2	64.4	73.6	82.8	92.0	101.2	110.4	119.6	128.8	138.0	147.2	156.4	165.6
18.8	28.2	37.6	47.0	56.4	65.8	75.2	84.6	94.0	103.4	112.8	122.2	131.6	141.0	150.4	159.8	169.2
19.2	28.8	38.4	48.0	57.6	67.2	76.8	86.4	96.0	105.6	115.2	124.8	134.4	144.0	153.6	163.2	172.8
19.6	29.4	39.2	49.0	58.8	68.6	78.4	88.2	98.0	107.8	117.6	127.4	137.2	147.0	156.8	166.6	176.4
20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0

5.4.6 Sonar Detection. Finding the sonar's active or passive range and detection chance are similar. Generation 1-4 sonars have to choose which mode (active or passive) they will operate in for a given Tactical Turn. Generation 5 and later can use both modes within a single Tactical Turn. For each mode there is a target signature value, a relative speed modifier, environment modifiers, and the effect of the Layer.

• The *Target Signature* measures a platform's noise signature (passive) or its target strength (active). These values can be adjusted upward or downward depending on the actions the target vessel takes, e.g., snorkeling, setting "ultra quiet," or presenting a narrow aspect to an active sonar.

• The *Relative Speed* modifier compares the target's and searching platform's speeds; it improves or reduces the sonar's detection range.

• *Environmental* modifiers account for wind and sea state. The passive sea state modifier can be affected by shipping intensity in the area; this allows for scenarios in high traffic locations like the Mediterranean Sea. Passive modifiers also include the effects of rain.

Only the noisiest environmental noise source is used for checking detection. For open ocean, either the sea state noise (including any shipping adjustment) or the rain noise value is used, but not both. Environments with sea ice are not modified by shipping or rain. For the Marginal Ice Zone (MIZ), the sea state and MIZ modifiers apply, and for pack ice, only the pack ice modifier. The modifier for shallow water (Intermediate II or less) is added to any of the above environments as necessary.

• The "*Layer*," is an acoustic boundary caused by the sudden change in the temperature of the seawater. It can significantly reduce sonar ranges. See 5.4.7.1 for a complete description of the layer.

To find out the Layer's effects, first see where the sonar is with respect to a Layer - above or below, and compare it to the contact's depth on the Layer Modifiers table on page 5-10.

For example, a LMF sonar below a Moderate Layer will have a -5 modifier trying to detect a target above the Layer. For targets below a Layer, there can still be negative modifiers in some depth bands. In this case, the Intermediate I and II depth bands have a -2 and -1 modifier respectively; with no negative modifiers for targets at Intermediate III or deeper.

Each sonar rolls for detection separately. Detection by one sonar in a turn allows any other sonars to use the +15% alerted operator detection modifier in following turns.

5.4.6.1 Active Sonar Detection. Find the sonar's active detection range in Annex K1 or K2. The annex lists the range in nautical miles at which it has a 50% chance of detecting a ship or submarine. This is called the "base range" and it may be modified up or down by various conditions. These modifiers are listed in the Active Sonar Modifiers table on page 5-10.

Next, add up all the applicable active sonar modifiers and find the range modifier value in the Detection Range Modifier table (page 5-11) that corresponds with the sum. Multiply the base range by the modifier to get the modified sonar range with a 50% probability of detection.

Lastly, go to the center column in the Sonar Range/Probability table and find the modified 50% range - round to the nearest cell. Depending on the target's range to the sonar, move to the left or right along the row until the actual range is just less than one of the table's cells. This cell's column header has the sonar's probability of detection for that Tactical Turn. The maximum modified chance of detection is 90%.

Generation 4 and earlier sonars that go active cannot do a simultaneous passive search. Generation 5 and higher sonars can do both active and passive searching at the same time.

Active sonars cannot detect torpedoes unless explicitly noted as having that capability in the remarks of Annex K1.

Only mine avoidance sonars, and hull sonars with very specialized modifications, can detect moored mine cases that are clear of the ocean floor. Bottom mines can only be detected by dedicated minehunting sonars. Mine cases (moored and bottom mines) have a VSmall active target strength.

Example: A Russian Project 1155 *Udaloy* class destroyer attempts to detect a US Improved *Los Angeles* class submarine with its MGK-355 Polinom [Horse Jaw/Horse Tail] LMF sonar suite. The Layer depth is Moderate, between the Shallow and Intermediate I depth bands, and the sea state is 3. The US boat is 4.2 nmi away, presents a quarter aspect (refer to the Aspect Diagram on page 10-2) to the *Udaloy* and is in the Intermediate I depth band. The submarine is size class B/Medium, and is fitted with special hull treatment (anechoic coating). The Russian destroyer is at a speed of 12 knots, the US submarine is at 8 knots.

Target strength for a B/Medium = +2
Anechoic coating = -1
Quarter aspect = 0
Relative speed Mod = 0
Sea State 3 = -1
Hull array Layer mod = -5
VDS array Layer mod = -2
Hull array total: -5
VDS array total: -2

The MGK-355 hull sonar has a range of 5.5 nmi and the VDS has a range of 4.5 nmi. The modifier total is found on the Detection Range table where a -5 has a range modifier of 0.30 and a -2 has a range modifier of 0.60. The modified base 50% detection ranges for the two sonars are:

• Hull array modified range = 5.5 x 0.30 = 1.65 nmi
• VDS array modified range = 4.5 x 0.60 = 2.7 nmi

Going to the Sonar Range/Probability table, the Horse Jaw hull array's modified 50% detection range of 1.65 uses the 1.5 nmi row. At this modified range, the best the hull array can do is 2.7 nmi with a 10% chance of detection. Since the US boat is 4.2 nmi away, the hull array has no chance of detecting it.

The Horse Tail VDS is below the Layer, but the US submarine is hugging the Layer, and this affects the sonar's performance. Running down the center column of the Sonar Range/Probability table, the player uses the 2.5 nmi row - the closest cell to the 2.7 nmi modified range. The player then finds a cell that has a greater range than the target's current range. In this case, the range of 4.2 nmi is just greater than 4.0 nmi, but is less than 4.3 nmi. The searcher must use the 4.3 nmi cell, for a 15% chance of detection. Thus, the *Udaloy*'s player gets one die roll with a 15% chance of picking up the US I688 with his active VDS sonar.

5.4.6.2 Passive Sonar Detection. Passive detection uses the same procedure as active sonar detection, except using the passive noise values and modifiers. Find the sonar's 50% base passive detection range in Annex K1 or K2. Add up all the applicable sonar modifiers and find the range modifier on the Detection Range Modifier table. Multiply the base range by the range modifier. With this modified base 50%

range, a player can then use the Sonar Range/Probability table to find the chance of detection. The maximum modified probability of detection is 90%.

Example: A US *Sturgeon* class SSN is stalking a Project 671RTM Victor III at a depth of Intermediate I, speed 6 knots, in a Sea State 4 environment. The Soviet Project 671RTM Victor III is also at Intermediate I, but is at a speed of 10 knots. The distance between the two submarines is 5.2 nmi. There is a Moderate Layer, between Shallow and Intermediate I, with both submarines below the Layer.

Project 671RTM Noise Rating (Quiet) = 0
Relative speed Mod = +1
Sea State 4 = -1
Spherical array (LMF-MF) Layer mod = -2
Conformal array (LF) Layer mod = -0
TB-16A towed array (VLF-LF) Layer mod = 0
(VLF sonars are unaffected by a Moderate layer.)

BQQ-5A spherical array total: -2
TB-16A towed array and conformal array total: 0

On the Detection Range Modifier table, a -2 has a range modifier of 0.60 and a 0 has a range modifier of 1.0. The modified 50% detection ranges for the sonars are:

• BQQ-5A Spherical array modified range = 3.4 x 0.60 = 2.0 nmi (use the 2.0 nmi row)

• BQQ-5A Conformal hull array modified range = 2.9 x 1.0 = 2.9 nmi (use the 3.0 nmi row)

• TB-16A towed array modified range = 4.3 x 1.0 = 4.3 nmi (use the 4.5 nmi row)

Going to the Sonar Range/Probability table, the chance of detecting the Project 671RTM Victor III at a range of 5.2 nmi for each of the arrays is:

• BQQ-5A Spherical array: Max range on the 2.0 nmi row is 3.6 nmi - no detection possible.

• BQQ-5A Conformal hull array: The actual range of 5.2 nmi is just past 5.1 nmi (15% column), so the player continues to the 5.4 nmi range that has a probability of detection of 10%.

• TB-16A towed array: The actual range of 5.2 nmi is just past 5.0 nmi (45% column), so the player continues to the 5.4 nmi range that has a probability of detection of 40%.

5.4.6.3 Sonobuoy Detection. Aircraft can only monitor as many sonobuoys as they have receiver or processing channels. Once the receiver channel limit is reached, no more sonobuoys can be laid within radio range of the existing field until some of the sonobuoys in the water sink and channels become available. In addition, not all of an aircraft's sonobuoy receiver channels are for search sonobuoys. Some are reserved for passive localization and active sonobuoys, so that a target can be attacked once detected. Annex K3 lists all the MPA and helicopters in the game along with their sonobuoy loadouts and the number of receiver channels for search, localization and active buoys the processor can support.

Any processing limitations are noted in the Remarks, and this will determine the number of sonobuoys that can be used in a Tactical Turn. In most cases, this will require players to select a portion of the laid sonobuoy field that will be monitored – only these sonobuoys can be used during the Detection Phase. The part of the field to be monitored must be identified during the Plotting Phase and cannot be changed.

Sonar searches with sonobuoys are made the same way as hull or towed arrays, except that searcher speed is zero, since sonobuoys do not move - they do drift, but not at any appreciable speed.

• *Search Patterns.* Passive sonobuoys used for search are laid out in multiple parallel lines (usually 2-4 lines). The spacing between each sonobuoy is typically 1.5 times the modified 50% detection range against an assumed target. To speed play, each line of sonobuoys is treated as single sensor for detection purposes, provided there are at least three buoys in the line.

If players choose, they can lay out each sonobuoy's position and use that for determining the detection chance. Measure the distance from the target to the closest point of the sonobuoy line to find the probability of detection.

After finding the chance of detection for a single buoy, add +15%. If the die roll is less than half the final modified probability of detection, multiple sonobuoys detected the target and a very rough location is known. This is a rough solution (Poor quality), and is not accurate enough to allow an effective attack. If only one sonobuoy detected the target, then all that is known is that a submarine is present (with an omni-directional sonobuoy) or a rough bearing is provided (with a directional sonobuoy) and no attack is possible.

• *Localization Patterns.* Once the general location of a sub is known, it can be "localized," that is, finding its position, course, and speed. Both active and passive sonobuoys are used; passive omni-directional sonobuoys are usually laid in large circle or box patterns (about 9-12 buoys) to figure out where the submarine is and where it is going. Spacing between buoys is usually less than a search pattern (0.75 or 1.0 times the modified 50% detection range). A localization pattern presumes a previous detection and thus, gets the alerted operator modifier of +15% to the probability of detection.

Passive directional sonobuoys are used in smaller square or triangle patterns (3-5 buoys) spaced at 0.75 times the modified 50% detection range.

While localization with passive sonobuoys provides a better estimate of the target's position (a Fair solution), it is still less than optimal for an attack and needs either a successful MAD detection or further localization with directional active sonobuoys detection to refine the solution. A torpedo attack with passive localization only must use the Fair weapon placement value. Depth charge attacks have their chance of a hit reduced one quarter (1/4).

• *Active sonobuoys* provide either a range to the target (range-only buoys) or a bearing and range (directional buoys). Since the number of active sonobuoys a processor can handle is small, the pattern is often just a single line dropped at the operator's best guess of the target's position with the buoys spaced at 1.5 times the modified 50% detection range.

• *Multi-static Echo Ranging.* Some passive sonobuoys act as receivers for active "pinger" sonobuoys, or for explosive echo ranging. The advantage of a multi-static system is that a single sound source can provide an active sonar pulse for numerous passive receivers, and if two or more sonobuoys pick up the echo and provide a cross-bearing, then the submarine has been located with sufficient accuracy to make an attack.

Pinger sonobuoys are like active sonobuoys, but they can't receive return echoes. Most are command-activated; they just don't start pinging once in the water.

Explosive echo ranging (EER) uses small charges to generate a single LMF sound pulse. If an aircraft wishes to continue tracking a submarine actively, it will have to deploy additional charges each Tactical Turn.

"Julie" was an early NATO EER technique. It was "mono-static" - only one sonobuoy could process the echo from an explosive charge. The aircraft literally bombs the sonobuoy that the aircraft's crew wants to use; the buoys have radar transponders, lights and dye markers to help find them. Multiple sonobuoys can be used in one pass, but each buoy requires a separate charge. To find the chance of detecting the sub, use the procedure for active search in section 5.4.6.1. Remember to add +15% for an alerted operator. Sonobuoys that can receive EER pulses have a base active range in their Annex K2 entry, as well as a note in the buoy's remarks.

To make a multi-static active search, the aircraft must fly through the center of a localization sonobuoy pattern or within 2 nmi of the sonobuoy that made the initial detection, and deploy the EER sound charges or a sound source buoy. To find the chance of the sub being detected by the sonobuoy closest to the submarine, follow the procedure for finding the chance of an active detection in section 5.4.6.1. Add 30% to the detection chance (+15% for an alerted operator and +15% for multiple sonobuoys in the field) after checking the range. Those sonobuoys that can receive EER or a sound source buoy pulses will have a base active range in their Annex K2 entry, as well as a note in the buoy's remarks. If the die roll is less than half the final modified probability of detection, multiple sonobuoys detected the target and the submarine's location is known and a Good fire control solution is obtained.

A disadvantage of all forms of active echo ranging, whether it is a sonobuoy, a pinger, or an explosive charge, is that the sub knows the jig is up, and will take measures to avoid detection.

• *GPS Sonobuoys*. Some Generation 6 and 7 sonobuoys are equipped with GPS receivers, so the buoy transmits its exact location along with any acoustic data. These sonobuoys provide very precise localizing data, and have a +1 die roll modifier on the Weapons Placement Roll (6.3.8).

• *Laying out a sonobuoy field.* After a player decides what type of field they will lay, they must decide what type of submarine they are attempting to detect, so they can calculate the sonobuoy's detection range using the sub's noise rating and the environmental conditions.

With one buoy's detection range calculated, figure out the spacing, depending on the type of pattern the aircraft will lay. Make sure it carries enough of the right type of sonobuoys.

The aircraft must fly directly over the location where the buoys will be laid. If the field is a line, it must fly the length of each line. If it is a box, triangle, or other shape, then the aircraft just flies over the center of the pattern, it's not necessary to maneuver the aircraft to drop each buoy.

Once the field is laid, the monitoring aircraft, which does not have to be the same aircraft that laid it, must remain within 40 nmi (or the radar line of sight, whichever is shorter) of the buoy field to receive any transmissions.

Although the field must be laid at Low altitude, the plane may monitor the field from any altitude.

5.4.6.4 Detecting Aircraft with Passive Sonars. Aircraft or helicopters that fly at Low altitude can be detected by passive VLF and LF sonars. Even though an aircraft/helicopter is noisy, the transfer of sound from air to the water is very inefficient. Therefore, an aircraft at Low altitude is a Very Quiet surface contact for passive detection. Maximum speed for detection is 8 knots; the Relative Speed Modifier is 0.

5.4.6.5 Special Passive Detection Conditions. These special conditions modify passive detection range:

• *Acoustic Countermeasures* (sonar jammers). Sonar jamming ACMs jam a cone 10° (±5°) wide when a passive sonar looks at them. Treat sonar jammers as Loud for passive sonar detection. For example, if a sonar jammer bears 030° true, the sonar would be unable to hear anything but the countermeasure from 025° to 035°. See section 12.6.1.

• *Active sonar* transmissions are very noisy by their nature. Putting a lot of acoustic energy into the water makes you very detectable. Active sonars are considerably noisier than Loud targets; they have a noise rating of +8, and are detectable by sonars with the same or the next lower frequency band. Thus, an active MF sonar could be detected by passive MF and LMF sonars but not HF or LF sets. There are very few LF active sonars and VLF transmissions cannot be made by any military sonar system in service today.

• *Cavitation.* This happens when a ship or sub travels so fast its propellers start making bubbles in the wake. At high speed the propeller blades are turning so fast that they create a vacuum at their trailing edge. The low pressure creates bubbles of water vapor (steam), which pop once they move away from the blade. This creates noise, and also over time chews up the trailing edge of the propeller.

At deeper depths, higher water pressure prevents the formation of the bubbles, so subs that want to go fast will first go deep. Surface ships don't have that option, of course.

If a ship or submarine's propeller cavitates, add +4 to the passive sonar noise rating. To find out at what speed a ship or sub will start to cavitate, cross-reference the vessel's speed with its noise rating on the Cavitation Speeds table. Use Shallow depth for all surface ships.

If a vessel is equipped with a pump jet propulsor or waterjets, it will not cavitate at all.

Cavitation will not affect a ship's own use of active sonar or hull-mounted passive sonar. The baffles block the noise from that direction (that's one of the reasons the baffles are there).

Cavitation Speeds

Contact's Noise Rating	*Target Speed* 0 - 8	9 - 15	16 - 20	21 - 25	26+
Loud	-	Shallow	Int I	Int II	Int III
Noisy	-	Shallow	Int I	Int II	Int III
Quiet	-	-	Shallow	Int I	Int II
Very Quiet	-	-	-	Shallow	Int I
Ext Quiet	-	-	-	-	Shallow

• *Explosions.* Treat explosions as Loud for passive sonar detection. Since it is a broadband source, all frequencies of passive sonar (VLF, LF, LMF, MF, HF) can detect it.

• *Launch Transients.* Whenever weapons are fired from a sub, the launching process, as well as the weapon, makes noise. Usually the launching process is louder; a rush of compressed air, along with pump noises and tube doors cycling. If a submarine launches a torpedo, its noise rating is temporarily raised to that of a "Noisy" target for that Tactical Turn - Noisy and Loud submarines already have high noise levels and the extra amount won't make them more detectable. However, the launch can still be detected.

Some submarines have “Quiet” launch systems or employ “swim out tubes;” the torpedo leaves the tube under its own power at slow speed. These launch systems are harder to detect. In the Tactical Turn that a torpedo is launched, the submarine’s noise level is temporarily raised to Quiet for detection purposes. Submarines with a swim out launching system will have it noted in the Remarks section of Annex A.

Missile firings are much louder and there is no way to do it quietly. If a sub launches a missile, the firing rocket motor raises the noise signature to “Loud” for that Tactical Turn.

• *Masking.* If there are two passive sonar contacts within 5° of each other, the stronger contact will mask the quieter one, preventing it from being detected. “Stronger” does not necessarily mean the contact with a higher noise rating, since a Quiet contact which is much closer could be stronger than a distant Loud contact. To find out if a contact is masked, calculate the final 50% passive detection range and then the final probability of detection for both contacts. The one with the highest chance of detection will mask the other contact with a lower chance. If the chance of detection is the same, then the contact that is closer will mask the more distant one. If they have the same noise rating, then neither is masked.

Most torpedoes will not mask or be masked by other passive sonar contacts. Rocket-powered torpedoes like the Shkval will mask other passive contacts.

Direct path contacts will not mask bottom bounce and Convergence Zone detections.

• *Nuclear Detonations.* The ultimate in noisy evolutions is the earth-shattering Ka-BOOM of a nuclear weapon. Any surface or subsurface nuclear burst within 75 nmi of a sonar will raise the ambient noise to that of Sea State 8 and makes CZ detections impossible. Other target modifiers still apply; it is just that the background noise is now so much higher. This “blue-out” effect lasts for 6+D6 hours.

• *Weapon Noise.* Once the weapon is launched, its own noise characteristics take over for detection purposes. Every torpedo has a rating of Noisy unless it is specifically listed in its Annex F remarks as a Quiet torpedo. If a Quiet torpedo has two or more speeds, it is Quiet at all the lower speeds. At the highest speed, the torpedo is Noisy. Rocket motors are Loud contacts.

5.4.6.6 Contact Classification. The sounds created by a ship, sub, or torpedo are caused by the machinery inside the hull, as well as the number and types of propellers. This set of sounds is distinctive for that class of ship, submarine, or torpedo. By analyzing these sounds, the detecting vessel can identify, or classify, the contact.

It depends on the sonar type and the contact. LMF, MF, and HF sonars can only determine if the contact is a ship or submarine. These sonars lack the frequency range to even hear the machinery noises used to identify a ship or submarine. Only VLF and LF frequency bands can do this.

First, the detecting vessel must have successfully detected the contact passively. Assuming contact is retained, on the following Tactical Turn, the classification process can begin.

Take the final probability of detection for the current Tactical Turn, including the +15% for an alerted operator, and add another 15% (Classification Modifier). This is the classification chance. Compare the D100 result to the Passive Sonar Classification Chance table.

Passive Sonar Classification Chance

Classification Die Roll	*Ship/Submarine Data*	*Torpedo Data*
%	Ship/Sub Class	Torpedo Type
% + 10	Ship or Sub, Nationality, Propulsion Type	Propulsion Type (thermal, electric, rocket, etc.)
% + 20	Ship or Submarine	It’s a Torpedo(!)
% + 21	No data	No data

Example: An Improved *Los Angeles* detected and began tracking a Project 971 Akula I SSN on the previous Tactical Turn. The two subs are at slow speed, 8 knots, and are 4 nmi apart. There is a moderate Layer. On the second Tactical Turn the probability of detection using its TB-23 towed array against a Very Quiet target with an alerted operator is 35% (20% + 15%).

Project 971 Noise Rating (VQuiet) = -3
Relative speed Mod = 0
Sea State 4 = -1
TB-23 towed array (VLF-LF) Layer mod = 0
(VLF sonars are unaffected by Moderate layers.)
TB-23 array total: -4

Find the modifier total on the Detection Range Modifier table; a -4 has a range modifier of 0.40. The modified 50% detection ranges for the TB-23 is:

• TB-23 towed array modified range = 6.8 x 0.4 = 2.7 nmi (use the 2.5 nmi row)

Going to the Sonar Range/Probability table, the chance of detecting the Russian sub at a range of 4 nmi for the TB-23 towed array is:

• TB-23 towed array: At 4 nmi the chance of detection is 20%; the +15% alerted operator modifier gives a final detection chance of 35%.

Adding another +15% for the classification modifier, and the classification chance is 50%.

The die roll results and contact data would then be:

% Die Roll	*Contact Data*
50% or less	Project 971 Akula I SSN
51% to 60%	Submarine, Russian, Nuclear-powered
61% to 70%	Submarine
71%+	No Data

• *Mobile decoys*, or submarine simulators, present a special case, since they are designed to sound like the submarine that launched them (see 12.6.2). First and second generation mobile decoys are broadband noisemakers only, but their ability to move can still complicate the sonar picture. Thus LMF, MF, and HF passive sonars will be unable to classify the contact as a decoy. However, if these sonars were to go active, there would not be a valid return and decoy’s true nature would be immediately obvious. Passive VLF and LF sonars with narrowband processing suffer a -15% classification modifier against first and second gen mobile decoys.

Third generation mobile decoys radiate a sub’s broadband and narrowband signature, and provide a valid return for active sonars. Passive VLF and LF sonars can still classify a third generation mobile decoy, but there is a -20% modifier.

> Before a game starts, the players should determine the acoustic conditions, using ones provided in a scenario, or possibly rolling randomly. The Acoustic Layer Effects table on page 5-18 can be used to see what the Layer depth is.

Fourth generation mobile decoys are even more sophisticated and provide a near-perfect recording of a submarine's signature. In addition to providing a valid return for active sonars, these advanced mobile decoys also will provide a valid hit for an aircraft's MAD sensor. Passive VLF and LF sonars can still classify a fourth generation mobile decoy, but there is a -30% modifier.

Example: If the Project 971 Akula I in the previous example were to launch a 3rd gen mobile decoy, the Improved *Los Angeles* player would have the same classification results as before, but they would have to roll a 30 or less on D100 (class/type) to identify the decoy. Otherwise, it looks like the submarine that launched it.

The die roll results and contact data of the 3rd gen mobile decoy would be:

% Die Roll	*Contact Data*
30% or less	Mobile decoy
31% to 50%	Project 971 Akula I SSN
51% to 60%	Submarine, Russian, Nuclear-powered
61% to 70%	Submarine
71%+	No Data

• *Torpedoes* must also be classified as such before a ship or sub can maneuver to evade them or deploy countermeasures (soft or hard kill). A torpedo is classified in the same way as any other sonar contact, but there is a big difference, in that all sonar frequency bands can now make the attempt, not just VLF-LF systems. Broadband sonars, LMF, MF, and HF systems get a +10% classification modifier against a torpedo at slower speeds and +20% at attack speed. For VLF-LF sonars that have a narrowband capability, they get a +30% classification modifier applicable to all torpedo speeds. Torpedoes have very distinct narrowband signatures, due to their propulsion plants. This makes it a bit easier to identify them. If a torpedo seeker is active and the detecting unit has an Acoustic Intercept Receiver, classification is automatic. Note: wake-homing torpedoes are an exception, as the wake seeker operates at very high frequency (VHF) and is pointed upward toward the surface, not at the ship.

5.4.7 Acoustic Propagation Paths. Sound in water doesn't always travel in a straight line. There are several possible propagation paths between a contact and the searching sonar, each with its own important tactical implications. In *Harpoon,* the propagation are: Direct Path (both above and below the Layer), Bottom Bounce, and Convergence Zones (CZ). The propagation path diagram below illustrates these different mechanisms.

5.4.7.1 Direct Path and "The Layer". The most common sonar detection method is the direct path. The biggest factor affecting direct path detection is the seasonal thermocline, also called "The Layer," an acoustic boundary caused by the sudden change in the temperature of the seawater. Close to the surface, a band of water warmed by sunlight and mixed by wave action can form, called a "surface duct." The Layer is the boundary between this duct and the slightly cooler water below it.

The Layer can reflect active sonar transmissions or block radiated sound, severely reducing range. The factors affecting detection range are the sonar's frequency band and the Layer's depth, which changes depending on the weather and even the time of day. Layer depth is described as shallow, moderate or deep.

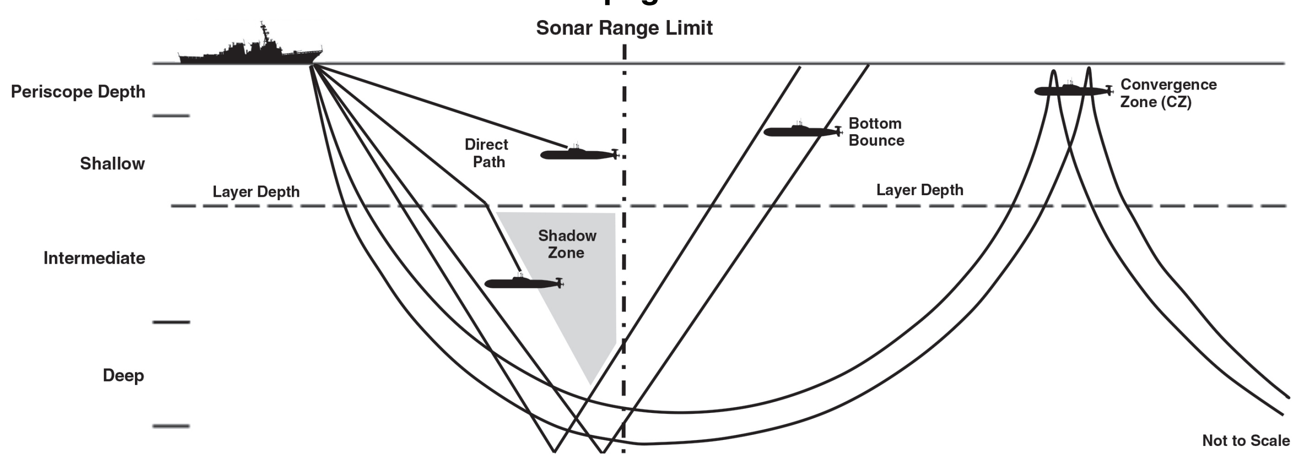
A Layer exists only in calm to moderate seas, since sea states of 6 or greater mix up the water too much and prevent its formation. Deep Layers cannot form in shallow water (the Intermediate II depth band or less), and no Layer can form in areas covered with ice (pack ice or floe ice). Information on the presence of any Layer and its depth will be provided in the environment section of a scenario.

VLF sonars are only affected by the Deep Layer.

5.4.7.2 Bottom Bounce. This rare propagation path can be used by active LMF sonars. The sonar pulses are literally bounced off the ocean floor and concentrate near the sea surface. This may provide longer detection ranges than is possible with direct path.

Bottom bounce requires a rocky, flat bottom and water depths between 2,000 and 5,000 meters. Soft bottoms, made of sand, silt, or mud, absorb the sound waves rather than reflecting them. Water too shallow or deep either prevents the sound waves from concentrating or causes them to bounce multiple times off the bottom and sea surface, confusing the sonar picture. Bottom bounce propagation is not affected by the Layer.

Acoustic Propagation Paths



Acoustic Layer Effects

Layer Depth	*Depth Band Boundary*	*Affected Frequency Bands*	*Surface Duct*	*General Occurrence*
Shallow	Periscope Depth - Shallow	MF/HF	None	35%
Moderate	Shallow - Intermediate I	LMF/MF/HF	Weak	55%
Deep	Intermediate I - Intermediate II	VLF/LF/LMF/MF/HF	Strong	10%

Unlike direct path propagation, bottom bounce detection ranges are a fixed-range band that depends on the water depth. The environmental conditions that allow bottom bounce are unusual, and can vary greatly even over a small area; thus scenario designers need to take care when including it in a game.

Bottom bounce detection ranges are shown in the following table. Take the scenario's water depth and compare it to the depth column in the table. Find the first row that is less than the scenario depth to identify the bottom bounce range interval.

Bottom Bounce Depth/Range

Water Depth (meters)	*Minimum Range (nmi)*	*Maximum Range(nmi)*
2,000	4.0	8.0
2,500	5.0	10.0
3,000	6.0	12.0
3,500	7.0	14.0
4,000	8.0	16.0
4,500	9.0	18.0
5,000	10.0	20.0

Sonar Generation	*BB Detection Modifier*
3	-2
4	-1
5	+0
6 - 7	+1

To find the chance of detection, add up all applicable active sonar modifiers (section 5.4.6) - disregard shallow water modifiers - and instead of using the total to modify detection range, multiply the total modifiers by 5%. Add this to the base detection probability of 60% to get the final detection chance. If a target was detected previously, the operator is alerted and gets the +15% detection bonus.

Example: A Russian Project 1155 *Udaloy* class destroyer attempts to detect a US Improved *Los Angeles* class submarine via the bottom bounce. The water depth is 2,800 meters and the sea state is 3. The US boat is 8.3 nmi away and presents a broad aspect to the *Udaloy*. The sub has anechoic coating. The Russian destroyer is at a speed of 12 knots, the US submarine is at 8 knots.

Water Depth: 2,800 meters (the 2,500 meter row is less than the example depth)

Bottom Bounce Range: 5.0 - 10.0 nmi

Project 1155 *Udaloy* has the MGK-355 Polinom sonar system, 4th Gen

Detection Modifiers
Medium Target Size: +2
Broad Aspect: +1
Anechoic Coating: -1
Sea State 3: -1
Relative speed modifier: 0
Generation Mod: -1
Total: 0
The detection chance is 60% [60% + (0 x 5%)].

5.4.7.3 Convergence Zones. When a sonar beam is directed into very deep water (at least 2,100 meters), the effect of increasing water pressure with depth increases the speed of sound and bends the beam back up towards the surface, forming a doughnut-shaped "annulus" at long ranges. Since the sound beam comes up at a very steep angle, CZ propagation ignores the effects of the Layer.

In the Atlantic, Pacific, and Indian Oceans, CZs tend to form at about 30 nmi increments for mid-latitudes and 25 nmi for polar latitudes (66° latitude). In the Mediterranean, CZs occur at about 20 nmi increments; this is the only body of water where MF sonars can use this propagation path.

Contacts inside a CZ annulus can be detected with passive or active sonars capable of CZ detection. The width of a CZ annulus is approximately 10% of the range. So, for an Atlantic Ocean CZ, the annulus widths would be 3 nmi for the first CZ (30 nmi), 6 nmi for the second CZ (60 nmi) and 9 nmi for the third CZ (90 nmi).

Surface ships and subs at any depth can use CZs if the water is deep enough, which will be specified in the scenario setup.

The number of CZs that a passive sonar can use depends on the type of sonar and the noise level of the target. The Convergence Zone Capability table lists the CZ rating by sonar frequency band. As the target increases in speed, it creates more noise and the number of CZs also increases. If a sonar covers multiple frequency bands, use the band that gives the most CZ detection opportunities. For active sonars, the sonar CZ capability by generation is on page 5-19.

Passive Convergence Zone Capability

	# of CZs by Sonar Type			
Target Noise Rating	*MF**	*LMF*	*LF*	*VLF*
Loud	1	1	2	2
Noisy	1	1	1	2
Quiet	0	0	0	0
Very Quiet	0	0	0	0
Ext Quiet	0	0	0	0

* CZ-capable only in the Mediterranean.

Passive Convergence Zone Speed Modifiers

Target Noise Rating	*CZs added based on Target Speed (knots)* 0-8	9-15	16-20	21-25	26-30	30+
Loud	+0	+1	+2	+3	+3	+4
Noisy	+0	+1	+2	+2	+3	+3
Quiet	+0	+1	+1	+2	+2	+3
Very Quiet	+0	+0	+1	+1	+2	+2
Ext Quiet	+0	+0	+0	+1	+1	+2
Searching Platform Speed	+0	-1	-2	-3	-3	-4

For an active or passive sonar to use the CZ propagation path, there must be more noise from the target than noise from its own ship, and both depend on speed. To find out if a sonar can use the CZ propagation path, add the speed modifiers (target and searching platform) to the target's base number for its acoustic signature. If the sum is greater than zero, the sonar can detect targets via convergence zones. Actually, the sum indicates the number of CZs that the sonar can attempt to detect a target.

Sonar Generation	CZ Detection Modifier
3	-2
4	-1
5	+0
6 - 7	+1

Example: A ship at 12 knots with an LMF bow sonar and a VLF-LF towed array tries to detect a noisy submarine contact at 10 knots through the CZ propagation path.

The CZ base value for a noisy platform is "1" for the LMF sonar and "2" for the VLF-LF towed array. The speed modifiers are +1 for the target and -1 for the detecting ship. Adding the values gives the LMF sonar a total of 1 (1+1-1) and the VLF-LF towed array a total of 2 (2+1-1). Thus, the LMF sonar can attempt to passively detect the target in the first CZ only, while the towed array has the ability to use the first and second CZ.

If the ship wants to detect the submarine with active sonar, the process is similar to the passive case with the CZ capability determined by sonar system generation.

Gen 3-4: 1 CZ
Gen 5-6: 2 CZs
Gen 7: 3 CZs

Use the searching platform speed passive modifier to find the find the number of CZs the sonar can support.

To find the detection chance, add up all applicable active or passive sonar modifiers (section 5.4.6.1 or 5.4.6.2) and instead of using the total to modify detection range, multiply the total by 5%. Add it to the base detection probability of 60% to get the final detection chance for the first CZ.

Subsequent CZs suffer a cumulative -10% modifier (-10% for the second CZ, -20% for the third CZ and so on.) If a target was detected previously, use the +15% alerted operator detection bonus.

Example: The same ship from the example above attempts to detect the noisy submarine in the first CZ with passive sonar. The sea state is 4 and the *Udaloy* is using both the LF-MF bow sonar and the **LF**-MF variable depth sonar. Calculate the probability of detection in the same way as for bottom bounce.

Detection Modifiers:
Noisy Target: +3
Sea State 4: -1
Speed Comparison: 0
Generation Mod: -1
Total: +1
(both ship and sub are in the 9-15 knot cell)

The detection chance for both the **LF**-MF bow array and the towed sonar is 60% + (1 x 5%), or 65% for the first CZ. If the ship had attempted to detect the submarine in the second CZ with either the bow or VDS, the probability of detection would have been 55% [60% + (1 x 5%) - 10%].

There is no easy way to tell a passive CZ contact from a direct path contact, except through deduction. A strong passive contact that suddenly appears and disappears after a few minutes might qualify. The use of other units might help eliminate one or the other possibility. An active CZ contact, however, will reveal the range and thus what CZ it lies in.

5.4.8 Alerted Operator and Holding Contact. Because of the changing properties of seawater, sound waves do not always follow a constant path from the target to the sonar array. Players must check each Tactical Turn to see if they maintain contact on a target that had been detected earlier. Maintaining a sonar contact is the same as detecting one, except that a +15% modifier for an alerted operator is applied to the detection chance. This bonus lasts for up to 4 Tactical Turns (12 minutes) after a contact is lost. At this time, mark the last known location with a "datum" marker as a lost contact.

5.5 Electro-Optical/Infrared Sensors. Modern electro-optical (EO) and infrared (IR) systems are carried on aircraft and surface ships. Their most important feature is that they are passive.

All IR sensors have an 80% chance of detecting a unit each Tactical Turn. Like radar, once a contact is detected, it will stay detected as long as it is within sensor range and the sensor is working. The detection range depends on the generation of the IR sensor and the type of contact being searched for. The IR Sensor Range table shows the ranges for each generation of shipboard scanning IR sensor (see 5.5.1), FLIR (see 5.5.2) and IRST (see 5.5.3).

Infrared sensors are not affected by Hasty or Prepared camouflage (see 5.8.5).

Infrared Sensor Ranges

IR Sensor Generation	*Stealthy*	*Small & Med Ships/Subsonic Aircr. or Msl*	*Lge Ship or Aircr./ Supersonic Aircr. or Missile*
1	2 nmi	3 nmi	5 nmi
2	3 nmi	5 nmi	10 nmi
3	4 nmi	8 nmi	15 nmi
4	5 nmi	10 nmi	20 nmi
5	7 nmi	15 nmi	30 nmi

IR ranges are reduced by water in the air. The more moisture, the shorter the range.

Precipitation	Range Mod
Drizzle/Misty/Lt Fog	x 0.90
Lt Rain/Moderate Fog	x 0.75
Moderate Rain/Heavy Fog	x 0.50
Heavy Rain	x 0.25
Torrential Rain	No Detection

Example: The French DIBV 10 Vampir is a second-generation IR sensor. It would have a 3 nmi detection range against a stealthy ship, aircraft or missile, 5 nmi against small & medium-sized ships and small aircraft or subsonic missiles, and 10 nmi against a large ship or aircraft, or any aircraft or missile at supersonic speeds. In a light rain, the ranges would be reduced to 2.3 nmi, 3.8 nmi, and 7.5 nmi.

As the contact gets closer, enough IR energy is received to give a recognizable image. A target can be visually classified (ship class or aircraft type) at half the detection range.

5.5.1 Shipboard Scanning IR Sensors. These are scanning FLIRs. They display contacts on video screen if the operator wants to examine a particular contact in detail. Ship IR scanners will be listed as one of a ship's sensors in Annex A, and will tell what generation the sensor is. For example, the French *La Fayette* class will have a listing under sensors: "DIBV 10 Vampir (2nd gen)."

IR scanners are used for surface and air warning rather than as a general search systems. As a passive system, it cannot provide range, only bearing and elevation. This is enough to cue another sensor or weapon, or trigger countermeasures. They are linked to point defense systems, so that if the scanner picks up something in the Detection Phase, it can be fired on in the Reaction Fire Phase.

5.5.2 Airborne Forward-Looking Infrared (FLIR). This is used as an airborne classification sensor in poor visibility. The TV image is sharp enough to allow identification by type/class (see 5.8.8). It has a narrow field of view, 15° for search (once cued), 5° for track and classification.

5.5.3 Airborne Infrared Search and Track (IRST). These systems are used as passive tactical search sensors. They cannot provide range, but this is not needed since their range is so short. First generation systems (USA F-106, F-4) work only against a rear-aspect target (±60° aft arc of target).

The second generation systems are the F-14A, MiG-29, Su-27, Rafale. Cryogenically cooled, they can pick up a contact from all aspects.

Third generation and later systems provide imaging capability as well as all-aspect detection.

The arc is ±60° off the plane's flight path.

5.5.4 TV and Low-Light Level TV. These EO sensors use only visible light, but they can intensify and magnify the available light to enable visual detection at ranges greater than a human lookout with binoculars. They are not search sensors, but can provide a magnified image of a contact already detected, aiding in visual classification and tracking (see 5.8.8).

Daylight TV sensors will function in 30% or better visibility. LLLTV will work in visibility conditions as low as 5% in clear conditions (no mist, fog, or precipitation).

5.6 Laser Sensors. These are listed under sensors for ships, submarines, and aircraft in Annexes A and B. Laser sensors are typically aimed optically, and accompany many low-light-level TV or imaging IR displays, so they are not affected by darkness.

5.6.1 Laser Rangefinders. These feed ranging data to a weapons system's fire control computer. Subs and planes use laser rangefinders as a covert method of obtaining range; a ship can use them for anti-aircraft and surface gunfire control. Shipboard laser rangefinders have a range of 10 nmi (see 6.2.2), submarines (see 6.3.5) and aircraft have a shorter range of 5 nmi. Aircraft laser rangefinders are already factored into the Bombsight rating, see section 9.6.1. Exceptions will be noted in the Annexes for a particular platform.

Lasers suffer from the same water problem as IR sensors and a rangefinder's effective range will be reduced per the range modifiers in section 5.5.

5.6.2 Laser Designators. These can be carried in a strap-on pod or built into the airframe. They are used to designate targets for laser-guided weapons. These may be dropped by the same aircraft carrying the designator, or a different one. See section 9.6.8 for SALH weapons.

A designator must have a visual line of sight to the target.

5.6.3 Laser Warning Systems. If a vessel or aircraft is equipped with a laser warning system (LWS), and it is illuminated by a laser for fire control, illumination, or any other reason, it will automatically know. It also provides the direction the laser is coming from. The warning is received in the detection phase.

5.6.4 Laser Spot Trackers (LST). These automatically detect a target lased by a designator. This allows other units to identify targets for aircraft.

5.6.5 Laser Ranger and Marked Target Seeker (LRMTS). These act as both laser spot trackers and laser rangefinders.

5.7 Non-acoustic Sensors. In addition to radar, electronic support measures (ES), and IR sensors, there are several other dedicated ASW sensors that do not use sound. While their performance is not on a par with modern sonars, they can provide some search support, and their real advantage is in localizing a submarine that has already been detected.

5.7.1 Magnetic Anomaly Detectors (MAD). MAD is used by ASW aircraft to detect submerged submarines, often ones that had been previously detected by another sensor, to refine the contact's location and accurately place ASW ordnance. MAD detects distortions in the Earth's magnetic field caused by the metal hull of a submarine. However, since the effective range of most MAD systems is very short (400 - 700 yards), a submarine's depth greatly affects the chance of detection. Only subs at Periscope Depth, Shallow, and the Intermediate I-V depth bands can be detected with MAD. Submarines in the Deep depth bands, and deeper, cannot be detected at all.

The searching aircraft must be at Low altitude and fly a straight and level path during the MAD pass. The base chance of detection is 70%, with modifiers for target size and depth. A sub made of titanium is treated as an E- G size target regardless of its Size Class.

Surface ships or submerged wrecks within 1,000 yards of a submarine of the same size class or larger will mask the sub's magnetic signature and reduce the detection chance.

If a MAD search is made without first using a localizing sonobuoy pattern (see 5.4.6.3), or having a radar contact, the final modified detection chance is halved. If the aircraft makes a successful MAD detection, it is a Good fire control solution and can attack in the next Tactical Turn. Western ASW aircraft do not use MAD as a search sensor; it is used only after a submarine contact has been detected and localized by sonar, radar, or visual means.

MAD Detection Modifiers

Depth Band	*Modifier*	*Size Class*	*Modifier*
Shallow	0%	A	+10%
Intermediate I	0%	B	0%
Intermediate II	-10%	C-D	-10%
Intermediate III	-20%	E-G	-20%
Intermediate IV	-40%		
Intermediate V	-60%		
Deep +	--		

• Base detection chance is 70%
• Titanium submarines are treated as an E - G size target.
• Masked submarine signature: -30%
• No localization sonobuoy pattern or radar contact before MAD run: modified detection chance is halved.

Example: A Soviet Tu-142M Bear F Mod 3 makes a MAD run on a US *Sturgeon* class SSN. The sub's Size Class is C/Small (-10%). The submarine's position was refined with a passive localization sonobuoy pattern in the previous Tactical Turn. The *Sturgeon* class submarine is at a depth of Intermediate III (-20%).

Probability of MAD detection = 70% - 20% - 10% = 40%

If the Bear F player had attempted a MAD search without the localizing passive sonobuoy pattern, the final probability of detection would have been 20%.

5.7.2 Wide-area MAD Search. Due to poor performance of early Soviet sonobuoys, Russian maritime patrol aircraft (MPA) often made a wide-area MAD search over the sonobuoy field they were also monitoring. It was not particularly efficient, but it provided another possible way of finding the sub, and the Russians retained the tactic even after better sonobuoys were brought into service.

Because of the large area that had to be covered, a wide-area MAD search is resolved only during Intermediate Turns (every 30 minutes). If a submarine only spends part of an Intermediate Turn inside the sonobuoy field, divide the chance of detection by 10 and multiply by the number of Tactical Turns the submarine was in the monitored area.

To find the detection chance for one Intermediate Turn's worth of searching, cross-index the area of the sonobuoy field with the submarine's depth. Use a column closest to the area of the sonobuoy field; larger areas are for MPA while the smaller search areas (less than 500 square nmi) are usually used by helicopters. If the submarine was at multiple depth bands, use the depth band the submarine occupied for the majority of the Intermediate Turn.

Wake Detection Chance

System	*Gen*	*Platform*	*75%*	*50%*	*25%*
MNK-100 Kolos	1	Submarine	0.5	1.0	1.5
MNK-200 Tukan	2	Submarine	1.0	2.0	3.0
MNK-300 Kaira	2	Ship (towed)	1.0	2.0	3.0

Time Late (hrs) modifiers
• Searching ship speed 9 -15 knots: halved
• Searching ship speed 16+ knots: detection not possible.
• Sea State 4: x 0.5 (Shallow/Intermediate I depth bands)
• Sea State 6 and greater: Detection not possible.
• Alerted operator: +15%

Example: Our friendly Soviet Tu-142M [Bear F Mod 3] has just completed laying a 24 RGB-75 passive sonobuoy search pattern (eight buoys in three lines spaced at 5 nmi) that covers 900 square nmi. The area is calculated by taking the number of buoys/lines, adding 1 and then multiplying by the spacing increment. So (8+1) x 5 = 45 nmi width, and (3+1) x 5 = 20 nmi depth; with 45 x 20 = 900 square nmi — this is actually on the small side for a Bear Mod 3 sonobuoy field. The Soviet player has the aircraft begin a wide-area MAD search along the width of the field. A *Sturgeon*-class SSN unknowingly enters into the field at a depth of Intermediate III. Looking at the table above, the Soviet player gets an 8% MAD check every 30-minute Intermediate Turn.

5.7.3 Wake Sensors. The Soviets/Russians have put considerable effort into complex, multi-faceted wake detection systems called *sistema obnaruzheniya kil'vaternogo sleda,* or SOKS. They have fielded at least three systems on some Russian attack submarines and ASW surface ships.

These sensors are designed to detect physical changes in the water after a submarine passes, including thermal, turbulence, conductivity, and radiological effects. They can detect a submerged submarine's wake up to several hours after it has moved on.

There are two generations of SOKS, with differing levels of performance. The measure of effectiveness is the amount of time (in hours) after a submarine created the wake that it can still be detected by a SOKS. This "time late" value also affects the probability of detection. For a SOKS to have a detection chance, the sensor must be in the same depth band as the target submarine when it made the wake. The searching sub should also be at slow speed for best performance. Speeds of 16 knots or greater prevent the system from being able to detect the faint residual wake. The radiological sensor is more of a classification tool, as it can determine if it was a nuclear-powered submarine that generated the wake.

Sonobuoy Field Search Area (square nmi) for Wide-Area MAD Search

Depth Band	*200 - 399*	*400 - 599*	*600 - 799*	*800 - 999*	*1000 - 1199*	*1200 - 1399*	*1400 - 1699*	*1700 - 2099*	*2100 - 2599*	*2600 - 3000*
Shallow	27%	16%	11%	9%	7%	6%	5%	4%	3%	3%
Intermediate I	27%	16%	11%	9%	7%	6%	5%	4%	3%	3%
Intermediate II	26%	15%	11%	8%	7%	6%	5%	4%	3%	3%
Intermediate III	24%	14%	10%	8%	6%	5%	4%	4%	3%	2%
Intermediate IV	21%	12%	8%	6%	5%	4%	4%	3%	3%	2%
Intermediate V	16%	9%	6%	5%	4%	3%	3%	2%	2%	1%
Deep +	--	--	--	--	--	--	--	--	--	--

To find the length of a contact's wake (in nmi), and the probability of detecting it, multiply the contact's speed by the time late value in the Wake Detection Chance table. The distance to the submarine has to be equal to, or less than, the wake length for the detection probability. To determine the contact's rough course will require the tracking submarine to cut across and successfully detect the wake at least three times.

Example: A Project 671RTMK [Victor III] SSN is fitted with a MNK-100 Kolos wake detection system and is cruising at 8 knots at Intermediate I. An American SSN passed through the area earlier, also at 8 knots and Intermediate I. The sea state is 3. The Soviet boat cuts through the wake 10 nmi behind the US submarine.

Wake length = contact speed x time late
75% wake length = 0.5 hrs x 8 knots = 4 nmi
50% wake length = 1.0 hrs x 8 knots = 8 nmi
25% wake length = 1.5 hrs x 8 knots = 12 nmi

The current range to the US SSN is 10 nmi. Since this is greater than 8 nmi, but less than 12 nmi, the chance of the Victor III detecting the wake is 25%. If the Soviet boat is successful, it will know a submarine has passed by recently, but not its direction of travel. To determine that, the Victor III will have to cut across the wake two more times at different points. The radiological detector will alert the Soviet player that the submarine they're tracking is nuclear powered.

5.7.4 Less Than Successful Non-Acoustic Sensors. Two other non-acoustic systems are listed here, not because they are particularly useful, but because they have been in earlier editions of *Harpoon* and their absence needs to be explained.

• *Diesel sniffers*. Numerous countries have looked at diesel exhaust detectors. Examples include the AN/ASR-3 "Sniffer" and the British Autolycus MkII and MkIII, developed during World War II to detect the diesel exhaust from snorkeling submarines. These systems required the aircraft to fly very low and stay there for long periods of time. This was not popular with the aircrews, especially as the "sniffers" had a really bad false alarm rate — fishing boats and merchant ship diesels smell a lot like submarine diesels. Exhaust detectors were dropped in the mid-1970s.

• *LIDAR systems* use blue-green lasers to penetrate the surface of the ocean and detect a submerged submarine; at least in theory. Many nations have looked at LIDAR and the Russians have tested a system called Amethyst on some early Tu-142MZ [Bear F Mod 5] aircraft. While theory suggests that current LIDAR technology should be able to detect a submarine down to about 50 meters (Shallow), many of the trial systems only managed to reach 30 meters (Periscope Depth). When combined with a much smaller search swath - effective range is about 100 meters — the detection chances of a LIDAR are a tenth (1/10) that of current MAD sensors. Because of the significant depth and search swath limitations, LIDARs are not being fielded as ASW sensors, although they may be more useful in mine warfare.

5.8 Visual Detection. Players trying to see another unit must first find out if it is within visual range.

Check the distance from the searching unit to the closest ship in an enemy formation, or group of units, not to each individual unit in a formation. If there are different-sized units in the same formation, check from the largest one as well, since it may have a different sighting range. If one unit in the formation is spotted, all the ships within sighting range are seen. This may be all of the formation, or just part of it.

5.8.1 Sighting From Ships. In the Detection Phase of an Intermediate or Tactical Turn, find the maximum line of sight on the Surface-to-Surface Visibility tables and use that distance on the Visual Detection table. Roll D100 and apply any modifiers. Then move across the range row to the first column where the detection value is greater than the modified die roll. The range in that column is the visual detection range.

Example: After movement, a battleship (size class A) attempts to see a cruiser (size class B) on a clear day with 60% visibility. The two ships are 19,800 yards (19.8 kyds) apart. On the Visibility table for 60% visibility sighting conditions, the maximum sighting range between two units of that size is 23 kyds. Going to the Visual Detection table and finding the 23 kyds row, the battleship player rolls D100 to see how far away he can visually detect a target. The player rolls a 58 and runs across the 23 kyds row until they reach the first column where the detection value is greater than the die roll. In this case, the 75% column. The visual detection range is 17 kyds and is short of the distance between the two ships. The battleship player does not see the cruiser.

If there were other ships nearby, including smaller ones, the same die roll would be used, but on the appropriate row for the target's size class.

Once a contact is detected visually, contact is maintained until it moves out of visual range, or conditions change that decrease the Visibility table from the one used for the initial detection.

(Optional rule) If players wish to forgo the visual detection die roll, just use the 50% detection sighting range as the detection range. This won't affect daylight battles much, but it places smaller units at a considerable disadvantage at night.

5.8.2 Sighting from Aircraft to the Surface. Use the row on the Air-to-Surface table for the sighting conditions and apply any appropriate modifiers. Then use the Visual Detection Chance table and modifiers.

Example: A patrol plane attempts to spot a carrier in 70% visibility conditions. The range is 36 kyds to a size class A ship.

Aircraft searching from the Low altitude band drop down two rows on the visibility table, because of the greater haze at lower altitudes and the reduced visual horizon.

5.8.3 Sighting Aircraft. Spotting attempts against aircraft from both ships and other planes are made on the same table. Use the row on the Air-to-Air and Surface-to-Air table for the sighting conditions and the aircraft's size. Then use the Visual Detection Chance table and modifiers.

Sighting range to formations of 3 - 8 planes is doubled. Formations of nine or more planes can be seen at triple range. Any number of planes making contrails can be seen at ten times the normal range.

5.8.4 Periscopes. A periscope can be extended, used, and retracted no more than three times in one Tactical Turn, during the Detection Phase. It is equipped with an optical rangefinding device. The submarine player may measure the range to one contact each time using these devices. Thus, periscope sightings can be used to support up to three fire control solutions at one time.

Surface-to-Surface Visibility

100% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	40.0	38.0	36.0	32.0	28.0	26.0	22.0
B	38.0	36.0	34.0	30.0	26.0	24.0	20.0
C	36.0	34.0	32.0	28.0	24.0	22.0	18.0
D	32.0	30.0	28.0	24.0	20.0	18.0	14.0
E	29.0	27.0	25.0	21.0	17.0	15.0	11.0
F/G	27.0	25.0	23.0	19.0	15.0	13.0	9.0
Per	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Horiz.	21.0	19.0	17.0	15.0	10.0	7.0	4.0

90% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	36.0	34.0	32.0	29.0	25.0	23.5	20.0
B	34.0	32.5	30.5	27.0	23.5	21.5	18.0
C	32.5	30.5	29.0	25.0	21.5	19.5	16.0
D	29.0	27.0	25.0	21.5	18.0	16.0	12.5
E	26.0	24.5	22.5	19.0	15.5	13.5	10.0
F/G	24.0	22.5	20.5	17.0	13.5	11.5	8.0
Per	3.5	3.5	3.5	3.5	3.5	3.5	1.5

80% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	32.0	30.5	29.0	25.5	22.5	21.0	17.5
B	30.5	29.0	27.0	24.0	21.0	19.0	16.0
C	29.0	27.0	25.5	22.5	19.0	17.5	14.5
D	25.5	24.0	22.5	19.0	16.0	14.5	11.0
E	23.0	21.5	20.0	17.0	13.5	12.0	9.0
F/G	21.5	20.0	18.5	15.0	12.0	10.5	7.0
Per	3.0	3.0	3.0	3.0	3.0	3.0	1.5

70% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	28.0	26.5	25.0	22.5	20.0	18.0	15.5
B	26.5	25.0	24.0	21.0	18.0	17.0	14.0
C	25.0	24.0	22.5	19.5	16.5	15.5	12.5
D	22.5	21.0	19.5	17.0	14.0	12.5	10.0
E	20.5	19.0	17.5	14.5	12.0	10.5	8.0
F/G	19.0	17.5	16.0	13.5	10.5	9.0	6.5
Per	3.0	3.0	3.0	3.0	3.0	3.0	1.5

60% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	24.0	23.0	21.5	19.0	17.0	15.5	13.0
B	23.0	21.5	20.5	18.0	15.5	14.5	12.0
C	21.5	20.5	19.0	17.0	14.5	13.0	11.0
D	19.0	18.0	17.0	14.5	12.0	11.0	8.5
E	17.5	16.0	15.0	12.5	10.0	9.0	6.5
F/G	16.0	15.0	14.0	11.5	9.0	8.0	5.5
Per	2.5	2.5	2.5	2.5	2.5	2.5	1.0

50% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	20.0	19.0	18.0	16.0	14.0	13.0	11.0
B	19.0	18.0	17.0	15.0	13.0	12.0	10.0
C	18.0	17.0	16.0	14.0	12.0	11.0	9.0
D	16.0	15.0	14.0	12.0	10.0	9.0	7.0
E	14.5	13.5	12.5	10.5	8.5	7.5	5.5
F/G	13.5	12.5	11.5	9.5	7.5	6.5	4.5
Per	2.0	2.0	2.0	2.0	2.0	2.0	1.0

40% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	16.0	15.0	14.5	13.0	11.0	10.5	9.0
B	15.0	14.5	13.5	12.0	10.5	9.5	8.0
C	14.5	13.5	13.0	11.0	9.5	9.0	7.0
D	13.0	12.0	11.0	9.5	8.0	7.0	5.5
E	11.5	11.0	10.0	8.5	7.0	6.0	4.5
F/G	11.0	10.0	9.0	7.5	6.0	5.0	3.5
Per	2.0	2.0	2.0	2.0	2.0	2.0	1.0

30% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	12.0	11.5	10.5	9.5	8.5	8.0	6.5
B	11.5	11.0	10.0	9.0	8.0	7.0	6.0
C	10.5	10.0	9.5	8.5	7.0	6.5	5.5
D	9.5	9.0	8.5	7.0	6.0	5.5	4.0
E	8.5	8.0	7.5	6.5	5.0	4.5	3.5
F/G	8.0	7.5	7.0	5.5	4.5	4.0	2.5
Per	1.5	1.5	1.5	1.5	1.5	1.5	0.5

20% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	8.0	7.5	7.0	6.5	5.5	5.0	4.5
B	7.5	7.0	6.5	6.0	5.0	4.5	4.0
C	7.0	6.5	6.0	5.5	4.5	4.0	3.5
D	6.5	6.0	5.5	5.0	4.0	3.5	3.0
E	6.0	5.5	5.0	4.5	3.5	3.0	2.5
F/G	5.5	5.0	4.5	4.0	3.0	2.5	2.0
Per	1.5	1.5	1.5	1.5	1.5	1.5	0.5

10% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	4.0	4.0	3.5	3.0	3.0	2.5	2.0
B	4.0	3.5	3.5	3.0	2.5	2.5	2.0
C	3.5	3.5	3.0	3.0	2.5	2.0	1.5
D	3.5	3.0	3.0	2.5	2.0	2.0	1.5
E	3.0	3.0	2.5	2.0	2.0	1.5	1.0
F/G	3.0	2.5	2.5	2.0	1.5	1.5	1.0
Per	1.0	1.0	1.0	1.0	1.0	1.0	0.5

5% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	2.0	2.0	2.0	1.5	1.5	1.0	1.0
B	2.0	2.0	1.5	1.5	1.5	1.0	1.0
C	2.0	2.0	1.5	1.5	1.0	1.0	1.0
D	1.5	1.5	1.5	1.0	1.0	1.0	1.0
E	1.5	1.5	1.0	1.0	1.0	1.0	0.5
F/G	1.5	1.5	1.0	1.0	1.0	0.5	0.5
Per	1.0	1.0	1.0	1.0	1.0	1.0	0.5

2% Visibility

Target Unit	Observing Unit A	B	C	D	E	F/G	Per
A	1.0	1.0	1.0	0.5	0.5	0.5	0.5
B	1.0	0.5	0.5	0.5	0.5	0.5	0.5
C	1.0	0.5	0.5	0.5	0.5	0.5	0.5
D	0.5	0.5	0.5	0.5	0.5	0.5	0.5
E	0.5	0.5	0.5	0.5	0.5	0.5	0.5
F/G	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Per	0.5	0.5	0.5	0.5	0.5	0.5	0.5

All Distances are in Thousands of Yards (kyds)

Visual Detection Chance

Visibility Range (kyds)	Probability of Detection and Visual Detection Range (kyds) 10%	25%	50%	75%	100%
52.0	52.0	49.5	44.5	38.5	35.5
48.0	48.0	45.5	41.5	35.5	32.5
46.0	46.0	43.5	39.5	34.0	31.0
44.0	44.0	42.0	38.0	32.5	30.0
42.0	42.0	40.0	36.0	31.0	28.5
40.0	40.0	38.0	34.5	30.0	27.0
38.0	38.0	36.0	32.5	28.0	26.0
36.0	36.0	34.0	31.0	26.5	24.5
35.0	35.0	33.0	30.0	26.0	24.0
34.0	34.0	32.5	29.0	25.0	23.0
32.5	32.5	31.0	28.0	24.0	22.0
32.0	32.0	30.5	27.5	23.5	22.5
31.0	31.0	29.5	26.5	23.0	21.5
30.5	30.5	29.0	26.0	22.5	21.0
30.0	30.0	28.5	25.5	22.0	20.5
29.0	29.0	27.5	25.0	21.5	19.5
28.0	28.0	26.5	24.0	20.5	19.0
27.0	27.0	25.5	23.0	20.0	18.5
26.5	26.5	25.0	23.0	19.5	18.0
26.0	26.0	24.5	22.5	19.0	17.5
25.5	25.5	24.0	22.0	19.0	17.0
25.0	25.0	24.0	21.5	18.5	17.0
24.5	24.5	23.5	21.0	18.0	16.5
24.0	24.0	23.0	20.5	17.5	16.5
23.5	23.5	22.5	20.0	17.5	16.0
23.0	23.0	22.0	20.0	17.0	15.5
22.5	22.5	21.5	19.5	16.5	15.5
22.0	22.0	21.0	19.0	16.5	15.0
21.5	21.5	20.5	18.5	16.0	14.5
21.0	21.0	20.0	18.0	15.5	14.5
20.5	20.5	19.5	17.5	15.0	14.0
20.0	20.0	19.0	17.0	15.0	13.5
19.5	19.5	18.5	17.0	14.5	13.5
19.0	19.0	18.0	16.5	14.0	13.0
18.5	18.5	17.5	16.0	13.5	12.5
18.0	18.0	17.0	15.5	13.5	12.0
17.5	17.5	16.5	15.0	13.0	12.0

Visibility Range (kyds)	Probability of Detection and Visual Detection Range (kyds) 10%	25%	50%	75%	100%
17.0	17.0	16.0	14.5	12.5	11.5
16.5	16.5	15.5	14.0	12.0	11.0
16.0	16.0	15.0	14.0	12.0	11.0
15.5	15.5	14.5	13.5	11.5	10.5
15.0	15.0	14.5	13.0	11.0	10.0
14.5	14.5	14.0	12.5	11.0	10.0
14.0	14.0	13.5	12.0	10.5	9.5
13.5	13.5	13.0	11.5	10.0	9.5
13.0	13.0	12.5	11.0	9.5	9.0
12.5	12.5	12.0	11.0	9.5	8.5
12.0	12.0	11.5	10.5	9.0	8.0
11.5	11.5	11.0	10.0	8.5	7.5
11.0	11.0	10.5	9.5	8.0	7.5
10.5	10.5	10.0	9.0	8.0	7.0
10.0	10.0	9.5	8.5	7.5	7.0
9.5	9.5	9.0	8.0	7.0	6.5
9.0	9.0	8.5	7.5	6.5	6.0
8.5	8.5	8.0	7.5	6.5	6.0
8.0	8.0	7.5	7.0	6.0	5.5
7.5	7.5	7.0	6.5	5.5	5.0
7.0	7.0	6.5	6.0	5.5	5.0
6.5	6.5	6.0	5.5	5.0	4.5
6.0	6.0	5.5	5.0	4.5	4.0
5.5	5.5	5.0	4.5	4.0	3.5
5.0	5.0	4.5	4.0	3.5	3.0
4.5	4.5	4.0	3.5	3.0	2.5
4.0	4.0	3.5	3.0	2.5	2.0
3.5	3.5	3.0	2.5	2.0	1.5
3.0	3.0	2.5	2.0	1.5	1.0
2.5	2.5	2.0	1.5	1.0	0.5
2.0	2.0	1.5	1.0	0.5	0.3
1.5	1.5	1.5	1.0	0.5	0.3
1.0	1.0	1.0	1.0	0.5	0.3
0.5	0.5	0.5	0.5	0.5	0.3

At ranges of less than 0.3 kyds, detection is automatic.

Visibility Modifiers that change the table/row used: These are based on the lighting conditions or the target's contrast and will change the Surface-to-Surface Visibility table used or the row on the Air-to-Surface and Air-toAir/Surface-to-Air Visibility tables.

- Carrier land/launch ops at night increase air-to-surface visibility by one table/row in good visibility conditions (60% or better).
- Ship stack smoke (see 5.8.11) or from fires doubles the daytime visible detection range by (visibility range x 2.0) up to a maximum of 52 kyds in good conditions (60% visibility or better).
- Firing missiles or other rocket-propelled weapons increases visibility at night by three tables/rows, up to 70% visibility.
- 75mm and larger gunfire flashes increase visibility at night by three tables/rows, up to 70% visibility.
- 20mm -74mm gun flashes increase visibility at night by two tables/rows, up to 70% visibility.
- Ships on fire increase visibility at night by three tables/rows, up to 70% visibility.
- Ship's wakes at high speed (≥ 20 knots) increase surface-to-surface visibility at night by one table/row.
- Ships and airships moving at 5 knots or less are reduced one table/row for both day and night.
- Aircraft may attempt to spot subs at P/S depth; subs moving at less than 8 knots are reduced two tables/rows in 70% visibility; they cannot be seen at night. Subs at P/S depth moving 8 knots or more are detected as surface craft.

Visibility Modifiers to the D100 detection roll: These will result in the range that a unit can visually detect a target.

- A cued visual search (knowing where to look): -20%
- Maritime Patrol aircraft conducting visual search (larger number of observers): -20%
- Sighting ships against a land background (within 3 nmi and ≤10 knots).
    - Daytime: +10% for size class A-D, +20% for size class E-G
    - At Night: +20% for size class A-D, +30% for size class E-G
- Narrow aspect Small Craft (Size Class F-G): +10%

Air-to-Surface Visibility (Range in kyds)

Visibility (%)	A	B	C	D	E	F-G	Per
100	52.0	48.0	44.0	38.0	30.0	27.0	6.0
90	46.0	44.0	40.0	34.0	27.0	24.5	5.0
80	42.0	38.0	35.0	30.5	24.0	22.0	4.5
70	36.0	34.0	31.0	26.5	21.0	19.0	4.0
60	31.0	29.0	26.5	23.0	18.0	16.5	3.5
50	26.0	24.0	22.0	19.0	15.0	14.0	3.0
40	21.0	19.0	17.5	15.0	12.0	11.0	2.5
30	15.5	14.5	13.0	11.5	9.0	8.0	2.0
20	10.5	9.5	9.0	7.5	6.0	5.5	1.5
10	5.5	5.0	4.5	4.0	3.0	2.5	1.0
5	2.5	2.5	2.0	2.0	1.5	1.5	0.5
2	1.0	1.0	1.0	1.0	0.5	0.5	0.3

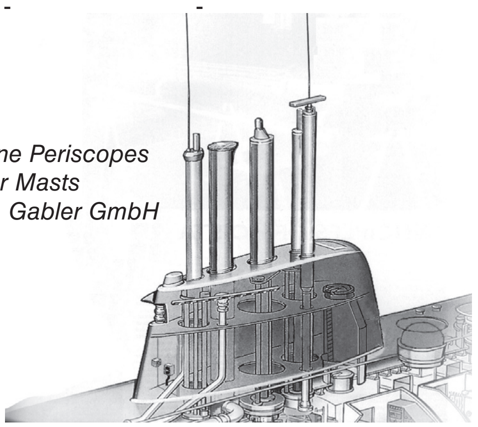
Visual Signals Range (kyds)

Visibility	Flag Hoist	Flashing Light Daytime	Flashing Light Nighttime
100%	8.0	16.0	--
90%	7.2	14.4	--
80%	6.4	12.8	--
70%	5.6	11.2	--
60%	4.8	9.6	--
50%	4.0	8.0	20.0
40%	3.2	6.4	20.0
30%	2.4	4.8	20.0
20%	1.6	3.2	20.0
10%	0.8	1.6	20.0/10.0*
5%	0.4	0.8	5.0*
2%	0.1	0.3	2.0*

* - Reduced signal range due to nighttime precipitation.

Periscope Visual Detection

Sea State	Pd vs. Normal Periscope	Pd vs. Feathering Periscope
0	.75	.95
1	.50	.65
2	.35	.45
3	.25	.30
4	.15	.20
5	.10	.15
6	.05	.10
7+	-	-



Typical Submarine Periscopes and Radar Masts Gabler GmbH

Air-to-Air / Surface-to-Air Visibility (Range in kyds)

Visibility (%)	VSmall, Small A/C	Medium, Large A/C
100	4.0	8.0
90	3.5	7.0
80	3.0	6.5
70	3.0	5.5
60	2.5	5.0
50	2.0	4.0
40	1.5	3.0
30	1.0	2.5
20	1.0	1.5
10	0.5	1.0
5	0.5	0.5
2	0.5	0.5

Land Sighting Visibility (Ranges in kyds)

Naval Target Size	Observation Post Height of Eye: 8 m	15 m	30 m	45 m	60m
A	30	34	40	44	48
B	28	32	38	42	46
C	26	30	36	40	44
D	22	26	32	36	40
E	19	23	29	34	38
F/G	16	21	27	31	35
Horiz	11	16	23	28	32
Peris.	4	4	4	5	5

Land Target Size	Observing Naval or Air Unit: A	B	C	D	E	F/G	Peris
C	24	24	24	20	18	14	10
D	20	20	20	16	14	12	9
E	16	16	16	16	12	12	8
F	12	12	12	12	10	10	6
G	8	8	8	8	8	6	4
H	4	4	4	4	4	4	3

Sighting Conditions

% Vis	Clear Day Conditions	Clear Night Conditions	Day Precip	Night Precip
100	Unlimited			
90	Unlimited			
80	V Clear			
70	V Clear			
60	Clear			
50	Clear	Full Moon		
40	Clear	Gibbous		
30	Lt Haze	Quarter	Misty	
20	Hazy	Crescent	Light	
10	Lt Fog	New Moon	Interm	Misty
5	Thick Fog	Lt Fog	Heavy	Light
2	Dense Fog	Thick Fog	Torrential	Interm-Hvy

The chance of sighting a periscope, snorkel, or other extended mast depends on the sea state and the sub's speed. If the periscope is within the sighting range, roll D100 using the value from the Periscope Visual Detection table.

If a periscope or mast is raised for the entire Tactical Turn, add 25%.

Periscopes cannot be seen in sea state 7 or greater. A periscope shows a "feather," or wake, if the sub is moving at 5 knots or more.

5.8.5 Spotting Targets on Land. Locating a land installation is a different proposition from sighting a ship at sea. In addition to the inherent contrast and projection of a ship above the sea's surface, a ship's motion also helps to make it easier to spot.

All emplacements and other structures have a size class. If only one structure is visible, such as a single gun emplacement, then the battery's size class is the size of that item. If there is more than one structure visible, the battery's size is one size greater than that of the largest structure.

Example: If a coastal missile battery consists of one emplacement the size of a house, size class E, the battery size class would be E. If it has several E-size emplacements, the size class would be D. If there were several structures, size classes F, E, and D, the battery would be treated as size class C for spotting purposes.

When a ship attempts to visually detect a land-based structure, use the same procedure as sighting a naval unit. The Shore-Based Spotting table has a section for spotting ships from land-based observation posts with varying heights of eye, and another for naval units attempting to spot land installations. Both ships and land-based observation posts use the Visual Detection Chance table (page 5-24) to determine how far they actually see.

Example: If a battery has a size class of E, it may be seen from 11 to 16 kyds in 100% visibility from a size class A vessel depending on the die roll on the Visual Detection Chance table. If a Coastal Motor Boat (size class E) was trying to make the detection, the battery would be spotted somewhere between 8 to 12 kyds.

Note: These ranges are for 100% visibility. To find the detection ranges for other visibility conditions, multiply the range in the Shore-Based Spotting table by the percentage describing that visibility. For example, a B-sized ship attempting to spot a D-sized land target in 40% visibility, has a base range of 20 x 0.40 or 8 kyds.

Land installations have four possible levels of camouflage:

• Sites with no camouflage are located normally on the visibility tables.

• *Hasty* camouflage implies that some effort was made to break up the outline of the structures with paint or other disruptive materials. This reduces the visual detection range of a land-based structure to 1/2 of the range shown on the Land Sighting table on page 5-25.

• *Prepared* camouflage consists of scaffolding and other elaborate measures that make the unit blend in with its background. An installation with prepared camouflage can be located at 1/4 of the listed ranges.

• *A Concealed* unit is so well-disguised that it can only be spotted after it fires. Once it has fired, it is treated as having prepared camouflage. Examples of Concealed batteries include those hidden in false houses or in caves.

Infrared sensors are not affected by Hasty or Prepared camouflage (see 5.5).

Example: For a size class A ship attempting to see a size class E missile battery, the detection range varies between 11 - 16 kyds depending on the detection die roll. This is the sighting distance if it has no camouflage. The same battery with Hasty camouflage would only be visible at 5.5 - 8 kyds, or 2 - 4 kyds yards if Prepared camouflage had been applied. The same penalties apply to aerial spotting.

5.8.6 Environmental Effects. The distance someone can see is affected by the light (day or night) and the weather (haze, rain, or snow). The Sighting Conditions table shows how the range is reduced by various conditions.

5.8.6.1 Weather. There are four categories: Clear Day, Clear Night, Day Precipitation, and Night Precipitation. Days and Clear Night are modified by weather. Clear Night is also modified by the phases of the moon. Night Precipitation is not modified by the moon since the clouds obscure it.

The visibility will be provided in the scenario description, or can be determined based on the existing conditions. For example, on a clear night with a quarter moon, the visibility is 30%. These are listed in the Sighting Conditions table. This will be reduced or increased by events during the battle. For example, gun flashes at night increase visibility by two tables (30% surface visibility would be increased to 50%). These are listed in the Visual Detection Chance table on page 5-24.

5.8.6.2 Clouds. Clouds block the visual line of sight. Annex W has rules for randomly generating cloud banks. Clouds occur in layers from one to ten thousand meters thick and from Low to High altitude. They can be solid (overcast), scattered (25% cloud coverage), intermittent (50%), and broken (75%). Clouds do not affect radar detection.

Airplanes actually in the clouds cannot see or be seen. Cloud layers block line of sight between aircraft on either side or between aircraft on one side and the sea surface. Spotting may still be possible if the cloud cover is not solid overcast.

The players must check to see if there is a hole through the clouds that gives the two sides a chance to see each other. This depends on the cloud coverage. The size or number of units on each side does not matter.

The base chance of a hole is 100 minus the cloud coverage. For example, in broken (75%) coverage, the base chance is 25%. This is affected by the distance between the two sides, because the clouds' thickness makes it harder to see units farther away. At shallower viewing angles, even scattered clouds will seem to form a solid band.

Find the vertical separation between the two units and compare it to the distance between them (horizontal separation). If the horizontal distance is less than half the vertical separation, use the base chance. If the distance is more than half but less than the vertical separation, cut the base chance in half. If the distance is greater than the vertical separation, divide the base chance by three. Roll on D100, and if it rolls the chance or less, there is a hole that allows visual detection. If it rolls over, the clouds prevent any visual detection.

A unit may roll each three-minute Tactical Turn for gaps through the clouds. Either player or a referee can make the roll, and the gap allows each side to attempt to sight the other. This roll must be successful before the two sides can make their visual detection roll.

Sighting is mutual. A hole in the cloud layer works both ways. It will not last more than one turn, though. The positions of the sighting units and the cloud layers are always changing.

Groups of aircraft (any number of aircraft greater than one flying together at the same altitude) risk collision every Tactical Turn that they are in a cloud layer, whether they are spotted or not. The risk is 10% plus the number of aircraft in the group. If a hole in the clouds is found, the group can fly through the cloud layer safely. Aircraft in trail with active radars and 2 nmi separation are not subject to collisions.

Aircraft can deliberately hide in the clouds to evade attack or avoid visual detection. If a plane wants to hide in the clouds it can add 25% to the effective cloud coverage, since the pilot is assumed to be steering for the clouds and avoiding open spots. On the other hand, since he is concentrating on staying in the clouds, he only covers half his normal distance at that speed.

5.8.6.3 Rain. Local thunderstorms can block visibility. Visible from many miles away, they are a cluster of cumulus clouds with a solid curtain of rain hanging beneath them. They can be present at any time of the day or night.

If squalls are present, represent them with circles of paper or plastic 6 kyds (3 nmi) in diameter. Within each circle, because of heavy precipitation, the visibility will be either Intermediate (1-7 on D10) or Heavy day precipitation values (8-0 on D10). Write the visibility distance on the circle, or use two colors to represent the difference.

Normal squall activity can be represented by 3D6 circles. There will be 2D6 circles for light squalls, and 4D6 for heavy squall activity.

Scatter the circles randomly over the game area (dropping them from about three feet over the board works well). As the game progresses, move them with the wind, at the same speed and in the same direction.

5.8.7 Firing Starshells. Starshells can illuminate or silhouette a surface target that has been visually detected. They may be fired by any surface combatant gun of 76mm or larger.

In the Plotting Phase, designate one mount (the gun must be able to fire in the desired direction) as firing starshell. That mount may do nothing else that Tactical Turn, but other mounts may fire normally.

Starshell Miss Diagram

Each square is 1,000 yards on a side.

31 - 35	36 - 40	16 - 20	41 - 45	46 - 50
21 - 25	01 - 05	06 - 10	11 - 15	26 - 30
51 - 55	56 - 60		61 - 65	66 - 70
71 - 75	76 - 80	81 - 85	86 - 90	91 - 95

Direction of fire

At the beginning of the Planned and Reaction Fire Phases, resolve the effectiveness of the starshell guns and place a marker that indicates the location of the starshell. After that, the other guns can fire and will benefit from any illumination/silhouetting the starshells provide. Like other gun attacks, multiple starshell rounds are fired throughout the Tactical Turn, with no further resolution of their fire needed.

Starshells have a maximum range of 5-9 kyds depending on the gun's caliber, and a minimum range of 3 kyds. Inside that range, the shell is moving too fast for the chute to deploy without shredding. If a starshell misses its target and falls short, and the range ends up being less than 3 kyds the starshell will not work at all and will fall promptly into the sea (and go "phsst").

Starshell Maximum Range

Gun Caliber *Inches*	*Gun Caliber* *Millimeters*	*Max Range*
5.0 - 6.1	127 - 155	9 kyds
3.9 - 4.7	100 - 120	7 kyds
3.0 - 3.5	76 - 88	5 kyds

Starshell illumination actually requires a series of shells fired over the entire three-minute Tactical Turn. Individual starshells illuminate a smaller area than flares (600-800 yards) and burn out quickly, in less than a minute. If the gun ceases firing, the light fades quickly. If the gun stops at the end of a turn, or shifts to another target, the previous target ceases to be illuminated/silhouetted in the following Tactical Turn.

To resolve where starshells land, in the Planned or Reaction Fire Phase, the player makes a standard gunnery attack and rolls to hit. If the player hits (the shells landed where they were supposed to), they can use the "illuminated" gunnery modifier. If the attack misses, roll D100 and consult the Starshell Miss Diagram on this page. If starshells fall behind the target, long by up to 1-2 kyds (gray boxes), the target ship is silhouetted.

A die roll of 96+ means the starshell salvo fails to function. All other boxes indicate the starshell has landed outside its illumination range from the intended target. Starshells that land in front of the target block the firing ship's line of sight and it loses visual detection of the target.

Starshells can be seen by other naval vessels out to 30 nmi (60 kyds) in night visibility conditions where there is no precipitation. If precipitation conditions exist, increase the visibility table by two to obtain the maximum detection range. Detection is automatic if the searching vessel is within range.

5.8.8 Identifying Visual Contacts (*optional rule*). In normal play, ships that have been spotted visually are immediately identified by class. In reality, and especially in the heat of battle, ships were often misidentified by class, by type, and even by nationality.

If most of the ship is over the horizon, "hull down," it is very difficult to determine the exact class. The best one can hope for is the ship's size, type, and if you're lucky, nationality. Once the superstructure and some of the hull are above the horizon, the ship is "hull up," and classifying gets a little easier.

A contact is hull up if the range from the detecting platform is equal to, or less than, the horizon range as listed in the 100% Sighting Range table. So, for a C-size vessel, the visible horizon is 17.0 kyds. Any contact that is 17.0 kyds or less from this ship would be considered "hull up."

Visual Classification Table

D10	*Hull Down*	*Hull Up*
1	Ship	Ship
2	Ship	Ship
3	Ship	Size
4	Ship	Size
5	Size	S T
6	Size	S T
7	S T	S T C
8	S T	S T C
9	S T C	S T C N
10	S T C	S T C N

Ship: There is a ship there.
Size (S): Large, Medium, Small, Very Small
Type (T): CV, BB, CG, DD, Merchant
Class (C): Individual ship class
Nationality (N): US, Russian, German, French, etc.

Note: Some classes of ship are used by more than one country, e.g., the British-built Type 42 destroyers used by Argentina during the Falklands War.

Classification Modifiers

Prob. of Det.	*10%*	*25%*	*50%*	*75%*	*100%*
	-3	-2	-1	0	+1

For close contacts, less than 4 nmi (8 kyds)
in good visibility (60% or better) +2

Environment Modifiers
Visibility 40% or less -2
Visibility 20% or less -3
(Ignore these if using night vision sensors, e.g., LLLTV, FLIR in clear weather)
Contact Illuminated -1 (Night only)
Contact firing missile +2 (Night only)

Only one of the environment modifiers can be applied. If a contact is illuminated and visibility is ≤20% at night, then the illuminated modifier takes priority. A target has to be illuminated at night to get the nationality and class identification results.

Example: A C-size destroyer detected a ship in the previous turn's Detection Phase. The target is B-sized, at a range of 16.2 kyds, in 60% visibility. Because the range is less than 17.0 kyds (C-size horizon), the contact is hull up.

Looking at the Visual Detection table (20.5 kyds row), compare the target's current distance to the column ranges and find the first column that has a range less than the target's. In this case, the contact is in the 75% column - 16.2 kyds is greater than the 75% column's 15.0 kyds - which has no effect on the identification die roll.

Rolling D10, the destroyer's player gets a 6. The results from the hull up column indicates that the player knows the contact is a medium cruiser-type ship, but nothing more.

5.8.9 Sighting In Intermediate Turns *(optional rule).* If both players agree, when moving ships in 30-minute Intermediate Turns, use unadjusted sighting ranges only, without the detection die roll. This speeds play considerably. This is not recommended for night engagements.

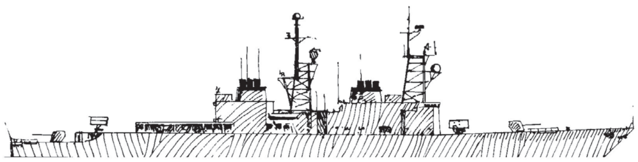
5.8.10 Visual Signaling. Signal flags and flashing light signals have a limited range. Signal flags can be used only in the daytime. Because of the limits of signal personnel and equipment, only one visual signal of 30 characters or less may be sent per side (port/starboard) each Tactical Turn.

Visual signaling is used to transmit non-tactical information in conditions of radio silence; examples include formation and maneuvering commands and administrative information.

The Visual Signals Range table on page 5-25 lists the distance flag and flashing light signals can be seen in different visibility conditions.

5.8.11 Stack Smoke. Some ship propulsion plants will emit smoke when running near full power. Western ships with non-nuclear steam propulsion plants will smoke at speeds within 3 knots of their original maximum speed. Russian ships use different fuel, and will smoke at 75% or more of their original maximum speed.

Gas turbine and diesel plants do not emit smoke at any speed.



US *Spruance*-class DD

Chapter Six - Fire Control

6.1 Combat Systems. A combat system integrates data from own platform's sensors or from other platforms via data links. It computes a fire control solution, and tells the unit's weapons when and where to fire.

This process is called a "kill chain." It has six steps: Find, Fix, Track, Target, Engage, Assess - repeat as needed. The quicker a unit can perform these steps, the better. This is especially critical when engaging fast-moving air threats.

Combat systems have evolved and improved over time. *Harpoon* groups them into generations. Later generations process data faster, reducing the system's reaction time. More modern combat systems also have a quicker kill assessment time and tend to make greater use of data links. A ship's combat system generation (CS Gen) is listed in Annex A. For their effects in AAW, see sections 8.1 and 8.2. For their effects in surface gunnery, see 8.3, and anti-air gunnery, 8.1.3. For detecting air contacts, 5.2.1. For submarine fire control, 6.4.

6.2 Weapons Directors. "Director" is a generic term for sensors used by gun or missile fire control systems. A ship's weapons can normally only engage as many targets as it has directors.

Weapons without directors, such as unguided torpedoes and some missiles, can engage only one target per Tactical Turn, although they may fire more than one weapon per turn at the target, if the weapon's rate of fire allows.

Directors use radar or electro-optical (EO) sensors, sometimes combined with laser backups. They track the target and sometimes also the outgoing shell or missile and sends steering commands to the gun mount, or the missile.

Directors are listed in Annex A after the "//" on a weapons line. If a director is listed for a weapon, that weapon needs it to aim properly; if no director is listed, then the weapon can be fired without one.

6.2.1 Missile Fire Control. The number of targets each director/illuminator can engage depends on the combat system generation.

• CS Gen 1 through 4, each missile director/illuminator has a single engagement channel and must track the target throughout a missile's flight. Soviet S-300 Fort directors have 6 channels each. US Talos directors can guide one missile per channel.

• CS Gen 5 Human Control has 2 engagement channels per illuminator (US New Threat Upgrade).

• CS Gen 5 Automatic Control has 3 engagement channels per illuminator (Aegis Baseline 1-3)

• CS Gen 6 Automatic Control has 4 engagement channels per illuminator (Aegis Baseline 4+)

SAM Salvo Summary

Combat System	Channels Per Director	Missiles Per Channel
1st Gen Cbt Sys		
Beam-R, Cmd	1	1
2nd Gen Cbt Sys		
Beam-R, Cmd	1	1
SARH	1	2
3rd Gen Cbt Sys		
Cmd	1	2
SARH	1	2
I&M/TSARH	1	2
TVM	6	2
4th Gen Cbt Sys		
SARH	1	2
I&M/TSARH	1	2
TVM	6	2
5th, 6th Gen Cbt Sys/Human		
SARH	2	2
I&M/TSARH, TARH	2	2
5th Gen Cbt Sys Auto		
SARH	3	2
I&M/TSARH, TARH	3	2
6th Gen Cbt Sys Auto		
SARH	4	2
I&M/TSARH, TARH	4	2

See section 7.4 for descriptions of the different missile guidance methods and their abbreviations.

6.2.2 Gunfire Directors. A ship equipped with a single gunfire director and several gun mounts can only fire at one target, since the director controls all mounts. However, if the gun system has a local control mode, each gun can attack a different target, but only one of the mounts can use the director. The others will have to fire in "Local Control," with their chance to hit significantly reduced. Gunfire directors have several different modes:

• *Optical (OP):* These use visual daylight-only sensors. They can only attack targets the ship can see, although they have the advantage of being completely passive. Optical directors are all sea-skimmer-capable.

• *Radar (RA):* These work in all weather and light conditions. However, if a radar-controlled gun is not described as sea-skimmer-capable in the remarks column in Annex C, it has a smaller chance of hitting targets in Very Low flight.

• *Electro-Optic (EO):* This uses visual, low level light, or infrared sensors. They work in all lighting conditions, although they are adversely affected by poor weather. EO directors often use laser ranger finders to measure range. If a unit is fired on by a gun using only EO fire control, it receives no ES/RWR warning, and the aircraft is treated as a non-maneuvering target for the first turn of fire. *Exception:* units equipped with a laser warning system (see 5.6.3). EO fire control systems with laser rangefinders are sea-skimmer-capable.

6.2.3 Local Control. Guns without directors, or guns that have lost their director because of damage or other causes, must fire in local control. The operator aims and fires the gun manually without the aid of a computer. There is a negative modifier to the gun's chance to hit surface and air targets, especially sea-skimming targets (ones flying Very Low).

Some guns normally controlled by a director cannot fire without it. These will be noted in the remarks column of Annex C as "No Local Control."

6.3 Fire Control Solutions. Properly aiming a weapon involves not aiming at where the target is, but where it will be. For long-range weapons, or inertial weapons with terminal homing, predicting the target's future position and movement are absolutely vital. Some antiship cruise missiles may take as much as half an hour to reach their target. If the target isn't where the solution said it would be, all the seeker will see is open water.

Any weapon that takes more than one turn to reach its target requires a fire control solution before it can be launched. Such weapons can be launched only in the Planned fire phase.

Getting a decent solution takes time, even with active sensors that provide bearing and range, and the farther away the target is, the longer it takes.

The three types of sensors are radio-frequency (radar and ES), acoustic, and visual. All can be passive or active.

Active sensors like radar provide both bearing and range, and will provide a fire control solution more quickly, but reveal a unit's presence. Passive sensors provide only bearing information. An accurate fire control solution takes longer than with an active sensor, but they don't reveal the shooter's location.

All types of sensors will require more time to produce a fire control solution the farther away the contact is from the shooter. The Fire Control Solution tables list the number of Tactical Turns an attacker must have sensor contact on the target to achieve the associated fire control solution quality. The better the solution, the higher the chance the weapon (antiship cruise missile or torpedo) will find the target.

6.3.1 Fire Control Solution Quality. There are four levels of solution quality: Good, Fair, Poor, and No Attack (NA). To find the solution quality, take the number of turns spent in contact with the target and apply any relevant modifiers. Target tracking begins the turn the contact is first detected. The modified contact time (Contact Track) is cross-referenced with the target's range to get the solution quality.

This is checked in the Detection phase of any turn that the shooter is in contact with a potential target, and will change as time passes and the range changes.

When firing a weapon in the Planned Fire phase, record the quality of the solution as well as the target.

If contact is lost for four Tactical Turns, or more, the fire control solution process must be re-started after the target is re-acquired.

6.3.2 Radio-frequency (RF) Fire Control Solutions. Although radar (active) and electronic support or ES (passive) can detect a contact at long distances, surface ship radars are limited to their radar horizon and can provide accurate targeting only out to 35 nmi. Accurate passive ES tracking is limited to about 50 nmi. While these systems can track targets at much greater ranges, the fire control solution quality degrades quickly due to the relatively large beam widths, which creates bearing inaccuracy. Active and passive RF systems that are not over-the-horizon targeting (OTH-T) capable not only take longer to generate a solution, but the solution quality is lower.

Dedicated targeting radars, such as the Russian Mineral, are far more accurate, and can provided targeting data out to their maximum range. These radars are typed as "SS-T" in Annex J1 (see 5.2.4).

Fire Control Solution Quality for Non-OTH-T Systems

Active RF Range (nmi)	*Max FCS Quality*	*FCS Modifier*
≤35.0	Good	0
35.1 - 50.0	Fair	-1
50.1 - 65.0	Poor	-2
65.1+	NA	--

Passive RF Range (nmi)	*Max FCS Quality*	*FCS Modifier*
≤50.0	Good	0
50.1 - 65.0	Fair	-1
65.1 - 80.0	Poor	-2
80.1+	NA	--

Example 1: A Russian *Sovremenny* class DDG is attempting to target a US destroyer at a range of 52.0 nmi with the passive component of the Mineral-M targeting system. The Russian ship has a 3rd Gen combat system and is armed with the 3M80 [SS-N-22 Sunburn] ASCMs. The 3M80 has a 3rd Gen seeker and a speed of 1,650 knots (Medium supersonic, see the ASCM speed modifiers table on page 6-3). The US destroyer's speed is 18 knots and the Russian has been tracking the ship for three Tactical Turns (four turns of detection). The fire control solution quality is:

Base Track Length = 3 turns
Contact Speed Mod = +0
CS Gen Mod = -1 (passive)
OTH-T Capable = 0
ASCM Seeker Mod = +1
ASCM Speed Mod = +0
Total = 3

The US destroyer is in the 50.1 - 100.0 nmi column (range is 52.0 nmi), where a "3" yields a "Fair" fire control solution that gives a 6 out of 10 chance of correctly targeting the missiles. To improve the ship's chances, the Russian player will need to continue tracking for another two turns to get a good solution, which isn't a major problem, since the 3M80 ASCM is currently outside its maximum range (50 nmi).

If the *Sovremenny* used the active component of the Mineral-M, and with an evaporative duct present, it could track the US destroyer, and the Russian ship would be able to generate a much better firing solution.

Base Track Length = 3 turns
Contact Speed Mod = +0
CS Gen Mod = 0 (active)
OTH-T Capable = 0
ASCM Seeker Mod = +1
ASCM Speed Mod = +0
Total = 4

Using the 50.1 - 100.0 nmi column (range is 52.0 nmi) on the Active RF FCS table a result of "4" yields a "Good" fire control solution that gives a 9 out of 10 chance of correctly targeting the missiles.

RF Fire Control Solution Tables

Active RF Fire Control Solutions

	Range (nmi)				
Contact Track	*0.0 - 25.0*	*25.1 - 50.0*	*50.1 - 100.0*	*100.1 - 150.0*	*150+*
-2	Poor	Poor	Poor	Poor	Poor
-1	Fair	Poor	Poor	Poor	Poor
0	Good	Fair	Fair	Fair	Poor
1	Good	Good	Fair	Fair	Fair
2	Good	Good	Good	Fair	Fair
3	Good	Good	Good	Good	Fair
4	Good	Good	Good	Good	Good

Passive RF Fire Control Solutions

Contact Track	*0.0 - 25.0*	*25.1 - 50.0*	*50.1 - 100.0*	*100.1 - 150.0*	*150+*
-2	Poor	Poor	NA	NA	NA
-1	Poor	Poor	Poor	NA	NA
0	Fair	Poor	Poor	Poor	NA
1	Good	Poor	Poor	Poor	Poor
2	Good	Fair	Poor	Poor	Poor
3	Good	Good	Fair	Poor	Poor
4	Good	Good	Fair	Fair	Poor
5	Good	Good	Good	Fair	Fair
6	Good	Good	Good	Fair	Fair
7	Good	Good	Good	Good	Fair
8	Good	Good	Good	Good	Fair
9	Good	Good	Good	Good	Good

Notes:
1) The turn a target is first detected (including a target that has been reacquired) has a base Contact Track of 0.
2) A negative Contact Track number means more time is needed to generate a Fair or Good quality fire control solution.
3) If a contact shifts from one range bracket to another, use the current Contact Track number in the new range bracket.

RF Solution Modifiers:

Combat System

Generation	*1*	*2*	*3*	*4*	*5*	*6*
Passive Mod	-2	-2	-1	0	+1	+2
Active Mod	0	0	0	0	+1	+1

Combat aircraft have a combat system modifier of zero.

Contact Speed

knots	*≤5*	*6-10*	*11-25*	*26-35*	*36+*
Passive Mod	-2	-1	0	-1	-2
Active Mod	-1	0	0	0	-1

Aircraft Sensor
Aircraft SS radar or ES: Shifts one range column to the left on the active or passive table. Other aircraft in contact and sharing data by TDL use applicable TDL modifier.

Long range missile seeker: +1
Long range missile seeker and Scout mode: +2

Tactical Data Link Cue
Other platforms in contact and sharing data by TDL, use applicable TDL modifier.
NRT TDL: +1
RT TDL: +2

Distraction Decoy

Passive Mod	-3
Active Mod	-2

ASCM Speed

		Range (nmi)				
	Speed (kts)	*0.0 - 25.0*	*25.1 50.0*	*50.1 - 100.0*	*100.1 - 150.0*	*≥150*
Subsonic	≤500	+0	-1	-2	-4	-5
Transonic	501-750	+0	-1	-2	-3	-4
Low Supers.	751-1525	+0	+0	-1	-2	-2
Med Supers.	1526-2300	+1	+0	+0	-1	-1
High Supers.	2301-3075	+1	+1	+0	-1	-1
Low Hypers.	3076-4100	+1	+1	+1	+0	-1
Med Hypers.	4101-5125	+1	+1	+1	+0	-1
High Hypers.	5126+	+1	+1	+1	+1	+0

ASCM Seeker

Gen	*1*	*2*	*3*	*4*
Mod	-1	0	+1	+1

Acoustic Fire Control Solution Tables

Active Acoustic Fire Control Solutions

Contact Track	Range (nmi) 0.0 - 3.0	3.1 - 6.0	6.1 - 10.0	10.1 - 15.0	15.1 - 20.0	1st CZ	2nd CZ
-2	Poor	Poor	Poor	Poor	NA	NA	NA
-1	Poor	Poor	Poor	Poor	Poor	NA	NA
0	Fair	Poor	Poor	Poor	Poor	Poor	NA
1	Good	Fair	Fair	Poor	Poor	Poor	Poor
2	Good	Good	Fair	Fair	Poor	Poor	Poor
3	Good	Good	Good	Fair	Fair	Poor	Poor
4	Good	Good	Good	Good	Fair	Fair	Poor
5	Good	Good	Good	Good	Good	Fair	Fair
6	Good	Good	Good	Good	Good	Good	Fair
7	Good	Good	Good	Good	Good	Good	Good

Passive Acoustic Fire Control Solutions

Contact Track	Range (nmi) 0.0 - 2.0	2.1 - 4.0	4.1 - 6.0	6.1 - 8.0	8.1 - 10.0	10.1 - 12.0	12.1 - 14.0	14.1 - 16.0
-2	Poor	Poor	NA	NA	NA	NA	NA	NA
-1	Poor	Poor	Poor	NA	NA	NA	NA	NA
0	Poor	Poor	Poor	Poor	NA	NA	NA	NA
1	Fair	Poor	Poor	Poor	Poor	NA	NA	NA
2	Good	Fair	Poor	Poor	Poor	Poor	NA	NA
3	Good	Good	Fair	Poor	Poor	Poor	Poor	NA
4	Good	Good	Fair	Fair	Poor	Poor	Poor	Poor
5	Good	Good	Good	Fair	Fair	Poor	Poor	Poor
6	Good	Good	Good	Fair	Fair	Poor	Poor	Poor
7	Good	Good	Good	Good	Fair	Fair	Poor	Poor
8	Good	Good	Good	Good	Fair	Fair	Fair	Poor
9	Good	Good	Good	Good	Good	Fair	Fair	Poor
10	Good	Good	Good	Good	Good	Fair	Fair	Fair
11	Good	Good	Good	Good	Good	Good	Fair	Fair
12	Good	Good	Good	Good	Good	Good	Fair	Fair
13	Good	Good	Good	Good	Good	Good	Good	Fair
14	Good	Good	Good	Good	Good	Good	Good	Fair
15	Good	Good	Good	Good	Good	Good	Good	Good

Modifiers:

Combat System

Generation	1	2	3	4	5	6
Passive Mod	-2	-2	-1	0	+1	+2
Active Mod	0	0	0	0	+1	+1

Contact Speed

knots	≤5	6-10	11-25	26-35	36+
Passive Mod	-2	-1	0	-1	-2
Active Mod	-1	0	0	0	-1

Mobile Decoy

Passive Mod	-3
Active Mod	-2

Passive Ranging/Localization Array
Wave front curvature array +4
Russian vertical flank array+3

Target Zig -2
A target zig is a course change of at least 20° or a speed change of at least 5 knots in one Tactical Turn. This temporarily throws off the fire control solution as the combat system tries to sort out the changes in bearing rate and range rate. This modifier is only applicable for the Tactical Turn immediately following the maneuver.

Torpedo Seeker

Generation	1	2	3	4
Mod	-1	0	+1	+2

If a contact shifts from one range bracket to another, use the current Contact Track number in the new range bracket.

Tactical Data Link Cue
Other platforms in contact and sharing data by TDL, use applicable TDL modifier.
- TL: Alerted Operator only (1 time)
- NRT TDL: +1
- RT TDL: +2

Notes:
1) The turn a target is detected (including a target that has been reacquired), it has a base Contact Track of 0.
2) A negative Contact Track number means more time is needed to generate a Fair or Good quality fire control solution.
3) If a contact shifts from one range bracket to another, use the current Contact Track number in the new range bracket.
4) TL – time late, NRT – near real time, RT – real time

Example 2: A US *Burke* class DDG is attempting to track a contact it has detected on its SPS-67 surface search radar. With an evaporative duct present, the *Burke* was able to detect the contact at 60 nmi, maximum range with an evaporative duct between Medium-sized ships; it has been tracking it for three Tactical Turns (four turns of detection). The *Burke* class has a 6th Gen Auto combat system and is armed with Harpoon 1D (RGM-84D) missiles with a speed of 561 knots (Transonic) and has a 3rd Gen seeker. The contact speed is 15 knots. The fire control solution quality is:

Base Track Length = 3
Target Speed Mod = +0
Ship CS Gen Mod = +1 (active)
Not OTH-T Capable = -2
ASCM Seeker Mod = +1
ASCM Speed Mod = -2
Total = 1

The *Sovremenny* destroyer is in the 50.1 - 100.0 nmi column (range is 52.0 nmi), where a "1" on the Active RF FCS table yields a "Fair" fire control solution. However, beyond 50 nmi, the best the Americans can do is a "Poor" fire control solution quality that only has a 3 out of 10 chance of correctly targeting the missiles. To improve the DDG's chances, the American player has to close inside 50 nmi, but even then, the best they can get is a "Fair" fire control solution quality.

• *Distraction decoys* are deployable devices that generate a false signal that is picked up by a radar or an ES system. There are two types of distraction decoys, stationary and mobile. Stationary decoys are false targets, such as long-range chaff rockets, inflatable radar reflecting buoys, or floating radar signal emitters, that interfere with the sensor's picture and takes extra time to sort out which contact is which. Stationary decoys get the modifier listed above as, eventually, the moving target will put noticeable distance between itself and the stationary decoys (see 12.3 and 12.4).

• *Mobile decoys* are a much bigger problem because they move. And unless the contact of interest does something foolish, like accelerating to a speed faster than the decoy can support, the mobile decoy is hard to distinguish from the real target and the attacking player has to keep track of two (or more) contacts until the decoy is either classified, exhausts its propulsion capability, or is destroyed.

6.3.3 Passive RF Cross-Fix. The Passive RF Fire Control Solutions table is for a single ship attempting to develop a firing solution; multiple ships combining their information speeds up the process. The solution's quality is driven by the bearing accuracy of the platform's ES sensors, and to a lesser degree, the angular separation between the units. A cross-fix requires the participating ships to have at least near-real time data links.

• 1st and 2nd Gen ES system have poor bearing resolution and passive cross-fixes are less accurate. Ships attempting a cross-fix use the Active RF Solutions table (pg 6-3) but reduce the solution quality by one level.

• 3rd and 4th Gen ES system bearing resolution, while better than earlier ES systems are still wide, and the information is not automatically integrated. Ships attempting a cross-fix use the Active RF table solution without modification.

• 5th and 6th Gen ES system bearing resolution have narrower beam widths but information is not automatically integrated. Ships attempting a cross-fix use the Active RF Table but increase the solution quality by one level.

• Dedicated targeting systems, such as the Russian Monolit and Mineral systems and the Chinese LJQ-366, have very fine bearing resolution (approximately 0.5°) and the information is automatically passed on and integrated with other ships via a dedicated data link. These ships use the Active RF table for the corresponding range column, and can generate a "Good" solution (see 5.2.4).

6.3.4 Acoustic Sensor Fire Control Solutions. While sonar can detect ships and subs at long ranges, they are far more restricted in their ability to support fire control, due to the limitations of their environment. Compared to RF sensors, fire control solutions take longer and are limited to much shorter ranges.

Direct path and bottom bounce active sonar can support accurate tracking out to 20.0 nmi, with passive fire control limited to 16 nmi or less, due to the very low bearing rates at longer range. Tracking in a convergence zone (CZ) can only be done with active sonar, and even then it's difficult. Passive fire control via the CZ propagation path is all but impossible.

• *Passive ranging arrays* are sonars designed to exploit how sound travels in water to estimate range through triangulation. Wave front curvature arrays, such as the DUUX-5, PRS 3-15, and BQG-5, use three equally spaced arrays to measure the time of arrival of the wave front. The Russian vertical flank arrays, (e.g., NATO Shark Rib), use multipath techniques to find not only range, but target depth as well.

Passive ranging sonars have a maximum range of 12 nmi for their ranging capability. Beyond 12 nmi they can still provide a detection, but they cannot discern target range.

6.3.5 Visual Sensor Fire Control Solutions. Visual sensors cover a wide range of systems from submarine periscopes to IRSTs. All visual sensors use the Active Acoustic Fire Control Solution table. If the system has a direct ranging capability, like a mast-mounted radar or laser rangefinder, shift the range column one to the left. Visual conditions do not affect the time to derive a fire control solution. If the system can "see" the target, it can be tracked.

Example: A submarine comes to periscope depth to observe a contact detected by the passive hull array. The visibility is 70%, and the contact is B-size bulk carrier at a range of 5 nmi. On the 70% visibility table, a periscope can see a B-size contact out to 7 nmi (14.0 kyds). See the Surface-to-Surface Visibility table on page 5-23.

The submarine player rolls D100 on the 14.0 kyds row on the Visual Detection Chance table on page 5-23 and gets an 83, which means the player can only see out to 4.75 nmi (9.5 kyds) and the ship is not visible. On the following Tactical Turn the player rolls better and the ship is sighted. If the sub player uses only the periscope, it will take two Tactical Turns to generate a Good fire control solution. If a radar or laser range finder is used, it will take only one Tactical Turn.

6.3.6 Bearing-Only Launch (BOL): If a shooter can't get enough information for a fire control solution, or doesn't want to wait the time it will take to generate one, he can choose to make a Bearing Only Launch. Any weapon with inertial or satellite navigation guidance and terminal homing can be fired in BOL mode. See section 8.4.2 for the procedure.

6.3.7 ASCM and Torpedo Firing Orders. Before launching cruise missiles or torpedoes, a player must plot the weapon's course, speed, and point where it will activate its seeker ("enable point").

A Fair or Good fire control solution automatically includes a default enable point, optimum for the situation. If it is a Poor solution, then the shooter must choose the enable point.

The seeker's enable point is very important, and requires careful consideration. It should be well before the weapon reaches the intended target, but not so early that it sees another unit in its path.

Any waypoints, locations where a course change takes place, must also be recorded, including the new course.

6.3.8 Rolling for Weapon Placement. The chance of successful weapon placement is rolled on a D10.

Weapon Placement Chance

Solution Quality	Good	Fair	Poor
Weapon Placement	9	6	3

Modifiers:

Active acoustic homing torpedoes attacking a sub with anechoic coating: -2

Torpedo in reverberation conditions, see 7.5.6.

Missiles attacking ships within 5 nmi of land, unless missile has satellite inertial guidance: -2

Wake-Homing torpedo: +1

Localizing sonobuoys with GPS: +1

The placement roll is made in the first detection phase after the weapon has traveled half the distance between the shooter and the target. The roll applies to all weapons fired that turn by a unit of the same type. For example, if a shooter fires a salvo of eight Harpoon missiles with a Fair solution, then the D10 roll applies to all the missiles in the salvo.

• If the number rolled is less than or equal to the placement chance, the weapon will continue on its intended course and roll for an attack normally.

• If the number rolled is higher, the weapon is not in the correct location and cannot detect the intended target with its seeker. At this point, it will be apparent to the intended target from bearing drift that the weapon will miss. It may not be apparent to the shooter until the weapon actually reaches the target and does not hit.

If its seeker is activated, it will look for any eligible target, other than its intended target, along its flight path. If there are several targets within the seeker's acquisition cone in the same Tactical Turn, use the Seeker Lock-On Chance table in 7.4.7 to find out which one the missile will attack.

If a weapon salvo fails its placement die roll, the missile salvo or torpedo is not on the correct heading for the intended target. To determine where the weapon(s) are going, roll a D6 for direction with 1-3 being to the right of the original weapons course and 4-6 to the left. The magnitude of the course deviation is made with another roll D6 x 5°. The weapon salvo steers the revised course immediately and when its seeker is activated, it will look for any eligible target, other than its intended target, along its flight path. If there are several targets within the seeker's acquisition cone in the same Tactical Turn, use the Seeker Lock-On Chance table in 7.4.7 to find out which one the missile will attack.

This procedure reflects the fact that the weapons course derived from fire control solution was inaccurate, not that the player fired on the wrong course.

6.3.9 Tactical Data Links (TDLs). There are three types of TDLs.

• The first is a *time late* system, such as the NATO Link 14, that provides little more than a warning of an enemy unit in the area. A time late TDL is similar in effectiveness to a voice report, only it reaches more ships faster as the TDL transmissions are done automatically. The slow rate of data transfer doesn't improve the receiving ship's chances of detecting a contact or generating a fire control solution. The only exception is that a time late TDL warning of a submarine will allow a one-time use of the alerted operator modifier for sonar searches.

• The second type of data link is a *near-real time* system, like NATO Links 11 and 22. This kind of TDL provides a sensor cueing function; it transfers data fast enough to help the receiving platform detect a contact more quickly. The data transfer rate can also assist a platform in generating its own fire control solution (sections 6.3, 8.1.1 and 8.5.2 TDL Cue).

• The last type of TDL is a *real time* system that is often a component of dedicated targeting systems like the US CEC and AN/ARQ-59 Hawklink and the Russian Mineral, but can also be an independent system such as the NATO Link 16 system. Real time systems are very similar in function to near-real time TDLs, just faster. A real-time TDL also provides sensor cueing and can help platform in generating its own fire control solution (sections 6.3, 8.1.1 and 8.5.2 TDL Cue and 8.2 BMD Special Cases), but its main advantage over slower TDLs is real time systems can immediately convey targeting quality fire control solutions from another platform without degradation in the information.

If a platform has a targeting system with a real-time TDL, that platform can send its fire control solution to another platform with a real time or near-real time TDL as long as the links are compatible. A receiving ship/aircraft with either TDL doesn't have to generate its own fire control solution, but can attack using the transmitting unit's solution. The distinction here is that real time TDLs uses the *same* fire control solution quality as the sending platform. Ships/aircraft with a slower near-real time TDL can also use a targeting system's fire control solution for surface and antisubmarine warfare situations, but the fire control quality is *reduced* by one level due to the longer time delay.

Information passed by a platform via TDL is received by other platforms in the same Detection Phase that the contact is detected, or in the same Increment that a firm track is established.

For example, a Soviet surface action group of two Project 956 *Sovremenny* DDGs and one Project 61MP Mod Kashin DDs are preparing to launch a coordinated anti-ship missile strike on a NATO squadron. The *Sovremenny*s have successfully generated a "Good" fire control solution using their Mineral targeting complex passive channels. While the two *Sovremenny*s automatically communicate data to each other through the Mineral targeting complex's real-time TDL, they have to relay the firing data through a separate near-real-time TDL to the Mod Kashin, and this reduces the Mod Kashin's fire control solution quality to Fair.

This example deals with a situation where a fire control solution had already been generated by the two *Sovremenny* DDGs and is then passed to the Mod Kashin. In a case where two or more platforms (ships or aircraft) combined their information to form a fire control solution, then the revised TDL modifiers for sections 6.3, 8.1.1 and 8.5.2 that follows would be used.

6.3.10 Sharing Contact Information Without TDLs. Contact data can be manually shared by radio (voice or teletype) or even cell phones, however, the process is slow, with a higher risk of errors, and has little tactical use other than reporting the presence of a contact in the area. If two, or more, units attempted to use passive sensor information, i.e. a cross-fix, without a TDL, the resulting fire control solution is inaccurate and has a “No Attack” quality. In this case, the only option for engaging with anti-ship missiles is to use a Bearing Only Launch and hope you get lucky.

Non-TDL messages are sent in the Plotting Phase, and received in the Detection phase of the same Tactical Turn.

If two or more, units attempted to use active sensor information without a TDL, the resulting fire control solution isn’t much better and has a “Poor” quality. Thus a ship receiving this information has a rough idea of where the target is and would either have to close the range until it gains contact and develops its own fire control solution, or again employ a Bearing Only Launch.

6.4 Submarine Fire Control Systems. The number of sonar contacts that a ship or submarine can hold is determined by the computer technology level of the sonar and fire control systems. If there are more contacts than the computers can handle, the player will have to decide which contacts he wishes to “hold” and which ones he wishes to drop. In addition, the fire control computers limit the number of wire-guided torpedoes that can be fired and controlled simultaneously. The Submarine Fire Control Systems table lists their capabilities, based on their technology. The generation of a sub’s fire control will be found in Annex A in the remarks section for each submarine.

Submarine Fire Control Systems

Generation	*Technology*	*# of Target Trackers*	*# of Wire-Guided Torpedoes*
1	Analog	1	0
2	Analog/Digital	2	1
3	Federated Digital	4	2
4	Microprocessor MSI	8	2
5	Microprocessor LSI	32	4*
6	Microprocessor VLSI	64	4*

*All US subs except the *Seawolf* class are limited to controlling 2 wire-guided torpedoes at once.

The “Kill Chain”

The “kill chain” is an abstract analytical model that breaks the complex nature of combat down into logical, manageable steps. There have been many kill chain models over the years; the current favorite is the “F2T2EA” approach - Find, Fix, Track, Target, Engage, and Assess. Each “step” is tackled by a particular system on the attacking platform, but the collective goal is to accurately place ordnance on target. Here’s how the F2T2EA process is broken down:

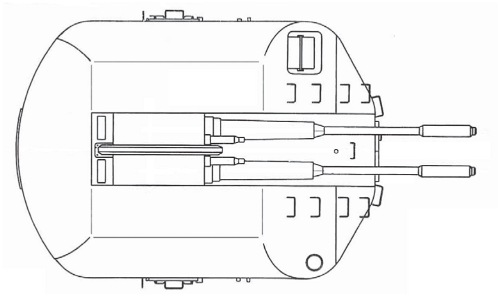
- The Find, Fix, and Track steps are performed by a platform’s sensors. They detect the target (Find), determine its location (Fix), and monitor its movements (Track). Although not included in this kill chain model, sensors can also be used to classify the target. That is, they can help determine just who, or what, the target is so that any ordnance sent down range is aimed at a hostile unit and not an innocent bystander or a friendly unit. There is no such thing as “friendly” fire.

It also helps identify the nature of the threat. A small surface contact might be a patrol boat with a couple of machine guns or a fast attack craft loaded with antiship missiles. And how hard will it be to kill?

- The Target step takes the information from the sensors and feeds it to the combat system that crunches the numbers and generates the likely future position of the contact - otherwise known as a fire control solution. This step is critical to correctly aiming whatever weapon is chosen. Finally, an appropriate weapon is selected, warmed up, and fed the necessary information from the combat system.

- The Engage step involves launching the weapon against the target. If it has a command link or uses wire guidance, fire control solution updates can be sent to the weapon to help compensate for mobile decoys or a less than accurate firing solution.

- The Assess step evaluates the effectiveness of the attack; was the target hit and determine, if possible, what damage it suffered. This step returns us to the platform’s sensors to collect more data, but figuring out the effects of an attack can be difficult. This is why many ships over the course of history took far more ordnance than was necessary to sink them.



Russian AK-726 76mm gun mount

Chapter Seven - Weapons

Refer to the annexes for the information on weapons systems (or the completed ship or aircraft form) to be used.

The die roll must be less than or equal to the modified chance to hit for the attack to be successful.

7.1 Rates of Fire. Weapons fire once per Tactical Turn. Guns may be firing many rounds, depending on their bore, and multiple-barreled weapons, like the Russian RBU ASW weapons, will fire all their tubes in one "salvo" or pattern. Automatic and rotary guns, like the US Phalanx, will fire a "burst" of several hundred rounds. Firing weapons in the Reaction Fire Phase halves the number they fire.

Unless otherwise stated, all weapons automatically reload from belowdecks magazines and are ready for use in the following Turn. If the weapon is listed as being manually reloaded in the Annexes, and does not list a reload time, it takes two Tactical Turns to reload one mount, missile rail, or torpedo tube.

Unless reloads are listed in the Remarks section of a particular ship, it has available only the ammunition listed on the weapons line for each mount.

Aircraft launching weapons against surface targets may launch any number of weapons at the same target in one Tactical Turn.

Any number of air-to-air missiles can be fired at the same target in a Tactical Turn. Planes with multiple launch capability (listed in the Remarks) may fire them at different targets.

Submarines can fire any number of torpedoes in a Tactical Turn, but the number of wire-guided weapons that can be controlled depends on their Fire Control systems. This is described in section 6.4 Submarine Fire Control.

7.2 Shipboard Weapon Firing Arcs. Each weapon mount has an arc of fire listed on the weapons line. These are described in section 2.2.1. and on page 2-2. If a target is not in the weapon's arc of fire, it cannot be fired at that target. The only exceptions to this are missiles that have waypoints (see 7.4.8), and torpedoes, which can turn from the mount's direction at time of launch (see 10.2.1 Torpedo Angle Offset).

7.3 Weapon Danger Space. If gunfire or a missile misses a targeted surface ship, it is possible that other surface units in the immediate vicinity may be hit instead. As ordnance owes allegiance to no one, both friend and foe are equally vulnerable.

For gunfire, if a unit is within ±5° of the line of fire, and within ±10% of the firing range of the intended target, it could be attacked. Roll for an attack on the nearby vessel but increase the range by one band. Short becomes Medium, Medium becomes Long, Long becomes Extreme. Ignore further attacks in the Extreme range band.

SAM cannot fire within +/-5° of a friendly ship against a VLow target due to the risk of the SAM hitting the friendly.

If cruise missiles (that do not make diving attacks) miss their intended target, they will attack any eligible target that is within their seeker cone (see 7.4.7). If the missile has a reattack capability (section 7.4.8) the original target may have to endure another pass by the weapon.

Cruise missiles that make diving or pop-up attacks and missiles with Direct flight profiles that miss their target crash into the water and cause no damage.

7.4 Guided Missiles. These weapons fly at maximum speed directly toward their target, changing course to correct for target movement. A missile's guidance method will be listed in Annex D if it is a SSM or SAM, and in Annex H if it is an ASM.

All missile seekers in the game are grouped into "generations" according to their level of technological development. A seeker's generation shows how resistant it is to defensive countermeasures. The chance of a missile hitting depends on the ability of the seeker to match its electronic wits against a target's defensive countermeasures fit.

Radar jammers and decoys work against radar-guided missiles. IR decoys and IR jammers only counter infrared guidance. EO and laser-guided weapons are not affected by electronic countermeasures, but can be affected by smoke (see 9.6.8). The defensive decoys deployed by ships include both radar and IR decoys.

Missiles may use a combination of methods, for example, an inertial system, with midcourse guidance receiving instruction from the launching platform, followed by terminal guidance when it is close to the target.

7.4.1 Directed Guidance Methods. The firing platform sends guidance signals to the missile, and require that the target is within the shooter's radar horizon.

• *Command (Cmd).* The firing platform sends guidance signals to the missile until it hits the target or misses. This may be by RF signal or over a wire.

• *Beam Rider (BR).* The launcher controls the missile's path by pointing a radar or laser at the target. The missile then "rides" the beam to the target.

• *Track Via Missile (TVM).* The launching ship sends guidance commands.

• *Semiactive Laser Homing (SALH).* A laser ("designator") is pointed at a target. The weapon homes in on the reflected laser light from the target. If the visual line of sight is lost the missile's hit chance is quartered.

• *Semiactive Radar Homing (SARH).* A director is pointed at a target and the missile homes in on the reflected radar signal.

7.4.2 Passive Guidance Methods. The missile's seeker homes in on its target using energy (IR, RF, or even light) given off by the target. The shooter must have detected the target before firing, but once launched, the seeker does not need further guidance.

• *Electro-Optic Homing (EO)*. The seeker uses an optical sensor. The shooter must have a visual line of sight to the target to lock the seeker on.

First-generation seekers are daylight and clear-weather only. They are listed as EO. They cannot lock onto moving targets.

Second-generation and later seekers can work at night, and are listed as EO, but cannot attack moving targets.

Third-generation EO seekers can attack moving targets in day or night.

• *Home on Jam (HOJ).* The missile homes in on offensive jammers. Radar-guided missiles with this feature will have it listed in the remarks. It is selected by the player before launch. Air-to-air missiles using HOJ mode have their ATA Rating halved, but are not affected by defensive countermeasures or decoys.

• *Imaging Infrared EO(IIR)* seekers are a type of EO seeker and are day/night capable.

• *Infrared Homing (IRH)*. The missile homes in on heat sources. They cannot home on targets inside or behind clouds.

First-generation IRH air-to-air missiles could attack from a rear aspect only. They needed to see the hot tailpipe directly in front of them before they could lock on and guide to the target. These missiles are listed as "N" (narrow-angle tail) in the type column of Annex H4.

Second-generation missiles were still limited to tail attacks, but they have a wider field of view. This gives the attacking plane a better chance of getting into launch position. These are listed as "W" (wide-angle tail) in Annex H4.

Third-generation seekers are sensitive enough to home in from any angle. They are listed as "A" (all-aspect).

Fourth-generation missiles use imaging infrared (IIR) seekers and have slewable seeker heads which can be used with a helmet-mounted aiming systems.

All IR-homing missiles ignore defensive jammers, unless they are listed as IR jammers. They are affected by decoy countermeasures, which have both flares and chaff.

• *Passive Radar Homing (PRH).* Passive radar homing missiles (sometimes called "ARMs" for "Antiradiation Missiles") home in on the electromagnetic signal given off by a target radar. The attacked player can turn off the radar as a defense, but that doesn't always work as the missiles get smarter. And if the radar turns on again while the missile is still in the air, the seeker will home in as before.

Almost all PRH missiles are designed to attack surface targets, but there have been a few AAMs proposed or tested with PRH seekers. They work the same as the air-to-surface types, but if the targeted radar is shut down until the missile reaches its max range, then it misses automatically.

First-generation seekers have the target radar preset before the plane takes off. It cannot be changed in flight. If the targeted radar turns off, first generation missiles will "go ballistic" and miss the target.

Second-generation PRH seekers can store the location of an emitter once the seeker has locked on. They have a one-quarter normal hit chance if the radar is turned off.

Third-generation missiles can be tuned in flight, and also store the target's location.

Most PRH missiles are designed to explode overhead (airburst), showering a fragile radar with fragments. They do not inflict damage points on their target, instead generating a die roll on the Airburst column of the critical hit table (see 14.1.4).

The die roll depends on the warhead size:

PRH Airburst Damage

Warhead Size (kg):	<u>*0-10*</u>	<u>*11-20*</u>	<u>*21-50*</u>	<u>*51-100*</u>	<u>*100+*</u>
Critical Hits:	1	D6/2	D6	D6+2	D6+3

The correct die roll is listed in Annex H2 Guided Air Ordnance. The first critical hit inflicted will always be a sensor hit, on the targeted radar.

7.4.3 Navigational Guidance. After launch, the missile travels to a location specified by the player which cannot be changed once the missile is launched. It must be a geographic location, and it will not move.

• *Inertial (Int or I)* seekers keep track of their own movement. Since there is no way to allow for small errors, Inertial seekers have a "navigational drift." The longer they are in flight, the greater their error. Later-generation Inertial seekers are more accurate than early ones.

• *Satellite (Sat).* Constellations of navigation satellites allows anyone equipped with a receiver to find their exact position within a few meters. The USA (GPS), Russians (GLONASS), Chinese (Beidou), and Europe (Galileo) all have such networks in operation.

Unlike inertial guidance, there is no time-dependent "drift." A GPS-guided weapon is just as accurate six hours after launch as it is after one minute.

• *Digital Scene Mapping and Correlation (DSMAC)*. These use an EO/IIR sensor to fly from one geographic waypoint to another, which the seeker compares with stored images. They can only attack stationary prebriefed targets, and cannot be retargeted in flight.

• *Terrain Contour Matching (TERCOM)*. Like DSMAC, these seekers compare the terrain they are passing over against a recorded contour map. Missions are planned as a series of waypoints. They can only attack stationary prebriefed targets.

7.4.4 Active Radar Guidance. (ARH or TARH) The missile has its own radar, and does not need any guidance from another unit. One variety of active radar is millimeter wave radar (MMWH), which has very high resolution.

Early TARH seekers (Gen 1 - 3) cannot distinguish ships from land, which presents an infinitely large radar return. Missiles fired at ships within five miles of shore or an island, and within the seeker's arc, will instead lock onto land and explode harmlessly somewhere ashore.

7.4.5 Midcourse Guidance (/M). Inertial- and satellite-guided weapons can be fitted with midcourse guidance, which allows the operator to send course corrections to the missile. The unit sending the signals must have radar line of sight to the missile, but does not have to be the shooter.

7.4.6 Guidance Links (/GL). Some missiles are fitted with a two-way real-time guidance link that allows the operator to see what the missile sees, and send it course corrections. The unit sending the signals must have radar line of sight to the missile, but does not have to be the shooter.

7.4.7 Terminal Guidance (-/T—). This method uses navigational guidance (7.4.3) to place a weapon near a target, where the weapon's seeker has a good chance to find it and home in the rest of the way (the "terminal phase"). This allows the launching unit to shoot even when it can't see the target.

Common terminal guidance includes Active Radar Homing (-/TARH), Infrared Homing (-/TIRH), Passive Radar Homing (-/TPRH), and Semiactive Radar Homing (-/TSARH).

The shooter decides when the terminal seeker will activate. This is the "enable point." It is either set before launch (in the Plotting phase the weapon was launched) or can be commanded in flight, if the missile has a guidance link.

Once a terminal seeker activates, it will begin searching for targets. All seekers have a 45° arc, centered on the missile's flight path. The missile's acquisition range depends on the generation of the seeker and its type.

Antiship Missile Seeker Acquisition Ranges

Seeker Range in Nautical Miles

	Target Signature			
Seeker Type	*Large/ Medium*	*Small*	*VSmall*	*Stealthy*
TARH/TSARH 1st Gen	8	6	5	3
TARH/TSARH 2nd Gen	15	12	10	5
TARH/TSARH 3rd Gen	25	20	15	8
TARH/TSARH 4th Gen	35	28	20	10
TIRH 1st Gen	5	4	3	2
TIRH 2nd Gen	10	8	4	3
TIRH 3rd Gen	15	12	6	4
TIRH 4th Gen	20	16	8	5

*See also 7.4.8 for Russian Long-Range Missile Seekers

If the missile was correctly Placed, when the seeker enables, the target will be within its acquisition cone.

Exception: SALH terminal seekers will always attack the designated target. They do not have acquisition cones.

If the missile failed its Placement Roll, the seeker will not necessarily choose the largest target within its view, but larger targets have a greater chance of being attacked. Apparent signature is also based on distance and target aspect.

The Seeker Lock-On Chance table shows the chance of a seeker choosing one target in its acquisition cone over the others. For radar and IR seekers, use the ship's radar signature. EO seekers use the ship's size class.

Seeker Random Lock-On Chance

Signature	*Large*	*Med*	*Small*	*VSmall*	*Stealthy*
Lock-on Chance	15	10	5	2	1

Example: A formation of a carrier (Large), one cruiser (Medium), and two destroyers (Small) would be rolled on a D100, with a result of 1-15 hitting the carrier, 16-25 hitting the cruiser, 26-30 hitting the first destroyer, and 31-35 hitting the second destroyer; a result over 36 must be rolled again.

If there are no targets in its field of view at all, the missile will continue to fly on its present course, attacking the first thing it finds, or until it runs out of fuel.

7.4.8 Special Guidance Features. These capabilities will be listed in the Remarks for that weapon.

• *Loiter*. Some missiles can be ordered to orbit over an area and wait for a target to appear. When it does, they will switch to whatever their terminal homing mode is and attack. The remarks for that weapon will describe how long it can loiter.

• *Multichannel Guidance (MCh)*. This is a combination of Inertial, Passive Radar Homing, and Active Radar Homing. The missile can switch modes as needed without human direction.

The shooter can also tell the missile's passive radar seeker to look for a specific hostile radar. After launch, the missile will listen for the specified radar and if it detects the radar, the missile will begin to home in on it.

If the missile doesn't detect the radar by the time it reaches its enable point, it will automatically search with its radar seeker (see Russian long-range radar seekers in this section). The missile will search until it detects a target, then loads that location into its inertial guidance and turns its seeker off until the turn it reaches its target.

• *Popup.* In the turn a missile reaches its target, the weapon pitches up sharply and then dives. It is treated as crossing target, but is no longer a seaskimmer and may be fired on normally by non-seaskimmer capable air defense systems. If the target is armored, it will strike the deck rather than the belt. A missile may always perform a popup when it attacks, or the shooter may be able to choose the method before launch. See the remarks in Annex D or H

• *Reattack.* If some missiles lock onto a target and then miss, they will search for the target at its last location.

If there is another valid target in the seeker's field of view, then the missile will proceed directly to that target and attack it normally. If there are no other targets in the seeker's field of view, then it executes a search/reattack. It will reach the original target and attack at the end of the same Movement Phase.

During the reattack, the missile can be engaged by the targeted ship as a crossing target. Air defense weapons on other friendly ships cannot shoot, since it is too close to the friendly vessel.

The second and later attacks are made with the same chance to hit as the first.

• *Russian Long-Range Missile Seekers.* Active radar seekers on some large Russian anti-ship missiles have very long detection ranges. If a missile has a long-range seeker, it will be listed in the remarks for that weapon and its range will be listed in Annex J3a, Airborne Radars. These seekers provide a +1 modifier on the RF Fire Control Table.

• *Scout Mode.* Some missiles can pass information on to other missiles in the same salvo as they proceed toward a target. They can also coordinate their attacks according to a priority preset by the shooter.

When a salvo of missiles with scout capability is fired, one missile (the scout) will search for the target while the rest remain electronically silent and concealed. The scout will use its active radar (see long range seekers above), or if the missiles have more than one flight profile, will fly at the highest altitude to maximize the chance for an ES detection.

If the scout detects a target, it will send the information to the other missiles in the salvo. If the scout is shot down, another missile in the same salvo will take over the role.

This capability, in combination with a long-range seeker, provides a +2 modifier on the RF Fire Control Table.

• *Sprint Vehicle*. A few missiles, e.g. the Chinese YJ-18, have a final stage that fires when it is close to its target. The vehicle accelerates to extremely high speed (Mach 3, or the Medium Supersonic speed band). This makes it a harder target and decreases the time the defender has to shoot.

Reduce the number of engagements against missiles with a sprint vehicle by one, first in the Short range band (see 8.1.1), and if there are none there, then in the Point Defense range band.

Also, be sure to take into account the increased speed of sprint vehicles in the Short and Point Defense range bands when calculating the hit chance.

• *Terminal Maneuvers.* In the turn these missiles attack their target, they will radically maneuver so they are a harder target for air defense systems.

• *TASM Search:* When it reaches its seeker enable point, the Tomahawk antiship missile variant flies a search pattern, which increases its chance of finding the target. Against targets at half range or less, add a +1 modifier to the placement die roll (see 6.3.8).

• *Waypoints.* Some inertially and satellite-guided missile guidance systems can make course changes preset before launch. The missile will fly from one point to the next until it reaches the target. The total distance flown cannot exceed the range of the missile, and the maximum course change at each waypoint is 90 degrees.

7.5 Torpedo Guidance. Before and throughout most of WW II, torpedoes were straight runners, kept on course by gyros, but with no homing ability. In the later part of WW II, they began to be fitted with miniature sonars that allowed them to home in on their targets. Early torpedo guidance systems were optimized to either attack subs (ASW torpedoes) or surface ships (antisurface torpedoes) only, but later weapons may be dual-purpose and can attack both submarines and surface ships. If there is an entry under the damage vs. sub or damage vs. surface ship column in Annex F, then the torpedo can attack that type of target.

7.5.1 Torpedo Seeker Generations. As torpedo guidance systems have improved, their ability to find a target, resistance to decoys, and chance of a hit have all improved. Torpedo seekers are rated by their generation, which will affect those three capabilities. Each torpedo will have its seeker generation specified, as well as its range, speed and other important performance data listed in Annex F. The Torpedo Seeker Generation table below shows the capabilities of each level of torpedo seeker development.

7.5.2 Tube-Launched Torpedoes. Tube-fired torpedoes are either ejected by a slug of water or air ("positive ejection system"), or they swim out of a torpedo tube and travel in a straight line along a fixed bearing, usually the corrected intercept course, until the enable point is reached.

To fire a tube-launched torpedo, the player must fire his weapon on a predesignated fixed bearing. This can be an intercept course (which the fire control system will provide) or some other bearing as desired by the player. Modern torpedoes can turn up to 120° from the direction at the time of launch. If a torpedo has wire guidance, the weapon's course can be changed at the discretion of the player (see 10.2.5).

Most torpedoes today have two or even three speeds for a player to choose from. Its speed not only affects its range, but its detectability as well. Before launch, the player must select the speed at which the torpedo will run until it acquires a target, when it automatically accelerates to its fastest speed, unless the player changes the speed via a wire.

The player must also select whether the torpedo will run out above or below the Layer and where it will go during its search, again above or below the Layer is all that is necessary. This is an important consideration as the Layer will reduce the acquisition range of a torpedo by 50% if the target is cross-layer to the torpedo. The torpedo's depth can also be changed by a player if it has wire guidance.

Acoustic homing torpedoes can be fired in spreads, but to avoid mutual interference, there must be at least 15° between the torpedo's courses. This happens when an acoustic homing torpedo of the same type is within twice another's passive acquisition range. The active pings of a torpedo are a much stronger signal than the echo from any submarine. The weapons then home in on each other and not the intended target.

7.5.3 Air-Dropped and Standoff Torpedoes. After entering the water, they search in a helical pattern until they detect a target and home in on it. The circle is 1,000 yards (0.5 nmi) in diameter, centered on the spot where the weapon entered the water. The helical path means that the torpedo also changes depth as it searches. If the sub's depth is known, the weapon can be set to search above or below the Layer as desired. With no direction from the player, it will spend half its run time above the Layer and the other half below.

As the torpedo searches, if another acoustic homing torpedo of the same type is within twice the first torpedo's passive acquisition range, it will "see" the second, whose active sonar will present a much stronger signal than the echo from any submarine. If mutual interference occurs, the weapons will home in on each other. Therefore these weapons must be separated by more than twice their passive acquisition range to prevent mutual interference.

7.5.4 Wire-Guided Torpedoes (Wire-G). The torpedo (called a "unit" by sub drivers) reels out a fine wire, connecting it to the launching sub's fire control system. This lets the submarine change the torpedo's course, speed (if variable), depth, enable point, and in "dual-wire guidance", receive data on its status, including the location of the target. If the wire remains unbroken, the firing submarine can manually control the torpedo in any reattacks or possibly avoid mobile acoustic countermeasures

The number of wire-guided weapons that may be controlled at one time depends on the sub's fire control system. This is listed in section 6.4 Submarine Fire Control Systems.

• At launch there is a 20% chance of the wire breaking, regardless of the launching sub's status. This chance includes a turn of up to 120° off the sub's course.

Torpedo Seeker Generations

Torpedo Generation	*Description*	*Chance of a hit*	*Active Acq. Range*	*Passive Acq. Range*
1	Act/Pass Homing	40%	500 yds	300 yds
2	Imp Act/Pass Homing	60%	1,000 yds	500 yds
3	Digital seeker	70%	2,000 yds	1,000 yds
4	Adv digital seeker	80%	4,000 yds	2,000 yds

All torpedo acquisition cone arcs are ±60° wide

• After launch, if the shooter changes depth, changes course by more than 45° from its course at the time of fire, or exceeds 10 knots, there is a chance the wire will break. Combinations of these effects increase the chance that the wire will break. A wire break check must be made each Turn when one or more of the above conditions apply. The chance of a wire breaking is listed in the Torpedo Wire Break Chance table.

Torpedo Wire Break Chance

Platform Speed	*Speed Only*	*Speed & Turn or Depth Change*
≤ 10 kts	0%	15%
11 - 15 knots	25%	60%
16 - 20 knots	50%	80%
21+ knots	100%	100%

• A launch platform can also cut the wire voluntarily, as it must if the player wishes to reload that tube (part of the wire reel stays in the launching tube). This can be done at any time during the torpedo's run, and it can be commanded to go active or change speeds before being cut loose.

Air-launched wire-guided torpedoes can only be launched by a hovering helicopter. The chance that the wire will break on launch is the same as a tube-launched weapon. If after launch the helicopter goes faster than 50 knots, the wire automatically breaks.

If the wire breaks or is cut, the torpedo reverts to active/passive acoustic guidance. The placement roll is resolved with the current fire control solution.

7.5.5 Wake-Homing (Wake-H). Wake-homing weapons can detect the turbulent wake of a ship with a very high frequency active sonar and then follow it back to its source. To acquire the wake, the torpedo is aimed to pass astern. Once the wake is detected, it will zigzag up the wake. This causes the torpedo to close the distance at 75% of its attack speed. Early acoustic countermeasures will not affect the seeker, but 3rd and 4th Gen towed countermeasures can trick the torpedo's fuze into detonating the warhead.

Wake seekers may be "decoyed" if another ship passes through the wake of the target ship. The chance of successfully decoying the weapon depends on the size of the crossing ship. Treat a small ship as a (working) first generation countermeasure, a medium ship as a second generation, and a large ship as a third generation decoy. If successfully decoyed, the weapon will begin homing in on the "countermeasure" ship.

See section 10.2.6 to resolve attacks by wake-homing torpedoes.

7.5.6 Acquisition Ranges. The Torpedo Seeker Generations table shows the acquisition range for each generation of torpedo guidance systems. All torpedoes have a ±60° acquisition cone based on the torpedo's course. Acquisition range can be modified by the following conditions:

• *Being cross-layer* (see 7.5.2)

• *Anechoic Coatings.* Submarines with acoustic tiles reduce the range of active acoustic seekers by 25%. This is accommodated in the -2 for the weapon placement die roll.

• *Target Noise Signature.* The passive acquisition ranges in the Torpedo Guidance Generation table are for a Quiet target. If the target has a higher or lower noise signature, the passive acquisition range must be modified by one of the following values:

Loud	x2
Noisy	x2
Quiet	x1
Very Quiet	x1/2
Ext Quiet	x1/4

• *Reverberation.* Water less than 200 meters in depth (Intermediate II) is often referred to as "shallow water" by ASW operators. Sonar propagation in water this shallow is very different from open ocean. This affects detection, sensor deployment, and some acoustic homing weapons.

Depth charges and ASW mortars are unaffected by shallow water effects. This is one reason why European navies, which operate in shallow waters much more than the US Navy, still use these weapons.

Shallow water and conditions under ice are both "high reverberation" environments. Reflections from the sea floor and sea surface, or the undersurface of the ice, create numerous false echoes that can confuse a torpedo's seeker. If an acoustic homing torpedo is fired in Shallow water, in the Marginal Ice Zone (MIZ), or under pack ice, there is a -2 weapon placement die roll modifier for Gen 1-3 seekers, and a -1 modifier for Gen 4. If the acquisition cone needs to be used, reduce active acquisition range by 50% for Gen 1-3 and 25% for Gen 4. There is no effect on passive seekers.

7.5.7 Dual-Speed Torpedoes. Some torpedoes have two or even three different speed settings; Slower speeds give a longer range, and high speed for attack. Players can choose to fire a torpedo at any speed/range setting. Wire-guided torpedoes can be commanded to change to any speed setting as long as the wire is intact.

If the torpedo is fired at slow or medium speed, it will automatically accelerate to attack speed once it acquires a target.

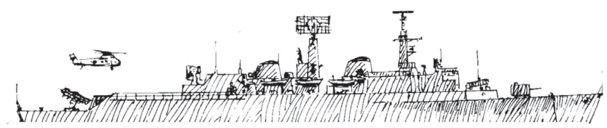
When a torpedo accelerates to attack speed, the engine makes more noise and the propulsor starts to cavitate, which increases its detectability. But cavitation and speed modifiers don't apply to torpedoes. Any torpedo at any speed setting is a "Noisy" contact, unless it is rated as "Quiet." Once detected, a torpedo must be classified as such. The procedure for classifying torpedoes is the same as that for identifying ships and submarines (see 5.4.6.6).

7.5.8 Quiet Torpedoes. Some multi-speed torpedoes, because of advanced propulsor design and sound isolation of the propulsion plant, are "Quiet" or possibly even "Very Quiet" at speeds less than 45 knots. This dramatically reduces the range at which the torpedo will be heard by the targeted unit and reduces its ability to evade or decoy an attacking torpedo.

7.6 Effects of Weather on Shipboard Weapons. Surface ship weapons are affected by high seas and winds. Rotating machinery can be thrown out of balance, guidance radars have problems tracking their targets, and the crew may be too busy hanging on to operate their equipment.

Large to VSmall (size class A-E) ships cannot fire their gun systems, rotating or elevating missile launchers, or ahead-thrown ASW weapons, or drop depth charges in sea state 7 or greater. Small craft (size class F - G) cannot fire at sea state 5 and above. There are negative modifiers to the chance of a gun hitting its target as the sea state increases, see page 8-11.

Missiles in fixed or vertical launchers can be fired up to sea state 8.



British County-class DDG

Chapter Eight - Surface Warfare

A ship can attack air, surface and submarine targets (with different mounts) at the same time.

8.1 Anti-Air Warfare (AAW). Surface ships can defend themselves against air attacks with guns, missiles, or energy weapons.

8.1.1 Radar-Guided Surface-to-Air Missiles (SAMs). To engage incoming bogeys (missiles or aircraft), mark the beginning and end of their 3-minute move.

1) Detection Range: During the detection phase, each defending ship's player measures out the range for the ship's air search, 3D or HF radars (remember the radar horizon, 5.2.8) and places detection markers along the flight path.

2) Detection: Move the bogey in 30-second increments (speed divided by 120) along the bogey's flight path until it reaches the radar detection marker. This is the earliest that the ship can detect the incoming unit.

3) Reaction Time: Roll 2D6 on the Combat System Reaction table on page 8-4, and add it to the Combat System Reaction time to find the delay in 30-second increments between when the ship can detect the incoming missile and when it can react.

Example: A ship with 3rd Gen Combat System has a normal reaction time of 3 increments. Rolling 2D6 on the Combat System Reaction table, he gets a three, meaning an additional delay of 4 increments. The ship must wait 7 increments - more than a Tactical Turn - before it can engage.

4) Intercept Range: Count that many increments along the missile's flight path, and mark the spot with an "Engage" marker. Make sure the ship's 3D or HF radar is in range. If it is not, the ship's SAM system can't engage yet (*exception:* SAM engagements at ranges of 15 nmi or less do not need a 3D or HF radar). In this case, move the bogey along its flight path until it reaches the 3D/HF radar's range or the 15 nmi point.

5) SAM Range Check: See if the bogey is inside Intercept Range. The shooter may get a bonus against very fast targets with closing (20° or less bearing shift per Tactical Turn) geometry.

If a closing non-maneuvering target's speed is 2,001 knots or more, the Intercept Range is twice the SAM range listed in Annex D. If its speed is 501 - 2,000 knots, the Intercept range is 1.5 times the listed SAM range.

This takes into account "f-pole," a calculation designed to intercept an oncoming bogey just as it enters maximum SAM range. If the incoming bogey turns 90° or more for a full Tactical Turn after the defender shoots, the Intercept range drops to the SAM range listed in Annex D, and missiles already fired will miss.

If the bogey is out of Intercept range, keep moving the marker along its flight path until it reaches Intercept range.

6) Bearing Rate: Measure the bogey's bearing change between the start and end of its movement for the 3-minute Tactical Turn. If it is less than 20°, it is a "closing" target; from 21° to 45°, it is "diverging"; over 45°, it is a crossing target. This affects how hard it is to hit.

7) Punch the Table: Find the SAM Intercept table that matches the bogey's type. For example, a Kh-22 has a speed of 2003 knots and flies at VHigh altitude. The defender would use the Intercept table for "High & VHigh, Medium Supersonic Missiles." The speed descriptions are listed in the Target Speed Modifiers table on page 8-8.

Use the smaller of either the SAM's range listed in Annex D or the actual Intercept Range to find the column on the Intercept table. It shows how many shots the ship gets at the incoming missiles at long, medium, short, and point defense range bands. *Exception*: SAMs with a minimum range greater than 2.5 nmi cannot fire into the Point Defense range band, even if the table allows a shot.

Example (see the diagram on page 8-2): A ship equipped with SM1ER Blk IV (SARH, range 40 nmi) and a 4th Gen combat system engages an incoming Kh-22N salvo. The detection range of a SPS-49(V)5 radar is 169 nmi vs. a Small target. The defending player rolls 2D6 on the Combat System Reaction table and gets a "4." This adds 2 increments to the normal reaction time of 2 increments - a total of 4.

The Kh-22N has a speed of 2003 knots (Medium Supersonic) in VHigh cruise, so it covers 16.7 nmi per increment. In 4 increments, it moves 66.8 nmi (16.7 nmi x 4) from the edge of the radar detection until the combat system can react. This gives an Intercept Range of 169 nmi - 68.8 nmi = 102.2 nmi.

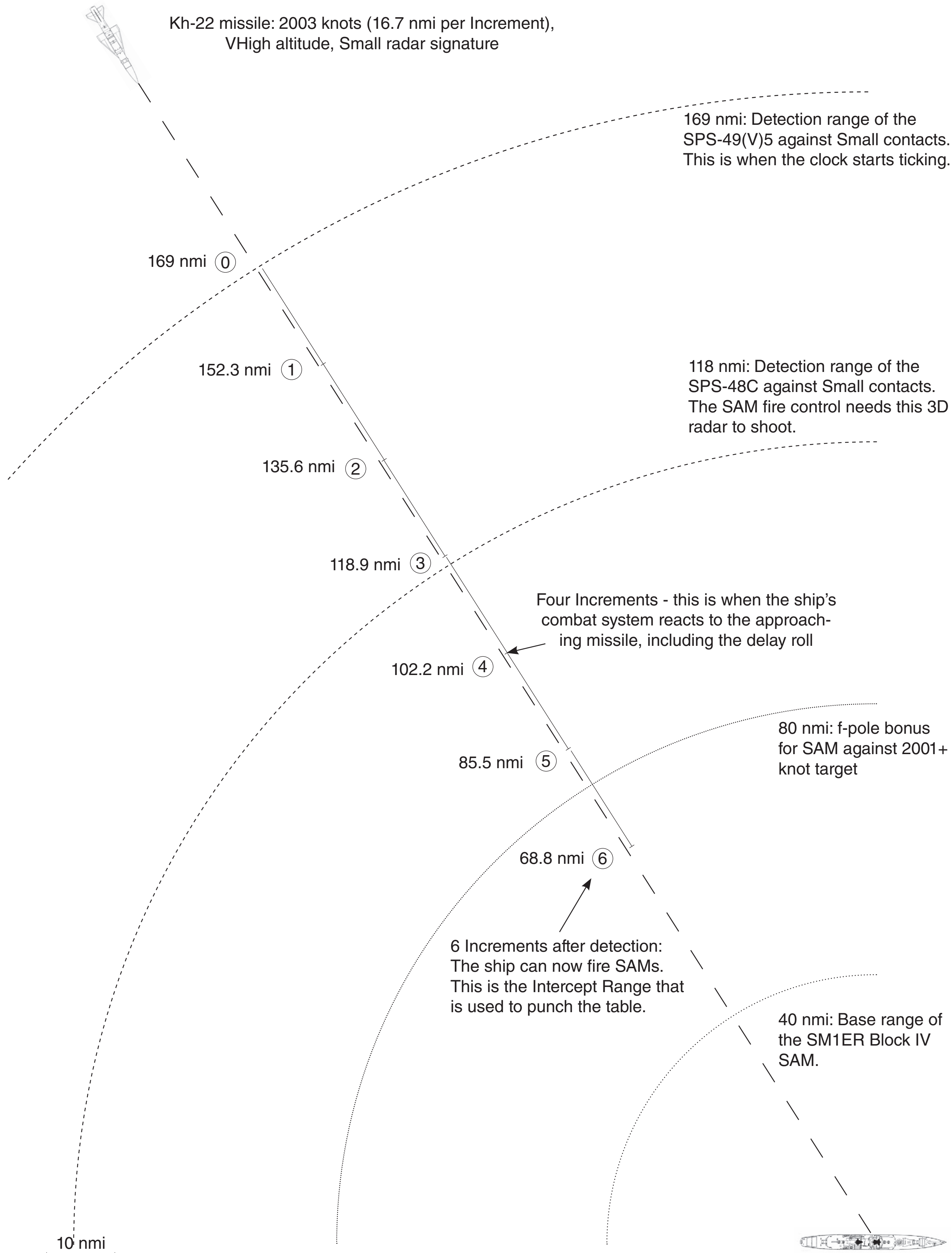
Checking the 3D radar's range, this is within the SPS-48C's detection range (118 nmi), but it is more than 80 nmi (twice the SAM's max range of 40 nmi). This means the missiles will have to move two more increments until they are within 80 nmi and the ship can shoot. That reduces the distance from 102.2 to 85.5, and then 68.8 nmi. This is the Intercept Range.

Since the missile is being fired directly at the ship, its bearing rate is zero, and is a closing target.

Looking at the SAM Intercept table for High and VHigh targets, using the Intercept Range of 68.8 nmi, on the 60.1 - 90.0 nmi section, at the intersection of the 4th Gen combat system line and the Medium Supersonic column, the ship gets "L-2M-S" meaning one long, two medium, one short, and no shots in the point defense band. The SM1ER Blk IV has a minimum range of 3.5 nmi, so it couldn't fire in the Point Defense range band, anyway.

8) Missile Salvoes: Each missile salvo may have more than one missile firing at more than one target. The SAM Salvo Summary table on page 6-1 lists the number of missiles each director can control and how many targets each director can engage. For example, each director for the SM1ER Blk IV (SARH guidance) controlled by a 4th Gen combat system can engage 1 target with two missiles each.

9) Chance to Hit: Subtract the bogey's Maneuver Rating from the missile's ATA Rating and apply any modifiers from the Antiair Missile Attack table on page 8-8.


Kh-22 missile: 2003 knots (16.7 nmi per Increment),
VHigh altitude, Small radar signature
169 nmi: Detection range of the
SPS-49(V)5 against Small contacts.
This is when the clock starts ticking.
169 nmi 0
152.3 nmi 1
118 nmi: Detection range of the
SPS-48C against Small contacts.
The SAM fire control needs this 3D
radar to shoot.
135.6 nmi 2
118.9 nmi 3
Four Increments - this is when the ship's
combat system reacts to the approach-
ing missile, including the delay roll
102.2 nmi 4
80 nmi: f-pole bonus
for SAM against 2001+
knot target
85.5 nmi 5
68.8 nmi 6
6 Increments after detection:
The ship can now fire SAMs.
This is the Intercept Range that
is used to punch the table.
40 nmi: Base range of
the SM1ER Block IV
SAM.
10 nmi

In this example, the SM1ER Blk IV has an ATA value of 2.0 with the following modifiers:

- Bogey speed: Med Supersonic = -2
- Bearing Rate: Less than 20° ("closing target") = 0
- Range: Medium1 range band intercept = 0
- Target Size: Small = 0
- Sea Skimmer: N/A
- Terminal Maneuver: N/A
- Combat System Mod: 4th Gen = +0.5

The final value is 0.5, which is the Missile Index; Cross-referenced on the Antiair Missile Attack table (page 8-8), this gives a single-missile hit chance of 35%, and a two-missile hit chance of 58%.

The defending player rolls D100, and if the result is less than or equal to the chance to hit, then the target was shot down.

All defending ship players should roll each range band's salvoes at the same time, before proceeding to the next range band.

8.1.2 Visually-Aimed Surface-to-Air Missiles (SAMs). Man-portable SAMs (MANPADs), some in naval mounts, and some land-based SAMs, are aimed and fired manually, with no other sensor but the human eye. They are either Command, Laser-beam-Riding, or IR- or EO-guided to their target. All visually-aimed SAM launches take place when the bogey is in the Point Defense band, within 8 kyds of the ship, and each launcher can make one attack.

Check the remarks in Annex D to see if a MANPADS can fire at head-on targets. Early systems could only fire at rear-aspect targets. See 8.1.6 Receding Targets.

8.1.3 Air Defense Gunnery. All AA-capable guns have an individual strength listed in Annex C. This value is modified by the ship's combat system/gunnery standard and multiplied by the number of barrels on the mount (rotaries counts as one), ammunition type, and the number of mounts firing at a target. The modified strength is listed in Annex A on the weapons line for each AA-capable gun. Annex Z provides a complete description of the formula.

All air defense guns fire at targets in the increment they pass through the Point-Defense range band, which extends out 8 kyds from the firing ship. All air defense guns of 65mm or less, including those in local control, will get at least one shot at air targets in this band. This assumes the ship is at general quarters.

If a gun does not have an AA strength listed, it cannot fire at air targets.

If a gun has an AA strength, but does not have a director listed, it must fire under "local control," with the gunner aiming the weapon. Guns that fire in local control have their AA strength marked by "L." The combat system modifier for them is 0.5. This is already factored into their AA strength.

Autonomous close-in weapons systems are handled separately in section 8.1.4.

The number of targets a ship's guns can engage depends on the number of directors the ship has, and their arcs. Directors will use either dedicated radars or EO sensors. They are listed on a weapons line after the "//." The director arcs are usually the same as the guns. For example:

F/P/S(R)6 AK-630 30mm//3 MR-123 **(3@5.4)**. There are three pairs of AK-630s, each controlled by a MR-123 (NATO Bass Tilt) fire control radar.

If the director arcs are different, they will be listed after the "//."

For example: F/A(1)2 AK-176 76mm/59//F MR-123 **(4.4)**. Although the gun mounts have F/A arcs, and both can fire to port and starboard, the director only has a forward arc, and thus a blind zone dead aft.

The AA strength represents a gun system's firepower to one side of the ship (a 180° arc). If there are eligible targets in both port and starboard hemispheres, then the AA strength can be applied to both sides, except that guns that can fire both to port and starboard can fire at only one target. For example: P/S(2)2 AK-725 57mm/75//2 MR-103 Bars **(1.3)**. One AK-725 mount bears to either side, and each has its own radar, so if there were targets on both sides, each could be attacked with an AA strength of 1.3.

Normally there is only one director per side, but on some ships there may be two or more, or the arcs may overlap. For example: PW/SW/PA/SA(R)8 AK-630 30mm//4 MR-123 **(4@5.4)**. This system gets four shots, one into each of the arcs, but because the arcs overlap, it can engage two targets in almost any direction. The guns can shoot two targets, or take two shots at the same air target.

To fire at air targets, take the ship's gun value and apply any appropriate antiair gun modifiers listed on page 8-9. Roll D100 on the Antiair Gun Hit Chance table, and if the D100 roll is less than or equal to the hit chance, the air target is destroyed.

Example: A(2)2 AK-726 76mm/59//MR-114 **(3.9)**

A Project 1135 Krivak I's AK-726 76mm guns have an AA strength of 3.9. This value represents both mounts controlled by a single MR-114 [NATO Kite Screech]. Both the guns and the director have an aft arc. To fire at a Harpoon missile (Transonic, VSmall, and VLow), the strength is: 3.9 +0 (Transonic) - 1 (VSmall) - 3 (VLow, the AK-726 is not seaskimmer-capable). The modified strength of - 0.1 means no chance of a hit.

8.1.4 Close-In Weapons Systems. Some short-range air defense guns are "Autonomous;" they operate independently of the ship's combat system. They have their own built-in fire control. They get two shots (usually bursts of automatic fire) in each increment of the missile's movement in the Point Defense band. These can be against two targets, or two shots at the same target if the first one misses. They do not have to choose their second target until the first attack is resolved.

Examples include Phalanx, Goalkeeper, and Kashtan. Autonomous CIWS systems will have it listed in the Annex C remarks column and their AA strength is marked with an "A."

8.1.5 The Three-Second Rule. Very fast missiles destroyed close to their target (within three seconds of flight time) still are a threat to the defending ship. Instead of being struck by a warhead, the missile's target may get hit by flaming debris. It's a little better, but not a lot.

Whether the ship gets hit by debris or not depends on exactly how far from the ship the intercept occurs. For each missile destroyed by SAMs or gunfire in the Point Defense band, roll D100 on the following table:

	Missile Speed		
Defending <u>Weapon</u>	*750 kts <u>or less</u>*	*751 - <u>1525 kts</u>*	*<u>1526+ kts</u>*
30mm or less	10%	50%	90%
65mm or less	0%	40%	70%
66mm or more	0%	10%	20%
SAM	0%	10%	30%

Combat System Reaction Time

Combat System	*Normal Delay (Increments)*
1st Gen Cbt Sys	8
2nd Gen Cbt Sys	6
3rd Gen Cbt Sys	3
4th Gen Cbt Sys	2
5th, 6th Gen Cbt Sys/Human	1
5th Gen Cbt Sys Auto	0
6th Gen Cbt Sys Auto	0

Combat System Reaction

2D6 Roll	*1st Gen*	*2nd, 3rd Gen*	*4th Gen, 5th &6th Human*	*5th Gen Auto*	*6th Gen Auto*
2	+4	+4	+4	+3	+2
3	+4	+4	+3	+2	+1
4	+4	+4	+2	+1	+1
5	+4	+3	+1	+1	0
6	+3	+2	+1	0	0
7	+2	+1	0	0	0
8	+1	+1	0	0	0
9	+1	0	0	0	-1
10	0	0	0	-1	-2
11	0	0	-1	-2	-2
12	0	0	-2	-2	-2

Own Ship ES cue: +1 to the die roll.

Tactical Data Link Cue (see also 5.2.1, page 5-1)
Other platforms in contact and sharing active sensor data by TDL, use applicable TDL modifier.
NRT TDL: +1
RT TDL: +2

Note: A negative result means the radar was able to detect the target that number of increments earlier, that is, at a longer range than the listed range in Annex J for that signature. The range is limited by the radar horizon.

AAW Range Bands

Range Bands	*Range (nmi)*
Point Defense	0 - 4.0
Short	4.1 - 15
Medium 1	15.1 - 30
Medium 2	30.1 - 45
Long 1	45.1 - 60
Long 2	60.1 - 90
Very Long	90.1 -135
Extreme	135.1+

- SAMs with a minimum range greater than 2.5 nmi cannot fire into the Point Defense range band.
- Incoming missiles with final-stage sprint vehicles (listed in the Remarks in Annex D or H2) have a Medium Supersonic speed in the Short and Point Defense range bands. They also allow one less engagement in either the Short range band, or if there are no possible engagements there, in the Point Defense range band.

The table shows the percent chance of missile fragments striking the defender. These will not inflict any damage points, but will cause half the airframe critical hits, rolled as airburst damage (see 14.1.4). The first critical hit inflicted does not have to be a fire.

Example: The Russian Kh-22N inflicts 65 + D6 damage and has a speed of 2003 knots. It is shot down by a Mk15 Phalanx 20mm. The defending player fails to roll over 90% (think of it as a "saving throw"), so the defender will suffer D6 critical hits, halved.

For Size Class A - E, the critical hits are rolled on the Airburst column of the Critical Hit Table. Small Craft (Size F and G) criticals are rolled on the Small Craft column.

8.1.6 Receding Air Targets. Aircraft or missiles flying away from a ship cannot be engaged by AAA guns. To use SAMs, use the listed range of the SAM system (no f-pole bonus) on the SAM Intercept table for the bogey's speed and altitude. Especially for manned aircraft, this may be different than its inbound speed and altitude.

After finding the appropriate number of missile shots, shift them one range band out, and halve them, rounding down. Modifiers for bearing drift, target speed, etc., apply.

Example: An aircraft attacks in VLow flight at 650 knots (Transonic), but once freed of ordnance, it accelerates to 790 knots (Low Supersonic) and "climbs" to Low altitude. For a 4th Gen combat system and a SAM with a range of 30 nmi (Medium 1), on the Intercept table for Low altitude targets, this becomes "M-2S-P," which shifted out becomes "L-2M-S," and halved becomes "M," with no shots at Long or Short.

Exception: MANPADS that can only fire at aft-aspect targets get their single attack in the PD band at this time.

8.1.7 Small Arms Fire at Aircraft. Infantry units embarked on a ship may use their automatic weapons to attack aircraft attacking the ship. While not very effective, it tends to distract the pilot and improve morale of the troops. The AA strength is 0.2 and can be applied to any air target that passes within 1000 yards at Low altitude.

8.1.8 Antiair Firing Restriction. No unit may fire any weapon or guide any missile at an air target the move increment it is due to reach another friendly vessel. Imagine an antiaircraft gun tracking and firing at a missile headed toward another friendly ship. Most of the rounds aimed at the missile will miss, and many will hit the friendly ship, even if the missile is shot down. The same effect would result with a SAM fired at the missile. A ship presents a much larger radar image than a missile, so there is a very good chance that the ship would be hit by the SAM as well as the enemy missile. See section 7.3.

8.1.9 Laser Dazzlers (LDS) are point-defense systems designed to disrupt optical sensors and the human eye. They affect EO, LLLTV, and TV sensors.

It has a range of 5.0 nmi. An LDS mount has a night vision scope allowing engagement at night, so the combination of this sight and the dark-adaptation of the target pilot's eyes extend the effective range by 150% in twilight and 200% at night.

As the weapon is optical, its range is affected by the environment, i.e., 50% visibility halves the range.

They can be used against manned aircraft attacking the ship fitted with an LDS, or UAVs within range. It can be used against aircraft in VLow flight (it is capable vs. sea-skimmers). They cannot be used against optically-guided missiles unless they are linked to a ship's combat system, i.e., fitted with a director.

SAM Intercept Table - High & VHigh Altitude Targets

CS Generation	Subsonic & Transonic	Low Supersonic	Med Supersonic	High Supersonic	Low Hypersonic
Intercept Range (135.1+ nmi) - Extreme					
2nd	E-V-2L-3M-S-P	--	--	--	--
3rd	E-V-3L-3M-2S-P	--	--	--	--
4th	E-2V-2L-3M-3S	E-V-L-M-2S-P	--	--	--
5th/6th Human	E-2V-2L-3M-3S	E-V-L-M-2S-P	--	--	--
5th Auto	E-2V-2L-3M-3S-P	E-V-L-2M-2S-P	--	--	--
6th Auto	E-2V-2L-3M-3S-P	E-V-L-2M-2S-P	--	--	--
Intercept Range (90.1 - 135.0 nmi) - Very Long					
2nd	V-2L-3M-2S	V-L-M-S-P	--	--	--
3rd	V-3L-3M-2S-P	V-L-2M-S-P	--	--	--
4th	V-3L-3M-3S	V-L-2M-2S-P	V-L-M-S-P	--	--
5th/6th Human	V-3L-3M-3S	V-L-2M-2S-P	V-L-M-S-P	--	--
5th Auto	V-3L-3M-3S-P	V-2L-2M-2S-P	V-L-M-2S-P	--	--
6th Auto	V-3L-3M-3S-P	V-2L-2M-2S-P	V-L-M-2S-P	--	--
Intercept Range (60.1 - 90.0 nmi) - Long 2					
2nd	2L-3M-2S	2L-M-S	L-M-S	--	--
3rd	3L-2M-3S-P	2L-M-2S	L-M-S-P	L-M-P	--
4th	3L-3M-2S-P	2L-2M-S-P	L-2M-S	L-M-S	L-M-P
5th/6th Human	3L-3M-2S-P	2L-2M-S-P	L-2M-S	L-M-S	L-M-P
5th Auto	3L-3M-3S-P	2L-2M-2S-P	L-2M-S-P	L-M-S-P	L-M-S
6th Auto	3L-3M-3S-P	2L-2M-2S-P	L-2M-S-P	L-M-S-P	L-M-S
Intercept Range (45.1 - 60.0 nmi) - Long 1					
2nd	L-2M-2S-P	L-M-S-P	L-M-P	--	--
3rd	2L-2M-2S	L-2M-S	L-M-S	L-M-P	L-S
4th	2L-2M-3S-P	L-2M-S-P	L-M-S-P	L-M-S	L-M-P
5th/6th Human	2L-2M-3S-P	L-2M-S-P	L-M-S-P	L-M-S	L-M-P
5th Auto	2L-3M-3S-P	L-2M-2S-P	L-M-2S	L-M-S-P	L-M-S
6th Auto	2L-3M-3S-P	L-2M-2S-P	L-M-2S	L-M-S-P	L-M-S
Intercept Range (30.1 - 45.0 nmi) - Medium 2					
2nd	2M-2S-P	2M-S	M-S	M-S	--
3rd	3M-2S-P	2M-S-P	M-S-P	M-S	M-S
4th	3M-2S-P	2M-2S	2M-S	M-S-P	M-S
5th/6th Human	3M-2S-P	2M-2S	2M-S	M-S-P	M-S
5th Auto	3M-3S-P	2M-2S-P	2M-S-P	M-2S	M-S-P
6th Auto	3M-3S-P	2M-2S-P	2M-S-P	M-2S	M-S-P
Intercept Range (15.1 - 30 nmi) - Medium 1					
2nd	2M-S-P	M-S-P	M-S	M-P	M
3rd	2M-2S-P	M-S-P	M-S	M-P	M-P
4th	2M-3S-P	M-2S-P	M-S-P	M-S	M-S
5th/6th Human	2M-3S-P	M-2S-P	M-S-P	M-S	M-S
5th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P	M-S
6th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P	M-S
Intercept Range (≤15 nmi) - Short					
2nd	2S-P	S-P	S	S	S
3rd	2S-P	2S	S-P	S	S
4th	3S-P	2S-P	S-P	S-P	S
5th/6th Human	3S-P	2S-P	S-P	S-P	S
5th Auto	3S-P	2S-P	2S-P	S-P	S-P
6th Auto	3S-P	2S-P	2S-P	S-P	S-P

1) Any SAM with 3,000+ knots speed gets an additional engagement at either Long - 1 or Medium - 2, at the player's discretion.
2) A "--" means the attack is kinematically impossible. Drop down to the first Intercept Range that allows an attack to take place.
3) The number of engagements in the above tables are for each missile fire control channel.

SAM Intercept Table - Medium Altitude Targets

Intercept Range (90.1 - 135.0 nmi) - Very Long				
CS Generation	*Subsonic & Transonic*	*Low Supersonic*	*Med Supersonic*	*High Supersonic*
2nd	V-2L-2M-2S-P	--	--	--
3rd	V-2L-3M-2S-P	--	--	--
4th	V-3L-3M-2S-P	V-L-2M-S-P	--	--
5th/6th Human	V-3L-3M-2S-P	V-L-2M-S-P	--	--
5th Auto	V-3L-3M-3S-P	V-L-2M-2S-P	--	--
6th Auto	V-3L-3M-3S-P	V-L-2M-2S-P	--	--

Intercept Range (60.1 - 90.0 nmi) - Long 2				
2nd	2L-3M-2S	L-M-2S	--	--
3rd	3L-2M-3S-P	2L-M-2S	--	--
4th	3L-3M-2S-P	2L-2M-S-P	L-M-S-P	--
5th/6th Human	3L-3M-2S-P	2L-2M-S-P	L-M-S-P	L-M-S
5th Auto	3L-3M-3S-P	2L-2M-2S-P	L-2M-S-P	L-M-S-P
6th Auto	3L-3M-3S-P	2L-2M-2S-P	L-2M-S-P	L-M-S-P

Intercept Range (45.1 - 60.0 nmi) - Long 1				
2nd	L-2M-2S-P	L-M-S-P	--	--
3rd	2L-2M-2S	L-2M-S	L-M-S	L-S
4th	2L-2M-3S-P	L-2M-S-P	L-M-S-P	L-M-S
5th/6th Human	2L-2M-3S-P	L-2M-S-P	L-M-S-P	L-M-S
5th Auto	2L-3M-3S-P	L-2M-2S-P	L-M-2S	L-M-S-P
6th Auto	2L-3M-3S-P	L-2M-2S-P	L-M-2S	L-M-S-P

Intercept Range (30.1 - 45.0 nmi) - Medium 2				
2nd	2M-2S-P	2M-S	M-S	--
3rd	3M-2S-P	2M-S-P	M-S-P	M-S
4th	3M-2S-P	2M-2S	2M-S	M-S-P
5th/6th Human	3M-2S-P	2M-2S	2M-S	M-S-P
5th Auto	3M-3S-P	2M-2S-P	2M-S-P	M-2S
6th Auto	3M-3S-P	2M-2S-P	2M-S-P	M-2S

Intercept Range (15.1 - 30 nmi) - Medium 1				
2nd	2M-S-P	M-S-P	M-S	--
3rd	2M-2S-P	M-S-P	M-S	M-P
4th	2M-3S-P	M-2S-P	M-S-P	M-S
5th/6th Human	2M-3S-P	M-2S-P	M-S-P	M-S
5th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P
6th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P

Intercept Range (≤15 nmi) - Short				
2nd	2S-P	S-P	S	S
3rd	2S-P	2S	S-P	S
4th	3S-P	2S-P	S-P	S-P
5th/6th Human	3S-P	2S-P	S-P	S-P
5th Auto	3S-P	2S-P	2S-P	S-P
6th Auto	3S-P	2S-P	2S-P	S-P

1) Any SAM with 3,000+ knots speed gets an additional engagement at either Long - 1 or Medium - 2, at the player's discretion.
2) A "--" means the attack is kinematically impossible. Drop down to the first Intercept Range that allows an attack to take place.
3) The number of engagements in the above tables are for each missile fire control channel.

SAM Intercept Table - Low Altitude Targets

CS Generation	Subsonic & Transonic	Low Supersonic	Med Supersonic	High Supersonic
Intercept Range (45.1 - 60.0 nmi) - Long 1				
2nd	--	--	--	--
3rd	L-2M-3S	--	--	--
4th	2L-2M-3S-P	L-M-2S-P	--	--
5th/6th Human	2L-2M-3S-P	L-M-2S-P	--	--
5th Auto	2L-3M-3S-P	L-2M-2S-P	--	--
6th Auto	2L-3M-3S-P	L-2M-2S-P	--	--
Intercept Range (30.1 - 45.0 nmi) - Medium 2				
2nd	2M-2S-P	--	--	--
3rd	3M-2S-P	--	--	--
4th	3M-2S-P	2M-2S	M-S-P	--
5th/6th Human	3M-2S-P	2M-2S	M-S-P	--
5th Auto	3M-3S-P	2M-2S-P	2M-S-P	--
6th Auto	3M-3S-P	2M-2S-P	2M-S-P	--
Intercept Range (15.1 - 30 nmi) - Medium 1				
2nd	2M-S-P	--	--	--
3rd	2M-2S-P	M-S-P	--	--
4th	2M-3S-P	M-2S-P	M-S-P	M-S
5th/6th Human	2M-3S-P	M-2S-P	M-S-P	M-S
5th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P
6th Auto	3M-3S-P	2M-S-P	M-2S	M-S-P
Intercept Range (≤15 nmi) - Short				
2nd	2S-P	S-P	--	--
3rd	2S-P	2S	S-P	P
4th	3S-P	2S-P	S-P	S-P
5th/6th Human	3S-P	2S-P	S-P	S-P
5th Auto	3S-P	2S-P	2S-P	S-P
6th Auto	3S-P	2S-P	2S-P	S-P

SAM Intercept Table - VLow Altitude Targets

CS Generation	Subsonic & Transonic	Low Supersonic	Med Supersonic	High Supersonic
Intercept Range (15.1 - 30 nmi) - Medium 1				
2nd	--	--	--	--
3rd	--	--	--	--
4th	--	--	--	--
5th/6th Human	--	--	--	--
5th Auto	M-3S-P	--	--	--
6th Auto	M-3S-P	--	--	--
Intercept Range (≤15 nmi) - Short				
2nd	P	--	--	--
3rd	S-P	P	--	--
4th	2S-P	S	P	--
5th/6th Human	2S-P	S-P	S	P
5th Auto	3S-P	2S-P	S-P	S
6th Auto	3S-P	2S-P	S-P	S

1) Any SAM with 3,000+ knots speed gets an additional engagement at either Long - 1 or Medium - 2, at the player's discretion.
2) A "--" means the attack is kinematically impossible. Drop down to the first Intercept Range that allows an attack to take place.
3) The number of engagements in the above tables are for each missile fire control channel.

SAM & AAM Missile Attacks

Antiair Missile Attack Table

Missile Index	*One Msl Pk*	*Two Msl Pk*
-4.5	01%	02%
-4.0	02%	04%
-3.5	04%	08%
-3.0	06%	12%
-2.5	08%	15%
-2.0	10%	19%
-1.5	15%	28%
-1.0	20%	36%
-0.5	25%	44%
-0.0	30%	51%
+0.5	35%	58%
+1.0	40%	64%
+1.5	45%	70%
+2.0	50%	75%
+2.5	55%	80%
+3.0	60%	84%
+3.5	65%	88%
+4.0	70%	91%
+4.5	75%	94%
+5.0	80%	95%
+5.5	85%	95%

Target Signature Modifier

Target Signature	*Msl ATA Mod*
Large, Medium, Small	0
VSmall	-1
Stealthy	-2

Combat System Modifier

Ship CS Gen	*AI & LD/SD Radar Gen*	*Missile Tgt ATA Mod*	*Aircraft Tgt ATA Mod*
2	1-2	-1.0	0.0
3	3	0.0	1.0
4	4	0.5	2.0
5/6H	5	1.0	2.5
5/6A	6	1.5	3.0

AAMs using HOJ mode have their ATA rating halved before applying modifiers. They will ignore decoys and jammers.

Target Modifiers (Modifies Missile ATA Rating)

Non-maneuvering aircraft ATA	0.0
Missile Terminal Maneuvers	-1.0
Seaskimmer Capable?	
Full Capability (min altitude VLow)	0
Partial Capability (min altitude PVLow)	-2
Not Capable (min altitude Low)	-4

Target Speed Modifiers

(kts)	*Mach*	*Descriptor*	*ATA Mod*
≤250	0.4	Slow	+2
251-500	0.8	Subsonic	+1
501-750	0.9-1.2	Transonic	0
751-1525	1.3-2.5	Low Supers.	-1
1526-2300	2.6-3.8	Med Supers.	-2
2301-3075	3.9-5.0	High Supers.	-3
3076-4100	5.1-6.7	Low Hypers.	-4
4101-5125	6.7-8.3	Med Hypers.	-5
5126+	8.4+	High Hypers.	-6

Bearing Rate Modifier

Description	*Tac Turn Bearing Shift*	*Msl ATA Mod*
Closing	0 - 20°	0
Divergent	21 - 45°	-2.0
Crossing	45+°	-4.0
High Diving*		-2.0

*Short Range and Point Defense engagements for 1st - 3rd Gen Combat Systems only.

Range Band Modifiers

Range Band	*Range (nmi)*	*Msl ATA Mod*
Point Defense	≤4.0	0
Short	4.1 - 15.0	0
Medium 1	15.1 - 30.0	0
Medium 2	30.1 - 45.0	-0.5
Long 1	45.1 - 60.0	-0.5
Long 2	60.1 - 90.0	-1.0
Very Long	90.1 - 135.0	-1.5
Extreme	135.1+	-2.0

• SAMs with a minimum range greater than 2.5 nmi cannot fire into the Point Defense Range Band
• If there is more than one engagement within the Long or Medium range bands, the first one uses the outer band, the rest use the inner band.

Antiair Missile Countermeasures Table

Msl Seeker Gen	*1st Gen Jam*	*2nd Gen Jam*	*3rd Gen Jam*	*4th Gen Jam*	*1st Gen Decoy*	*2nd Gen Decoy*	*3rd Gen Decoy*	*4th Gen Decoy*	*1st Gen J&D*	*2nd Gen J&D*	*3rd Gen J&D*	*4th Gen J&D*
1	-1.5	-2.0	-2.5	-3.5	-1.0	-1.5	-2.0	-3.0	-2.5	-3.5	-4.5	-5.5
2	-1.0	-1.5	-2.0	-3.0	-0.5	-1.0	-1.5	-2.5	-2.0	-3.0	-3.5	-5.0
3	-0.5	-1.0	-1.5	-2.5	-0.5	-0.5	-1.0	-2.0	-1.0	-2.0	-3.0	-4.5
4	--	-0.5	-1.0	-2.0	--	-0.5	-0.5	-1.5	-0.5	-1.0	-2.0	-3.5
5	--	--	-0.5	-1.5	--	--	-0.5	-1.0	--	-0.5	-1.0	-2.5

Note: If the defending aircraft cannot or chooses not to maneuver, then halve the countermeasure modifier before applying it to the Missile Index. Its Maneuver Rating is also reduced to 0.0.

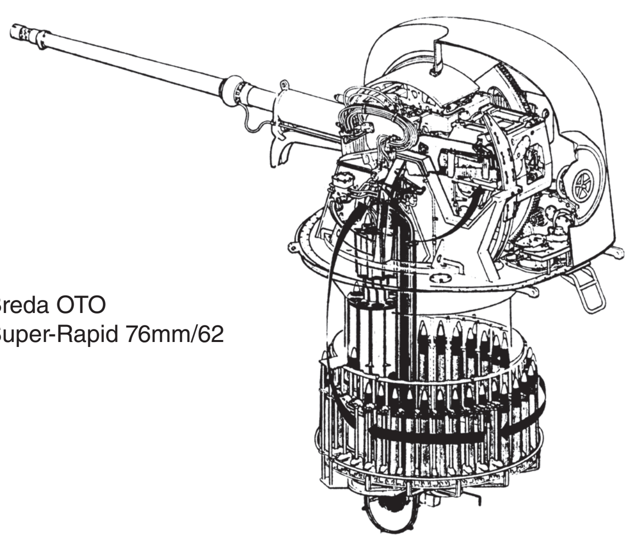
Antiair Gun Hit Chance

AA Strength	*Hit Chance*	*AA Strength*	*Hit Chance*
0.1	0.06	5.4	0.61
0.2	0.09	5.5	0.62
0.3	0.12	5.6	0.62
0.4	0.14	5.7	0.63
0.5	0.16	5.8	0.64
0.6	0.17	5.9	0.64
0.7	0.19	6.0	0.65
0.8	0.21	6.1	0.66
0.9	0.22	6.2	0.66
1.0	0.23	6.3	0.67
1.1	0.25	6.4	0.67
1.2	0.26	6.5	0.68
1.3	0.27	6.6	0.69
1.4	0.28	6.7	0.69
1.5	0.29	6.8	0.70
1.6	0.31	6.9	0.70
1.7	0.32	7.0	0.71
1.8	0.33	7.1	0.72
1.9	0.34	7.2	0.72
2.0	0.35	7.3	0.73
2.1	0.36	7.4	0.73
2.2	0.37	7.5	0.74
2.3	0.38	7.6	0.74
2.4	0.39	7.7	0.75
2.5	0.39	7.8	0.76
2.6	0.40	7.9	0.76
2.7	0.41	8.0	0.77
2.8	0.42	8.1	0.77
2.9	0.43	8.2	0.78
3.0	0.44	8.3	0.78
3.1	0.45	8.4	0.79
3.2	0.45	8.5	0.79
3.3	0.46	8.6	0.80
3.4	0.47	8.7	0.80
3.5	0.48	8.8	0.81
3.6	0.49	8.9	0.81
3.7	0.49	9.0	0.82
3.8	0.50	9.1	0.82
3.9	0.51	9.2	0.83
4.0	0.52	9.3	0.83
4.1	0.52	9.4	0.84
4.2	0.53	9.5	0.84
4.3	0.54	9.6	0.85
4.4	0.54	9.7	0.86
4.5	0.55	9.8	0.86
4.6	0.56	9.9	0.87
4.7	0.57	10.0	0.87
4.8	0.57	10.1	0.88
4.9	0.58	10.2	0.88
5.0	0.59	10.3	0.88
5.1	0.59	10.4	0.89
5.2	0.60	10.5	0.89
5.3	0.61	10.6	0.90

- The maximum AA hit chance, with modifiers, is 90%.
- Modified AA strengths of 0 or less means no shot is possible.
- RA- or EO-directed AA guns in local control have their base AA Strength divided by four.

Antiair Gun Modifiers to AA Strength

Target Speed	*Strength Modifier*	*Speed kts*
Hovering	+3	0
Slow	+2	≤250
Subsonic	+1	251-500
Transonic	0	501-750
Low Supersonic	-1	751-1525
Med Supersonic	-2	1526-2300
High Supersonic	-4	2301-3075
Hypersonic	-6	3076+
Target Maneuvers		
Missile Terminal maneuvers	-1	
High Diving	-2	
Divergent	-2	
Crossing Target	-4	
Non-maneuvering Target	+2	
Target Signature		
Large	+1	
Medium	0	
Small	0	
VSmall	-1	
Stealthy	-2	
Target Altitude		
VLow flight	-3 (if gun is not SSC)	
Low & Medium	0	
High	-2	



Breda OTO
Super-Rapid 76mm/62

Some LDS are operated in local control, and have a 30% chance to hit. If they are linked to the ship's combat system, they have an 80% chance to hit.

A hit on a manned aircraft will dazzle the pilots, forcing them to abort their attack and immediately return to base. The aircraft must cease VLow flight.

UAVs struck by a LDS will lose any optical sensors.

Missiles hit by a LDS will automatically miss.

8.2 Ballistic Missile Defense (BMD). Ballistic missiles can be engaged by air defense systems like any other aerospace vehicle. The biggest difference from aircraft or other missiles is their high speed, which makes them harder to hit. However, their ballistic trajectory makes determining the missile's flight path a little easier.

Although there are several types of Ballistic missiles (see the sidebar on page 8-17), there are two groups. CRBMs & SRBMs are shorter-ranged missiles that remain in the atmosphere ("endo-atmospheric"). MRBMs, IRBMs, and ICBMs have such long ranges that they arc up out of the atmosphere ("exo-atmospheric"). Their general type affects which systems can intercept them.

Ballistic missile defenses come in three generations that describes the number and type of ballistic missiles the system can engage.

• *First generation*, or Basic, BMD are limited to terminal intercepts of SRBMs and MRBMs and midcourse intercept of MRBM by the US SM3 only. While engaging ballistic missiles, 1st generation BMD systems cannot defend against aircraft, cruise missiles, or other guided weapons. Their engagement rate is limited to one target per director/illuminator.

• *Second generation*, or Intermediate, BMD can make terminal intercepts of SRBMs and MRBMs and midcourse intercepts of MRBMs and IRBMs. While engaging ballistic missiles, 2nd generation BMD systems cannot defend against aircraft, cruise missiles, or other guided weapons. Their engagement rate is limited to one target per director/illuminator.

• *Third generation*, or "Advanced," BMD can make terminal intercepts of SRBMs and MRBMs and midcourse intercepts of MRBMs and IRBMs. Third generation BMD systems can simultaneously engage ballistic missiles, aircraft, cruise missiles, or other guided weapons. The engagement rate is increased to two targets per director/illuminator.

The engagement procedure is the same as for other air targets, but the actual range of the BMD missile is irrelevant - most engagements take place within the Medium 1 range band. Depending on the reaction time, the best that a BMD system can hope for is two engagements in the terminal phase and usually only one in the midcourse phase. Each engagement uses the SAM Modifier table, applying the standard modifiers, as applicable. The only difference is that the combat system modifier is doubled to reflect the ballistic trajectory.

Special Cases

• A *Maneuvering Warhead* has a -3 maneuvering modifier during exo-atmospheric flight and a -1 for endo-atmospheric, but the combat system modifier is still applied. If the warhead is a hypersonic glide vehicle, then not only is the -1 maneuvering modifier applied but the combat system modifier is also negated, i.e., it is 0.

• *Remote Targeting*. If a remote sensor can detect a ballistic missile and transfer the tracking data via a real-time data link (see 6.3.9), then a 3rd generation BMD system gets an additional midcourse engagement opportunity - a maximum of two engagements.

Example: A US Aegis cruiser with 1st generation BMD engages a Chinese DF-21D anti-ship ballistic missile. As the DF-21D is a MRBM (range of 1,600 - 1,700 km) it can be engaged by SM3 Blk IA missiles during the midcourse phase and by SM-2 Blk IV in the terminal phase.

<u>Midcourse Intercept</u> - SM3 Blk IA, ATA of 6.0
Combat System Modifier: 2 x 1.0 = 2
DF-21D Terminal speed - Medium Hypersonic: -5
Non-maneuvering warhead: -0
Single weapon

Chance of a hit = (6.0 + 2) - 5 - 0 = 3.0, which gives a 60% chance for the SM3 Blk IA to hit a DF-21D before it enters the atmosphere. As there are four directors on an Aegis cruiser, up to four incoming missiles can be engaged.

<u>Terminal Intercept</u> - SM2 Blk IV, ATA of 3.5
Combat System Modifier: 2 x 1.0 = 2
DF-21D Terminal speed - Medium Hypersonic: -5
Maneuvering warhead: -1
Two weapon salvo

Chance of a hit = (3.5 + 2) - 5 - 1 = -0.5, which gives a 44% chance for a two weapon salvo to hit a DF-21D. As there are four directors on an Aegis cruiser, up to four incoming missiles can be engaged. If the Aegis cruiser were the target of the DF-21D, it would get a second engagement with the same probability of hit. If the DF-21Ds' target was a different ship, even if it were close by, the second engagement would include a crossing target modifier of -4. This would reduce the hit total to -4.5, which gives a 02% chance of hit for a two-weapon salvo.

8.3 Surface Gunnery. Gun ranges are divided into four range bands: Short, Medium, Long, and Extreme. Long range is often called "effective" range.

The ballistics of a shell in flight are the same for all guns. The only things that change are the shape and weight of the shell and its muzzle velocity. These affect how far it flies and how hard it strikes. Since the ballistics are the same, the chance of a hit is the same for all guns in each range band.

Harpoon uses Gunnery Standard 4 (GS 4) for Gen 1 combat systems, GS 5 for Gen 2 and 3 Combat Systems, and GS 6 for Gen 4 and later combat systems. The chance of a hit depends on which Gunnery Standard the ship uses.

	Short	*Medium*	*Long*	*Extreme*
GS 4	60%	40%	15%	5%
GS 5	70%	50%	20%	10%
GS 6	75%	55%	25%	15%

The chance to hit cannot be raised over 90%, even with modifiers.

While the base hit chances are the same, the size of the range bands vary for each gun. A US Mk42 5"/54 has a "short" range of 7,800 yards, almost four nautical miles, while a Russian AK-725 57mm/70 has a short range of 1,800 yards. The chance to hit is the same.

Gunfire Hit Chance Modifiers

Base Chance of a Hit	GS4	GS5	GS6
Short	60%	70%	75%
Medium	40%	50%	55%
Long	15%	20%	25%
Extreme	5%	10%	15%

Visibility/Environmental Modifiers			
Visibility 20% or less (Ignore with radar GFC or when target illuminated or silhouetted)		-4	
Visibility 40% or less (Ignore with radar GFC or when target illuminated or silhouetted)		-2	
Target in line with the sun - Target obscured. Must be within 10° of a line from observer to the sun		-2	
Target in line with twilight sun - Target silhouetted. Must be within 30° of a line from observer to the sun		+1	
Target is illuminated by starshell, fire, searchlight/is using a searchlight		-1	
Dead Reckoning Fire - First turn of fire after loss of visual contact on a target		-4	
Blind Fire - Firing at muzzle flashes (ignore visibility mod)		-6	
Sea state (Heavy seas make it difficult to aim the guns properly)	A&B	C&D	E-G
Sea State 3	NA	NA	-2
Sea State 4	NA	-2	-4
Sea State 5	-2	-4	-6
Sea State 6 (No fire possible above sea state 6)	-4	-6	NFP

Fire Control/Gun Modifiers	
Firing Ship is not being fired on	+1
Overconcentration. Using EO/OP fire control, more than one ship firing the same size shells at target, and the target is at Long or Extreme range from the firing ship (see 8.3.1).	-1 per ship above limit
More than one set of shell splashes confused range corrections.	
Point-blank fire (1/2 of Short range, 30% vis or better)	+4
Land within ±45° of target and inside unmodified fire control radar range	-1
Land return clutters the screen and obscures target echo	
Local Control (OP mode)	-3
Ships without stable elements changing course by 45° or more	-3
Firing ship steering evasively. Takes precedence over course change modifier.	-3
Number of barrels firing	
1 - 2	+0
3 - 4	+1
5 - 6	+2
7 - 8	+3
9 - 10	+4

Target Modifiers			
Target Speed			
40+ knots		-3	
30 - 39 kts		-2	
10 kts or less		+1	
Stationary (“Dead in the Water”)		+2	
Target Steering Evasively (minimum speed of 20 kts)			
Size Class B		-2	
Size Class C - D		-4	
Size Class E - G		-6	
Target Aspect (Broad/Quarter/Narrow)	Brd	Qtr	Nrw
Size class A	+2	+1	+0
Size Class B	+1	+0	-1
Size Class C - D	+0	-1	-2
Size Class E - G	-2	-3	-4

Multiply the final modifier by 5% for Short or Medium range targets, and 3% for Long and Extreme range targets, and add it to the base chance to hit.

The chance to hit cannot be raised over 90%, even with modifiers.

Procedure: Measure the range from the firing ship to the target and note the target's aspect (broad, narrow, or quarter). Find the proper range band (short, medium, long, or extreme) by comparing the measured range with the numbers for that gun in Annex C. Count the number of barrels firing. Be sure to check arcs of fire (described in section 2.2.1) to see if the guns can bear on the target.

Total up the modifiers from the Gunfire Hit Chance Modifiers table that apply to the shot, and multiply it by 5% at short or medium range, and 3% at long or extreme range, and then add or subtract it from the base chance to hit.

Roll D100. If the roll is less than or equal to the modified chance to hit, the target has been hit.

Find the damage points inflicted by the gun in that range band (found in Annex C). Look on the Gun Damage Multiplier table and cross-index the number of barrels firing and the range band. This gives a multiplier for the damage inflicted in Annex C. Multiply the two numbers to get the number of damage points suffered by the target. Guns that fire only in the Reaction Fire Phase have their damage halved. Rotary guns (listed as "(R)") are counted as single barrels. Their rate of fire is already included in their damage values.

Gun Damage Multipliers

No. of Barrels	*Multiply by the Damage in Annex C*			
	Short	*Medium*	*Long*	*Extreme*
1 - 2	1	1	1	1
3 - 4	2	2	1	1
5 - 6	3	3	2	1
7 - 8	4	3	2	1
9 - 10	5	4	3	2
11 - 12	6	4	3	2

Example: A Russian *Sovremenny* class guided missile destroyer operating at night opens fire at a frigate at medium range. Both of the destroyer's AK-130 130mm mounts will bear (4 barrels total). The frigate is full broadside to the firing ship, and is steaming at 20 knots. It has a 3rd Gen combat System, so uses GS 5.

The base chance of a hit at medium range is 50%. The shooter applies the following modifiers: visibility less than 40% due to it being night (normally -2, but the ship is using radar GFC, so it is ignored), 4 barrels firing (+1), size class C, broad aspect (+0). The total modifiers are +1, which is multiplied by 5% for medium range, so +5% is added to 50% and the modified chance to hit is 55%.

The player rolls D100 and gets a 26, which is a hit. The HE shells (the only option) inflict 22 points at medium range. The multiplier for 4 guns at medium range is 2, so the Russian inflicts 44 damage points. Against some targets, this might be affected by armor penetration, see 14.1.6.

Players do not have to keep track of gun ammunition, unless required by a scenario. It is very rare for a naval gun mount to run out of ammunition during an engagement.

8.3.1 Overconcentration. Optical directors and even radar can only get shells close to an enemy ship. Adjusting the fire requires being able to see the shell splashes and correct the next salvo based on whether they were long or short of the target. These are made by the director operator.

If a second ship fires at the same target, the director operator will have a hard time telling which shell splashes belong to him and which belong to the other ship. A third ship makes the problem even worse, and so on.

The problem is most acute at longer ranges, when the extended time of flight makes it hard to link a salvo with its shell splashes.

Overconcentration will occur if the shell splashes are roughly the same size. For figuring overconcentration, large shells are 11 to 18 inches (279 - 456mm), medium shells are 5.9 to 10.9 inches (151 - 278mm), and small shells are less than 5.9 inch (150mm) diameter.

If more than one ship fires at the same target, all the ships firing the same size guns at that target at Long and Extreme range are subject to a gun hit chance modifier equal to the number of ships firing at that target minus one.

It doesn't matter if some of the ships firing at the target are at Short or Medium range. Those ships can easily link their shots with the splashes and adjust their fire, but their splashes will cause problems for ships at longer ranges.

8.3.2 Point-Blank Fire. If the visibility is 30% or better, and a ship is within half of the Short range band of a gun (round down), the firing ship has a +4 to hit modifier and does double the damage if it hits. Armor penetration is not affected. At such short distances, more shells from a salvo will strike the target, increasing the damage inflicted.

8.3.3 Line of Fire Restrictions. A ship's line of fire to a target may be blocked. This will happen if a friendly ship is in the gun's Short or Medium range band and is within 5° of the line of fire (10° total arc).

Land of 100 m elevation or more will block a ship's line of sight, although an aircraft may provide over-the-horizon spotting to replace it. Land of less than 100 meters elevation may still block line of sight. This will be specified in the scenario description.

8.3.4 Attacks by Small Craft. For weapons under 20mm, including machine guns, and infantry weapons like rocket launchers, when fired from F and G-sized craft, use the following tables:

Hit Chances for Manually-Aimed Light & Heavy Machine Guns less than 20mm

	<12.7 mm	*12.7 - 14.5 mm*	*Base Ph*
Point Blank	00-50 yds	00-100 yds	70%
Short	51-100 yds	101-200 yds	50%
Medium	101-300 yds	201-500 yds	30%
Long	301-500 yds	501-800 yds	10%
Extreme	501-700 yds	801-1000 yds	5%

Hit Chances for Multiple Rocket Launchers, Recoilless Rifles, & RPGs from Small Craft

		Base Ph
Point Blank	00-75 yds	70%
Short	76-150 yds	50%
Medium	151-250 yds	30%
Long	251-350 yds	10%
Extreme	350-500 yds	5%

Modifier for shooter speed:

Less than 3 rockets in a salvo: -20% (applied before any speed modifiers)

16 - 25 knots: Halved base chance to hit

26 knots or more: Quartered base chance to hit

The surface gunnery modifiers section apply. If the attack hits, it inflicts a critical hit as described in 8.3.7 Infantry fire against ships.

Multiple rocket launchers (MRL) and handheld anti-tank rockets are unguided, very short-range weapons that can be used against ships. Rocket and recoilless rifle attacks are resolved in salvoes of three weapons. If fewer than three rockets or shells are used in an attack, there is a -20% to the hit chance in the table on page 8-12. This reduction takes place before any speed modifies are applied.

If one of these weapons hits, their damage and penetration values will be provided in the scenario data.

8.3.5 Artillery Fire Against Ships. Field artillery can attack ships off shore. However, they are not very effective since they lack fire control systems designed to track a moving target. Range, damage and penetration will be provided in the scenario data. The base chance to hit and the modifier for the number of barrels firing are:

Field Artillery Hit Chances

Range Band	*Ph*	*No of barrels*	*Ph Modifier*
Short	20%	1 - 3	0%
Medium	15%	4 - 7	+1
Long	10%	8+	+2
Extreme	5%		

The battery may fire for up to three minutes (one Tactical Turn) in burst mode (full damage), then it will revert to sustained fire due to gunner fatigue. This reduces the hit chance by half.

This does not apply to dedicated coastal defense guns. They fire as ships using the rules in 8.3.

8.3.6 Tank and Antitank Fire Against Ships. Most antitank guided missiles, antitank rockets, tank guns, and recoilless rifles can attack ships close to shore. The attacking unit must have a direct line of sight to the ship before it can fire.

Antitank guided missiles (ATGMs) have a range of 2.0 nmi and a probability of hit of 85%.

Modern tank guns are typically between 100mm to 125mm in diameter and are limited in elevation. They are fitted with computer fire control and laser rangefinders, which make their fire highly accurate. The maximum effective range of tank gun is 2.0 nmi and the base chance to hit is 85% at up to half range, 40% up to maximum range.

Towed antitank guns and recoilless rifles are manually-aimed weapons. Antitank guns have a maximum effective range of 2.0 nmi while recoilless rifles have a maximum effective range of 1.0 nmi. The base chance to hit is 30% at up to half range, 10% up to maximum range.

These weapons can fire for only two Tactical Turns, then they must cease fire because they will be low or out of ammunition.

If one of these weapons hits, their damage and penetration values will be provided in the scenario data.

8.3.7 Infantry Fire Against Ships. Infantry may fire on ships using the table in section 8.3.4 and adding 10% to the chance of a hit. A hit causes one critical hit on the target. Roll D20 on the critical hit table. If the result is Flooding, Engineering, Rudder, Flight Deck, Hangar, or Pressure Hull, treat it as no damage. If the hit location is armored, treat it as no damage.

8.4 Antiship Missiles. Surface-to-surface missiles (SSMs) are fired only in the Planned Fire Phase. They cannot be fired in the Reaction Fire Phase, since it takes some time to set up an SSM's flight path.

Depending on the missile's guidance, the launching player may have to set one or more modes in the missile before he fires it. Some can perform evasive maneuvers, others can fly to waypoints, allowing the missile to attack from another angle to conceal the launcher's position. The enable point of a bearing-only Launch must be chosen. Section 7.4 discusses missile guidance systems.

8.4.1 Antiship Missile Attacks. Using the Antiship Missile Attack Table on page 8-15, first, find the table for the target's Signature, then the generation of the ECM system being used, and finally the generation of the missile seeker. If the targeted ship has no ECM, just use the missile generation value in the second column.

The third column shows the chance of the missile to hit on D100 if there are no countermeasures being used. The next three columns to the right show that chance to hit for that missile seeker generation if a jammer is used, if decoys are used, or if the two are used in combination.

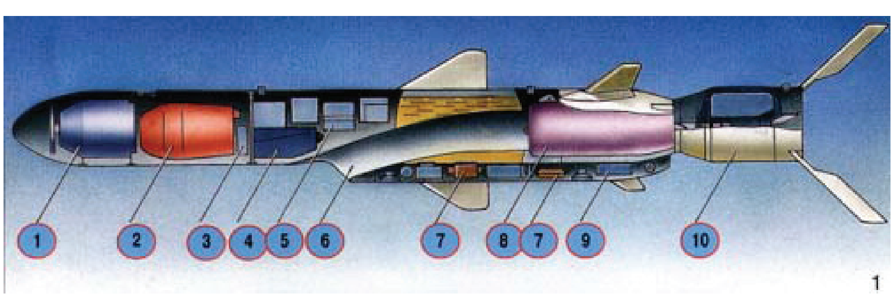
The defending player does not have to give any specific orders to use countermeasures. If the ship has them, and knows it is being attacked, they will be used.

Under the column for the combination of countermeasures being used, find the chance of the missile locking on for that generation of seeker. Roll D100 for each missile of that type attacking. If the number rolled is less than or equal to the chance to hit, the missile has locked on. Unless it is shot down by the ship's defenses, it will hit.

If it misses, it will continue on the same course in the following Movement Phase, as long as it has fuel (see 7.3). If it acquires another target, then it will attack that. Except see also Missile Reattacks in section 7.4.8.

Kh-35 Uran Antiship Missile

Military Parade



1. Active Radar Homing Head
2. Penetrating Warhead
3. Autonomous Self-Destruct System
4. Inertial Control System
5. Radio Altimeter
6. Air Intake
7. Fuel System Units
8. Turbojet motor
9. Servo Unit
10. Solid Propellant Rocket Booster

Example 1: A Chinese HY-2 is fired at an *O.H. Perry*-class frigate. The HY-2 has a 2nd-generation seeker. The *Perry* has a Small Signature and carries 3rd-gen jammers and decoys. Using the Small Target Signature, the attacking player finds the row for 3rd generation ECM, then over to the 2nd generation missile row and then over to the jammers and decoys column. The chance of the missile locking on the frigate and hitting (if it survives the defensive weapons) is 26%.

8.4.2 Bearing-Only Launch (BOL) Attacks. Any weapon with inertial or satellite guidance and terminal homing may be fired in bearing-only launch mode. The shooter plots a direction that the missile will fly and a point where it will activate its seeker (the "enable point").

Since the player does not have a complete picture of the target area, the fire control solution quality is Poor. A disadvantage of BOL attacks is that any ships along the missile's course after the seeker activates become fair game, including neutral or even friendly units.

Once the seeker is enabled, the missile flies down that bearing until it finds something or it runs out of fuel. If the placement roll was successful, then the seeker will acquire the intended target. If the placement roll fails, then the weapon will attack the first thing it sees - friend, foe and neutral alike.

Section 7.4.7 Terminal Seekers shows the area (the "acquisition cone") the seeker will search as the missile flies. If there are several targets within the seeker's acquisition cone, use the Seeker Lock-On table in the section 7.4.7 to find out which target the missile will attack.

8.4.3 Ballistic Missile Attacks Against Ships. China has developed and fielded anti-ship ballistic missiles (ASBM). While their impressive range and speed suggest they could be a significant threat to surface ships, little has been written on the ability to accurately target these weapons.

Only three systems can provide targeting-quality data so far out to sea: over-the-horizon backscatter radar (OTH-B), a satellite with a synthetic aperture radar (SAR), and an aircraft or unmanned aerial vehicle (UAV) with a radar and a data link. All other sensors, (electronic reconnaissance satellites, submarines, non-military ships, etc.) can only "cue" (alert) command to the presence of a possible target, so another system can be steered to that location to find the target.

Due to the relatively long dwell time, OTH-B and a SAR satellite automatically detect a ship within the radar's search envelope. Aircraft and UAVs conduct radar searches as described in 5.2.5 Airborne Radars.

After detection, it takes time to develop a fire control solution. Information from an aircraft or UAV radar requires two Tactical Turns to produce a solution; an OTH-B radar needs five Tactical Turns and a SAR satellite takes ten Tactical Turns.

Once there is a solution, a player may attack with ASBMs. Find the appropriate table in the ASBM Attack Tables on pages 8-16 and 8-17, based on the targeting sensor and the type of missile. Roll D10, apply any modifiers for sea state and jamming of the sensor, and cross-reference the result with the target's average speed during the missile's time of flight. This is the base chance of a hit.

Note: for a SAR satellite, the ship's average speed includes the time needed to develop the solution, as well as the missile's time of flight.

With the intended primary target ship at the center, measure an 18 nmi radius circle. This is the field of view of the missile's seeker. Roll D100 on the table below against the target's Size class. Because of the approach angle, the missile seeker is not affected by any signature reduction on the ship.

If the die roll is equal to, or less than, the value in the table, then the missile homes in on the intended target. Otherwise, it randomly selects another target within the seeker's field of view.

Ballistic Missile Random Lock-On Chance

Target Size class	*Chance of Homing on the Desired Target*
Large	15
Medium	10
Small	5
VSmall	2

Once the missiles have been assigned to individual targets, take the hit chance for each missile, apply any modifiers for defensive countermeasures on the targeted ship, and roll D100 to see if it was hit.

Example: A Chinese player has an ASBM brigade with twelve missile launchers ready to launch on a US carrier group. The brigade has DF-21D MRBMs with a range of 1,750 km (945 nmi), meaning a flight time of four Tactical Turns.

The US formation of six ships was detected by OTH-B radar at 1430 hours. He can attack at 1445 hours - five Tactical Turns after detection. At 1445, the Chinese player confirms the launch and rolls D10 on the ASBM Attack Table for OTH-B targeting and a MRBM-type missile. The Sea State is three. The die roll of 6 is compared to the carrier group's average speed during the missile's flight (21 knots) to give a base hit chance of 60%.

While the DF-21D missiles are in flight, US SM3 and SM6 interceptors shoot five down, leaving seven to make the attack. The intended target is the aircraft carrier, which has an A/Large size class. All the ships in the formation are within the DF-21D missile seeker's field of view.

Rolling for the attack distribution results in four missiles targeting the carrier and one missile each on three of the escorts, all B/Medium size class. All the US ships are fitted with 4th Gen decoys and jammers. The four attacks on the carrier have a modified hit chance 30% (60% minus 30% for the carrier's ECM), while the three escort ships suffer a single attack each with a final hit chance of 15% (60% minus 45%).

8.5 Surface Ship Attacks on Subs. Antisubmarine Warfare (ASW) is the classic duel between surface and subsurface vessels. Ships can fire ASW mortars, conventional depth charges, homing torpedoes, and standoff weapons (nuclear depth bombs and homing torpedoes carried by a missile to the target and lowered into the water by parachute).

8.5.1 Surface-Launched Torpedoes. Torpedoes must be fired against a detected target, with a successfully achieved fire control solution.

Details of different torpedo guidance systems are described in section 7.5. Rules for resolving homing torpedo attacks are in sections 10.2.5 and 10.2.6. They should be used for surface ship attacks on subs or other surface ships.

The torpedo run, or range, is measured from the geographic point of firing to the torpedo's current position. If the distance traveled by the torpedo since its launch is greater than the listed range, the torpedo automatically misses. Modern torpedoes will not leave a wake, but the propeller and flow

Antiship Missile Attack Table

A/Large Target Signature

ECM Gen	Seeker Gen	Base Ph	Jamming	Decoy	Jamming & Decoy
1	1	0.65	0.61	0.59	0.55
	2	0.75	0.75	0.69	0.75
	3	0.80	0.80	0.75	0.80
	4	0.85	0.85	0.82	0.85
2	1	0.65	0.60	0.56	0.51
	2	0.75	0.70	0.67	0.62
	3	0.80	0.80	0.73	0.80
	4	0.85	0.85	0.80	0.85
3	1	0.65	0.56	0.52	0.45
	2	0.75	0.67	0.63	0.56
	3	0.80	0.73	0.70	0.64
	4	0.85	0.80	0.78	0.74
4	1	0.65	0.45	0.36	0.24
	2	0.75	0.56	0.48	0.36
	3	0.80	0.65	0.58	0.47
	4	0.85	0.74	0.70	0.61

B/Medium Target Signature

ECM Gen	Seeker Gen	Base Ph	Jamming	Decoy	Jamming & Decoy
1	1	0.65	0.56	0.52	0.45
	2	0.75	0.75	0.63	0.75
	3	0.80	0.80	0.70	0.80
	4	0.85	0.85	0.78	0.85
2	1	0.65	0.50	0.44	0.34
	2	0.75	0.62	0.56	0.46
	3	0.80	0.80	0.65	0.80
	4	0.85	0.85	0.74	0.85
3	1	0.65	0.47	0.39	0.28
	2	0.75	0.58	0.51	0.40
	3	0.80	0.67	0.61	0.51
	4	0.85	0.75	0.71	0.63
4	1	0.65	0.38	0.26	0.15
	2	0.75	0.50	0.39	0.26
	3	0.80	0.60	0.51	0.38
	4	0.85	0.71	0.65	0.54

C&D/Small Target Signature

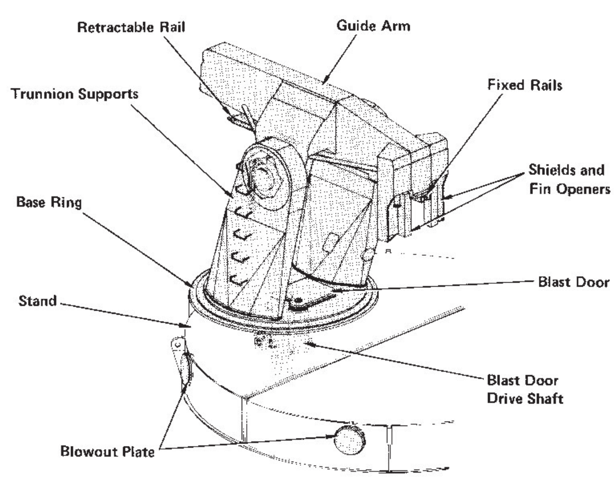
ECM Gen	Seeker Gen	Base Ph	Jamming	Decoy	Jamming & Decoy
1	1	0.65	0.48	0.40	0.30
	2	0.75	0.75	0.52	0.75
	3	0.80	0.80	0.62	0.80
	4	0.85	0.85	0.72	0.85
2	1	0.65	0.40	0.30	0.19
	2	0.75	0.52	0.43	0.30
	3	0.80	0.80	0.54	0.80
	4	0.85	0.85	0.67	0.85
3	1	0.65	0.38	0.26	0.15
	2	0.75	0.50	0.39	0.26
	3	0.80	0.60	0.51	0.38
	4	0.85	0.71	0.65	0.54
4	1	0.65	0.31	0.16	0.08
	2	0.75	0.44	0.30	0.17
	3	0.80	0.55	0.44	0.30
	4	0.85	0.67	0.60	0.47

E &F/VSmall Target Signature

ECM Gen	Seeker Gen	Base Ph	Jamming	Decoy	Jamming & Decoy
1	1	0.65	0.42	0.33	0.21
	2	0.75	0.75	0.45	0.75
	3	0.80	0.80	0.56	0.80
	4	0.85	0.85	0.68	0.85
2	1	0.65	0.35	0.23	0.12
	2	0.75	0.48	0.36	0.23
	3	0.80	0.80	0.49	0.80
	4	0.85	0.85	0.63	0.85
3	1	0.65	0.31	0.16	0.08
	2	0.75	0.44	0.30	0.17
	3	0.80	0.55	0.44	0.30
	4	0.85	0.67	0.60	0.47
4	1	0.65	0.26	0.10	0.04
	2	0.75	0.39	0.24	0.13
	3	0.80	0.51	0.39	0.25
	4	0.85	0.65	0.56	0.43

G/Stealthy Target Signature

ECM Gen	Seeker Gen	Base Ph	Jamming	Decoy	Jamming & Decoy
1	1	0.65	0.38	0.26	0.15
	2	0.75	0.75	0.39	0.75
	3	0.80	0.80	0.51	0.80
	4	0.85	0.85	0.65	0.85
2	1	0.65	0.31	0.16	0.08
	2	0.75	0.44	0.30	0.17
	3	0.80	0.80	0.44	0.80
	4	0.85	0.85	0.60	0.85
3	1	0.65	0.26	0.10	0.04
	2	0.75	0.39	0.24	0.13
	3	0.80	0.51	0.39	0.25
	4	0.85	0.65	0.56	0.43
4	1	0.65	0.24	0.07	0.02
	2	0.75	0.37	0.21	0.10
	3	0.80	0.50	0.37	0.23
	4	0.85	0.64	0.54	0.41



US Mk13 Missile Launcher

ASBM Attack Table

*FCS: Fire Control Solution

Targeting: OTH-B/Missile: SRBM

	Target Average Speed (kts)										
FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
2	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
3-6	0.80	0.80	0.80	0.75	0.75	0.75	0.70	0.70	0.65	0.65	0.60
7-8	0.60	0.60	0.60	0.55	0.55	0.55	0.50	0.50	0.50	0.50	0.45
9	0.45	0.45	0.45	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35
10	0.35	0.35	0.35	0.35	0.35	0.30	0.30	0.30	0.30	0.30	0.30

Targeting: OTH-B/Missile: MRBM

	Target Average Speed (kts)										
FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.77
2	0.80	0.80	0.80	0.80	0.80	0.75	0.70	0.65	0.60	0.60	0.55
3-6	0.75	0.70	0.65	0.60	0.60	0.55	0.50	0.50	0.45	0.45	0.40
7-8	0.55	0.50	0.50	0.45	0.45	0.40	0.40	0.40	0.35	0.35	0.30
9	0.40	0.40	0.40	0.35	0.35	0.35	0.30	0.30	0.30	0.25	0.25
10	0.35	0.30	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.20	0.20

Targeting: SAR Satellite/Missile: SRBM

	Target Average Speed (kts)										
FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.75	0.60	0.50	0.45	0.40	0.35	0.30
2	0.80	0.80	0.80	0.80	0.70	0.55	0.50	0.40	0.35	0.30	0.30
3-6	0.80	0.80	0.80	0.75	0.65	0.50	0.45	0.40	0.35	0.30	0.25
7-8	0.80	0.80	0.80	0.70	0.60	0.50	0.45	0.35	0.35	0.30	0.25
9	0.80	0.80	0.80	0.65	0.55	0.45	0.40	0.35	0.30	0.25	0.25
10	0.80	0.80	0.75	0.60	0.50	0.45	0.40	0.35	0.30	0.25	0.25

Targeting: SAR Satellite/Missile: MRBM

	Target Average Speed (kts)										
FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.65	0.55	0.45	0.40	0.35	0.30	0.25	0.20
2	0.80	0.80	0.80	0.60	0.55	0.45	0.40	0.30	0.30	0.24	0.20
3-6	0.80	0.80	0.75	0.60	0.50	0.40	0.35	0.30	0.25	0.20	0.20
7-8	0.80	0.80	0.70	0.55	0.45	0.40	0.35	0.30	0.25	0.20	0.20
9	0.80	0.80	0.65	0.50	0.45	0.35	0.30	0.25	0.25	0.20	0.20
10	0.80	0.75	0.60	0.50	0.40	0.35	0.30	0.25	0.20	0.20	0.15

Targeting: SAR Satellite/Missile: IRBM

	Target Average Speed (kts)										
FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.65	0.50	0.40	0.35	0.30	0.25	0.20	0.20	0.15
2	0.80	0.75	0.60	0.45	0.40	0.30	0.25	0.20	0.20	0.15	0.15
3-6	0.80	0.70	0.60	0.45	0.40	0.30	0.25	0.20	0.20	0.15	0.15
7-8	0.80	0.65	0.55	0.40	0.35	0.30	0.25	0.20	0.20	0.15	0.15
9	0.80	0.60	0.50	0.40	0.35	0.25	0.20	0.20	0.20	0.15	0.10
10	0.80	0.60	0.50	0.35	0.30	0.25	0.20	0.20	0.20	0.15	0.10

Targeting: Aircraft/UAV w/ datalink/Missile: SRBM

Target Average Speed (kts)

FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
2	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
3-6	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
7-8	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
9	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80

ASBM Attack Table (continued)

Targeting: Aircraft/UAV w/ datalink/Missile: MRBM

Target Average Speed (kts)

FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
2	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
3-6	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
7-8	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70
9	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.74	0.65
10	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.60

Targeting: Aircraft/UAV w/ datalink/Missile: IRBM

Target Average Speed (kts)

FCS* Die Roll	≤10	11-13	14 - 16	17-19	20 - 22	23-24	25-27	28-29	30-32	33-34	≥35
1	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.60	0.55	0.45
2	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.60	0.50	0.45
3-6	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.65	0.55	0.50	0.45
7-8	0.80	0.80	0.80	0.80	0.80	0.80	0.75	0.60	0.55	0.45	0.40
9	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.55	0.50	0.45	0.40
10	0.80	0.80	0.80	0.80	0.80	0.75	0.65	0.55	0.50	0.40	0.35

FCS* Die Roll Modifiers:

Sea State 4:	+1
Sea State 5:	+2
Sea State 6+:	+3
Jamming:	+1
0000 - 0800 (OTH-B only)	+1

ASBM Attack Countermeasure Modifiers

Target Size Class	3rd Gen D	3rd Gen J	3rd Gen J & D	4th Gen D	4th Gen J	4th Gen J & D
A	--	--	--	-0.10	-0.20	-0.30
B	-0.10	-0.10	-0.20	-0.20	-0.25	-0.45
E - G	-0.25	-0.10	-0.35	-0.30	-0.25	-0.55
C & D	-0.20	-0.10	-0.30	-0.25	-0.25	-0.50

All tables assume a 3rd Gen ASBM seeker. For a 2nd Gen seeker, subtract 5% (-0.05).

Ballistic Missile Types

Ballistic missiles are classified by their maximum range, which also defines the missile's terminal velocity and flight time. The types are:

Close-range ballistic missiles (CRBM): These are battlefield, or tactical, missiles with a range of 50 to 300 km (27 - 162 nmi). These missiles do not leave the atmosphere during flight ("endo-atmospheric") with a maximum altitude below 100 km, and have a High supersonic terminal velocity. Time of flight is one Tactical Turn (2 to 3 minutes). Because of their short range, CRBMs are treated as High Supersonic anti-ship missiles, and do not use the ASBM rules.

Short-range ballistic missiles (SRBM): These have a range of 300 to 1,000 km (162 - 540 nmi). In *Harpoon V*, all SRBMs are considered to be endo-atmospheric throughout their flight and have a Low Hypersonic terminal speed. Time of flight is two to three Tactical Turns (4 to 9 minutes).

Medium-range ballistic missiles (MRBM): These have a range of 1,000 to 3,000 km (540 - 1,620 nmi). They leave the atmosphere during flight ("exo-atmospheric") with a maximum altitude above 100 km, and have a Medium Hypersonic terminal speed. Time of flight is three to six Tactical Turns (9 to 18 minutes.)

Intermediate-range ballistic missiles (IRBM): These have a range of 3,000 to 5,500 km (1,620 - 2,970 nmi). They have an exo-atmospheric flight and have a High Hypersonic terminal velocity. Time of flight is six to eight Tactical Turns (18 to 24 minutes).

Intercontinental ballistic missiles (ICBM): These have a range greater than 5,500 km (>2,970 nmi), an exo-atmospheric trajectory, and a Very High Hypersonic terminal speed. Time of flight is 25+ minutes. ICBMs are not covered in *Harpoon V*.

Chinese DF-21 during drill

CCTV

noise, as well as an active acoustic seeker, can be heard by some passive sonars. Torpedoes cannot hit hovercraft when they are airborne or hydrofoils when they are foil-borne.

8.5.2 ASW Standoff Weapons. A standoff weapon is a rocket-assisted torpedo or nuclear depth bomb designed to quickly attack a submarine at some distance from the launching ship. After an ASW standoff weapon is launched, it usually flies a ballistic trajectory (the Russian 85R and 85RU being exceptions) to its aim point just like any other missile. When it arrives, instead of enabling a seeker, it releases a homing torpedo or nuclear depth bomb.

While a standoff weapon has the advantage of being able to attack a sub at some distance, the payload must be positioned accurately or it is wasted. A torpedo must be placed close enough to the submarine for it to acquire and home in. Even a nuclear depth bomb, especially a "small" yield warhead, must be placed close to its target, or it will not be a sure kill. The chance of proper placement depends on the accuracy of the fire control solution (section 6.3), the target's range, and the type of weapon.

To determine if the ASW standoff weapon is properly positioned, use the fire control solution placement die roll; add any applicable modifiers for the target's range, weapon characteristics and submarine coating and roll D10 on the Weapon Placement Table in 6.3.8.

For engagement ranges in excess of 15 nmi an active sensor (sonar or radar) must be used to compute the fire control solution.

If the ASW standoff weapon is properly positioned, the homing torpedo will automatically acquire the submarine target and the attack is resolved immediately. For ASW standoff weapons with a nuclear depth bomb payload, the placement die roll is actually the to hit roll. If the die roll is less than or equal to the modified placement die roll, then the submarine is within the kill radius of the weapon. If the placement die roll is greater than the modified value, but less than or equal to the modified value +3, the submarine experiences D6 major damage critical hits. If the die roll is more than twice the placement die roll, then the weapon has no effect. Yes, a small nuke (≤20 kT) can indeed miss a target.

If the standoff weapon is not properly positioned, and its exact location is a concern because of other nearby units, then roll randomly for its position. For target ranges of 15 nmi or less, the miss distance is D6/2 nmi and for ranges greater than 15 nmi, the miss distance is D6 nmi. The direction of the miss is D6x60°. Use the miss distance and direction to set Ground Zero when measuring the range from the explosion to other units. See 14.1.8 for the effects of nuclear weapons.

ASW Standoff Weapon Placement Modifiers

Target Range (nmi)	*D10 Modifier*
≤15	0
15.1 - 20.0	-1
20.1 - 25.0	-2
25.1 - 30.0	-3
30.1 - 35.0	-4
35.1 - 45.0	-5
45.1 - 55.0	-6
55.1 - 65.0	-7

Modifiers:

- Tactical Data Link: Other platforms in contact and sharing data by TDL, use applicable TDL modifier.
  - NRT TDL: +1
  - RT TDL: +2
- Anechoic coated submarine: -2 (for torpedo payloads only)
- Guided Standoff weapon: +1
- Nuclear Depth Bomb:
  - Yield ≤20 kT: +1
  - Yield 100-200 kT: +2

Example: The Soviet/Russian 83R Vodopad (SS-N-15a) is an unguided ASW missile with a torpedo payload and a maximum range of 27 nmi against a non-coated submarine. If it is fired with a Good fire control solution out to its maximum range, the chance of a successful placement is 9 (Good Solution) - 3 (25 - 30 nmi Range Modifier) = 6 on a D10.

If the weapon were fired with a Fair solution, the placement die roll drops to a roll of 3 or less on a D10 (6-3). A Poor fire control solution has no chance of placing the torpedo close enough to the target. If the placement die roll is successful, the UMGT-1M torpedo payload will make an immediate attack.

In the case of the 84R Vodoley (SS-N-15b) with a 200 kT nuclear depth bomb and the same maximum range, the placement roll (which serves as the hit chance) is 8 or less on a D10 (9-3+2) for a Good solution, 5 or less on a D10 (6-3+2) for a Fair solution, and 2 or less on a D10 (3-3+2) for a Poor solution. Even if a Russian player were to roll badly with a good solution, the target platform has a 10 or less on a D10 chance of taking serious damage - in other words, it's an automatic result. For the Fair and Poor solution cases however, the serious damage values are 8 and 5.

8.**5.3 ASW Projectors** fire a pattern of explosive charges over a sub's position. A Good fire control solution is required. A Fair quality solution halves the hit chance, and a Poor quality solution will automatically miss. This prevents firing them against submarines in the Reaction Fire Phase. ASW projectors cannot be fired in Sea State 7 or higher.

Some ASW projectors can also fire anti-torpedo projectiles; these can be fired in the Reaction Fire Phase (see 10.5 Torpedo Defense). This ability is noted in the Remarks in Annex E3.

ASW projectiles may be contact-fuzed, hydrostatically (depth)-fuzed, or influence-fuzed. A contact-fuzed weapon will have a hit chance listed in the "Contact Ph" column. A depth-fuzed weapon will have two hit chances listed under "Major Ph" and "Minor Ph." If it has both fuzes, then it will have all three hit chances. The hit chances are listed in Annex E3. Influence fuzing is factored into the major and minor Ph values.

The player first notes the speed and depth of the target and finds the modifier on the ASW Projector and DC Modifiers table. They apply this to the hit chances, then rolls a single D100 and compares it with the hit chances for that weapon. If the result is less than the percent chance listed in the column, then that is the type of hit, and damage inflicted.

Example: The Russian RBU 1200, firing the RGB-12 projectile, has three hit chances and three corresponding damage levels. From Annex E3:

Chance of a Hit			*Damage Points*		
Contact	*Major*	*Minor*	*Contact*	*Major*	*Minor*
2%	9%	13%	20	6	3

ASW Projector and DC Modifiers

Sub Speed (kts)	Depth Band Shallow /Int I	Interm II & III	Interm IV & V	Deep I
≤5	x1.0	x.75	x.50	x.25
6 - 10	x.75	x.50	x.25	x.15
11 - 15	x.50	x.25	x.15	x.10
16 - 20	x.25	x.15	x.10	x.05
21 - 25	x.15	x.10	x.05	--
26 - 30	x.10	x.05	--	--
31+	x.05	--	--	--

-- = attack not possible

If the target is a creeping sub at Intermediate II depth, the modifier is .75, so the three hit chances are changed from 2%/9%/13% to 2%/7%/10% (round normally, e.g. 1.5% becomes 2%).

If the player rolls a "9," they inflict Minor damage, which is 3 points, on the sub.

The chance to hit is rolled for the entire pattern. Most patterns are fired by a single mount, but some early ASW projectors needed two mounts combined to fire a complete-pattern. These are noted in the remarks in Annex E3. If only one mount can fire, the hit chances are halved.

A contact-fuzed projectile may also inflict a Hull Penetration Critical Hit (see 14.5). Compare the hull design, single or double, with the submarine's size class to find the chance of a hull penetration. A submarine with a double hull will have it noted in the Remarks section of it Annex A listing.

ASW Projectile Contact Hit Hull Penetration

Hull Design	Submarine Size Class VSmall	Small	Medium	Large
Single	90%	60%	30%	15%
Double	75%	45%	15%	5%

Submarine class in service before 1955: +30%

8.5.3.1 Attack sonars. Early search sonars are not accurate enough to provide aiming data for an ASW projector. Instead, ships were fitted with a specialized attack sonar, performing the same role as a gunfire control radar. An ASW projector will have its attack sonar listed on the weapons line after "//". Attack sonar must be active to provide firing data.

Ships fitted with Gen 4 and later search sonars do not need a dedicated attack sonar. They are accurate enough to provide firing data. Attack sonars cannot perform searches.

8.3.5.2 Multiple attacks. If a projector can make more than one attack in a Tactical Turn, two attacks are split, one each in the Planned Fire and Reaction Fire phases, and three attacks are split with two in the Planned Fire and one in the Reaction Fire phases.

8.5.3.3 The Special Hedgehog Rule. The Hedgehog and the Russian MBU-200 and 600 have a chance of getting more than contaact one hit from a single salvo. Their charges land in a pattern that is less than the length of a submarine. Thus, if the ship's aim is spot on, there is a chance that the oval overlaps both ends of the hull.

Rolling the chance of a hit or less guarantees at least one hit. If the die roll is half or less than the hit chance, it is two hits; rolling one-quarter or less is three hits. Each hit not only inflicts the listed number of damage points, but is another chance of a pressure hull penetration.

8.5.4 Depth Charge Attacks. Depth charges (DCs) can be used by both ships and aircraft, and are usually dropped in patterns. Surface ships can deploy DCs from stern rails and with projectors. Depth charge rails and projectors cannot be used in sea state 7 or higher seas.

Rails can only lay charges in a straight line behind the ship. To widen the size of a pattern ("dispersed"), projectors use a small explosive change to throw DCs a short distance from the ship.

Depth charge rails and projectors all have a capacity, listed in Annex A for each weapon. The player can only use as many charges as are listed. For example, if a ship has two DC rails each with 9 charges and two K-guns, each with 4 charges, it can only use 26 charges before it has to reload the rails and projectors.

A Size class C or larger ship can bring up 15 depth charges in a 30-minute Intermediate Turn. A Size class D or smaller ship can bring up 10 depth charges. The reloads can be put into any rail or projector the player chooses.

8.5.4.1 Ship DC Patterns. Ships with both DC rails and projectors can lay dispersed patterns of varying sizes in a large circle or oval. To lay a dispersed pattern, one-half of the charges must come from the rails and the other half from the projectors (a minimum of two DCs). A single rail can drop up to six DCs per Tactical Turn and a single projector can launch a maximum of two DCs per turn.

8.5.4.2 Depth Charge Procedure. In the Plotting Phase, the surface ship's player writes down the size of the DC pattern they will use. In the Movement Phase, the ship must pass within 250 yards of the submerged submarine. It may have detected the submarine itself, or be directed over the spot by another friendly unit that has contact. (Note: If a surface ship passes over a submarine at periscope/snorkeling depth, there is a risk of collision, see section 3.3).

As the ship makes its approach, the attacking player declares an attack. The sub player must then give two adjacent depth bands (for example, Intermediate II and III), one of which must be the submarine's true depth. Although most sonars will not reveal a sub's depth, they can narrow it down, based on the width of the sonar beam and when contact was lost. If a ship is equipped with a depth-determining or fire control ("attack") sonar, the submarine's depth band is known.

Fourth generation and later active sonars, with the exception of active towed arrays, can also provide accurate depth data. If the sub is held by one of these sonars during the attack, the sub's player must provide the correct depth band.

Once the sub player has provided the required depth information, the attacking ship player announces the number of charges in the pattern and its depth. If the pattern was not set to the same depth as the submarine player (a simple "yes" or "no" from the submarine player) the pattern will have no effect. If the attack matches the sub's depth, the surface ship's player resolves the attack immediately.

The sub player must declare whether or not the submarine is attempting to evade (and almost always will). If the sub player chooses not to evade, or the submarine cannot evade due to damage, subtract ten (-10) from the D100 die roll. The submarine player may choose the new direction, speed, and depth as the boat evades the DC attack.

To find the chance of a hit, add up the number of DCs in the attack. For a dispersed pattern, the base chance is the number of charges. If the pattern is a straight-line, halve this value. Then find the speed-depth combination modifier in the ASW Projector and DC Modifier table and apply this to the base value. The final number is the probability of one DC in the pattern being close enough to cause damage to the submarine.

Roll D100. If the die roll is less than or equal to the modified attack value, then the submarine is within the major damage radius of a DC. If the attack die roll is greater than the modified value, but less than or equal to twice that number, the submarine is within the minor damage radius of the weapon. If the die roll is more than twice the attack value, then the attack has no effect.

Example: A Norwegian *Ula* class sub is at Intermediate Depth I when it is attacked by a Project 1124M Grisha III-class FFL with BPS depth charges. The submarine is at a speed of 9 knots. As the ship passes overhead, the Soviet player declares a DC attack, and the Norwegian player replies that the submarine is at Intermediate Depth I and is evading. The Grisha III has a 4th Gen MGK-335 Platina sonar that provides depth information.

The Soviet player announces that a 12-BPS straight pattern will be dropped, six DCs each from the two rails, which gives a base probability of 6% (12 charges x 1% and then halved since this is a straight pattern). For a submarine at a depth of Intermediate I and a speed of 9 knots the modifier is x0.75, and this gives a final probability of 5% (6% x 0.75 = 4.5% round to the nearest whole number, or 5%).

On a roll of 01 - 05, the Norwegian submarine takes major damage from a BPS depth charge. On a roll of 06 - 10, the submarine only experiences minor damage. A roll of 11 or greater results in no damage.

Roll any critical hits on the Submarine Major or Minor Column on the Critical Hit table on page 14-2. If a Pressure Hull Penetration critical hit occurs, the attacking player must roll on the ASW Projectile Contact Hit Hull Penetration table (page 8-19). If the die roll is unsuccessful, a hull penetration did not occur, then that critical hit is ignored.

8.5.4.3 Depth Charge Attack Restrictions. Ships dropping depth charges into Shallow and Intermediate I depth bands must be at a speed of at least 15 knots or automatically take damage from the depth charges' blast equal to the damage points of one charge, with any critical hits resolved on the Underwater Attack column of the Critical Hit table on page 14-2.

Only one ship may attack a sub with depth charges in each Tactical Turn. If more than one ship attacks the target, the second and following ships will be caught in the blast area from the first ship's charges. They will automatically suffer damage equal to the major damage points of a single charge with any critical hits rolled on the Underwater Attack column.

8.5.4.4 Air Dropped Depth Charge Attacks. Aircraft can also drop depth charge patterns; they are treated as a dispersed ship pattern. Aircraft, with the exception of 4th Gen active dipping sonars, have a difficult time determining the submarine's depth, and a sub player is allowed to list three possible depth bands when they are attacked. Aircraft typically drop DCs on a visual, IR, or radar contact, since the depth is known (Shallow).

Passive and active homing DCs do not need to know the submarine's depth; the DC will look for the target as it passes through each depth band until the weapon's maximum depth is reached.

Since homing DCs have a larger effective area than timed or hydrostatic-fuzed weapons, they have a corresponding larger multiplier. A 1st Gen homing DCs has the total number of weapons dropped multiplied by three (x3) to determine the attack's base value, while 2nd Gen homing DCs are multiplied by ten (x10). If a submarine deploys acoustic countermeasures of any generation, the probability of hit is halved.

An aircraft my drop up to eight depth charges in a single attack.

Example: The Norwegian *Ula* class sub is at Periscope/Snorkel depth when it is detected by an Il-38 May maritime patrol aircraft's radar. The sub player orders the boat deep (although it will only get to Intermediate I by the time the attack takes place), accelerates to 11 knots and deploys a jamming countermeasure (x.5 against homing DCs). The Soviet player announces that the May will drop a six-charge pattern. The speed-depth modifier is x.5 from the ASW Projector and DC Modifier table (Intermediate I/11 knots).

Traditional DC (PLAB-250-120): Assuming the Soviet player set the DCs for Intermediate I, the probability of hit is 6 x 1% x .5 = 3%

1st Gen Homing DC (KAB-250-100PL/Zagon/S3V): 6 x 3% x .5 x.5 = 4.5% or 5%

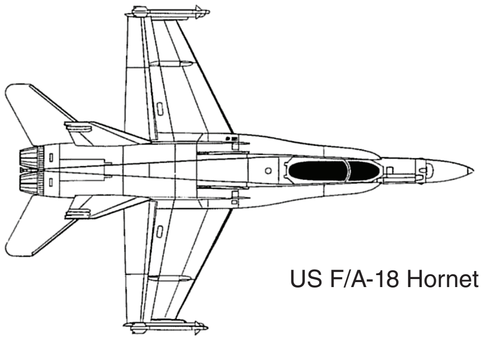
2nd Gen Homing DC (KAB PL/Zagon-2): 6 x 10% x .5 x.5 = 15%

Russia has also developed some unique ASW cluster bombs. These weapons carry submunitions with small shaped-charge warheads that require a direct hit in order to do any damage to a submarine. The first system is the PLAB-MK, a very small bomblet carried in large numbers and introduced in 1954. Each dispenser houses two cassettes with 25 PLAB-MK submunitions each. As the bomblets were released directly from the cassette, their dispersal over the contact area was poor. Added to that the very small explosive charge, 0.74 kg, and the system had a lackluster reputation.

The contents of up to six cassettes may be released in one attack; however, because of the poor submunition dispersal this ASW cluster bomb has a x.5 penalty - similar to laying a straight DC pattern from a ship. The submarine speed-depth combination modifier is also applied. If a hit does occur, the aircraft player rolls D6/2 to see how many submunitions hit the boat. Roll for a pressure hull penetration for each hit, but halve the chance in the Pressure Hull Penetration table. Resolve damage and any critical hits using the Submarine Minor Damage column of the Critical Hit table.

The second weapon is the recent RBK-100 PLAB-10K, mid-1990s IOC, which is a more traditional cluster bomb. The bomb itself is dropped and it releases the six PLAB-10K submunitions at a pre-selected height. The RBK-100 cluster bomb does a much better job of covering the area of a probable submarine and has a x2% multiplier for each bomb in the attack - up to eight cluster bombs can be used in a single attack. The submarine speed-depth combination modifier is also applied. Only one submunition in the pattern will have a chance of hitting a submarine.

If a submunition does hit the target submarine, roll for a pressure hull penetration critical using the values as listed in the Hull Penetration table. If a pressure penetration does not occur, resolve damage and any critical hits using the Submarine Minor Damage column of the critical hit table.


US F/A-18 Hornet

Chapter Nine - Air Warfare

9.1 Aircraft Maneuver Ratings. All aircraft have two Maneuver Ratings, e.g., "3.0/1.5." The first is used when the aircraft is lightly loaded or unloaded (carrying less than 80% of its maximum payload). The second is used when the aircraft is carrying 80% or more of its maximum payload.

For example, a Mirage IIIE has a Maneuver Rating of 3.0/1.5 and a maximum payload of 4000 kg. It is 3.0 when loaded with 2 AIM-9B Sidewinder, one R.530 AAM, and two 500 L drop tanks. (1147 kg total). When carrying 2 1700 liter drop tanks and an AS.30 ASM (3240 kg total, making 81%), the Maneuver Rating drops to 1.5. It would have to jettison the drop tanks to get its higher Maneuver Rating back.

9.2 Aircraft Damage Ratings. Each aircraft has a single number that rates its resistance to damage. It is based on its construction, the number and type of engines, its structure, and any special protective measures it carried. See Annex Z.

9.3 Air Combat Restrictions. There are cases when air combat cannot take place or one aircraft will be at a disadvantage.

• Aircraft landing or launching cannot attack or actively defend themselves; they have a Maneuver Rating of 0.0 and cannot use countermeasures.

• Aircraft cannot shoot down surface-to-air (SAM) or air-to-air (AAM) missiles because of their small size, very high speed, and limited flight time. They can engage surface-to-surface (SSM) and air-to-surface (ASM) missiles that are in the air for a full 3-minute Tactical Turn.

• Aircraft cannot attack more than one target with one type of weapon in a single dogfight round. *Exception:* Some air intercept radars can engage more than one target with AAMs at a time. This is listed in Annex J3.

• Planes can defend themselves with defensive guns while they also fire offensive weapons.

9.4 Dogfighting. To make an attack with guns, the attacker must close to within dogfighting range of his opponent. They can also use AAMs, although some missiles suffer a heavy penalty if used in a dogfight.

Once the attacking player is close enough, he declares a dogfight. The range for declaring a dogfight depends on the speed of the aircraft involved:

Max speed of fastest aircraft (kts)	*200*	*400*	*401+*
Dogfight Radius in nmi	1	3	6

The player declaring the dogfight must be no more than one altitude band below his opponent and no more than two levels above his opponent. A plane at Low cannot engage an enemy at High altitude, but the plane at High altitude can declare a dogfight with the plane at Low. A dogfight takes place at the altitude of the lowest aircraft involved in the fight, and all dogfighting aircraft are at the same altitude band.

A plane's exact speed changes during the dogfight from moment to moment, but it remains at subsonic speeds. See also 4.1 Dogfight Movement.

Once a dogfight is declared, place a marker on the board representing the center of the dogfight circle. The radius of the circle is the same as the dogfight range. All the planes involved in the fight are somewhere within the circle, but their exact position is not defined. Each plane is maneuvering, trying to get into firing position while avoiding attack itself. All ranges to the dogfight are taken from the marker.

Planes in a dogfight cannot attack ground targets, land or do anything that compromises their ability to maneuver and attack. If an aircraft cannot or chooses not to maneuver (e.g., a recce plane on a photo run), then it has a Maneuver Rating of 0.0.

Dogfights are fought in rounds of one minute each, with three rounds to a three-minute Tactical Turn. During each round, players first roll dice to get in firing position, and if successful, fire at the other aircraft. In each one-minute dogfight round:

1) Planes with a higher Maneuver Rating move before planes with a lower Maneuver Rating. If two planes have the same Maneuver Rating, the plane with the higher full power speed at that altitude moves first. If their speeds are also the same, flip a coin.

It is entirely possible that planes will be shot down before they can take their turn.

2) As each plane takes its turn, the player can maneuver to gain position, maneuver defensively (section 9.4.4), or try to leave the dogfight (9.4.5). Each of these actions is described more completely below.

9.4.1 Gaining Position. Each player chooses a target aircraft and rolls D100.

Dogfight Position Chance

D100 Roll	*Result*
01 - 50	Fail
51+	In position for all-aspect AAM
61+	In position for wide-angle AAM
71+	In position for narrow-aspect AAM
81+	In position for gun shot

D100 Modifiers:
Attacker's Man Rtng - Defender's Man Rtng * 5%
If the Attacker has a:
Helmet-Mounted Sight, +10% to AAMs
Helmet-Mounted Display, +20% to AAMs
Helmet-Mounted Vision system, +30% to AAMs
If the Attacker's Full Military Power speed at that altitude
is 150 knots faster +10%
is 150 knots slower -10%

If the attacker successfully gains position, then he can attack with guns (9.4.2) or AAMs (9.5).

Example: An attacking F-4E has a Maneuver Rating of 2.5, and its FMP speed at high altitude is 920 knots. A MiG-23BN's Maneuver rating is 3.0, and its speed at High altitude is 911 knots. The attacking player rolls D100 and gets an 83, but must subtract 2.5 (rounded to 3) because of the difference in maneuver rating. The result is 80, which puts him in position to fire a wide-angle missile like an AIM-9E or a narrow-aspect missile like the AIM-9B.

9.4.2 Gun Attacks. On the Aircraft Gun Attack Table (page 9-3), find the gun rating of the attacking aircraft and the damage rating of the defender. This is the chance of a kill.

9.4.3 Defensive Guns. Any plane with defensive guns will have them listed in Annex B. In a dogfight, a plane fitted with them automatically gets to fire back at its attacker. There is no position roll.

Also, a plane's defensive guns can shoot at every plane that attacks it. These are rolled at the same time as the attack, and the effects take place simultaneously.

Planes attacking with AAMs in a dogfight cannot be fired at by a target's defensive guns. The missile's range is greater than the defensive guns' effective range.

9.4.4 Defensive Maneuvering. By concentrating entirely on evasion and giving up any chance of getting on an opponent's tail, a defending aircraft can improve its Maneuver Rating by 0.5.

The aircraft's player must declare that it is maneuvering defensively at the start of the round before any aircraft have taken their turn.

Planes maneuvering evasively can still use their defensive guns if they are attacked, but their Defensive Gun Rating is halved because of their more violent maneuvers.

9.4.5 Escaping a Dogfight. If a plane wants to break off combat before the dogfight ends, he declares this when it is his turn to move. During the round he is breaking away, he is maneuvering defensively (9.4.4). He cannot make an attack, although if he has defensive guns, they can fire.

The player attempting to escape rolls D10, adding one to the die roll for each 50 knots of speed advantage over the other side (subtract one for each 50 knots slower). If the final roll is 6 or more, the plane has escaped combat and cannot be pursued; use 9.4.6 to find its position. If it is less, the plane has not escaped. It can try again next turn.

Helmet-Mounted Sights

In the 1980s, the first effective helmet-mounted sights were introduced. They display fire control information right on the pilot's visor, and cued them to contacts in their field of view. They also pointed missile seekers in whatever direction the pilot was looking. This improved both the pilot's situational awareness and his reaction time.

The first-generation Helmet-Mounted Sight (HMS) displays only fire control data. The later Helmet-Mounted Display is virtually a HUD, providing more information.

The third generation is the Helmet-Mounted Vision system, that fuses information from all the plane's sensors, including EO sensors all over the aircraft. In addition to providing night vision capability, it allows the pilot see parts of the sky blocked by the aircraft, for example, below his feet.

If a plane is fitted with an HMS, HMD or HMV, it will be listed as one of its sensors in Annex B.

9.4.6 Ending a Dogfight. After three dogfight rounds, (one Tactical Turn), both players rolls a D6. If either rolls a 1 or 2, the dogfight is over. After the sixth round (two Tactical Turns), if the D6 roll is 1 - 4; the fight is over. All dogfights automatically end after nine rounds (three Tactical Turns). This simulates the effects of low ammunition or fuel or the two sides simply deciding they've had enough.

When the dogfight stops, planes can take up any heading and speed the players choose. If their altitude matters, roll D10 and subtract one for every round of dogfighting. If the result is a 5 or less, the combatants ended the fight one altitude level lower than they started. If it is 1 or less, it ended two levels lower, but no lower than Low altitude.

Planes leaving a dogfight must return to base. It cannot declare a dogfight, but if it is attacked and enemy aircraft declare a dogfight, then it fights normally, with a +1 on the D6 roll to end the fight.

9.4.7 Special Starting Conditions *(optional)*. Inside a dogfight circle, the positions and speeds of the individual aircraft are not defined, but their relative positions and speeds on the first dogfight round are known. If the players all agree, they can apply the special modifiers to the *first-turn* Maneuver Difference:

• *Starting Speed:* Instead of the maximum full power speed at that altitude listed in Annex B, use the plane's actual plotted speed for the turn the dogfight begins. For example, a plane in a diving attack might gain a real advantage on the first turn, or a plane caught climbing to altitude might find itself severely disadvantaged. For loitering aircraft, use 80% of its cruise speed at that altitude.

• *Attacking From Astern:* If an aircraft starts the fight behind a group of enemy aircraft (anywhere in their rear hemisphere), and there are no hostile aircraft behind it, add +1.0 to the attacker's Maneuver Difference. In effect, it's almost in firing position when the fight starts.

If an aircraft starts the fight with an enemy behind it, subtract 1.0 from its Maneuver Difference.

• *Surprise:* If one group of aircraft can surprise another, they are allowed one round of free attacks without the defenders being able to shoot back. This includes not only fighters, but aircraft with defensive armament. Also, the Maneuver Rating of the opposing side is reduced by 2.0 (to 0.5 minimum), since the surprised pilots are not maneuvering to avoid the attack.

To gain surprise, attacking aircraft must approach from behind the enemy and be undetected. The attackers then roll on the surprise table.

The number on the surprise table represents the percent chance of a successful surprise attack, rolled on D100. If the aircraft being attacked are not single-seat fighters, shift one column to the right. In other words, treat 3-4 multicrewed aircraft as 5-8 single-seat aircraft. Extra eyes really help in spotting attackers. If the aircraft are of mixed types, use the majority as the determining type.

Chance of Surprise

		Number of Defending Aircraft				
		1	2	3-4	5-8	9+
	1	30%	25%	15%	10%	5%
Number of	2	25%	20%	15%	10%	5%
Attacking	3-4	15%	15%	10%	5%	2%
Aircraft	5-8	10%	10%	5%	2%	1%
	9+	5%	5%	2%	1%	0%

Aircraft Gun Attack Table

Target Damage Rating	*Aircraft Gun Rating* .05	.10	.25	.50	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
4	.05	.15	.20	.30	.45	.50	.60	.70	.75	.80	.85	.90	.90	.90	.90
5	.05	.15	.20	.25	.40	.50	.55	.60	.65	.70	.75	.80	.85	.90	.90
6	.05	.15	.15	.25	.35	.45	.50	.55	.60	.65	.70	.75	.80	.80	.85
7	.03	.10	.15	.25	.30	.40	.45	.50	.55	.60	.65	.70	.70	.75	.80
8	.03	.10	.15	.20	.30	.40	.45	.50	.50	.55	.60	.65	.70	.70	.75
9	.03	.10	.15	.20	.30	.35	.40	.45	.50	.55	.60	.60	.65	.65	.70
10	.03	.10	.10	.20	.30	.35	.40	.45	.50	.50	.55	.60	.60	.65	.65
12	.03	.10	.10	.20	.25	.30	.35	.40	.45	.45	.50	.50	.55	.60	.60
14	.03	.10	.10	.15	.25	.30	.30	.35	.40	.45	.45	.50	.50	.55	.55
16	.03	.10	.10	.15	.20	.25	.30	.35	.40	.40	.45	.45	.50	.50	.50
18	.03	.10	.10	.15	.20	.25	.30	.30	.35	.40	.40	.45	.45	.50	.50
20	.03	.10	.10	.15	.20	.25	.30	.30	.35	.35	.40	.40	.45	.45	.45
25	.01	.05	.10	.10	.20	.20	.25	.30	.30	.30	.35	.35	.40	.40	.40
30	.01	.05	.10	.10	.15	.20	.20	.25	.30	.30	.30	.35	.35	.35	.40
40	.01	.05	.10	.10	.15	.15	.20	.20	.25	.25	.30	.30	.30	.30	.35
50	.01	.05	.05	.10	.10	.15	.20	.20	.20	.20	.25	.25	.30	.30	.30
60	.01	.05	.05	.10	.10	.15	.15	.20	.20	.20	.20	.25	.25	.25	.30
70	.01	.05	.05	.10	.10	.10	.15	.15	.20	.20	.20	.20	.25	.25	.25
80	.01	.05	.05	.10	.10	.10	.15	.15	.15	.20	.20	.20	.20	.20	.25
90	.01	.05	.05	.05	.10	.10	.15	.15	.15	.20	.20	.20	.20	.20	.20
100	.01	.05	.05	.05	.10	.10	.10	.15	.15	.15	.20	.20	.20	.20	.20

If the attackers wish to make their attack from "out of the sun," which increases the chance of surprise, they must approach the enemy aircraft directly from the east in the morning or the west in the afternoon. The attacking player then declares that he is attempting to approach from out of the sun. He rolls a D10, using the left-hand-most column (number of aircraft attacked is 1) of the Surprise Table to determine the chance of positioning his aircraft. If he succeeds, add 30% to the chance of surprise, which is rolled separately and under the appropriate column for the number of planes attacked.

If any of the defending aircraft are equipped with a RWR or ES, they cannot be surprised by an attack using a radar-guided weapon. This includes gun attacks using a plane's radar for gun ranging. RWRs will not be alerted by IRH missiles.

If the defending aircraft are in communication with any other unit (ground, naval, or air) that is actively tracking the attacking aircraft, then they cannot be surprised.

Example: A pair of MiG-29s sees a group of four Tornado strikers, escorted by three F-16s. The NATO aircraft has not seen them yet (see 5.8.3 Sighting Aircraft), and the Russian fighters are being vectored by GCI radar.

The Russian carefully positions himself above and behind the group, approaching directly from the east. He declares that he is attempting to attack from out of the sun, then rolls the die. Since there are two aircraft in the attacking group, there is a 25% chance he successfully positions them, and he succeeds.

The base chance of the two Fulcrums surprising the group is 10%, taken from the Surprise Table. This must be moved one column to the right, though, since the majority of the NATO aircraft are multicrewed. This lowers the chance to 5%, but the successful sun attack raises it to 35%. This is the number the Russian player must roll on D100.

9.4.8 Dogfighting in Poor Visibility. Planes can use guns and missiles at night against targets with a Maneuver Rating of 0.5 or less.

Against more maneuverable targets, planes can fire missiles against targets detected by onboard radar or IRST. Dogfighting with guns is too dangerous due to pilot disorientation.

Planes cannot dogfight in clouds.

9.5 AAM Attacks. Aircraft can attack other air platforms (e.g. aircraft, UAVs, missiles) with AAMs during a dogfight or without dogfighting.

Outside a dogfight, if a target is within the range and altitude limitations for the missile listed in Annex H4, a player can order it in the Plotting phase. It happens in the Planned Fire Phase, and is resolved immediately. If more than one side can fire AAMs at the same time, players should use one-minute dogfight rounds. Planes with longer-ranged AAMs fire first.

A plane may fire up to two missiles in a dogfight round at the same target.

1) If the missile is being fired in a dogfight and is not "dogfight-rated" (this is listed in the AAM Annex), then halve the missile's Air-to-Air Rating.

2) Subtract the Maneuver Rating of the defending aircraft from the Maneuver Rating of the missile. This is the Missile Index.

3) Add the modifier for the attacking aircraft's AI or LD/SD radar from the Combat System Modifier table.

4) Check the Target Speed Modifiers table on page 8-8 and apply that modifier to the Missile index.

5) Check the Target Signature Modifier table on page 8-8 and apply the modifier to the Missile Index.

6) If the defending aircraft is fitted with countermeasures, compare the seeker generation of the attacking missile with the generation and type of countermeasures fitted on the

Antiair Missile Countermeasures table on page 8-8. Apply the result to the Missile Index.

7) If the attacker is not at the same altitude as the target aircraft and is not using a snap up/snap down missile, apply a -1.0 modifier to the Missile Index.

8) Find the modified Missile Index on the Antiair Missile Attack Table. The result is the chance of a hit for a one-missile shot and a two missile salvo.

Example: F-4E Phantom II vs. MiG-23ML Flogger G at Medium altitude, attacking with an AIM-9L: The MiG-23ML has a maneuver rating of 3.0, a Small size and Signature, a FMP speed of 590 knots at Medium Altitude, and has 2nd Gen D countermeasures. The Phantom's APQ-120 is a 2nd Gen AI radar.

The AIM-9L is a IRH/3rd Gen missile with an ATA Rating of 3.0.

The Missile Index is 0, for the AIM-9L's 3.0 minus the MiG's 3.0. The radar's combat system modifier is 1.0 (2nd Gen vs. aircraft), the target speed modifier is 0 (590 kts), the target signature modifier is 0 (Small), and the countermeasures modifier is -0.5 (3rd Gen seeker vs. 2nd Gen D). The modified index is +0.5; the chance of a kill for a single missile is 35%, and 58% for a two-missile salvo.

9.5.1 Evading AAMs Outside a Dogfight. When an AAM attacks an aircraft, the targeted plane can do nothing but attempt to evade the missile. By dropping chaff and flares in combination with evasive maneuvers, a plane can reduce the missile's chance to hit. These are things planes automatically do in a dogfight, but their exact movements are not tracked. This is reflected in the Countermeasures modifier.

If the plane is surprised, or the player chooses not to maneuver, he must declare this when the AAM is fired. Halve any countermeasures modifier and treat the plane as having a Maneuver Rating of 0.0.

Aircraft evading a missile cannot launch or drop any ordnance on any targets. Any missiles that the aircraft launches or is controlling will automatically "go stupid" and miss. *Exception*: TARH AAMs are not affected.

The only action permitted an engaged aircraft is that it may jettison part or all of its external ordnance, if it wishes to change its Maneuver Rating from fully loaded to lightly loaded. Ordnance that is jettisoned automatically misses.

9.5.2 Speed Effects on AAM Range. Missile range (out of a dogfight) is affected by the speed of the launch aircraft.

If the missile shooter is moving at less than 330 knots halve the AAM's range.

If the shooter is flying at faster than 860 knots at High or VHigh altitude, increase the range by 50% (times 1.5).

9.5.3 Firing AAMs into a Dogfight. A non-dogfighting aircraft firing an AAM or a ship firing a SAM into a dogfight has a equal chance of locking onto any aircraft in the fight, friendly or enemy. If a plane fires an AAM into a dogfight, roll randomly to see which aircraft, friendly or enemy, is attacked.

The missile's chance to hit is figured once the target is known. The attacking player cannot stop guiding the missile (if it needs guidance) once the target is determined.

9.6 Air Attacks on Surface Targets. An aircraft involved in a dogfight cannot attack a naval or ground target in the same Tactical Turn. If a weapon launched or dropped on a ground target misses, it has no other effect.

9.6.1 Bombsights. Attacks with unguided ordnance are affected by the quality of the aircraft's bomb sight.

• *Basic:* These use the TLAR method of aiming: "That Looks About Right." The pilot/bombardier makes manual corrections to the flight path and releases the weapons. There are no modifiers for this sight.

• *Ballistic:* These use an analog computer to calculate the drop point. Actual weapon release is done manually.

• *Computing:* These use digital computers to more accurately calculate the drop point. The computer will automatically release the ordnance at the proper time.

• *Advanced:* These second-generation digital systems use high-resolution ground mapping radars, laser rangefinders, imaging infrared sensors, and GPS to enhance bombing accuracy even farther. They can provide near-guided accuracy for unguided ordnance when dropped from low altitude.

9.6.2 Air Attack Planning. When pilots attack a group of surface ships or a ground target, they must be briefed before takeoff, or over the radio (if they have it) when the enemy is sighted. For example, pilots could be instructed to attack the biggest ship, or the lead ship, or the nearest ship. Pilots attacking an airfield might be briefed to attack the hangars or the revetments. The strike commander can assign different targets to different divisions, or even to individual aircraft.

The instructions can be as detailed as the attacking player wishes, with the understanding that the more complex the orders, the easier they will be to misunderstand. This is especially true in a refereed game, where a third party will implement a player's orders.

Players should choose ordnance appropriate to the target. Different types of bombs and other ordnance cause different types of damage. Some have settings that must be made before takeoff.

If aircraft ordered to attack a ground or naval target sight their objective and they have not been given instructions about what to attack, the group will break up into sections (three or four aircraft, depending on nationality) and each section will randomly attack one of the eligible targets present.

If the pilots do have instructions, they will do their best to interpret them. The visibility rules (5.8) or optional visual identification rules (5.8.8) may prevent them from seeing an eligible target or misidentify a potential target.

9.6.3 Air Attack Procedure. After surviving any defensive missile fire, if an attacking aircraft is within one Increment's movement of its intended target, it is placed next to their target. It is assumed that the defending ships will be maneuvering to bring aircraft under fire and that aircraft will be maneuvering to avoid the worst concentrations of fire.

Up to 12 aircraft can attack a ship within one Tactical Turn.

Once all attacking planes have been moved next to their targets, follow the steps in section 8.1.3 to resolve defensive gunfire. Unguided ordnance attacks are then resolved.

9.6.4 Types of Bombing Attacks. Bombs can be dropped on their target by three methods: horizontal laydown (level bombing), glide bombing, and lobbing ("tossing") the bomb. Each technique has its advantages and disadvantages.

• *Level Bombing or Laydown* includes attacks by aircraft both in level flight and in very shallow dives. It can be used from any altitude band. The aircraft flies in a straight line directly over the target without changing altitude. The plane is treated as having a Maneuver Rating of 0.0 in the turn it makes the attack.

• *Glide Bombing*. Planes can improve their accuracy by going into a shallow dive (less than 45°). They must start at Medium altitude and move straight toward the target the Movement Phase they attack. They will release their bombs at either Medium or Low altitude (player's choice) as they overfly the target.

• *Lob-Toss Bombing* has the lowest accuracy, but it is the safest, since a plane doesn't get within effective range of the target's point defenses. To make a lob-toss attack, a plane must have an ATA rating of at least 1.0 and have a Ballistic or better bombsight. Starting in the Low (including VLow) or Medium altitude band, the plane flies straight toward the target at full military power. At 15 nmi from the target, it goes into a steep climb and releases the weapon, literally throwing it toward the target. The aircraft finishes its movement facing directly away from the target at Medium altitude.

Only one type of weapon can be lofted in each attack, but any number can be released. Powered ordnance like rockets or missiles cannot be lofted. Conventional unitary unguided ordnance cannot be lob-tossed against moving targets.

Laser guided bombs and EO/IR bombs can be lofted without any reduction in their Ph, however, the aircraft that lofts the bomb cannot be the same one that provides the laser designation or the controlling data link.

9.6.5 Resolving Unguided Bomb Attacks. Use the Unguided Ordnance attack table on page 9-6.

1) Find the base chance to hit by comparing the type of attack with the size of the target being attacked.

2) Use the applicable modifiers for the type of attack, but if it's a level bombing attack, apply the altitude modifier instead. This gives you the base chance to hit.

There are several other modifiers that can be applied, which determines the final hit chance by shifting up or down rows on the Air Attack Table. Up is good, down is bad. Figure out the net up/down shifts from modifiers, and then roll on the Air Attack Table.

3) On the Air Attack Table, In the left-hand column, find the base hit chance, then shift it up or down as the modifiers require. This is the row the attacking players will roll on. The salvo size across the top refers to the number of bombs being dropped (exception: level bombers, see below). If a plane is dropping three bombs, and the final Ph was 30%, then the player would roll D100 and find the part of the row under salvo size = 3. The row reads .66/.22/.03. This means that if the D100 roll is 67 or higher, he misses. From 66 to 23, he scores one hit. From 22 to 04, he scores two hits. If he rolls a 03 or less, all three bombs hit the target.

Example: A flight of four Iranian Su-24s makes a glide bomb attack with four FAB-500 iron bombs each on a US cruiser steaming at 30 knots. The salvo size is 4, and they will use this column on the Air Attack table.

The ship is firing both guns and SAMs at the incoming aircraft, qualifying as "Heavy AA."

Size class B glide bombing: base Ph is 24%.

Target Speed 25 - 34 kts, down 1 row
Computing Bombsight, up 3 rows
Heavy AA fire, down 1 row

A net of one row up from 24% puts them on the 26% row. Each plane rolls D100 and reads across the row that says .70/.28/.06/--. The first plane of four rolls a 30, scoring one hit. The second rolls a 12, scoring two hits, the third rolls a 75, missing, and the last rolls an 01, scoring three hits. In total, the cruiser has been hit by six bombs.

If more than four bombs are being dropped by each plane, roll them in groups.

Level bombers are a special case. This table is only effective for Medium altitude (7500 m) or less. Above that, the hit chance is effectively zero, unless it is dropping a nuclear bomb. Additionally, in level bombing, the salvo size is the number of aircraft making the attack. If a plane hits, then one bomb from that plane's stick hit. More than one hit means that more than one plane hit.

9.6.6 Resolving Cluster Bomb Attacks. Cluster munitions are area effect weapons. They are designed to attack land targets, where their bomblets are large enough to destroy individual vehicles or troops. Against naval targets, the individual bomblets will not inflict damage points, but they can cause critical hits.

They can be used with any delivery profile, except they cannot be dropped below 100 meters altitude (this includes VLow or NOE flight), because the submunitions will not have time to deploy. Any cluster bomb dropped in VLow or NOE flight is an automatic dud.

Cluster munitions have two pattern sizes that can be set while the aircraft is in flight. The 'Large' pattern has a greater hit chance, but will do half damage.

Add the modifier from the Cluster Munitions Hit Chance Modifier table below to the hit chance in the Air Attack Table.

Cluster Munitions Hit Chance Modifiers

	Weapon Hang Weight		
	0-300 kg	*301-600 kg*	*601+ kg*
Target Size	*Small/Lge*	*Small/Lge*	*Small/Lge*
A - B	+30%/40%	+30%/50%	+30%/60%
C - E	+20%/30%	+30%/40%	+30%/60%
F - G	+10%/20%	+20%/30%	+20%/40%

Example: A French Mirage 2000 drops two Belouga cluster bombs from Low altitude on an Osa II PTG (Size class E/VSmall) at 25 knots. The pilot uses the Large pattern size to increase the hit chance. The Mirage 2000 has a Computing bombsight. Using the Glide Bombing Column on the Unguided Ordnance Attack Table, the base chance of a hit with a regular bomb against an E-size target is 6%. Taking into account the target's speed and the aircraft's bombsight shifts the probability of hit to 10%. The Belouga has a weight of 290 kg, so the player adds 30% to the hit chance, for a total of 40%.

Cluster weapons must be aimed at a single target. If another potential target is next to the designated target, e.g., ships moored together, then it is also attacked.

The damage inflicted depends on the target size and the hang weight of the weapon:

Cluster Munitions Damage

	Weapon Size (Hang Weight)		
Target Size	*0-300 kg*	*301-600 kg*	*601+ kg*
A - B (Large, Medium)	D6+2	2D6+1	2D6+4
C - D (Small)	D6+1	D6+2	D6+3
E - H (VSmall)	D6/2+1	D6/2+1	D6/2+1

For size classes A-E, roll critical hits on the Airburst critical hit column of the Critical Hit table. For small craft (size class F and G), use the Small Craft column.

Example: The Mirage hits the Osa II with one of his Belouga cluster bombs. Since the Belouga has a weight of 290

Unguided Ordnance Attack Tables

Base Chance to Hit

Target Size Class	*Glide Bombing Base Ph*	*Level Bombing Base Ph*	*Lob-Toss Base Ph*[2]	*Strafing*
A	35%	8%	12%	35%
B	24%	6%	10%	30%
C	12%	4%	6%	30%
D	10%	2%	4%	20%
E	6%	1%	2%	14%
F-G	2%	1%	1%	14%

Note : On larger ships, the chance of a hit on the strafing table is not the chance of hitting the ship, but hitting something on the ship worth knocking out.

General-purpose (GP) explosive bombs of 1000 kg/2000 lb or less can be fuzed for either impact or airburst. See section 14.1.4

VLow attacks with retarded bombs do not change the chance to hit. The armor penetration rating of all retarded ordnance is halved.

Attack Altitude Modifier (Level Bombing)

<1,500 m	Base Ph x 3.0
1,500 - 2,999 m	Base Ph x 2.0
3,000 - 3,999 m	Base Ph
4,000 - 4,999 m	Base Ph x 0.5
5,000- 7,500 m	Base Ph x 0.25

Target Speed Modifiers

5 knots or less	Up 2 rows
6 - 10 knots	Up 1 row
25 - 34 knots or more	Down 1 row
35+ knots	Down 2 rows

Attack Altitude Modifier (Glide Bombing)

Medium alt. release	Down 2 rows

Final Ph Modifiers

Rudder Casualty	Up 2 rows
Land Targets	Up 2 rows
Ballistic Bombsight:	Up 1 row
Computing Bombsight:	Up 3 rows
Advanced Bombsight:	Up 5 rows
No AA Fire:	Up 1 row
Heavy AA Fire[1]:	Down 1 row

[1]Antiaircraft rating of 3.0 or more firing at the attacking aircraft or SAM launched at the plane.

[2]Inertially-guided ordnance that is lob-tossed uses the Glide Bombing column.

Air Attack Table

Base	*Salvo =1*	*Salvo = 2*		*Salvo = 3*			*Salvo = 4*			
Ph	*1*	*1*	*2*	*1*	*2*	*3*	*1*	*2*	*3*	*4*
0.85	0.85	0.90	0.72	0.90	0.89	0.61	0.90	0.89	0.88	0.52
0.80	0.80	0.90	0.64	0.90	0.88	0.51	0.90	0.89	0.82	0.41
0.75	0.75	0.90	0.56	0.90	0.84	0.42	0.90	0.89	0.74	0.32
0.70	0.70	0.90	0.49	0.90	0.78	0.34	0.90	0.89	0.65	0.24
0.65	0.65	0.88	0.42	0.90	0.72	0.27	0.90	0.87	0.56	0.18
0.60	0.60	0.84	0.36	0.90	0.65	0.22	0.90	0.82	0.48	0.13
0.55	0.55	0.80	0.30	0.90	0.57	0.17	0.90	0.76	0.39	0.09
0.50	0.50	0.75	0.25	0.88	0.50	0.13	0.90	0.69	0.31	0.06
0.45	0.45	0.70	0.20	0.83	0.43	0.09	0.90	0.61	0.24	0.04
0.40	0.40	0.64	0.16	0.78	0.35	0.06	0.87	0.52	0.18	0.03
0.35	0.35	0.58	0.12	0.73	0.28	0.04	0.82	0.44	0.13	0.02
0.30	0.30	0.51	0.09	0.66	0.22	0.03	0.76	0.35	0.08	0.01
0.28	0.28	0.48	0.08	0.63	0.19	0.02	0.73	0.31	0.07	0.01
0.26	0.26	0.45	0.07	0.59	0.17	0.02	0.70	0.28	0.06	--
0.24	0.24	0.42	0.06	0.56	0.15	0.01	0.67	0.24	0.04	--
0.22	0.22	0.39	0.05	0.53	0.12	0.01	0.63	0.21	0.03	--
0.20	0.20	0.36	0.04	0.49	0.10	0.01	0.59	0.18	0.03	--
0.18	0.18	0.33	0.03	0.45	0.08	0.01	0.55	0.15	0.02	--
0.16	0.16	0.29	0.03	0.41	0.06	--	0.50	0.12	0.01	--
0.14	0.14	0.26	0.02	0.36	0.05	--	0.45	0.10	0.01	--
0.12	0.12	0.23	0.01	0.32	0.04	--	0.40	0.07	0.01	--
0.10	0.10	0.19	0.01	0.27	0.03	--	0.34	0.05	--	--
0.08	0.08	0.15	0.01	0.22	0.02	--	0.28	0.03	--	--
0.06	0.06	0.12	--	0.17	0.01	--	0.22	0.02	--	--
0.04	0.04	0.08	--	0.12	--	--	0.15	0.01	--	--
0.02	0.02	0.04	--	0.06	--	--	0.08	--	--	--
0.01	0.01	0.02	--	0.03	--	--	0.04	--	--	--
<0.01	--	--	--	0.01	--	--	0.02	--	--	--

kg and the Osa II is a VSmall target, the number of critical hits would normally be D6/2+1, but the pilot selected a large pattern, so the die roll result is divided by two. He will inflict 1 or 2 critical hits on the Airburst column of the Critical Hit Table.

9.6.7 Resolving Unguided Rocket Attacks. To attack with rockets, a plane must fly directly over the target at Low altitude. They can be fired by a plane in VLow or NOE flight. Rockets must be fired in pairs up to the full load of the aircraft at a single target.

Make one roll for each aircraft attacking. The hit chance is the same as making a glide bomb attack with all applicable modifiers for target size, speed, attack mode, etc. The salvo size is the number of pairs of rockets fired. If more than eight rockets (four pairs) are fired, there is no increase in the chance of a hit, but there is an improved chance of more damage, given a hit.

If a hit occurs, roll 2D6 on the Unguided Rocket Attack Table. The result is the number of hits on the target.

Unguided Rocket Attack Table

# of					*2D6 Roll*						
Rkts	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2	1	1	1	1	1	1	1	1	1	1	2
4	1	1	1	1	1	2	2	2	2	2	3
6	1	1	1	1	2	2	2	2	2	2	3
8	1	1	1	2	2	3	3	3	3	3	4
10	1	1	2	2	3	3	3	3	3	4	4
12	1	2	2	3	3	3	3	3	4	4	4
16	2	2	3	3	3	3	3	4	4	4	5
24	2	3	3	3	3	3	4	4	4	5	5
32	3	3	3	3	3	4	4	4	5	5	5

Tgt Size	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Die Modifier	+2	1	0	0	-1	-2	-3	-4

Example: A MiG-21 attacks a gun emplacement (size class F) with two UB-32-57 rocket pods. The base chance of a hit for this size target is 0.02. Although this is a land target, the target speed modifier still applies (+2 rows), and the MiG has a ballistic bombsight (+1 row), which raises the base Ph to 0.08. More than eight rockets means the attack uses the Salvo = 4 table which gives a 28% chance of the attack hitting. If the attack is successful, roll 2D6 and subtract two (-2 for Size Class F target) to find the number of rockets that hit the gun emplacement. In this case, make two rolls on the 32-rocket row for the 64 rockets fired.

9.6.8 Resolving Guided Weapon Attacks. These include guided missiles and "smart bombs," or Precision-Guided Munitions (PGMs). Their statistics are listed in Annex H2, Guided Air Ordnance.

Missiles with a Cruise flight path will climb or descend after launch to their cruise altitude, and remain there until they reach the target. They may make a terminal maneuver, either a popup or a steep dive, depending on their design. See sections 4.10.1 and 7.4.8.

Like surface-launched cruise missiles, they must have a fire control solution. The shooter must either detect the target with their own sensors or receive targeting information over a data link, then roll on the RF Fire Control Solution Tables to find out the fire control solution quality. They can work over successive Tactical Turns to improve it. Combat aircraft use a combat system modifier of zero.

When a group of aircraft are all attacking a single target, they roll for the RF fire control solution in 3-4 plane sections, according to their organization. Also, when they fire, they roll for weapon placement by 3 or 4-plane sections.

Weapons with a Glide or Direct flight path will fly directly towards their target and will not maneuver. They only fly their full distance if launched from High or Medium altitude. If released from Low altitude their range is halved.

Annex H2 lists the launch altitude for guided air ordnance. Most cannot be launched in Very Low or NOE flight because after they are released, it takes a moment for their motors to ignite. Only those missiles launched directly off a rail, like the Hellfire, can be launched in VLow or NOE flight. These weapons will have "rail-launched" included in their remarks in the Annex.

The intended target must lie within arc ±30° of the plane's flight path. Most guided weapons require a clear Line of Sight (LOS) to the target at some point during the attack. If the LOS is lost, the base hit chance is quartered (divide by 4).

A PGM attack against a ship or any other moving target within 10 nmi can skip the Weapons Placement Roll and proceed directly to resolving the attack.

To find the chance of a hit, go to the Precision-Guided Munitions Attack table and cross-index the target's size class with the generation of seeker being used.

• *Command Guided and Semiactive Radar Homing (SARH) Weapons*. These are controlled by a radio or radar from the launching aircraft. The aircraft must have a clear LOS to the target from the time the weapon is launched until it hits. To find the probability of hit, go to the Precision-Guided Munitions Attack table and cross-index the target's size class with the generation of Command or SARH weapon being used.

• *Semiactive Laser Homing (SALH) Weapons.* These include laser-guided bombs (LGBs) and missiles. A laser designator "paints" the target and the weapon homes in on the reflected laser light.

The designator may be carried by the launching aircraft or another friendly unit with a visual line of sight (LOS) to the target. If the launching aircraft is making a level or glide bomb attack, it may designate the target for itself. If the aircraft is making a lob-toss attack, another unit must designate the target. This unit can be on the surface or another aircraft.

One designator may "paint" the same target for any number of SALH weapons. However, only two weapons may attack an individual target each turn without affecting the chance to hit. For the third and subsequent weapons in the same Tactical Turn, the target is obscured by smoke and airborne debris from the first explosion. This is created whether the first weapons hit or missed. It takes one Tactical Turn for the target to clear.

The designator must have a clear visual LOS until the weapon hits the target (see 5.8.2). Aircraft designating the target must keep the target in the forward 270° arc (135° either side of the plane's nose, with a 90° dead zone centered aft).

• *Electro-Optical/Infrared Homing Weapons.* These weapons use TV (regular and low-level light) or imaging infrared sensors to home in on a target.

To attack with a first-generation EO/IR weapon, the firing plane must maintain a clear LOS to the target from launch until the weapon hits the target. However, since the radio data link is not aspect-dependent, the aircraft is free to maneuver as it sees fit after launch.

Precision-Guided Munitions Attack Table

	Countermeasures Generation and Target Size									
Guidance Type	Base Lg-Sm	Base VSmall	1st Gen Lg-Sm	1st Gen VSmall	2nd Gen Lg-Sm	2nd Gen VSmall	3rd Gen Lg-Sm	3rd Gen VSmall	4th Gen Lg-Sm	4th Gen VSmall
1st Gen Cmd/SARH	0.40	0.30	0.24	0.18	0.18	0.14	0.12	0.09	0.06	0.05
2nd Gen Cmd/SARH	0.50	0.40	0.40	0.32	0.30	0.24	0.23	0.18	0.15	0.12
3rd Gen Cmd/SARH	0.70	0.60	0.63	0.54	0.56	0.48	0.42	0.36	0.32	0.27
4th Gen TARH	0.85	0.75	0.85	0.75	0.85	0.75	0.77	0.68	0.51	0.45
1st Gen SALH	0.60	0.50	0.48	0.40	0.36	0.30	0.27	0.23	0.18	0.15
2nd Gen SALH	0.70	0.60	0.67	0.57	0.56	0.48	0.42	0.36	0.32	0.27
3rd Gen SALH	0.80	0.70	0.80	0.70	0.80	0.70	0.64	0.56	0.48	0.42
1st Gen EO/IR	0.75	0.65	0.60	0.52	0.45	0.39	0.34	0.29	0.23	0.20
2nd Gen EO/IR	0.80	0.70	0.76	0.67	0.64	0.56	0.48	0.42	0.36	0.32
3rd Gen EO/IIR	0.85	0.75	0.85	0.75	0.85	0.75	0.68	0.60	0.51	0.45
1st Gen SATNAV	0.70	0.60	0.42	0.36	0.35	0.30	0.28	0.24	0.21	0.18
2nd Gen SATNAV	0.75	0.65	0.64	0.55	0.56	0.49	0.53	0.46	0.45	0.39
3rd Gen SATNAV	0.80	0.70	0.80	0.70	0.72	0.63	0.68	0.60	0.60	0.53

If smoke obscures the target from the bomb's sensor, the LOS is considered to have been broken and the weapon's hit chance is quartered (divide by four).

• *Satellite Navigation (SATNAV)-Guided Munitions*. An aircraft must have an Advanced or Computing bombsight to use a SATNAV-guided bomb. Attacks are resolved on the Precision-Guided Munitions table.

First Generation SATNAV weapons must be dropped from High altitude or higher, because the seeker takes time to orient itself and make corrections to the bomb's flight path.

Second Generation weapons can be dropped from Medium altitude, and third generation weapons can be dropped from Low altitude, although not in VLow flight.

SATNAV-guided weapons cannot be used against a moving target, unless it is also fitted with a terminal seeker. If it does have a terminal seeker, resolve the attack on the appropriate PGM table.

• *Passive Radar Homing/Antiradiation Missiles*. Treat these as radar-guided missiles, using the 1st/2nd/3rd Gen Cmd/SARH lines on the Precision-Guided Munitions tables. Use the left (Lg-Sm) column regardless of target size. Remember that an ARM automatically inflicts a critical hit on the radar that it homes in on.

• *Terminal Active Radar Homing (TARH) Weapons*. These weapons use an active radar seeker to home in on the target.

9.6.9 Resolving Strafing Attacks. Although strafing attacks will not sink most ships, they can knock out weapons and sensors.

To strafe a ship or land target, a plane must fly directly over it at Low altitude. Use the Strafing column on the Unguided Ordnance Attack Table, with all applicable modifiers for target size, speed, attack mode, etc. Once the final hit chance is determined, roll on the Salvo = 1 table to see if the attack is successful.

Example: An F-4E with a 20mm Vulcan cannon and a Computing bombsight makes a strafing run on a Soviet P-6 PT boat. The P-6 is a F/VSmall target at 20 knots. It is also firing at its attacker, but the AA strength of 0.3 is not enough to qualify for the Heavy AA fire modifier.

The base chance of a strafing attack on a F-sized target is 0.14. The computing bombsight increases it three rows, to 0.20. There are no modifiers for speed. The attack is rolled on the salvo = 1 table.

Strafing damage does not inflict damage points, but critical hits, based on the gun caliber:

15mm or less: D6/2-2 critical hits
25mm or less: D6/2-1 critical hits
26mm or more: D6/2 critical hits

For size class A-E ships, roll on the Airburst & Frag Hits column of the Critical Hit table. For F and G-sized ships, roll on the Small Craft column.

If the location is armored, make sure the weapon can penetrate before inflicting the critical hit. Penetration ratings for aircraft guns are listed in Annex H3.

9.7 Airborne ASW. Aircraft may attack a submerged target with torpedoes, conventional depth charges, or nuclear depth bombs.

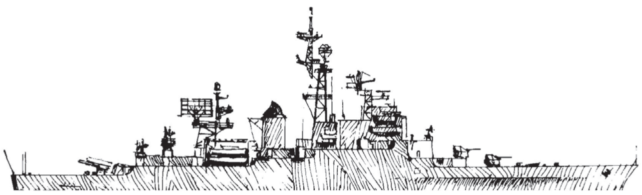
9.7.1 Air-Dropped Torpedoes. Air-dropped torpedoes must be dropped from Low altitude at no more than 50% of the aircraft's speed at Full power. The aircraft must know the location of the sub, either from its own sensors or through communications with a friendly unit. One torpedo may be dropped each Turn. Helicopters may drop torpedoes from in flight or in hover.

Once the torpedo is in the water, resolve the attack per section 6.3.8 Rolling for Weapon Placement with whatever solution the aircraft's sensors have. If the Placement die roll is successful, then the weapon attacks immediately (see 10.2.5).

If the weapon misses, it may be able to reattack using 10.2.7.

If another air-dropped torpedo is launched against the same target while the first one is still attacking, they will interfere with each other, and both will miss (see 7.5.3).

9.7.2 Air-Dropped Conventional Depth Charges. This is included in the section on surface ship depth charge attacks. See 8.5.4.4 Air-Dropped Depth Charges.



French Colbert-*class CG*

Chapter Ten - Submarine Warfare

Modern submarines can fire not only torpedoes, but submerged-launch antiship missiles and standoff weapons. Many subs also must carry more than one type of torpedo, having special types for antisubmarine or antiship use, or simply older models still in inventory.

10.1 Restrictions. Subs can only fire weapons loaded in their torpedo or VLS tubes. These must be logged by the player. They may only fire submerged-launch missiles from Shallow or Periscope depth. They may fire torpedoes from any depth allowed in Annex F for that weapon.

Reloading torpedo tubes can be accomplished at the rate of one tube per Tactical Turn with up to two tubes for Western submarines and four tubes for Russian designs being reloaded simultaneously. The player should write down before the game what each tube is loaded with, as it takes three Tactical Turns to change either a tube or an initial reload. The torpedo room crew can either reload torpedo tubes as mentioned above or change one tube at a time (it's crowded). The choice should be made with some care, since a limited number of tubes are available.

10.2 Sub-Launched Torpedoes. These rules apply for all torpedo attacks. Torpedoes must be fired against a detected target, hopefully with a "Good" fire control solution for the attack to be effective. Torpedoes cannot hit hovercraft or hydrofoils when they are airborne or foil-borne.

Homing torpedoes can be used to attack subs or surface ships. Torpedo guidance type is listed in Annex F. They are described in section 7.5.

Range for torpedoes is measured from the geographic point of firing (players should put a datum marker on the spot) to the torpedo's current position. If the distance covered by the torpedo since its launch is greater than the listed range, the torpedo stops running and automatically misses. Modern torpedoes will not leave a wake, but the propeller and flow noise, as well as an active acoustic seeker, can be heard by some passive sonars. See Weapon Noise in section 5.4.6.5.

10.2.1 Torpedo Angle Offset. Early non-homing torpedoes traveled in a straight line, and the sub had to be on the same course as the intercept bearing to aim the weapon. Later non-homing torpedoes could be fired at an angle off the sub's axis which allowed more precise aim, as well as a set spread between each weapon in a salvo.

Acoustic homing torpedoes, both passive and later active/passive seekers, allowed an even greater off-angle at launch (and of course, once the torpedo acquired its target, it would change course as needed to home in).

Wire-guided weapons can be fired with an even greater angle offset, allowing "over the shoulder" attacks, although any course change increases the chance of a wire break.

There is one exception: The Russian VA-111 Shkval has no homing system, but can accept a small angle offset.

Submarine Torpedo Angle Offsets

Guidance Type	Offset
Gyro/1	0°
Gyro/2	45°
Pass Homing, Act/pass Homing	90°
Wire-Guided, Dual-wire Guided	120°
VA-111 Shkval	10°

10.2.2 Non-Homing Torpedoes. Torpedoes without a terminal homing seeker are called "straight-runners;" they are preset to a particular course which will hopefully intersect that of their target. They are normally fired in spreads. A straight-running torpedo will never hit a submerged target below Periscope depth.

To make a torpedo attack, the player must fire the weapons toward a point where the weapons will intercept the moving target. The intercept course will be figured automatically by the fire control system. The player can also pick the firing bearing himself, if he believes the target is going to maneuver. The course must be within the tube's firing bearing plus any offset (see 10.2.1 Torpedo Angle Offset).

In every Movement Phase the turn after they were fired, torpedoes move at their rated speed in a straight line on the firing bearing or the corrected intercept course. Depending on the targets' maneuvers after launch, it may or may not be at the expected point of intercept. In addition, any other ship (friendly as well as enemy) may be struck by a torpedo if it gets in the way.

If a torpedo spread comes within .25 nmi (500 yards) (Note: See *optional rule* below) of any eligible target, that unit is attacked by the spread, and the torpedo attack is resolved against it.

Torpedoes move like any other surface ship or sub. If there appears to be a chance of a torpedo spread and a ship's path intersecting, use proportional movement to see if the torpedoes pass close enough to resolve an attack. If the players are not using a referee, they will have to plot movement one Tactical Turn ahead.

Torpedo Danger Zone (optional rule). As a spread of torpedoes moves away from its launch point, it fans out slightly, with the size of the danger zone depending on how many torpedoes were fired and how far they have moved. Instead of a 500-yard danger zone, use the size listed in the Torpedo Danger Zone table.

10.2.3 Resolving Non-Homing Torpedo Attacks. When a torpedo reaches a ship (its intended target or another that gets in the way) the attacking player rolls to see how many torpedoes actually hit. This is based on the target's size class (Large, Medium, Small, etc.) and the angle that the torpedoes attack from. A side shot on a destroyer stands a better chance of hitting than a bow-on attack on an aircraft carrier.

To find the target's effective length, use the Aspect Diagram on page 10-2. The degree numbers around the edges of the box refer to relative bearing; in other words, the bearing of the torpedo relative to the ship's bow. Most shots will be on one of the quarters. Broad is the best, narrow is the worst.

Non-Homing Torpedo Attack Tables

Effective Target Size: Large

Salvo Size = 1		*Salvo Size = 2*			*Salvo Size = 3*				*Salvo Size = 4*				
Torp Run	*1*	*Torp Run*	*1*	*2*	*Torp Run*	*1*	*2*	*3*	*Torp Run*	*1*	*2*	*3*	*4*
(nmi)	*Ph*	*(nmi)*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*Ph*
0.25	0.85	0.25	0.85	0.80	0.25	0.85	0.85	0.73	0.25	0.85	0.85	0.79	0.66
0.5	0.72	0.5	0.85	0.52	0.5	0.85	0.67	0.37	0.5	0.85	0.75	0.51	0.27
1.0	0.38	1.0	0.62	0.15	1.0	0.76	0.27	0.06	1.0	0.85	0.33	0.14	0.02
2.0	0.20	2.0	0.37	0.04	2.0	0.49	0.10	0.01	2.0	0.60	0.16	0.03	-
4.0	0.11	4.0	0.20	0.01	4.0	0.29	0.03	-	4.0	0.33	0.06	-	-
6.0	0.07	6.0	0.14	-	6.0	0.18	0.02	-	6.0	0.21	0.03	-	-
8.0	0.06	8.0	0.09	-	8.0	0.11	-	-	8.0	0.12	0.01	-	-
10.0	0.04	10.0	0.05	-	10.0	0.06	-	-	10.0	0.07	-	-	-

Effective Target Size: Medium

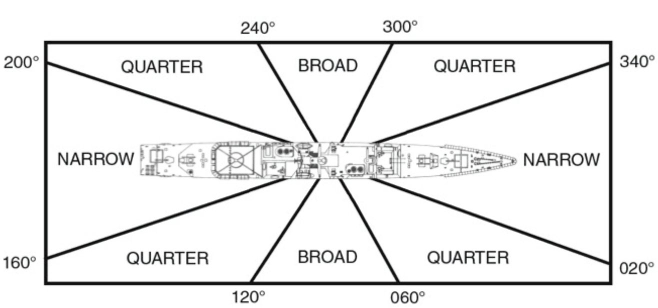
Salvo Size = 1		*Salvo Size = 2*			*Salvo Size = 3*				*Salvo Size = 4*				
Torp Run	*1*	*Torp Run*	*1*	*2*	*Torp Run*	*1*	*2*	*3*	*Torp Run*	*1*	*2*	*3*	*4*
(nmi)	*Ph*	*(nmi)*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*Ph*
0.25	0.73	0.25	0.85	0.50	0.25	0.85	0.62	0.39	0.25	0.85	0.67	0.42	0.28
0.5	0.39	0.5	0.63	0.15	0.5	0.77	0.28	0.06	0.5	0.85	0.34	0.14	0.02
1.0	0.20	1.0	0.36	0.04	1.0	0.49	0.10	0.01	1.0	0.59	0.15	0.03	-
2.0	0.09	2.0	0.17	0.01	2.0	0.25	0.02	-	2.0	0.31	0.04	-	-
4.0	0.05	4.0	0.11	-	4.0	0.15	0.01	-	4.0	0.16	0.02	-	-
6.0	0.03	6.0	0.07	-	6.0	0.09	-	-	6.0	0.10	-	-	-
8.0	0.02	8.0	0.04	-	8.0	0.05	-	-	8.0	0.06	-	-	-
10.0	0.01	10.0	0.03	-	10.0	0.03	-	-	10.0	0.03	-	-	-

Effective Target Size: Small

Salvo Size = 1		*Salvo Size = 2*			*Salvo Size = 3*				*Salvo Size = 4*				
Torp Run	*1*	*Torp Run*	*1*	*2*	*Torp Run*	*1*	*2*	*3*	*Torp Run*	*1*	*2*	*3*	*4*
(nmi)	*Ph*	*(nmi)*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*Ph*
0.25	0.44	0.25	0.68	0.19	0.25	0.82	0.32	0.08	0.25	0.85	0.36	0.19	0.06
0.5	0.21	0.5	0.37	0.04	0.5	0.50	0.10	0.01	0.5	0.61	0.16	0.03	0.01
1.0	0.10	1.0	0.19	0.01	1.0	0.27	0.03	-	1.0	0.34	0.05	-	-
2.0	0.05	2.0	0.09	-	2.0	0.14	0.01	-	2.0	0.18	0.01	-	-
4.0	0.03	4.0	0.04	-	4.0	0.07	-	-	4.0	0.08	-	-	-
6.0	0.02	6.0	0.03	-	6.0	0.04	-	-	6.0	0.04	-	-	-
8.0	-	8.0	0.02	-	8.0	0.02	-	-	8.0	0.03	-	-	-
10.0	-	10.0	-	-	10.0	0.01	-	-	10.0	0.01	-	-	-

Effective Target Size: VSmall

Salvo Size = 1		*Salvo Size = 2*			*Salvo Size = 3*				*Salvo Size = 4*				
Torp Run	*1*	*Torp Run*	*1*	*2*	*Torp Run*	*1*	*2*	*3*	*Torp Run*	*1*	*2*	*3*	*4*
(nmi)	*Ph*	*(nmi)*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*(nmi)*	*Ph*	*Ph*	*Ph*	*Ph*
0.25	0.24	0.25	0.42	0.06	0.25	0.56	0.13	0.03	0.25	0.66	0.20	0.06	0.03
0.5	0.12	0.5	0.23	0.02	0.5	0.33	0.04	0.01	0.5	0.41	0.07	0.02	0.01
1.0	0.07	1.0	0.13	-	1.0	0.18	0.01	-	1.0	0.24	0.02	-	-
2.0	0.03	2.0	0.07	-	2.0	0.10	-	-	2.0	0.13	0.01	-	-
4.0	0.02	4.0	0.04	-	4.0	0.05	-	-	4.0	0.06	-	-	-
6.0	0.01	6.0	0.02	-	6.0	0.03	-	-	6.0	0.04	-	-	--
8.0	-	8.0	0.01	-	8.0	0.01	-	-	8.0	0.02	-	-	-
10.0	-	10.0	-	-	10.0	-	-	-	10.0	0.01	-	-	-



Target Aspects

Target		*Size Class*	
Aspect	*Large*	*Medium*	*Small*
Broad	Large	Medium	Small
Quarter	Medium	Small	VSmall
Narrow	Small	VSmall	VSmall

Non-Homing Torpedo Attack Tables

Effective Target Size: Large

Salvo Size = 5

Torp Run nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*
0.25	0.85	0.85	0.85	0.72	0.59
0.5	0.85	0.78	0.58	0.38	0.19
1.0	0.85	0.50	0.21	0.07	0.01
2.0	0.68	0.21	0.05	0.01	-
4.0	0.37	0.08	0.01	-	-
6.0	0.24	0.04	-	-	-
8.0	0.13	0.03	-	-	-
10.0	0.09	0.01	-	-	-

Salvo Size = 6

Torp Run (nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*	*6 Ph*
0.25	0.85	0.85	0.85	0.77	0.68	0.53
0.5	0.85	0.82	0.65	0.46	0.32	0.14
1.0	0.85	0.60	0.26	0.12	0.03	0.01
2.0	0.74	0.25	0.09	0.02	-	-
4.0	0.44	0.11	0.02	-	-	-
6.0	0.30	0.06	-	-	-	-
8.0	0.17	0.04	-	-	-	-
10.0	0.10	0.02	-	-	-	-

Effective Target Size: Medium

Salvo Size = 5

Torp Run nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*
0.25	0.85	0.74	0.56	0.38	0.21
0.5	0.85	0.35	0.22	0.07	0.01
1.0	0.67	0.20	0.05	0.01	-
2.0	0.38	0.06	0.01	-	-
4.0	0.20	0.02	-	-	-
6.0	0.11	0.01	-	-	-
8.0	0.07	-	-	-	-
10.0	0.04	-	-	-	-

Salvo Size = 6

Torp Run (nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*	*6 Ph*
0.25	0.85	0.81	0.70	0.53	0.34	0.10
0.5	0.85	0.37	0.27	0.13	0.03	0.01
1.0	0.74	0.25	0.08	0.02	-	-
2.0	0.43	0.08	0.01	-	-	-
4.0	0.23	0.03	-	-	-	-
6.0	0.13	0.01	-	-	-	-
8.0	0.08	-	-	-	-	-
10.0	0.04	-	-	-	-	-

Effective Target Size: Small

Salvo Size = 5

Torp Run nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*
0.25	0.85	0.43	0.26	0.19	0.07
0.5	0.69	0.22	0.06	0.02	0.01
1.0	0.41	0.07	0.01	-	-
2.0	0.22	0.02	-	-	-
4.0	0.11	-	-	-	-
6.0	0.05	-	-	-	-
8.0	0.03	-	-	-	-
10.0	0.01	-	-	-	-

Salvo Size = 6

Torp Run (nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*	*6 Ph*
0.25	0.85	0.51	0.30	0.27	0.24	0.02
0.5	0.75	0.26	0.09	0.05	0.02	0.01
1.0	0.47	0.10	0.02	0.01	-	-
2.0	0.25	0.03	-	-	-	-
4.0	0.14	0.01	-	-	-	-
6.0	0.06	-	-	-	-	-
8.0	0.03	-	-	-	-	-
10.0	0.02	-	-	-	-	-

Effective Target Size: VSmall

Salvo Size = 5

Torp Run nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*
0.25	0.74	0.25	0.12	0.09	0.02
0.5	0.49	0.10	0.04	0.02	0.01
1.0	0.29	0.03	0.01	-	-
2.0	0.16	0.01	-	-	-
4.0	0.08	-	-	-	-
6.0	0.05	-	-	-	-
8.0	0.03	-	-	-	-
10.0	0.01	-	-	-	-

Salvo Size = 6

Torp Run (nmi)	*1 Ph*	*2 Ph*	*3 Ph*	*4 Ph*	*5 Ph*	*6 Ph*
0.25	0.80	0.29	0.15	0.11	0.04	0.01
0.5	0.55	0.14	0.06	0.03	0.02	-
1.0	0.33	0.05	0.02	0.01	-	-
2.0	0.19	0.02	-	-	-	-
4.0	0.10	-	-	-	-	-
6.0	0.05	-	-	-	-	-
8.0	0.03	-	-	-	-	-
10.0	0.01	-	-	-	-	-

Torpedo Danger Zones (yards)

Range (nmi)	*Torpedoes in Spread* 1	2	3	4	5	6
≤1.0	250	250	250	250	250	500
1.1-2.0	250	250	250	500	500	750
2.1-3.0	250	250	500	750	750	1000
3.1-4.0	250	250	500	750	1000	1250
4.1-5.0	250	500	750	1250	1500	1750
5.1-6.0	250	750	1000	1500	1750	2250
6.1-7.0	250	750	1250	1750	2250	2500
7.1-8.0	500	1000	1500	2000	2500	3000
8.1-9.0	500	1000	1750	2250	2750	3500
9.1-10.0	500	1250	1750	2500	3250	3750
10.1-11.0	500	1250	2000	2750	3500	4250
11.1-12.0	750	1500	2250	3000	4000	4750
12.1-13.0	750	1750	2500	3250	4250	5250
13.1-14.0	750	1750	2750	3750	4500	5500
14.1-15.0	1000	2000	3000	4000	5000	6000
15.1+	1000	2250	3500	4750	6000	7000

Cross-index the ship's real size class with the angle of the attack on the Target Aspect table to determine the target's effective size. Go to the appropriate table in the Non-Homing Torpedo Attack Tables that matches the effective target size and the number of torpedoes in the spread. This is the table to use to resolve the attack.

Now measure the range from the impact point back to the firing point. Note: torpedo run at impact is not necessarily the same as target range at time of fire. The range that matters is not the range at firing, but at impact. This is how far the torpedo has actually traveled, and this is what affects its chance to hit.

Look down the torpedo run column for the row whose listed range is closest to the actual attack range. If the range is exactly between two rows, shift to the row with the longer range.

Roll D100, and starting at the right, compare the result to the hit chances in the corresponding row. If the die roll is less than or equal to that value, the number at the top of the column is the number of torpedoes that have hit the target. If the die roll is greater than that number, look at the next number to the left in that row and compare the die roll with it.

As the number rolled gets bigger, the number of torpedoes hitting gets smaller. If the die roll is bigger than the number in the column with "1" at the top, all the torpedoes in the spread missed.

Example: A Project 641 Foxtrot class sub fires a spread of four 53-39 non-homing torpedoes at a medium-size (Size Class B) merchant ship. At the time of intercept, the merchant had a broad aspect and the torpedo run was 2,500 yards or 1.25 nmi. Looking on the Torpedo Aspect table, we find that a medium merchant with a broad aspect is a medium effective target size. Going to the Medium table, find the Salvo Size = 4 section and cross-referencing the torpedo run of 1 nmi (closest to 1.25 nmi) we get the following probability of hit values:

Torp Run	*1*	*2*	*3*	*4*
1 nmi	0.59	0.15	0.03	--

This means:

Die roll of 60 - 00	no hits
Die roll of 16 - 59	1 hit
Die roll of 04 - 15	2 hits
Die roll of 01 - 03	3 hits

There is no chance for four hits.

Rolling D100, the result is 22, which is less than 59, but more than 15; thus the merchant was hit by one torpedo.

Any torpedoes in the spread that miss their intended target may hit other nearby targets, if they exist. However, only the first target is attacked by the full spread. All remaining torpedoes are treated as individual weapons (i.e., spread size =1). The only exception to this rule is if the entire salvo misses the first target completely, then the second target in the torpedoes path would be attacked by the full salvo.

If the target ship is stationary (speed zero, dead in the water), move one line up on the torpedo attack table.

10.2.4 Homing Torpedo Attacks. A description of the different types of torpedo guidance is provided in section 7.5. This section covers the rules for their launch and resolving attacks once they reach their target.

Once a unit has a fire control solution (see 6.3), it may fire a torpedo in the Planned Fire Phase. Only a "snapshot," based on a threat detected in the Detection Phase, can be launched in the Reaction Fire Phase.

Before launch, the firing player must plot the torpedo's target, course (which can be listed either as "intercept" or as a fixed bearing), depth, and the target. The enable point, where the weapon will turn on its seeker, is already included in with the Weapon Placement die roll. However, a player may choose to set a different enable point at the time of launch, if they desire.

If the torpedo is wire-guided, the firing player must plot whether or not the wire is to be cut after launch. See section 7.5.4 on wire-guided torpedoes for a description of their characteristics.

After launch, guided torpedoes move at their rated speed toward the target. As described in section 7.5, guided torpedoes will either run out in a straight line toward the target, or circle around the water entry point looking for a target.

Guided torpedoes have an "acquisition range," a distance at which they pick up the target and can home in. As the weapon moves through the water, the seeker looks out ahead in a cone. The Torpedo Seeker Generations table on page 7-4 lists the acquisition range for each generation of torpedo seeker. All torpedo acquisition cone arcs are ±60° wide.

Make the placement roll in the first detection phase after the weapon has traveled half the distance between the shooter and the target. If acoustic homing torpedoes are fired in salvos, each weapon makes its own Placement die roll, not the salvo as a whole.

If the player successfully makes the roll, when the torpedo reaches acquisition range, it will acquire and home in on its target. After it acquires the target passively, it will shift to active homing, if the weapon is so equipped.

Each Movement phase after the detection, the torpedo will move directly toward the detected vessel at its maximum speed, automatically changing course if it maneuvers. Its turning radius is much tighter than that of any ship or sub.

In the Movement phase that the torpedo reaches the target, the attacking player rolls to see if the torpedo hits its target.

10.2.5 Resolving Homing Torpedo Attacks. The base chance of a hit for an acoustic torpedo is given in the Homing Torpedo Attack Table below. It depends on the seeker's generation and whether or not the target deploys countermeasures and attempts to evade. The reductions are shown in the three columns to the right of the base probability of hit in the Homing Torpedo Attack Table.

One column shows the reduction if the target uses acoustic countermeasures (ACMs) only, another shows the reduction for evasive maneuvers only, and the third shows what happens if they are used together.

To be able to use the evasion modifier, once the torpedo has been detected, the target must do at least two of the following three things:

• increase speed by a minimum of five knots to at least 20 knots (if their max speed is less than 20 knots, they can't use the modifier)

• change course by at least 45°.

• change depth by at least one level.

If the target can meet any two of these requirements before the torpedo reaches it, use the Evasive Maneuvers column on the Homing Torpedo Attack Table. If the target deploys just acoustic countermeasures (ACMs) use the torpedo ACMs column, however, if it maneuvers and deploys countermeasures use the last column.

10.2.6 Resolving Wake-Homing Torpedo Attacks. Wake-homing torpedoes must cross a ship's wake before they can begin homing; it is aimed to cross just astern of its target. Because a wake is much larger than just the ship, wake-homing torpedoes get a +1 to the Weapon Placement die roll, however, they home in by zigzagging across the wake; thus, the distance made good (closing on the target) each Movement Phase is only 75% of the torpedo's speed.

Surface ships can try to evade a wake-homing torpedo, but it is harder than evading an acoustic homing weapon; when using the value in the Evasion Only column on the Homing Torpedo Attack Table, add 0.05.

A surface ship trying to evade a wake-homer must:

• increase speed to at least 25 knots (if their max speed is less than 25 knots, they can't use the modifier)

• change course by at least 90°.

Homing Torpedo Attack Table

ACM Gen	*Torpedo Gen*	*Torpedo Base Ph*	*ACMs Only*	*Evasion Only*	*Evasion & ACMs*
1	1	0.40	0.22	0.32	0.18
	2	0.60	0.42	0.48	0.34
	3	0.70	0.63	0.56	0.50
	4	0.80	0.78	0.64	0.63
2	1	0.40	0.16	0.32	0.13
	2	0.60	0.33	0.48	0.26
	3	0.70	0.56	0.56	0.45
	4	0.80	0.72	0.64	0.58
3	1	0.40	0.10	0.32	0.08
	2	0.60	0.24	0.48	0.19
	3	0.70	0.39	0.56	0.31
	4	0.80	0.64	0.64	0.51
4	1	0.40	0.08	0.32	0.06
	2	0.60	0.15	0.48	0.12
	3	0.70	0.28	0.56	0.22
	4	0.80	0.44	0.64	0.35

If the ship can meet these requirements before the torpedo reaches it, then the attack will be made on the Evasive Maneuvers column on the Homing Torpedo Attack Table, which although increased by 5%, is still better than not evading at all.

Example: If a ship attempts to evade a 3rd Gen wake-homing torpedo, the probability of a hit is 0.56 + 0.05, or 0.61. The chance with no evasion is 0.70.

• Wake-homers can be *decoyed* if another ship crosses the wake of the intended target (see 7.5.5). To see if the torpedo is decoyed, roll using the ACMs Only column in the Homing Torpedo Attack Table. If the D100 roll is greater than the number in the table, the torpedo has been decoyed and begins to follow the crossing vessel.

• Wake-homers can be *seduced* by 3rd and 4th Gen towed countermeasures. The magnetic influence fuze is tricked into setting off the weapon's warhead. When the torpedo reaches its target, roll an attack on the ACM-only column for that seeker. If the roll is successful, the weapon ignores the ACM and continues on. An unsuccessful result (from the torpedo's point of view) means the countermeasure successfully seduced the torpedo and both are destroyed.

If the torpedo is not seduced by the ACM, it will continue on to its target, making a second attack roll. This is when the ship can attempt to evade using the Evasion Only column, reducing the torpedo's chance to hit, slightly.

10.2.7 Homing Torpedo Reattacks. Homing torpedoes from the very first had a reattack capability if they missed on the first pass. If a torpedo misses it travels 1,000 yards past the target and executes a reattack maneuver. In addition, if it is a wire-guided weapon and the wire is intact, the firing submarine can steer the weapon back towards the target.

For acoustic homing torpedoes, the reattack maneuver is a circle search to the right 500 yards (0.25 nmi) in diameter for 1st and 2nd generation weapons, and 1,000 yards (0.5 nmi) for 3rd and 4th generation. If the target is reacquired, make another attack as described in section 10.2.4.

For wake-homing torpedoes, all generations travel 500 yards (0.25 nmi) away from the target and then turn 180° to the right to a reverse course back toward the wake.

The chance that the target is reacquired is based on a second Weapon Placement die roll, however, as the target is likely no longer compliant, the fire control solution is not as clear as it was at the beginning of the attack. If the target deployed ACMs (excluding passive sonar jammers) and/or the target is maneuvering evasively, the fire control solution quality degrades by one for each reattack. Thus, a Good solution for the initial attack becomes a Fair solution for the first reattack and Poor for a third and subsequent attempts. The -2 modifier to the Weapon Placement die roll for an anechoic-coated submarine still applies.

If the torpedo fails to reacquire the target, and there is a mobile submarine simulator or another target within the torpedo's acquisition range, check to see if the torpedo acquires it, using the same procedure described above. If the torpedo does acquire, it will home in on the target of opportunity and attack.

Resolve any attack on a mobile simulator using the Torpedo ACM column. If a torpedo hits a mobile simulator, it is destroyed.

If the torpedo does not acquire any target, it will continue to search in a circle/racetrack pattern until it runs out of fuel.

If the torpedo is wire-guided, and the wire hasn't broken, the attacking submarine can steer the weapon back toward the target. This won't improve the Weapon Placement die roll; the submarine's fire control solution is just as confused if decoys and evasion are involved, but it will allow a wandering torpedo the opportunity to get back in the fight. However, since the torpedo is executing a high-speed, large turn there is a 40% chance that the guidance wire will break.

Example: An Project 971 Akula I SSN is attacked by an Improved *Los Angeles* SSN with two Mk48 ADCAP (4th generation) torpedoes with a Fair solution. The Akula I hears the torpedoes as they go active and deploys 3rd generation ACMs, a mobile decoy from a torpedo tube, and counter-fires two USET-80 (3rd generation) torpedoes, without wires on a Poor solution - a snapshot. Range at time of fire for both submarines is 3.0 nmi and the Mk48 ADCAPs wires are intact.

The Improved *LA* shot on a "Fair" solution: the Weapon Placement die roll is 4 (6 for a Fair solution and -2 for an anechoic coated submarine). Both US torpedoes make the Weapon Placement die roll. If the US player successfully places one, or both of the torpedoes, the probability of hit given an evading and countermeasure-employing target is 51%. If the torpedoes miss, the US player can steer them back towards the Akula I, provided the wires remain intact. For the reattack, however, the Weapon Placement die roll is 1 as the fire control solution quality has degraded to "Poor" and the target is still coated.

The Akula I's torpedoes on the other hand, are much worse off. Not only was the solution Poor, the Improved *LA* is also coated. This leaves the Russian player with a Weapon Placement die roll of 1 (3 for a Poor solution and -2 for a coated target). If one of the USET-80s happens to detect the Improved *LA*, the US player still has time to evade and deploy countermeasures, in this case 3rd Gen ACMs. The final probability of hit for the USET-80s under these circumstances is 31%. If the torpedoes miss, they cannot execute a reattack, since the Poor solution degrades to No Attack.

No one said hunting submarines was easy, or fast.

10.3 Submerged-Launch Antiship Missiles & ASW Stand-off Weapons. These must be fired from Shallow or Periscope depth, with the sub's speed between 3 and 10 knots. A missile launch reveals the submarine's position by visual means, by sonar (launch transient), and on surface search radar. The missile should not be placed on the playing surface unless it is detected, to prevent revealing the sub's location.

10.4 The Shkval. In 1977, the Russians fielded a rocket-powered underwater weapon designated the VA-111/M-5 Shkval ("Squall"). By routing exhaust gases to the nose and traveling at very shallow depths, a super cavitating gas bubble is formed around the body of the weapon that dramatically reduces the weapon's drag and allowing it to travel at fantastic speeds (195 knots). Although usually described as a torpedo, it is actually an underwater rocket.

No acoustic seeker can function at this speed; the weapon was not designed as a homing torpedo. The rationale for the Shkval rested on the Soviet assessment of superior Western sonar technology and submarine quieting. They designed the Shkval to even the odds.

If the first warning of a US submarine's presence was the sound of an incoming torpedo, Russian doctrine was to immediately counterfire a Shkval back along that same bearing.

Although a passive sonar bearing on an incoming torpedo would not provide any range data, the Russians could make several assumptions about the enemy boat's location, based on factors like enemy firing doctrine and the acoustic conditions. That estimate would be set into the Shkval with a simple timer. At the prescribed distance, the timer would detonate a 150 kiloton nuclear warhead.

From the attacking boat's point of view, the oncoming Shkval would demand immediate evasive action, which might break the guidance wire on their own torpedo. The noise of the Shkval would probably mask the sound of the Russian boat, and even if the nuclear warhead did not kill or cripple the other sub, the earth-shattering KABOOM would blind all sonars in the area, allowing the Russian to make good his escape. See Nuclear Detonations, section 5.4.6.5.

The Shkval could also be used offensively against a high-value target.

In all cases, the firer launches the weapon on a fixed bearing ±10° of the sub's course, and declares at what distance the nuclear warhead will detonate - not too close, or this weapon will have a probability of kill of 2.0.

Although there have been claims of a guided version, there is no indication that these variants have been deployed, or even fully developed. Russia has sold a number of (non-nuclear) Shkvals to China and Iran; the latter has tested them under the Iranian name of "Hoot."

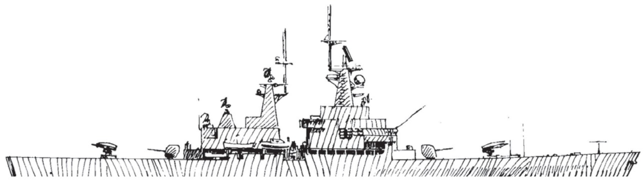
Statistics for the Shkval are provided in Annex F.

10.5 Torpedo Defenses (Hardkill Systems). While theoretically possible, intercepting a torpedo is much more difficult than shooting down an aircraft or missile. Active sonar's range and bearing information are not as precise as radar, and it is much harder to determine a torpedo's depth. For straight-running and wake-homing torpedoes, this is less of an issue, but figuring out where to place hardkill ordnance is problematical.

Once an incoming torpedo has been detected and classified, a ship may engage a torpedo if it is fitted with either a rocket bomb unit (RBU) or an anti-torpedo torpedo (ATT) launcher. There are two types of RBUs. The first is a barrage-type system that lobs depth bombs into the general vicinity of the incoming torpedo. The second RBU (such as the Russian RKPTZ-1 or UDAV-1) uses a "bait and blast" approach that draws a torpedo with a decoy toward a set of nearby floating explosive charges.

Anti-torpedo torpedoes are small interceptors that are fired at the approaching weapon, in the hopes that the ATT will acquire, home in, and destroy the incoming torpedo. Despite the many claims of the manufacturers of these systems, none seem to be particularly effective.

Hardkill System	*vs. Straight-runner, Wake-homer*	*vs. Acoustic Homing*
RBU	5%	3%
RKPTZ-1	20%	10%
1st Gen ATT	25%	10%
2nd Gen ATT	35%	15%



US *Virginia*-class CGN

Chapter Eleven - Strike Warfare

Strike Warfare (SSW) is projecting naval power ashore, by attacking land targets with guns, aircraft, and missiles.

11.1 Damage to Land Targets. Buildings, tanks, and gun batteries cannot be sunk. They must be destroyed or rendered useless by damaging vital equipment (critical hits, see 11.1.2).

Like ships, land targets have damage points based on the size and the construction of the target. A large building may have 400 damage points. An artillery piece has 2 damage points. Individual land structures can be knocked out through critical hits. If a structure has had 100% of its damage points inflicted on it, it is destroyed and ceases to function. No critical hit needs to be rolled. If a structure has 200% of its damage points inflicted, the structure is a pile of rubble and cannot be repaired.

Scenarios will provide the characteristics of land targets that can be attacked by naval and air forces. It will list their size class, armor rating, and damage points.

11.1.1 Land Target Armor Ratings. Steel armor plate is rarely used in land structures. Instead, high-strength reinforced concrete is used for protection. Other materials, most commonly earth and wood, can also be used. This type of protection is collectively known as "earthworks." See Annex Z.

Land structures use the same vertical and horizontal armor rating system as warships.

11.1.2 Land Target Critical Hits. If a land target is hit and not destroyed outright, the attacker must roll to see if he has inflicted a critical hit. He should compute the damage ratio as described in section 14.1.2, then roll on the Critical Hit Damage Ratios table on page 14-3. If the D6 roll results in a critical hit, the target ceases to function, regardless of how much damage is actually inflicted.

Some targets may have more than one function, or may only be partially degraded by a single critical hit. Tables for these targets will be provided as needed by the scenario designer.

Example: A uranium centrifuge facility is being attacked. The facility itself has several hundred centrifuges, but a single weapon hit may not knock them all out. Instead, each critical hit inflicted will destroy 50 centrifuges.

11.2 Ballistic and Cruise Missile Attacks Against Land Targets. Although ballistic and cruise missiles were first used in late World War II, they are ineffective against point targets, because of their poor accuracy. Modern digital inertial navigation systems (INS) have significantly reduced their circular error probable (CEP), but their accuracy still isn't good enough for a conventional high explosive warhead, unless satellite-aided navigation or a terminal homing system is also used.

To resolve ballistic missile attacks on point targets on land, use the Ballistic & Land Attack Cruise Missile Attack Table on page 11-3. To find the chance of a hit, cross-reference the target's size class with the missile's INS.

11.3 Air Attacks Against Land Targets. Attacks against land structures are resolved in exactly the same way as attacks against ships (see 9.6), and automatically get the Land Target modifier. Find the base hit chance for the type of attack and target size (the target's horizontal surface), and apply any appropriate modifiers, such as a bombsight or heavy AA.

11.4 Naval Gunfire Attacks Against Land Targets. If a target's position is known and it is visually detected, it can be attacked directly using any of the following spotting methods. If the target's position is unknown and it is undetected, then barrage fire must be used to strip away any concealing camouflage and hopefully degrade the target's functions.

- *Ship Spotting:* Ships can improve their chance to hit by continuous fire against the same target. To employ this type of spotting, a ship must have visual contact on the target (detected and within visual range). Ships that meet this criterion gain a +1 modifier to their chance to hit on the third and later turns. Note: there are penalties for the first two turns of fire as the ship finds the range to the target.
- *Aerial Spotting:* An aircraft within 3 nmi of a target at Low or Medium altitude can spot the fall of shot for one ship firing at that target, giving a +2 modifier to hit on the second and later turns of fire.
- *Ground Observers:* A team of gunnery spotters can observe the fall of shot for one ship against one target on the beach, giving a +2 to hit modifier on the second and later turns of fire. The scenario will provide information on the observers' location and capabilities.
- *Radar Beacons:* Naval gunfire radars cannot distinguish targets from the land background and cannot be used to attack any land target. However, if a ground observer team places a radar beacon close to the target, the fire control radar can see the beacon's signal, and combined with offsets from the ground observers, get accurate range and bearing information. The gunnery observer team, after arriving near the target, needs D6 Tactical Turns to place the beacon. Once emplaced, the beacon provides a +3 modifier on the first and later turns of fire.
- *Map Fire:* A form of Neutralization Fire where the target's location is only generally known, based on aerial reconnaissance or other intelligence. Firing is allocated by map coordinates and has a penalty of -4.
- *Blind Fire:* A form of Neutralization Fire where the target's location is unknown. Fire is allocated to pre-established areas that may or may not contain the target and has a penalty of -6.

Ships can perform two different Naval Gunfire Support (NGFS) missions: Destruction Fire against visually detected targets or Neutralization Fire (barrage fire) against undetected targets presumed to be present.

NGFS is used to destroy point land targets, such as gun emplacements or other structures. It requires accurate flat-trajectory gunfire, so if a ship is spotting the fire itself, it must be in the Short to Medium Range Band and less than 10 kyds from the target. If using Aerial Spotting or Ground Observers for Destruction Fire NGFS can fire out to Extreme range.

Because of its precise nature, it can be used even after friendly troops have landed. The degree of accuracy required also restricts the number of shooters to one ship for each target. Several ships firing on the same target would make it virtually impossible to correct the fall of shot. If more than one ship attacks the same target with destruction fire, modify the hit chance for each ship by the number of ships firing at that target, minus one times the -2 overconcentration penalty.

To find the chance of a hit, use the procedure in section 8.3. If the target is hit, check to see if the round penetrates the structure.

The number of hits depends on the size of the target. For Size Class A-D targets, use the Gun Damage Multiplier table in section 8.3. For Size Class E and smaller targets, only one hit is possible regardless of the number of guns firing.

11.5 Air Attacks on Airfields. An airfield has many different components, each of which may be attacked separately.

11.5.1 Runway Attacks. Either conventional free-fall or specialized anti-runway ordnance can be used, but there is a smaller chance of success with standard iron bombs. High-drag or retarded bombs cannot be used against runways, because their high-drag feature keeps them from building up enough speed to pierce the concrete surface.

Anti-runway ordnance is specially designed to penetrate the runway surface and "heave" the concrete sections. This requires the damaged sections to be removed and replaced, instead of just filling in the crater. Delayed action bombs and minelets may be mixed in to delay repair efforts.

Anti-runway ordnance is described in Annex H6. Each attack may consist of a single weapon, such as Durandal, or a cluster of small weapons, such as BAP 100.

Attacking aircraft can make glide or level bombing attacks on a runway. While an entire runway is longer than a Size Class A target, its width is only about twice that of a typical capital ship and is the limiting factor for bomb attacks. Furthermore, an aircraft can only attack a portion of a runway. Thus, a runway is treated as a Size Class A target for bombing attacks.

Runway Use

Number	Runway Length (m)					
of Cuts	*500*	*1000*	*2000*	*3000*	*4000*	*5000*
1	Small	Med	Large	Large	Large	Large
2	Small	Med	Med	Med	Med	Large
3	STOL	Small	Med	Med	Med	Med
4	STOL	Small	Small	Med	Med	Med
5	X	STOL	Small	Small	Small	Small
6	X	STOL	STOL	Small	Small	Small
7	X	X	STOL	STOL	STOL	STOL
8	X	X	X	STOL	STOL	STOL
9	X	X	X	X	STOL	STOL
10	X	X	X	X	X	STOL

The table assumes fully loaded aircraft. Lightly loaded aircraft are treated as one class smaller.

For level bombers attacking with iron bombs from altitudes greater than 5,000 meters, the salvo size on the Air Attack Table is 1/4 the number of bombs dropped (round down), with a minimum salvo size of 1. Regardless of its bomb load, an aircraft will always be allowed to execute an attack on the Salvo =1 table. Only one bomb will strike out of any salvo.

The three factors affecting runway use are its original length, the number of cuts, and the class of aircraft attempting to use the runway. Players must keep track of the number of cuts in each runway on the airfield. Use the Runway Use table to find out which classes of aircraft can use the runway if it has been cratered.

A "cut" is a crater that makes it impossible for an aircraft to use that section of runway. One cut may not be enough to put the runway out of action for all types of aircraft. The more cuts in a runway, the better.

Runways can be repaired quickly. Special techniques and materials have been developed that allow minor damage to be repaired in as little as two to four hours, and extensive damage in one or two days. Repair resources and times will be described as part of a scenario.

11.5.2 General Attacks. The player allocates aircraft to attack the airfield's buildings and installations. Even with the runway damaged, many other critical functions, such as the repair of aircraft, can continue.

11.6 Naval Bombardment of Airfields. Unlike coastal defense batteries, airfields are far more dispersed and are a little easier for surface combatants to bombard, given their large size. However, since much of an air base is made up of empty space there is a good chance that a shell will do nothing but make a big hole in the ground. When resolving naval gunfire against an airfield, first roll D100 to see what part of the base the shells come closest to (sort of a reverse critical hit). If the die roll result is "empty space," then the attack has automatically failed to hit anything. If on the other hand, if an air base component is rolled, then make the naval gunfire attack normally.

Air Base Component	*D100*
Runways	01 - 20
Aircraft storage	21 - 40
Buildings	41 - 50
Taxiways	51 - 55
Defenses	56 - 60
Empty space	61 - 00

11.7 Naval Bombardment of Ports. Ports can be shelled using this table. The attack is resolved using the same method as airfields.

Naval Base Component	*D100*
Ship Berths	01 - 30
Workshops/stores	31 - 50
Accommodations/Admin	51 - 70
Dry Dock	71 - 80
Defenses	81 - 90
Empty space	91 - 00

Ballistic & Land-Attack Cruise Missile Attack Table

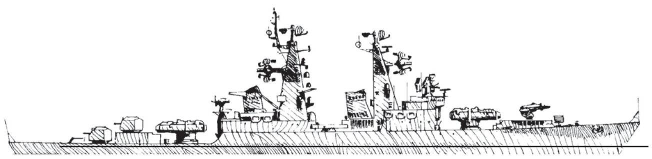
Ballistic Msl Guidance	*Generation*	*CEP (m)*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
			Target Size Class							
Mechanical	M1	500 - 1,000	0.01	--	--	--	--	--	--	--
	M2	250 - 499	0.02	0.01	0.01	--	--	--	--	--
Digital	D1	125 - 249	0.10	0.05	0.02	0.01	--	--	--	--
	D2	60 - 124	0.15	0.10	0.05	0.02	0.01	--	--	--
	D2+	40 - 59	0.40	0.30	0.20	0.10	0.02	0.01	--	--
Terminal	T1	25 - 39	0.75	0.75	0.60	0.45	0.30	0.10	0.01	--
	T1+	15 - 24	0.75	0.75	0.75	0.75	0.60	0.35	0.10	0.01
	T2	10 - 14	0.80	0.80	0.80	0.80	0.70	0.45	0.20	0.01

LACM Guidance	*Generation*	*CEP (m)*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
			Target Size Class							
Mechanical	M1	500 - 2,000	0.01	--	--	--	--	--	--	--
	M2	150 - 499	0.07	0.05	0.02	0.01	--	--	--	--
Digital	D1	60 - 149	0.40	0.25	0.15	0.07	0.02	--	--	--
	D2	30 - 59	0.75	0.75	0.65	0.25	0.07	0.02	--	--
	D2+	25 - 29	0.75	0.75	0.70	0.50	0.30	0.15	0.01	--
Terminal	T1	20 - 24	0.80	0.80	0.70	0.65	0.45	0.20	0.02	--
	T1+	15 - 19	0.80	0.80	0.75	0.75	0.60	0.35	0.10	0.01
	T2	10 - 14	0.85	0.85	0.80	0.80	0.70	0.45	0.20	0.01

- Satellite navigation can be added to any missile guidance.
This shifts the CEP down one row.
- Digital 2+, Terminal 1+, and Terminal 2 assumes the use of satellite navigation.
- Terminal 1 is a Gen 2 seeker and Terminal 2 is a Gen 3 seeker.
- The hit chances are for a conventional HE warhead; a nuclear warhead always hits.

Generic Land Targets

Target Type	*Size Class*	*Damage Points*	*Armor*	*Results*
Aircraft in open, tight parking	G	--	0	D6 aircraft lost
Aircraft in open, dispersed	G	--	0	D6/3 aircraft lost
Aircraft Revetment	F	40	6	Aircraft lost
Hardened Aircraft Shelters (HAS)				
NATO Standard	D	100	5	Structure & aircraft inside destroyed
Reinforced HAS	C	120	10	Structure & aircraft inside destroyed
Large Hangar	C	150	0	D6/2 aircraft inside lost
Medium Hangar	D	100	0	D6/2 aircraft inside lost
Small Hangar	E	80	0	D6/3 aircraft inside lost
Airfield Control Tower	F	45	3	Landing/takeoff rate halved
Radar Tower and Building	E	88	3	Landing rate halved, in visibility ≤20%
Magazine Bunker	E	60	16	Gun ammo only for D10 turns
Large Maint Building	D	90	0	Reduced repair rates
Medium Maint Building	E	75	0	Reduced repair rates
Small Maint Building	F	50	0	Reduced repair rates
Taxiways	C	--	0	Cut isolates aircraft from runways
AA Gun Emplacement	F	45	3/0	Gun lost
Ship Berth	B	400	0	Ship cannot be resupplied alongside
Dry dock pumping station	F	84	3	Cannot pump out flood dry dock
Dry dock gate	E	245	9	Dry dock floods and is unusable
SAM or SSM launcher	G	2	0	Launcher destroyed
Search or MFC radar	G	20	0	Radar destroyed
Command Bunker	E	225	13	No GCI control possible
Soft vehicle (jeep)	G	--	0	Vehicle destroyed
APC or SP Artillery	G	20	2	Vehicle destroyed
Main Battle Tank (1955-80s)	G	45	20/5	Vehicle destroyed
Main Battle Tank (1980s on)	G	50	80/10	Vehicle destroyed



Russian Project 58 *Kynda*-class CG

Chapter Twelve - Electronic Warfare

12.1 Airborne ECM. Aircraft can carry ECM pods on weapons hardpoints or be fitted with internal systems. They may be defensive, protecting only the plane carrying them, or offensive, reducing the detection range of hostile radars.

Defensive ECM and radar decoys work against radar-guided missiles and AA directed by radar gunfire (RA). IR jammers or IR decoys only counter infrared guidance. The generation of the pod will be listed in Annex H5, along with its hang weight. For example, the ALQ-131 is a second-generation defensive ECM pod, and weighs 272 kg. Internal systems will be listed in Annex B Remarks.

If a unit has dual coverage, for example, a fighter with a first-generation defensive ECM pod is also screened by an ECM aircraft with a second-generation offensive jammer, use both countermeasures, since offensive jamming affects radar detection range, while defensive jamming affects weapon hit chances.

12.2 Airborne Chaff Barriers. Some aircraft are specially designed to lay large amounts of chaff in chaff corridors. Others can be equipped with pods for sowing chaff corridors. The amounts involved are more than the small bursts used to decoy missiles. In some cases they are measured in tons of fine, coated Mylar slivers that will stay in the air for up to 30 minutes.

A chaff-laying aircraft has its capacity described in nautical miles. The controlling player should order chaff laid in the Plotting Phase, and it is laid in the Movement Phase of that Tactical Turn. The distance the aircraft flies is subtracted from its chaff capacity. The barrier blocks radar line of sight at whatever altitude the plane was flying.

The chaff barrier is one-quarter nautical mile wide and occupies the entire altitude band. Aircraft can move through a chaff barrier as long as they do not spend more than two Tactical Turns in the chaff cloud. If they do, their engines may fail (10% chance). Chaff is not visible to the naked eye when deployed. Chaff does not block ES detection of a radar signal.

Chaff falls one altitude band every three Tactical Turns, and moves in the direction and speed of the wind. Unless the wind speed is very high, the chaff barrier only needs to be moved every ten minutes, during the Movement Phase.

12.3 Long-Range Chaff. Several navies use rockets or gun shells loaded with chaff as a way of deceiving enemy radar. The USN ALQ-190 AIRBOC entered service in 1990; this is a sonobuoy-sized chaff dispenser. Chaff is used in combination with shipboard jammers to seduce antiship missile seekers and defend a ship under attack.

Long-range chaff has a maximum range of 5 nmi and will last for 15 minutes (5 Tactical Turns). They are fired in the Planned Fire Phase and are effective in the Detection Phase of that turn. The chaff clouds appear to be Small or Medium-sized radar contacts (roll when the chaff deploys, 50% chance of each size).

These chaff clouds will not distract missiles locked on real ships, but missiles without a lock-on, as well as missiles that were fired at the chaff clouds, will attack them. They are treated as Distraction decoys under 6.3.2.

12.4 Floating Antiship Missile Decoys. These distraction decoys are carried on ship and can be deployed to present enemy search radars with false targets. Sometimes called "Rubber Duckies," they are rubberized rafts fitted with a large radar reflector. They are ordered deployed in the Plotting phase, and take one minute to deploy; they are effective in the Detection Phase of the Turn they are deployed. They can be set to provide a small or medium-sized radar return, and will stay afloat for up to three hours. They can be commanded to sink before that time. See Distraction Decoys in section 6.3.2.

The Russians have floating decoys from 1965, the RN from 1986, the USN from 1991. All warships from frigates to aircraft carriers were fitted. The USN retired floating decoys in the early 2000s, but have recently reintroduced them. The RN continues to use them, and the current Russian status is unknown. Any other fits will be noted in Annex A.

They cannot be used in sea states above four. If they are deployed, they are immediately swamped and sink.

They move with the wind at half the wind's speed, or they can be towed (at the end of a very long cable) behind a ship. However, the tow speed can't exceed 10 knots or the cable breaks.

12.5 Noise Jamming. Deception jamming ("radar countermeasures"), designed to reduce radar-guided weapon accuracy, is covered in the sections for resolving guided weapon attacks.

Noise jamming affects search radars by reducing their effective range; the jammers use a powerful signal that blinds radar displays. Treat a noise jammer as a radiating radar for the purposes of ES detection (see 5.3), but it is identified as noise rather than a radar signal.

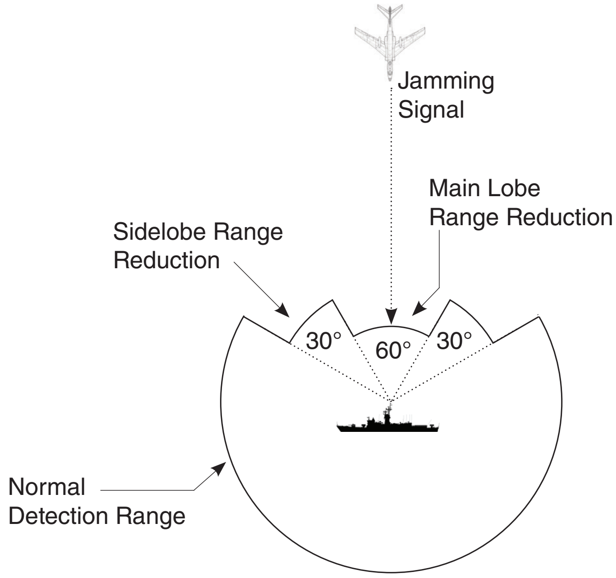
Each noise jammer has a clutter rating listed either in Annex B for specialized aircraft or Annex H5 for jamming pods. The higher the value, the stronger the jammer. This is used to calculate the reduction in the target radar's range in section 5.2.9.4.

There are three types of noise jammers:

• *Standoff jammers* are carried by dedicated aircraft and reduce all radar ranges within the radar horizon.

• *Escort jammers* are similar to standoff jammers, but have a narrower effective arc of 30° centered on the flight path of the aircraft (±15°). They are used to screen a group of aircraft.

• *Spot jamming* uses a very narrow beam to attack an individual radar. The number of radars that can be jammed depends on the type of pod or jammer installed in the aircraft, and will be listed in the Annex for that equipment, along with its clutter rating.



Main and sidelobe arcs for noise jamming against a 3rd-generation radar.

Spot jammers must detect a radiating radar with an ES or RWR sensor before they can begin jamming it. To attack a specific radar with spot jamming, a player orders it in the plotting phase and it is in effect in the detection phase of the same turn. Targeting the same radar with more than one jammer has no added effect.

Spot jammers can also serve as escort jammers at half their listed clutter value.

Radars affected by a jammer have their range reduced by the percentage listed on the Radar Clutter Effects table on page 5-5 within an arc centered on the bearing between the victim radar and the jamming source. Range outside this arc but inside the sidelobe arc suffers reduced effects. Halve the net clutter effect for ranges in the radar's sidelobe. Ranges outside the sidelobe are not affected.

Noise Jamming Arcs

	Victim Radar Generation					
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*
Main Lobe	*120°*	*90°*	*60°*	*45°*	*5°*	*1°*
Sidelobe	*120°*	*90°*	*30°*	*15°*	*1°*	*--*

Example: An Su-24MP Fencer F (Escort Jammer, Clutter Rating of 11) is escorting an incoming strike of Fencers. A ship fitted with an SPS-49(V)2 (Gen 4, clutter resistance 12), and SPS-48C (Gen 3, clutter resistance 8) is trying to detect the Fencers.

Subtracting the SPS-48's Clutter Resistance of 8 from the Fencer's rating of 11 means that the SPS-48's range will be reduced to 60% of normal.

Since the SPS-49 has a clutter resistance of 12, it is unaffected by the jamming.

Against a Medium target, the detection ranges for the SPS-48 in the main lobe is:

SPS-48C: 165 nmi * 60% = 99 nmi

In the sidelobes, the net effect is 3 halved, rounded down, so a clutter value of 1 on the Clutter Effects table reduces the range to 85% of normal, or:

SPS-48C: 165 nmi * 85% = 140 nmi

12.6 Acoustic Countermeasures. Torpedo (acoustic) countermeasures will affect torpedo homing systems but won't interfere with passive search sonars at all. Conversely, sonar jammers will play merry hell with passive sonars but won't degrade a homing torpedo's ability to hit its target. Mobile simulators can affect both torpedoes and search sonars, but do it in a different way, by creating a submarine's acoustic signature.

12.6.1 Torpedo Countermeasures (ACM). The endurance of an ACM depends on its size, which also determines its launching system.

Internally launched sonar jammers and torpedo ACMs are stationary floaters and have an endurance of two Tactical Turns.

External sonar jammers and torpedo ACMs can be stationary floaters or very short range mobile jammers. Small external ACMs last just as long as the internally launched ones (two Tactical Turns), while the larger external ACMs can last up to seven Tactical Turns. Only the US Navy CSA Mk1 and Mk2 are classed as large external size, 5 or 6 inches in diameter. Everyone else uses the smaller three or four inch ACMs.

When several torpedo ACMs are deployed, use a counter to mark the spot. Individual torpedo ACMs will not be kept track of because they don't last that long and are usually launched in rapid succession. Sonar jammers, especially the larger ones, are usually launched singly and with a greater distance between each one, requiring an individual marker for each jammer.

Sonar jamming ACMs jam a cone 10° (±5°) wide when the sonar looks at them; the effects of jammers on torpedoes is included in the combat models. For example, if a sonar jammer bears 030° true, a ship's or sub's search sonar would be unable to hear anything but the countermeasure from 025° to 035°. Sonar jammers have a Loud signature for passive sonar detection.

Towed decoys are used exclusively by surface ships, and are torpedo countermeasures with an unlimited endurance. Examples of these include the SLQ-25 Nixie and British Sonar 182. The effectiveness of towed decoys is incorporated in the Homing Torpedo Attack Table on page 10-5. See section 10.2.5 for effects of ACM against homing torpedoes and 10.2.6 for 3rd and 4th Gen towed decoys against wake-homing torpedoes.

If a towed decoy successfully seduces a torpedo, the torpedo's warhead destroys the decoy.

The countermeasures section of a ship's listing in Annex A will provide the name and generation of any countermeasures it carries. For example, the *O.H. Perry*-class guided-missile frigate has an SLQ-25 Nixie, which is a 2nd generation towed torpedo countermeasure.

12.6.2 Mobile Submarine Simulators. Mobile decoys are the most sophisticated type of ACM and can affect both search sonars as well as torpedo sensors. If launched as a torpedo decoy along with other ACMs or alone, it is included in the ACM part of the Homing Torpedo Attack Table. However, if the torpedo misses and reattacks, there is a chance that the torpedo will acquire the decoy instead of the submarine, because by that time there is enough separation between the decoy and the target for the decoy to be truly effective (see 5.4.6.6). See section 6.3.2 for the effect on acoustic fire control solutions.

Mobile decoys are also designed to pull an ASW force off a submarine while she makes her escape. The endurance and effectiveness of the mobile decoy depends on its generation and is listed on the Submarine Mobile Decoys table.

Submarine Mobile Decoys

Simulator Generation	*Endurance (hours)*	*MAD Capability*	*Max Speed*	*Active Capability*
1	1	No	7 kts	No
2	1.5	No	10 kts	No
3	2	Yes	12 kts	Yes
4	2	Yes	15 kts	Yes

The endurance is the number of hours that the simulator can run at maximum speed. MAD capability means that the simulator tows a magnetic field generator which will look like a submarine to a MAD equipped aircraft. Third and fourth generation submarine simulators can make up to two course changes and two speed changes. The earlier simulators are single-speed devices that follow a preset course.

Player should plot the speed, course and depth of the simulator in the Plotting phase of the turn it is launched.

12.7 Air-Launched Decoys. These are designed to dilute or deceive enemy defenses.

The ADM-141A Tactical Air-Launched Decoy (TALD) is a US-built version of the similar Israeli Samson decoy. First delivered late in 1986, the US Navy had 4000 in inventory at the start of Desert Storm, including 3600 RF decoys and 400 chaff variants. About 130 were used. Over 20 were sometimes launched by the leading aircraft in a strike package. Some TALDs flew aircraft profiles, while others deployed chaff. They were very successful.

Other air-launched decoys exist such as ADM-20 Quail and ADM-160 MALD. These are powered decoys and change course and altitude at each waypoint (see section 4.10.4)

On a hostile radar screen, a TALD will look like a Small radar contact. If it is launched just outside of radar range, and flies the proper profile, hostile radar operators will have no way of knowing which blips are real planes and which ones are decoys.

Unpowered, each one weighs 180 kg. Any plane that can carry a Mk82 500 lb bomb can carry a TALD in the same position and numbers. It can be carried in clusters of three on a TER (Triple Ejection Rack) and dropped just like a Mk82 bomb.

The flight profile of the TALD must be set before the plane takes off. It can execute pre-programmed turns. Its speed can be changed between 250-500 knots by changing the glide angle. This affects the range. It has a glide ratio of 10:1 If launched from 11000 meters at 250 knots, it has a 68 nmi range, or a 25 nmi range with a 400 kts glide from 7000 m. It can also be lob-tossed from low altitude, giving a range of 15 nmi.

There are three versions. The RF TALD is used to saturate air defense systems. The Chaff TALD can dispense 80 pounds of chaff in 40 incremental ejections. It can be programmed to fly out, turn, and lay 1 nmi of chaff in a line. Multiple TALDs can be coordinated, with each TALD building on the line of previous aircraft. Thirty decoys can lay a 30 nmi barrier.

Possible tactics include simply launching RF TALDs as the “leading wave” of a strike to draw SAM and antiaircraft fire. TALDs can also lay chaff to mask a strike, or two aircraft with TALDs can create a false strike, forcing an enemy to reveal his position or divert CAP aircraft.

Suter Attacks

First seen in Operation Iraqi Freedom, this tactic was also used by the Israelis in the September 2007 attack on the Syrian nuclear site near at Dayr az-Zawr. It can be called a network attack, or information warfare, but it’s basically hacking into a hostile air defense network and messing with your opponent’s mind.

It’s part of a US program called Senior Suter, which is in turn part of another program called Big Safari, which is all about attacking an enemy’s information systems. By locating hostile antennas (both radar and communications), and feeding them false data, the electronic attackers can create fake contacts, delete real ones, insert false instructions, and possibly even crash the entire air defense network. At a minimum, a successful Suter attack allows the intruder to monitor the enemy’s air defense activity. This is far more sophisticated stuff than noise or deception jamming.

Technobabble aside, it’s a Jedi mind trick: “These aren’t the planes you're looking for.” At the highest level of success, the opposition doesn’t even know they’re being hacked.

The US used a combination of RC-135 Rivet Joint and EC-130 Compass Call aircraft in Iraq in 2003. The Israelis carry it in a Gulfstream 550 airframe, called the Shavit (“Comet”) Special Electronics Mission Aircraft.

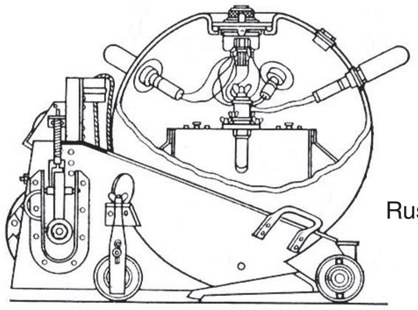
It is likely that Israeli UAVs can also carry special packages designed to support the intrusion effort by either locating emitters or transmitting signals at close range without risking the primary aircraft.

Other nations’ abilities are unknown, but it can be safely assumed that both Russia and China have some level of capability.

There is little an air defense operator can do to respond to an attack, except build as robust a system as possible, and train his people to recognize and respond to an intrusion when it occurs.

Suter attacks can also be accompanied by conventional (noise or deception) jamming, decoys, and physical attacks on air defense nodes. These methods also provide a fallback plan in case the Suter attack fails.

Suter attacks only work against land-based air defense networks, and are very scenario-specific. If one or both opponents can make a Suter attack, the scenario designer should include rules for it in the scenario.



Russian M08-1939 Mine

Chapter Thirteen - Mine Warfare

Mines have always been the unwanted stepchild of naval warfare. Unglamorous, unchivalrous and unmanned, mines have been a source of constant frustration for naval commanders throughout history. However, in shallow or restricted waters, such as the Baltic Sea or Persian Gulf, nations have employed mines to such a degree that they dominated their operations.

While laying mines is simple, the same cannot be said of mine sweeping. Risky business at best in uncontested waters, attempting to clear a minefield while under fire is virtually suicidal. And in the end, one can never be sure that all of the mines have been removed.

This chapter addresses the laying of mines, attacks against ships and submarines, and mine sweeping.

13.1 Mine Types. Mines are classified by their means of control, position in the water and fuzing.

• The *control* aspect deals with whether the mine is autonomous (i.e., independent) after being laid, or if they are under direct human control via a cable. While used often during WW II, controlled minefields are no longer in fashion. Independent mines, once laid, will cause harm to friend and foe alike.

• Their *position* describes where in the water column the mine body or case is located. Is the mine moored, or anchored, with a buoyant capsule at a shallower depth, or does the mine lie on the sea floor?

• Finally, *fuzing* describes what causes the mine to detonate. A contact mine explodes when you hit it, and an influence mine explodes when a ship's signature (magnetic, acoustic, or pressure) reaches a preset level. Mines are defined by type (e.g., Bottom, Moored, etc.) and fuzing in Annex G.

Moored contact mines have slowly become less popular after WW II, as it was hard to prevent them from being swept, even with thick chains or minefield defenders (anti-sweep devices). And while they continue to be used by many minor navies, moored contact mines have largely been replaced by advanced bottom influence mines.

Perhaps the most innovative developments in mine warfare include the propelled-warhead mine, which releases a homing torpedo or rocket after a target was detected and localized, and mobile mines.

13.2 Mine Generations. After WW II, navies developed new mines that resisted sweeping. These included multiple influence fuzing, i.e., a mine with both acoustic and magnetic fuzes, as well as the widespread use of pressure influence fuzes. This type of fuze makes it extremely difficult to sweep a mine, forcing a mine countermeasures ship to have to hunt and eliminate mines one at a time.

If a mine has some form of sweep resistance, it will be listed in Annex G under the generation column. The newer the generation, the greater the resistance to mine sweeping. Thus a 1st generation mine has no sweep resistance, while a 2nd generation mine has some resistance, and 3rd generation even more. To simplify play, rather than model the mechanics, mines with sweep resistance will increase the time required to clear mines.

13.3 Minefields. Mines were always laid in fields because an individual mine has a very limited danger area. The chance of a ship striking one depends on the number of mines in the field and the spacing between them, or its "density."

Minefields are usually not laid as part of a tactical game. Of greater significance for tactical game play are pre-laid minefields part of one side's defenses, or offensive minefields that have been laid in secret.

Large minefields, usually defensive, were laid by surface combatants or purpose-built minelayers. Smaller fields, especially those laid by submarines, tended to be offensive, and had little chance of success unless they were laid in narrow channels or other choke points.

If a scenario requires mines, the scenario designer or the referee will provide a player with their location, if appropriate. On those rare occasions where the players are required to plan and then lay a minefield, the number and types of mines available will be provided in the friendly forces section of the scenario.

13.4 Designing a Minefield. First, look at what you intend to defend or restrict. Is there a narrow passage that can be exploited? What's the water depth? What types of mines are available? Also, remember that unless they are controlled from a shore station, mines owe allegiance to no one. Any ship that enters a minefield will be attacked.

Unless it is a controlled minefield, a defensive field will need at least one safe passage for friendly ships through it. These are typically 500 yards wide, and require at least one course change.

Once a suitable location is found, measure the length of

Russian MDM-1 Mod 1 bottom influence mine. (Rosoboronexport) the area to be mined. Next, select the desired chance of a hit for a single row of mines from the Mine Attack Table (page 13-3). The distance between mines for a given hit chance can be found at the top of the column. Note that contact mines must be at least 50 yards apart, and influence mines must be 75 yards apart to prevent the sympathetic detonation of other mines in the line. Now divide the length of the area by the mine spacing and add one. This is the number of mines needed to lay one line, or row, of the minefield.

To find the width of the minefield, take the number of lines, add one and multiply by the desired spacing between lines. The minimum spacing between mine lines is 200 yards. Typical spacing is 200 - 500 yards.

Water depth is also very important in planning a minefield. In Annex G, there are two depth bands listed for each mine type. The first is the maximum anchor depth. This is the deepest water that the mine can be laid in and still function properly. The second depth band is the case depth, and this is the maximum water depth that the mine case with the warhead can be at without being crushed. For moored contact mines, there can be a very big difference between anchor depth and case depth. For bottom mines, anchor depth and case depth are the same.

To attack surface ships, the case of a contact mine must be in the Periscope Depth/Snorkeling depth band. Bottom influence mines must also be in the Periscope Depth/ Snorkeling depth band for size class D and smaller ships. For larger surface ships (size class A, B, and C), a bottom mine can be in the Shallow Depth band.

To attack a submarine, the mine's case depth must be in the same depth band as the submarine.

Example: A Soviet player has 150 MDM-1 bottom influence mines for a minefield in the approaches to the Kola Peninsula. The area to be mined has a length of 5,000 yards. The Soviet player wants to have as many lines as possible with about a 40% chance of hitting a cruiser (Medium or size class B). Referring to the Mine Attack Table, they find the correct size class, then reads across the chance of a hit row to find a value near 0.40 column, then up to read the necessary spacing between mines. In this case, the mines could be spaced at 100 yards for a 0.45 chance of hitting, or 125 yards with a chance of 0.36. Choosing the 125 yard spacing, the minefields area is determined below.

# of mines/line = (5,000/125) + 1 = 40 + 1 = 41 mines

# of lines = 150/41 = 3.65 = 3 lines (120 mines total)

Minefield depth = (3 lines+1) x 300 yards = 1,200 yards

Thus, the Soviet minefield would have a danger area 5,000 yards long by 1,200 yards deep, containing three lines of mines with each mine 125 yards apart.

13.4.1 Mixed Minefields. Minefields can be made up of several different types of mines, but each line in a minefield uses only one type. A mixed minefield is made up of several lines.

A mixed field can have mines with different fuzing (contact and magnetic), or different targets (antiship and antisub mines). Mixed fields can have one hit chance for ships and a different one for subs.

13.5 Minefield Attacks. If a ship or sub enters a minefield and the mine case or antenna is at the correct depth, it will be attacked. Since most minefields will have more than one line, a ship will be attacked more than once as it passes through the minefield. Keeping track of each mine line on the playing surface is very tedious, so an abstracted method is used, based on the distance traveled by a vessel, to find out when an attack takes place. The distance between attacks is equal to the depth of the minefield divided by the number of lines in the field, rounded to the nearest 50 yards.

Example: The Soviet minefield in the previous example (three lines, 1,200 yards deep) would have a distance between attacks equal to:

Distance = 1,200 yards/3 lines = 400 yards
Rounding to nearest 50 yards is not necessary.

Thus, every time a ship or submarine travels 400 yards in the minefield it is subject to an attack by a mine. *Note:* This means that if the entire depth of the minefield is crossed, then the vessel will be attacked at least as many times as there are lines in the field.

Once the ship or submarine has traveled the required distance in the minefield, the minefield player rolls for the success of the attack. On the Mine Attack Table, cross-reference the ship size class with the mine spacing, for either a contact or influence-fuzed mine to find the chance that the target will hit a mine. Roll D100 and if the number rolled is less than or equal to the value in the table, then the target has hit a mine. Mine attacks are made secretly by the minefield player, or a referee, since the victim cannot tell initially where the attack came from and may not even be aware they are in a minefield. Many times a detonating mine was mistakenly thought to have been a submarine-launched torpedo.

For *magnetic influence* mines, the Mine Attack Table assumes the target is a standard steel-hulled ship. Combatants usually have a degaussing system on board, which reduces the ship's magnetic field, and even if a ship doesn't have a degaussing system, it is regularly "depermed" which also reduces the ship's magnetic field. Because of this, warships are attacked as the next smaller size class; e.g., a B size ship is treated as a C-size ship.

For extremely large ships, such as a supertanker (160,000 dwt or more), add 15% to the value in the Mine Attack Table.

For *acoustic influence* mines, if a ship is at a speed of 15 knots or greater, it is also more vulnerable and is attacked as a ship of the next higher size class. Going slowly through a minefield, ≤5 knots has no appreciable effect on acoustic mines, but it can help reduce the threat from *pressure* mines (reduce the ship's size class to the next lower size, no benefit for F and G size classes).

13.6 Damage from Mines. Mines, like torpedoes, inflict underwater damage and all critical hits use the Underwater Attacks column on the Critical Hit Table.

• *Contact Mines.* If the mine is a contact mine, any torpedo protection system on the ship will have to be penetrated first before damage can be applied (see 14.1.7). For a bottom or propelled-warhead mine, the torpedo protection system does not help, because the mine detonates/ attacks under the ship, not beside it.

If a submarine hits a contact mine, roll for a Pressure

Hull Penetration critical hit on the ASW Projectile Contact Hit Hull Penetration table on page 8-19, but double the percent chance. The sub has a 15% chance of getting to the surface if it is at Shallow depth. If it is deeper, it is lost.

• *Influence mines.* Ships and submarines both take full damage if the mine is at Periscope/Snorkeling depth and a ship or surface sub passes over the mine. If a mine is laid in the Shallow depth band, it will cause major damage to ships and submarines at periscope depth; however, if a submarine is in the same depth band as the mine, it suffers full damage from the attack. Influence mine attacks against subs also have a 50% chance of an immediate pressure hull penetration critical for Large and Medium submarines and 80% for Small and VSmall submarines. If a pressure hull penetration critical hit does not occur, then the submarine suffers a hull deformation critical hit. All other submarine critical hits are per the Submarine Major Damage column on the Critical Hit Table.

Influence mines deeper than Shallow cannot attack a ship.

• *Antenna mines*. These mines have a contact fuze on the mine body itself, but they are also equipped a wire electrode attached to a float.

If a surface ship hits the antenna, the attack is resolved as a contact mine attack, but the damage is treated as a major influence mine hit.

If a submarine is at the same depth as the mine case itself, the to hit roll and damage is resolved as a contact mine attack.

If the submarine strikes the antenna, it suffers severe influence mine damage. For antenna mines with a case depth in the Intermediate I depth band, or deeper, the antenna will not reach submarines at periscope depth or surface ships.

• *Optional Influence Mine Damage Rule:* Influence mines are susceptible to a number of environmental issues that can result in less than optimum detonation of the mine even with advanced target detection devices and sophisticated computer logic. This results in mines exploding further away from the target ship than desired. To simulate the variation in performance of influence mines, compare the Mine Attack Table die roll to the table below:

Die Roll (% of to Hit Value)	*Mine Damage in Annex G*
01% - 40%	Full Damage
41% - 70%	Severe Damage
71% - 90%	Major Damage
91% - 100%	Minor Damage

Submarines that take full, severe, or major damage resolve critical hits on the Major Damage column on the Critical Hit Table. Minor damage resolves critical hits on the Minor Damage column.

For submarines, a pressure hull penetration critical is resolved using the table in section 8.5.3 Ahead Thrown Weapons. If a pressure hull penetration critical hit does not occur, then the submarine suffers a hull deformation critical hit.

Example: A minefield made up of Italian Manta bottom influence (acoustic and magnetic) mines is crossed by a guided missile cruiser (Medium/Size class B). Because it has a degaussing system, the ship is treated as one size class smaller, or Small/size class C. The mines are 75 yards apart, and the probability of hit from the Mine Attack Table is 0.35.

If the minefield player rolls 14 or less on a D100, a Manta mine inflicts the full 104 DPs. If the die roll is between 15 and 24, the damage is reduced to severe, 63 DPs. From 25 to 31, the mine does major damage - 31 DP. And if the die roll is between 32 and 35, the mine's damage is reduced to minor - 16 DPs. Any die roll above 35 is a miss.

• *Propelled Warhead Mines.* These mines contain either a rocket or torpedo payload that is launched once the mine detects a target. The activation distance depends on the individual mine, but is usually between 500 to 1,000 yards. Most propelled warhead mines have an acoustic homing seeker and these attacks are resolved per 10.2.5 Homing Torpedo Attacks. For those propelled warhead mines that do not have a seeker, the warhead does not home in on the target, but it does get much closer to the target before

Mine Attack Table

Contact Mines

Distance between Contact Mines (yds)

Ship Size	50	75	100	125	150	175	200	250	300	350	400	450	500
A	0.60	0.40	0.30	0.24	0.20	0.17	0.15	0.12	0.10	0.09	0.08	0.07	0.06
B	0.48	0.32	0.24	0.19	0.16	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05
C	0.28	0.19	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03
D	0.16	0.11	0.08	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01
E - G	0.10	0.07	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01

Probability of hit is for one row of contact mines.

Influence Mines

Distance between Influence Mines (yds)

Ship Size	75	100	125	150	175	200	250	300	350	400	450	500	600
A	0.75	0.56	0.45	0.37	0.32	0.28	0.22	0.19	0.16	0.14	0.12	0.11	0.09
B	0.60	0.45	0.36	0.30	0.26	0.22	0.18	0.15	0.13	0.11	0.10	0.09	0.07
C	0.35	0.26	0.21	0.17	0.15	0.13	0.10	0.09	0.07	0.06	0.06	0.05	0.04
D	0.20	0.15	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.02
E - G	0.12	0.09	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01

Probability of hit is for one row of influence mines.

detonating. For these types of mines, the damage is limited to Full or Severe.

• *Mobile Mines.* These are bottom influence mines strapped to a torpedo to enable the mine to travel into waters a submarine cannot possibly navigate. A standard minefield cannot be laid with mobile mines, as there is no way to lay nice neat lines, so this type of minefield is far more random. If a submarine lays a minefield with mobile mines, there will only be one attack on a vessel as it crosses the mined area, and the distance between the mines is randomly rolled with a D6 x 100 yards.

13.7 Minelaying. Unlike WWII, when most ships were capable of laying mines, the majority of modern ships now lack the capability to carry mines-with the exception of Soviet and some Chinese warship designs. Since minelaying is not typically a tactical evolution, only the most basic rules are provided in this chapter. Scenario specific rules will be provided as necessary.

Mines can be laid from ships up to 20 knots; however, it is more commonly done at 15 knots or less. At speeds higher than 20 knots, the mines would likely be damaged and it is harder to control the spacing. This would prevent them from working properly and could even cause premature detonation. Submarines need to be at significantly slower speeds, around 5 knots, unless they are launching mobile mines; they can fire mobile mines at any speed.

Surface ship minelaying operations can only be done in sea states of 4 or less. Submerged submarines are less affected by sea state and can lay mines up to sea state 5. In higher sea states, the wave heights will damage the mines as they bob on the surface.

Aircraft laid minefields look a lot like a field laid with mobile mines, both in the number of mines and density. Each aircraft drops its mines and they land in a haphazard, random field. If a scenario calls for an aircraft dropped minefield, take the total number of aircraft and divide by two. This is the number of mine attacks a ship will have to undergo as it transits the field. The distance between the mines is randomly rolled with a D6 x 100 yards.

The rate at which mines can be laid depends on the type of ship. Specially built minelayers can lay twenty mines per Tactical Turn. Surface ships with specialized mine rails can lay sixteen mines per Tactical Turn, otherwise a ship can only lay eight mines per turn. This rate is halved if the surface ship is engaged in combat. Modified merchant ships can lay twelve mines per Tactical Turn. Submarines can lay as many mines as they have torpedo tubes. The standard reloading rate of two Tactical Turns per torpedo tube is used.

Arming. Mines that have case depths in the Shallow depth band are armed the second Tactical Turn after they are laid. This includes bottom mines. Mines with case depths in the Intermediate I depth band arm after three Tactical Turns. *Note:* Many modern influence mines have activation delay timers (up to two weeks) and ship counters as countermeasures to influence mine sweep systems.

13.8 Minesweeping and Minehunting. Once mines have been found in an area, they must be removed to allow ships to pass safely. Minesweeping is the tedious and dangerous task of clearing an area, usually a channel, of mines.

For moored mines, this was done by streaming a heavy gauge steel wire cable with mechanical cutters behind a specially-equipped ship as it passed it through a minefield. The wire sweep would catch the mooring wire or rope of a mine and drag it to a cutter, which would sever the mooring wire. The buoyant mine case would rise to the surface where it was destroyed by gunfire. If a minefield had mine defenders or sweeping countermeasures on the mine themselves, the process of clearing the mines took a lot more time.

Influence mines, and in particular bottom influence mines, were swept by vessels towing devices that duplicated a ship's magnetic or acoustic signature. To counter these sweeps, mine designers built mines that needed both types of signatures to detonate, and then added ship counters that waited for a preset number of ships to pass over before exploding.

Pressure influence mines emerged at the very end of WW II. The only way to generate a proper pressure wave is with a ship, so the only way to "sweep" them is to run a specially modified ship through the field. Worn out merchants, manned by a skeleton crew, would have their holds filled with buoyant material and then steam back and forth through the field with the intent of setting off the mines. The Germans called them "Sperrbrechers," but they were also used by other countries. The US called them "guinea pigs" or "expendable minesweepers."

This is why advanced influence mines (3rd Gen and later) and any pressure influence mine are now hunted and destroyed individually. A very time consuming process.

13.8.1 Types of Sweep Gear. Minesweeping gear basically falls into two categories: 1) Oropesa mechanical sweeps and 2) acoustic and magnetic sweeps.

It takes two Intermediate Turns to stream a double Oropesa sweep. The minesweeper must be at slow speed (5 knots or less) to deploy the sweep gear. Once streamed, Oropesa sweep gear can be towed up to speeds of 15 knots and has a sweep width of 500 yards. With Oropesa sweep gear streamed, a minesweeper can turn at the normal 45° interval, but it must spend four Tactical Turns before making a turn reeling in the sweep gear to short stay to prevent fouling. After the turn is complete, it takes another four Tactical Turns to re-stream the sweep.

With the advent of acoustic and magnetic influence mines, new techniques to sweep them had to be developed. For moored influence mines, the mechanical sweep would still work, but this was useless against bottom mines.

A magnetic sweep, such as the UK "LL" series or the Soviet PEMT-1, takes one Intermediate Turn to stream. The minesweeper must be at slow speed (≤5 knots) to deploy the sweep gear. Once streamed, magnetic sweep gear can be towed up to speeds of 12 knots and has a sweep width of 200 yards.

An acoustic sweep, such as the UK "SA" series or the Soviet BAT-2, also takes one Intermediate Turn to stream. The minesweeper must be at slow speed (≤5 knots) to deploy the sweep gear. Once streamed, acoustic sweep gear can be towed up to speeds of 7 knots and has a sweep width of 250 yards.

Both acoustic and magnetic sweeps can be streamed simultaneously from fleet minesweepers and destroyer minesweepers. Coastal minesweepers can only stream one type of influence sweep at a time. If a mine has multiple influence fuzes, for example magnetic and acoustic, then both sweeps must be deployed simultaneously to trigger the mine.

When they have a mechanical or influence sweep streamed behind them, treat minesweepers as Size Class C vessels for calculating their chance of hitting a mine.

13.8.2 Helicopter Minesweeping. Very few countries have invested in helicopter minesweeping gear, such as the US MH-53 Sea Dragon. These heavy-lift helicopters can tow both mechanical and single influence sweeps at faster speeds than a ship - 20 knots, but helicopter sweeping isn't as effective as ship-based methods and two passes need to be made to get the same results. Helicopter sweeps must make two passes to equal a single ship pass.

While helicopters are immune to the effects of naval mines, their operation requires a permissive, non-combat environment for them to be able to do their mission.

13.8.3 Minehunting. Modern influence mines often incorporate acoustic, seismic, magnetic, and pressure target detection devices that make them all but invulnerable to sweep gear. To deal with these mines, dedicated mine countermeasure ships have to slowly search for them, then classify them as mines before then can destroy them with sea mammals, remote operating vehicles, or human divers. Needless-to-say, minehunting can take several hours to destroy a single mine.

13.8.4 Effects of Minesweeping and Minehunting. Minesweeping doesn't completely eliminate the threat from mines, but it will reduce a minefield's effectiveness. Within the sweep width of a minesweeper's gear, the number of mines will be gradually reduced with every pass over the area. At the beginning of World War II, three or four passes over an area was considered sufficient to reduce the mine threat to an acceptable level, although more sophisticated mines would require more passes to get the same results. To reduce the effectiveness of an entire minefield would require a considerable amount of time and resources. That is why it was standard practice during the war to sweep out safe channels rather than trying to clear the entire field.

A "pass" is defined as the passage of a sweep gear through a mined area. Three passes could be achieved by one ship making three separate runs or three ships making a single pass each. Each time that a pass is made, each line of mines has its probability of hit decreased. The size of the reduction depends on the effectiveness of the sweep gear. The Minesweeping Reduction tables list the remaining effectiveness of a minefield as a percentage of its original capability. The maximum reduction of a minefield's probability of hit during a tactical game is 75%, e.g., if a minefield's hit chance was 60%, the most it can be reduced is to 15%.

Mechanical Minesweeping Reduction

Oropesa Sweep Gear

Moored Mine Generation

Pass #	1st Gen	2nd Gen	3rd Gen
1	0.70	0.80	0.85
2	0.50	0.65	0.70
3	0.35	0.50	0.60
4	0.25	0.40	0.50
5	NE	0.30	0.45
6	NE	0.25	0.40
7	NE	NE	0.35
8	NE	NE	0.25

NE = No additional effect.
Remaining probability of hit for one row of contact mines.
1st Gen = No defenses, regular mooring cable
2nd Gen = Cutters or tombac tubes on mines, heavy chain mooring cables. 1st Gen moored mines with mine defenders
3rd Gen = 2nd Gen moored mines with mine defenders
Helicopter sweeps must make two passes to equal a single ship pass.

Example: A moored contact minefield has three lines of twenty 2nd generation mines with 75 yards spacing. A minesweeper squadron with Oropesa sweep gear sweeps out a channel in a mined harbor. Four passes are made by successive ships steaming in a stretched out column.

Ph for an Medium/B-size ship = 0.32
Remaining effectiveness after sweeping = 0.40
New Ph for a B-size ship = 0.32 x 0.40 = 0.13

Thus, each B/Medium ship has a 13% chance of hitting a mine inside the swept channel. Outside of the channel, the chance of a hit per mine line is still 32%. Swept channels were marked by dan buoys placed by the minesweepers as they made their passes through the minefield.

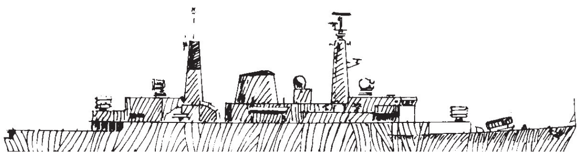
Influence Minesweeping Reduction

Influence Mine Generation

Pass #	1st Gen	2nd Gen	3rd Gen
1	0.70	0.85	0.90
2	0.60	0.75	0.85
3	0.40	0.65	0.80
4	0.30	0.55	0.75
5	0.20	0.45	0.65
6	NE	0.35	0.55
7	NE	0.25	0.45
8	NE	NE	0.35

NE = No additional effect.
Remaining probability of hit for one row of influence mines.
1st Gen = Coarse sensitivity influence fuze
2nd Gen = Fine sensitivity influence fuze/two influence fuzes
3rd Gen = 2nd Gen mines with ship counters and activation delays
Helicopter sweeps must make two passes to equal a single ship pass.

Influence mines that have three target detection devices/fuzes (4th Gen), or rely on pressure influence alone, must be hunted on an individual basis. Each mine takes D6/2 hours to be neutralized. This process cannot be done in a combat environment.



*British Type 22 (*Broadsword*)-class FF*

Chapter Fourteen - Damage Results

14.1 Applying Damage. Whenever a Size Class A - E ship is hit by a weapon, subtract the damage points inflicted by the weapon from the ship's damage point total. When the ship's total reaches zero, the ship sinks.

Small craft, size class F and G, are tougher, ton for ton, and cannot be sunk by successive turns of fire that add up to their total damage point rating. They have to roll for critical hits for damage effects, but their point total is not reduced after each hit like larger craft. If the damage they receive in a single turn is twice their damage point rating, they are sunk.

When a weapon inflicts damage on a target, the weapon must penetrate any armor in the location of the hit before it can do internal damage. Non-penetrating hits will cause less damage (see 14.1.6).

The effects of damage, including critical hits, are applied simultaneously to both sides at the end of the phase.

Damage from fire or flooding critical hits is applied in the Resolution Phase of the third Tactical Turn after the critical hit is inflicted and after the initial damage control roll, with two exceptions: Flooding from torpedo and mine hits is applied immediately, in the Movement Phase the weapon hits. Flooding and Fire criticals are inflicted on Small Craft (Size class F - G) immediately.

Secondary effects from criticals, like explosions, are applied immediately, in the phase in which the damage is resolved.

• *Movement Phase*. Resolve torpedo, missile, air-to-surface and mine attacks.

• *Planned Fire Phase*. Gunfire, ASW ahead-thrown weapons, AAM and depth charge attacks made in this phase are resolved in this phase, including damage effects.

• *Detection Phase*. No combat resolution occurs.

• *Reaction Fire Phase*. Resolve gunfire and depth charge attacks made in this phase.

• *Resolution Phase*. Fire and flooding criticals are resolved.

Example: In Turn 1200, a cruiser is hit by a torpedo in the Movement Phase, and suffers 35 damage points. As a result, the ship suffers several flooding criticals. In the Planned Fire Phase it is hit by enemy gunfire, which results in more damage and a fire critical. The secondary damage from the fire and flooding will be applied to the cruiser in the Resolution Phase of Turn 1209.

If one of the shell hits in turn 1200 had hit a weapons magazine, the cruiser would have been immediately destroyed by an explosion at the end of the Planned Fire Phase.

Weapons hitting aircraft render it unflyable (if on the ground), or damage it so severely (if airborne) that it aborts its mission. It is removed from play. See 14.9 for optional aircraft damage procedures.

14.1.1 Speed Reduction. As a ship or sub's damage point total is reduced, its speed goes down. Loss of structural strength and drag on the hull will slow it, and general damage to the propulsion plant will affect its efficiency.

A ship's speed is reduced by one quarter each time it takes one quarter of its original damage point level, and is reduced to zero at the 90% damage level.

The break points for damage are 0%, 25%, 50%, 75%, 90%, and 100%. The speed percentages are 100%, 75%, 50%, 25%, 0%, and sunk.

Each ship class has a different table which is included with its other characteristics in Annex A. The top line represents the damage point levels where the speed is reduced, while the bottom line shows the new maximum speed at that level of damage.

Example: The US frigate *Knox* takes 168 points of damage. Its damage and speed breakdown table is shown below:

Damage & Speed Breakdown:

Dam Pts:	0	42	84	126	151	168
Surf Speed:	27	20	14	7	0	Sinks

With no damage, *Knox's* max speed is 27 knots. With 41 points of accumulated damage, she can still do 27 knots, assuming no propulsion criticals or other restrictions. At 42 points, though, her maximum speed is reduced to 20 knots. From 42-83 points of damage, she can make 20 knots. The 84th point reduces her speed to 14 knots, and so on.

Acceleration/Deceleration rules (section 3.1.1) apply here, so the ship slows, coasting to a slower speed at half the deceleration rate; its speed next turn would be 27 - (12/2) = 21 knots. The following turn it would slow to its new maximum speed, 20 knots.

If a ship has taken propulsion criticals or other damage that also reduces its speed, these are applied to the ship's original maximum speed.

14.1.2 Ship & Sub Critical Hits. A ship can be destroyed by sinking it, but it can also be rendered useless by destroying the equipment that makes it a warship. This is called a "mission kill."

Damage to a vital component of the ship is called a critical hit. These include not only weapons and sensors, but engineering (propulsion), the rudder, and flight decks.

In each phase that a ship takes damage, divide the damage points taken by the points the ship has remaining after that phase's damage points are applied. This is the damage ratio used to figure out how many critical hits a ship may have suffered.

Example: A *Knox* class frigate has 168 damage points. If it takes 55 points of damage from gunfire in the Planned Fire Phase, the damage ratio is 55/(168-55) or 55/113 = .48. Since the damage ratio is always rounded down, this will be rolled on the .40 line of the Critical Hit Damage Ratio table on page 14-3.

Small Craft (size class F - G) are tougher, ton for ton, than larger vessels. The damage points inflicted in a phase are always divided by the craft's original damage points to find the damage ratio and find out if the craft suffers any critical hits.

Critical Hit Table

D20 Roll	Pre 1955 Surf Cmbts (Size A-E)	1955+ Surf Cmbts (Size A-E)	Guided vs Surf Cmbts (Size A-E)	Small Craft Combatant (Size F-G)	Aviation Ship	Underwater Attacks	Airburst & Frag. Hits[5]	Merchant/ Auxiliary (Size A-E)	Small Cargo Craft (Size F-G)	Sub Major Dam.	Sub Minor Dam.
1	Weapon*	Weapon	Weapon	Weapon	Weapon	Weapon	Weapon	Weapon[1]	Weapon[1]	Weapon	Weapon
2	Weapon*	Weapon	Weapon	Weapon	Flt Deck*	Weapon	Weapon	Weapon[1]	Weapon[1]	Weapon	Weapon
3	Weapon*	Weapon	Sensor	Weapon	Flt Deck*	Weapon	Weapon	Sensor	Sensor	Weapon	Weapon
4	Weapon*	Weapon	Sensor	Weapon	Flt Deck*	Sensor	Weapon	Engineering	Engineering	Sensor	Sensor
5	Weapon*	Sensor	Sensor	Sensor	Flt Deck*	Sensor	Sensor	Engineering	Engineering	Hull Pen	Hull Deform
6	Weapon*	Sensor	CIC	Sensor	Hangar*	CIC	Sensor	CIC[1]	Personnel	Hull Pen	Hull Deform
7	Sensor	Sensor	CIC	CIC	Hangar*	Engineering*	Sensor	Cargo	Personnel	Hull Pen	Hull Deform
8	Sensor	CIC	CIC	Engineering*	Hangar*	Engineering*	Sensor	Cargo	Cargo	Battery	Battery
9	Sensor	CIC	Engineering*	Engineering*	Ammo/Fuel*	Engineering*	Sensor	Cargo	Cargo	Battery[3]	Battery[3]
10	CIC	Engineering*	Engineering*	Engineering*	Sensor	Engineering*	Sensor	Cargo	Cargo	Engineering	Engineering
11	Engineering*	Engineering*	Engineering*	Personnel	CIC	Flooding*	Sensor	Cargo	Cargo	Engineering	Engineering
12	Engineering*	Engineering*	Engineering*	Personnel	Engineering*	Flooding*	Engineering	Cargo	Cargo	Flooding	1/2 Flooding
13	Flooding*	Flooding*	Engineering*	Flotation	Engineering*	Flooding*	Wpn/Flt Deck[2]	Flooding	Flotation	Flooding	1/2 Flooding
14	Flooding*	Flooding*	Flooding*	Flotation	Flooding*	Flooding*	Wpn/Flt Deck[2]	Flooding	Flotation	Flooding	1/2 Flooding
15	Flooding*	Flooding*	Flooding*	Flotation	Flooding*	Flooding*	Wpn/Flt Deck[2]	Flooding	Flotation	Fire	1/2 Fire
16	Fire	Fire	Flooding*	Flotation	Fire	Flooding*	Wpn/Flt Deck[2]	Fire	Flotation	Fire	1/2 Fire
17	Fire	Fire	Fire	Fire	Fire	Fire	Wpn/Flt Deck[2]	Fire	Fire	Fire	1/2 Fire
18	Fire	Fire	Fire	Fire	Fire	Fire	Wpn/Flt Deck[2]	Fire	Fire	Sensor	Sensor
19	Bridge*	Bridge	Fire	Fire	Brdg/Air Plot[4]	Brdg/Air Plot[4]	Flt Deck	Bridge	Fire	Control	Control
20	Rudder*	Rudder	Bridge	Bridge	Rudder	Rudder	Brdg/Air Plot[4]	Rudder	Bridge	Rudder	Rudder

- *Armored location. Any armor must be penetrated before the critical hit is inflicted.
- Guided weapon attacks on aviation ships and small craft combatants are resolved on the column for that ship type.
- Aviation ships are CVs, CVHs, LHAs, CVHGs, CHG, or other vessels that have at least half of their main deck devoted to aircraft land/launch facilities. A ship with a one- or two-spot helo pad is not an aviation ship.
- Surfaced subs are treated as surface combatants.
- Amphibious ships (e.g., LST, LPD) should use the Merchant/Auxiliary column, unless they have a flight deck (LHA, LPH), in which case use the Aviation Ship column.

Notes:
1. Merchant/Auxiliary/Small Cargo Craft: If the ship doesn't have a CIC or weapons treat it as a Cargo critical hit.
2. Wpn/Flt D critical hits are flight deck critical hits for aviation ships, and weapon critical hits for all other types.
3. Nuclear subs treat #9 Battery hits as Engineering Critical hits.
4. For aviation ships, roll D6: 1 - 3 Bridge, 4 - 6 Air Plot.
5. Fragments from airbursts are stopped by any level of armor protection (CHP or Armor Rating of 1 or greater).

Critical Hit Damage Ratios

Damage Ratio	*D6 Die Roll* 1	2	3	4	5	6
<.10						1
0.10					1	2
0.20				1	2	3
0.30			1	2	3	4
0.40		1	2	3	4	5
0.50	1	2	3	4	5	6
0.60	2	3	4	5	6	7
0.70	3	4	5	6	7	8
0.80	4	5	6	7	8	9
0.90	5	6	7	8	9	10
1.00	6	7	8	9	10	11

Note: Higher ratios can be extrapolated by adding one to the number of criticals for each .2 that the Damage Ratio exceeds 1.00. Ratios of 3.0 or greater should be treated as reducing the ship to 10% DP remaining (see 14.2.1 Massive Damage).

Light Weapons Critical Hits

Largest gun fired	*Criticals allowed against Size class E and larger*
<12.7mm	Bridge, Weapon
12.7 - 15mm	Aircraft, Bridge, Weapon, Sensor (not sonar), Cargo
20 - 27mm	Aircraft, Bridge, Weapon, Sensor (not sonar), Cargo
30 - 45mm	Aircraft, Bridge, Fire, Weapon, Sensor (not sonar), Cargo
57 - 65mm	Aircraft, Weapon, Bridge, Fire, Flooding (-2 severity), Sensor (not sonar), Cargo

Cargo Damage

Contents *Result*

Ammo:

1-2 D100% of the ammo is lost

3-7 D100% ammo lost. Fire, add one to the fire severity and reduction die rolls. There is a 25% risk of explosion each following Intermediate Turn.

8-10 Explosion. Nearby ships take damage points according to the amount of ammo, in tons, in the hold.

500 yds away tons/5 DP
1000 yds away tons/25 DP
2000 yds away tons/200 DP

There is a 70% chance ammo in each adjacent hold will explode. Fires or the chance of explosion can be stopped by flooding the hold, but all the cargo in that hold is lost.

Petroleum Products: Fire. Add one to the severity die roll for crude oil. If it is a refined product, add two. If it is avgas, add three. Add the same number to the reduction die roll.

Troops: 1-3 DP casualties
4-6 2*DP casualties
7-9 3*DP casualties
10 4*DP casualties

General Cargo: DP/2 tons destroyed
Vehicles: DP/2 Destroyed
Aircraft: DP/5 Destroyed

Roll D6 on the Damage Ratio table. This is the number of critical hits inflicted on the ship.

Example: After suffering damage, a *Knox* class frigate has a damage ratio of .35. The attacking player rolls D6, using the .30 line (always round down). The result is a 4, and the frigate suffers two critical hits.

Minimum Damage: Ships must suffer some measurable damage before they must roll for critical hits. If the damage inflicted is less than 1% of the ship's original damage points, then no criticals are inflicted. This prevents unrealistic results, such as a submachine gun sinking a destroyer.

Once the players know how many critical hits have been inflicted, find the nature of each on the Critical Hit Table. Each type of ship has its own column. Roll D20 for each critical hit on that column to see what its effect on the ship is.

Some weapons will automatically inflict some types of critical hits, in addition to any generated by damage points:

• Each contact-fuzed torpedo or mine that hits a ship will automatically inflict a flooding critical, in addition to any other critical hits. Any torpedo protection system (see 14.1.7) will have to be penetrated before the flooding critical hit occurs.

• The first two Critical hits on a ship by a wake-homing torpedo will be Rudder and Engineering.

• Each hit on a ship by a missile with a warhead of 10 DP or larger will cause an extra, automatic Fire critical hit, in addition to any other critical hits (hot engine and fuel).

• If a sub is hit by a 533mm or larger torpedo, there is an 80% chance of a Pressure Hull Penetration Critical hit for all single-hull and Medium and smaller double-hull submarines. Large double-hull submarines have a 60% chance of a hull penetration. Smaller torpedoes (450mm or smaller) have a 70% and 50% respectively. If the warhead uses a shaped charge, add 20% to the die roll. If no automatic pressure hull critical occurs, resolve the remaining critical hits on the Major Submarine Damage table.

• Any ship that takes 60% or more of its original damage from a single weapon hit must roll D10. For torpedoes or mines, on a 1 - 8, and for bombs and missles on a 1 - 4, the keel has been broken and the ship will sink immediately.

• Each bomb of 100 lb/50 kg or larger that hits a carrier automatically inflicts a flight deck critical hit (penetration allowing), in addition to any other criticals it causes.

• Each turn of 120mm or larger shellfire from Long or Extreme range that hits a carrier may inflict a flight deck critical hit (penetration allowing) in addition to any other criticals caused by its damage points. The chance is 60% from Long range and 70% from Extreme range.

14.1.3 Critical Hits from Light Guns. Shells of 65mm and less do not have the explosive force to inflict all the critical hits listed on the Critical Hit Table on larger ships (size class E and larger). When checking for Critical hits from light weapons fire, roll normally on the appropriate column of the Critical Hit Table for the target type. Then check the type of critical against the Light Weapons Critical Hits table.

If the critical rolled is not listed, or the area's armor protection is not penetrated, the critical hit is ignored.

14.1.4 Airburst Damage. Airbursts do not inflict damage points. Instead, they use a die roll to generate critical hits on the Airburst & Frag Hits column of the Critical Hit Table. Fragments from airbursts are stopped by any level of armor protection (CHP or Armor Rating of 1 or greater).

Airbursts can be caused by:

• Anti-Radiation Missiles (PRH guidance) (see 7.4.2).

• GP bombs fuzed for airburst. GP bombs of up to 1000 kg/2000 lbs, whether unguided or guided, can be fuzed for airburst, instead of direct impact. They will not inflict any damage points, instead causing criticals on the Airburst column of the Critical Hit Table, based on their size:

GP Bomb Airburst Damage

Warhead Size (DP):	*0-30*	*31-40*	*41-50*	*51+*
Critical Hits:	D6/3-1	D6/2-1	D6-2	D6-1

• Cluster weapons (see 9.6.6).

• HE gunfire (65mm and larger) can be fuzed for airburst. This is declared in the Plotting Phase. If the gunfire hits, calculate the critical hit roll normally, then ignore the damage points normally inflicted, but double the critical hit ratio. It cannot penetrate armored targets.

• Aircraft cannon fire (strafing, see 9.6.9).

• Incoming SSMs destroyed too close to their target (see 8.1.5 The Three-Second Rule)

Airburst critical hits on weapons do not cause magazine explosions. This applies to airbursts caused by any type of weapon.

14.1.5 Missile Impacts. Guided missiles not only inflict damage points; there is also an additional die roll for critical hits caused by the airframe, and they also inflict an automatic Fire Critical hit, in addition to any other criticals (the hot engine and fuel).

The number of extra Critical hits depends on the weapon's damage points:

Missile DP	*10-24*	*25-44*	*45+*
Critical Hits	D6/3	D6/2	D6

Missiles with damage ratings less than 10 DP do not cause extra Critical hits.

The required die roll is already included in the data annexes as part of the weapon's damage value. If there is nothing listed with a weapon's damage point rating, then there's no additional critical hits, and no automatic fire critical. For example, glide bombs are unpowered and are smaller, and will not inflict airframe or engine-related damage.

Aircraft which crash onto a ship also cause a Fire critical hit.

14.1.6 Effects of Armor. Armor reduces the amount of damage a ship takes and provides special protection to critical areas of a ship. Deck and belt armor ratings are provided for each ship. Many ships are unarmored, and their rating will be zero, but some ships have armor protection. For example, a Russian *Sverdlov* class light cruiser has a rating of 15/6, meaning a belt thickness equivalent to 15 centimeters, and a deck armor equivalent to 6cm. A *Nimitz* class aircraft carrier has a rating of 0/5, meaning no vertical protection, but 5cm of horizontal armor on the flight deck.

Compare the penetration ability of the weapon with the armor rating where it struck (deck or belt). If the weapon's penetration is greater than the armor rating, it inflicts full damage. If it does not penetrate, halve the number of damage points inflicted.

If the weapon does not penetrate, certain critical hits cannot happen. These are marked with an asterisk (*) on the critical hit table.

Some vessels are fitted with armor over only parts of the ship. This will be listed in the remarks section for that class as "CHP (critical hit protection) armor rating."

Example: The Russian *Sovremenny* class DDG Remarks has "CHP armor rating for AK-130 and Moskit-M is 2." Critical hits to those two weapons must penetrate the armor.

Each weapon has a penetration rating.

• *Gun* penetration is precalculated for each gun at each range bracket, and are listed in Annex C. To find a gun's penetration, measure the range and find the appropriate range band in the annex for that gun and shell type. The most common shell types are Armor-Piercing (AP), High Explosive (HE), Semi-Armor Piercing (SAP), and Common (Com).

Short and Medium-range gunfire has a relatively flat trajectory, and will strike the side of a ship on its armor belt. Long and Extreme-range fire must arc much higher and is called plunging fire. At Long range, there is a 40%/60% chance the shellfire will strike the belt or deck armor, and the firing player must roll to see which armor value must be penetrated. Extreme-range shellfire has a 30%/70% chance of striking the belt or deck armor.

• *Missiles* will strike a ship's deck armor unless they have a VLow Cruise profile, or a VLow terminal phase. These will strike the belt armor.

• *Bombs* always strike the deck armor. They are classed as Armor-Piercing (AP), Semi-armor piercing (SAP), MC (for medium-capacity), general-purpose (GP) or HC (for high-capacity).

Bombs have armor penetration ratings listed in Annex H1. They are given for glide bombing attacks from Low and Medium altitude, and level bombing attacks from Low, Medium, and High altitude. Lob-toss attacks are treated as Medium-altitude glide bombing for penetration. The penetration rating of retarded ordnance is halved.

Players may want to attack from higher altitudes. Much of a bomb's penetration ability comes from kinetic energy, not explosive force. AP bombs do not detonate until after they have penetrated a ship's armor. This means that for AP bombs to get the best possible penetration, they must be dropped from High altitude.

• *Unguided rockets* will strike the deck armor.

• *Strafing* attacks must penetrate the ship's deck armor.

14.1.7 Armor and Underwater Attacks.

• *Contact-fuzed torpedoes* can be set to run shallow or deep. They must run shallow to hit size C-class and smaller ships. A shallow torpedo will strike a larger ship's belt armor, however. Deep torpedoes will run under small ships and will strike larger ships below the belt armor.

Whatever their depth, contact-fuzed torpedoes that strike a ship from the narrow aspect (see the Aspect Diagram diagram on page 10-2) strike outside the armor belt or the torpedo protection system. Divide the torpedo's damage by two. An extreme bow or stern hit wasted a lot of its energy moving water and not damaging the ship.

If a torpedo hits in the narrow stern aspect, the first two critical hits (beside the automatic flooding, which doesn't count against the critical hit number) are automatically Engineering and Rudder hits. Roll the remaining critical hits using the Underwater Attacks column on the Critical Hit Table.

• *Moored Mines* have a 50% chance of striking a ships bow in the narrow aspect, halving its damage, as with torpedoes. They otherwise strike the hull side, and will be affected by the ship's belt armor, it if has any.

• *Bottom Mines* will always detonate under the ship, and are not affected by a ship's armor or protection system.

• *Armor Effects:* If a shallow-running contact-fuzed torpedo or a contact-fuzed mine strikes the armor belt, its damage is reduced according to the following table.

Contact-Fuzed Damage Reduction from Belt Armor

Target's Belt Armor	*0-5*	*5-10*	*11-20*	*21-30*	*31+*
DP Reduction	None	10%	25%	40%	50%

• *Torpedo Protection* ratings are given for those ships that have them. The carrier *Enterprise*, for example, has an armor rating of 0/5/315. The first two numbers are belt and deck ratings. The third number is the underwater protection rating. This is the number of damage points the protection system will absorb before it fails.

Torpedo protection systems only work against contact torpedoes set to run deep. These actually strike the hull. Influence-fuzed weapons explode under the hull, so the system can't protect against them.

The system itself consists of empty compartments, called voids, inside the skin of the ship. By lining the ship's side with them, the torpedo will hit one of them and expend its explosive force. The compartments will only absorb one torpedo hit in a given area of the ship, though. After that, a hit in the same area will reach the ship's vitals. Also, the area around the actual hole is weakened and is less able to resist a hit. If a ship takes several torpedo hits on the same side, the protection system will be destroyed. There are separate protection systems for the port and starboard sides.

A system can absorb only one-third the rating's value (105 for *Enterprise*) from a single torpedo. Any points over this are applied to the ship.

A torpedo protection system can be overloaded. If a torpedo's damage is more than a ship's remaining protection, but is less than twice the protection system rating, then the automatic flooding critical hit inflicted by a torpedo is halved. If the torpedo damage is greater than two times the protection system rating, a full automatic flooding critical hit is inflicted on the ship.

Example: The USS *Enterprise* is hit by a Russian 53-56 torpedo, with a 101 damage point warhead. One-third of 315 is 105, so the carrier's protection system absorbs all 101 dp, leaving 214 dp remaining on that side.

A ship can absorb torpedo damage on each side equal to the strength of the protection system. Thus, *Enterprise* can absorb 315 points of torpedo damage on the port side and another 315 on the starboard side as well. Damage done to one side will not carry over to the other. Torpedo damage points inflicted on the protection system, even if they do not penetrate, still reduce its total resistance.

For example, *Enterprise* is now struck on the same side by three more 53-56 torpedoes, each with a 101 dp warhead. That side's system absorbs 101 points from the first two weapons, but only 12 points remain for the third (214 - (101*3)) = -89. The third torpedo inflicts 89 damage points on the ship; this is more than twice the remaining damage, so it inflicts a flooding critical; the carrier's torpedo protection system on that side is completely destroyed. Any further hits on that side will inflict full damage.

Nuclear Weapons Effects Table

(ranges in nmi)

Warhead Yield (kt)	*Kill Radius Sub/Surf Ships*	*Kill Radius Inflight Aircraft*	*Damage Radius*
1	0.19	0.29	0.46
2	0.24	0.36	0.58
3	0.27	0.41	0.66
5	0.32	0.49	0.78
7	0.36	0.55	0.88
8	0.38	0.57	0.92
10	0.41	0.62	0.99
12	0.43	0.66	1.05
15	0.47	0.71	1.13
20	0.51	0.78	1.25
25	0.55	0.84	1.34
30	0.59	0.89	1.43
45	0.67	1.00	1.62
60	0.74	1.12	1.80
65	0.76	1.15	1.85
70	0.78	1.18	1.89
100	0.88	1.33	2.13
160	1.03	1.55	2.49
170	1.05	1.59	2.54
200	1.11	1.67	2.68
250	1.19	1.80	2.89
300	1.27	1.92	3.07
350	1.33	2.02	3.23
400	1.39	2.11	3.38
500	1.50	2.27	3.64
800	1.75	2.66	4.26
1000	1.89	2.86	4.59
1100	1.95	2.95	4.74
1200	2.01	3.04	4.88
1450	2.14	3.24	5.19
1500	2.16	3.28	5.25
1800	2.30	3.48	5.58
8900	3.92	5.93	9.51
9000	3.93	5.95	9.55
9500	4.00	6.06	9.72
50000	6.96	10.54	16.91

Static overpressure in psi	*8*	*4*	*2*
Radius in m for 1 kt surf	350	530	850
Radius in nmi for 1 kt surf	0.19	0.29	0.46

Notes:

1) All ship damage calculations assume an 8 psi surface burst overpressure to sink or gravely damage a surface ship and a 2 psi overpressure is required to damage its weapons and sensors. Aircraft on the ground or on deck are included.

2) Aircraft and missiles in flight require a 4 psi overpressure to kill them or force a mission abort, or a 2 psi to damage them and force a mission abort.

3) Airbursts are assumed to detonate at the target's altitude. Nuclear SAMs may be used against surface targets. They will detonate at low altitude over the target vessel, if they hit.

14.1.8 Nuclear Weapons Effects. Nuclear weapon yields are listed in the appropriate annex (D for surface missiles, H for air ordnance, etc.). The warhead's damage radii are listed in the Nuclear Weapon Effects table on the previous page.

• *Aircraft***.** A surface or air detonation of a nuclear weapon will destroy aircraft or missiles within the aircraft kill radius listed in the Effects table for that warhead. Subsurface bursts will destroy aircraft at Low altitude within the ship kill radius.

Nuclear-tipped antiair weapons must be aimed at a specific unit, but all air units within the blast radius are destroyed.

• *Surface Ships.* Any surface vessel caught within the ship kill radius listed in the effects table is destroyed, for game purposes. It may still be afloat, but will be so badly damaged it can take no further part in the action.

If the ship is within the damage radius, it takes D6 x 10% of its original damage points. Any aircraft within the damage radius are so damaged they are forced to abort.

These distances apply to surface bursts only. Subsurface bursts halve their effective range against surface ships.

• *Submarines.* Subs are affected at the full distance listed in the effects table by underwater bursts. A surface burst's effectiveness is halved against a submerged target.

• *Fuzing:* Nuclear warheads are not fuzed to detonate until they are close to the target. Weapons with terminal seekers are fuzed when the seeker is activated. Weapons without a terminal seeker (mostly inertially-guided) are fuzed to detonate when they are within two Increments (one minute's flight time) of their target.

Free-fall weapons are armed when they are released.

Once fuzed, nuclear warheads have a 50% chance of detonating even if the weapon carrying them is destroyed.

Also, because of its power, a nuclear warhead may do serious damage even if it "misses." A conventionally-armed missile is assumed to harmlessly splash into the sea. This is not the case with a nuclear warhead. If a nuclear-armed weapon acquires a target, then loses guidance lock, it will detonate.

When a guided weapon misses, it is because the seeker has locked onto a false target, probably because of countermeasures, or in rare cases because the seeker malfunctions. Whatever the reason, the missile will either "hit" the false target or the target will disappear, and the seeker will lose the lock. In either case, the warhead will be triggered.

If a guided weapon misses its target, it continues in the previous direction of flight for one increment (30 seconds), then detonates.

Finally, because a nuclear weapon is a device, it has to function properly to detonate. Any time a nuclear weapon is detonated, the attacking player must roll a D10. On a 10 ("0") the weapon fails to function and has no effect.

14.2 Special Damage Effects.

14.2.1 Massive Damage. Even though some of a ship's weapons may still be intact, there is a time where overall damage to a ship will prevent their operation.

When a ship has only 25% of its original damage points left, all weapons are out of action. Subs must surface. Aircraft carriers cannot launch or land aircraft on the flight deck.

14.2.2 Damage to Reduced-Signature Ships. Ships with reduced signatures depend on their shape and smooth surfaces to reduce their radar signature. If they are damaged, the careful shaping is disrupted and they become more visible to radar and other sensors.

If a surface ship has a Signature less than its Size class in Annex A and it receives 10% or more of its original damage points, its signature is increased one level. A ship's signature cannot be increased to more than its size rating.

Example: A US *Arleigh Burke* Flight I destroyer has a Medium size and a Small signature. It is hit by an Exocet missile, which has a 36-damage point warhead. Since an *Arleigh Burke* has 326 damage points, this is more than 10% (32.6 DP) and in addition to its other troubles, the *Burke* now has a Medium signature.

14.2.3 Damage and Acoustic Signature. If a ship or submarine sustains 10% of its original DP rating from an underwater attack, treat them as a Noisy target for sonar detection. The vessel also loses any benefits it may have from its anechoic coating, if carried. Vessels that already have Noisy or Loud acoustic signatures are not affected.

14.2.4 Firing at Beached or Grounded Craft. Vessels of all sizes were often beached if they were in danger of sinking. Small Craft and amphibious vessels were often beached to offload cargo. Ships that strayed too close to shore sometimes ran aground.

Destroying a beached vessel requires twice as many damage points as it does to sink it. Flooding/flotation criticals are still applicable, since the boat is not completely out of the water, but subtract two from the severity roll of all flooding critical hits.

Vessels that have taken more than their listed damage point rating cannot be refloated, but they are not "destroyed."

14.2.5 Transferring Crew from One Small Craft to Another. Crew can be transferred from a sinking or immobilized boat to another one, or can be sent over to assist a boat that has casualties. It can also be used for transferring boarding parties from one ship to another, or from a boat to a pier.

If one of the vessels is stationary, and the other moves alongside and stops, the transfers happen automatically.

If both craft are moving, they must be moving at the same speed and on the same course. Transfers between two moving small craft are:

1 - 5 kts: 75% chance of success
6 - 10 kts: 5% chance of success
11+ kts: Prohibited

A failure means the crew factor(s) (see 14.5, Personnel Critical Hits) attempting the transfer go in the water, and there is a 50% chance of a collision between the two units involved.

A player can move within 50 yards of the boat, slow to 10 knots or less and roll a D6. It takes that many Impulses to maneuver the boat alongside and bring it to a stop.

In the impulse that the boat is stopped alongside the stationary vessel, any number of uninjured crew factors can move from one boat to the other. Transferring crew factors that have been injured (Personnel Critical hits) takes one Impulse each, and can only be transferred one at a time.

A boat can carry a total of 12 crew factors, injured or uninjured (twice its normal complement).

Once the transfer is complete, boats can maneuver normally.

14.3 Sinking. A ship or surfaced sub that has received damage sufficient to sink it rolls D10*10 for the number of minutes it will take to sink; the final disappearance occurring during the Movement Phase. Submerged submarines sink immediately. Ships with magazine explosions sink as soon as the pieces land.

14.4 Fire & Flooding Critical Hits. Either a fire has started, or the ship's watertight integrity has been violated (that sounds better than, "there's a hole in the hull").

For each flooding or fire critical, roll D6 to see how severe the casualty is.

1) Halve the result if the hit is non-penetrating.

2) Halve the result if it is caused by guns of 65mm or less.

The result is a percentage of the ship's original (undamaged) DPs. These damage points are inflicted on the third Tactical Turn after the critical hit and on each Intermediate Turn after that, until the critical hit is corrected or repaired (*exception:* flooding damage caused by underwater attacks is applied immediately).

Example: A Type 42A destroyer is bombed by an Argentine Skyhawk on turn 1506. The British player rolls for the type of critical hits, and one of them is a fire. Rolling D6, the British player rolls a 5, meaning the fire inflicts 5% of the destroyer's undamaged rating each Intermediate Turn. The Type 42's undamaged DP rating is 199, so she suffers 10 damage points in the Resolution Phase of turn 1515. The destroyer will also have to roll in the Resolution Phase of 1515 to see if the 10 points of fire damage causes any new criticals.

Record the time the critical was inflicted and its severity as a percentage.

When figuring out what line of the table to use, look at the ship's in service date in Annex A.

• *Fire & Flooding Severity Levels.* Add up the percentage of the fire and flooding critical hits from existing and newly inflicted hits. For example, a ship with two fires of 4% and 9% and a 3% flooding critical has a severity level of 16%. This affects how well damage control teams will be able to fight the casualties, and if it's bad enough, will affect the ship's ability to move and fight.

The ship's damage control ability is affected by its size:

Severity Level

Size Class	*Minor*	*Major*	*Severe*	*Overwhelmed*
A - B	1 - 10%	11 - 15%	16 - 17%	18%+
C - D	1 - 8%	9 - 12%	13 - 14%	15%+
E - G	1 - 6%	7 - 10%	11 - 12%	13%+

These levels are modified by the age of the ship. Over time, designers have made ships more resistant to damage.

Ship In Service Date	*before 1908*	*1908-1924*	*1925-1941*	*1942-1959*	*1960+*
% Reduction	-2%	-1%	0%	+1%	+2%

Example: USS *Forrestal* (size class A) was built in 1955, so her severity levels would be increased by 1% or 11%/16%/18%/19%

If the severity of the fire criticals adds up to:

Minor: Submarines must snorkel to ventilate the boat, or surface if not equipped with snorkel.

Major or worse: Ships must cease flight operations, maneuver to put the wind 30° on either bow and slow to 15 knots or less. If they do not maneuver and reduce speed, add +2 to the die roll for reducing the fire. Submarines must surface.

When applying gunfire and visual detection modifiers at night, treat the ship as illuminated. It will also illuminate or silhouette other ships similarly to a starshell (see 5.8.7).

Overwhelmed: The ship is suffering a "conflagration." There is a 25% chance, cumulative per Intermediate Turn, of the fire reaching the ship's magazines and causing an earth-shattering kaboom. A ship's player can prevent this by ordering the magazines to be flooded in the Plotting Phase. The ship loses all weapons and aircraft ordnance.

• If the severity of the flooding criticals adds up to:

Major or worse: Ships must slow to 15 knots or less. Submarines must come to shallow depth.

Submarines: If submarine flooding reaches the severe level, it has one chance to reduce the percentage, or it must surface.

Overwhelmed: The extensive flooding may cause the ship to capsize. There is a 25% chance per Intermediate Turn of the ship capsizing. The only way to prevent this is to reduce the level of the flooding to severe or less.

If the die roll fails, the ship will capsize.

• *Controlling Fires and Flooding:* Players can try to reduce/control fire and flooding critical hits in the Plotting Phase of the third Tactical Turn after the casualty is inflicted and the Plotting Phase of each Intermediate Turn that follows.

The ability of a ship's damage control parties to effectively fight casualties depends on how much stress they are under. On a large ship, one or two small fires are relatively easy to deal with. On the other hand, several large fires and flooding will be harder to manage. Therefore, the severity condition (the total of all fires and flooding on the ship) affects how well the damage control parties deal with the casualties.

Fire and Flooding Reduction

D10	*Minor*	*Major*	*Severe*	*Overwhelmed*
1	-2D6%	-2D6%	-2D6%	-D6%
2	-2D6%	-2D6%	-D6%	-D6%
3	-2D6%	-D6%	-D6%	-D6%
4	-D6%	-D6%	-D6%	NC
5	-D6%	-D6%	NC	NC
6	-D6%	NC	NC	+D6%
7	NC	NC	+D6%	+D6%
8	NC	+D6%	+D6%	+D6%
9	+D6%	+D6%	+D6%	+2D6%
10	+D6%	+D6%	+2D6%	+2D6%

"NC" means "No Change"

Players try to reduce fires and flooding by rolling a D10 once for all fires and once for all flooding (or roll red and blue D10s at the same time). This happens in the Resolution Phase of the third Tactical Turn after the critical is inflicted and in each Intermediate Turn after that.

Compare the D10 rolls with the ship's severity level. This is how many dice must be added or subtracted from the fire and flooding criticals.

Example: A Royal Navy Type 42 guided missile destroyer has suffered two fire critical hits (5% total) and one flooding critical hit (4% total). The destroyer has a total secondary damage of 9%, which for a 1970s-built Size Class C ship puts it in the Minor severity condition. Rolling D10 for the fire casualties results in a "4" and the two fires will be reduced by D6%. Rolling another D10 for the flooding casualties results in a disappointing "9" and the flooding will increase by D6%.

• *Assigning more crew to fight the casualties.* A ship can increase its damage control capability by taking crew from the weapons. This will modify the effective total percentage of the casualties by half of the minor severity level. For example, a size class A or B ship has a minor rating of 10%. This means that he can reduce the total of the fire and flooding casualties by an additional 5%, which may be enough to reduce the severity level and improve his chances of controlling the casualties. It takes one Intermediate Turn for their effects to be felt.

• *Assistance from other ships.* If another ship maneuvers within 100 yards of the damaged ship and matches its course and speed, it can assist in battling fires. Up to two ships may assist, one per side. As long as all ships' speed is below 10 knots, there is no risk of collision. It takes one Intermediate Turn for their effects to be felt.

Each ship assisting in firefighting lends one-half of its minor rating to the other vessel.

Ships which themselves have any fires, including minor ones, or which have more than 50% damage, cannot assist in fighting fires on another ship.

Fleet tugs and similar vessels can lend their entire minor capacity to another vessel.

Example: A US *Nimitz*-class carrier has been hit by several missiles and has suffered a number of fire and flooding critical hits. *Nimitz's* severity levels are 12%/17%/19%/20% (in service in 1973). The combined fire percentage is 16% and the flooding damage is 8%. The total of the two is 24%, which puts the carrier well over the 20+% level. The carrier's damage control teams are officially overwhelmed.

The CO orders all weapons crew to fight the casualties, and ceases any further aviation operations - not a hard decision when your flight deck has holes in it. Two escorting DDs also approach to lend assistance.

By augmenting his damage control teams, the carrier CO reduces (for purposes of the damage control rolls) his combined fire and flooding total to 18% (24% - 6%: half of the carrier's Minor capacity). This lowers it to Severe.

The two DDs assist the carrier. Each DD lends 4% (half of the DD's Minor capacity value) to her and this drops the carrier's percentage from 18% to 10% to Minor with an effective percentage of 10%. The carrier's crew now has a good chance to reduce both the fire and flooding critical hits and save the ship.

14.5 Effects of Other Critical Hits. Critical Hits result in systems going out of action, affecting the fighting capability of the ship.

• *Aircraft.* An aircraft aboard the ship has been destroyed. There is also a chance that a fire has started. Roll D6-2% for the severity of the fire. A result of less than one means there is no fire.

Armed or Fueled Aircraft (optional rule). Hits on armed or fueled aircraft ready for launch roll on the fire critical with a +2 modifier instead of -2. If the D6+2% roll is a six or more, the ordnance on the plane explodes, inflicting 2/3 normal damage points on the ship (part of the damage to a ship comes from the kinetic energy of a weapon, not just its explosive power). If the ship is armored, the damage will not penetrate.

Closely Parked Aircraft (optional rule). Massed parked aircraft were especially vulnerable to attack. If there are other aircraft parked near a plane in a hangar or on a flight deck that has been hit (within 10 meters) there is also a chance that they were hit as well. The chance of a hit is one-half the modified chance to hit the first plane. Up to four other planes are also subject to attack.

If the attacked plane explodes because its ordnance detonates, the chance of another aircraft nearby being hit is 50%.

If the attacked plane burns, there is a 25% chance of the fire spreading to nearby (within 10 meters) planes.

• *Air Plot:* The ship must cease land/launch operations. Roll D6/2 for the number of Tactical Turns it takes to restore functionality. A fire has started, roll D6-2% for severity.

• *Ammo/Fuel.* Roll D10, with a 1-3 indicating a hit in the aviation ordnance magazine, and a 4-10 is a hit in the aviation fuel storage.

If the magazine was hit, roll another D10. A roll of 10 means that the magazine has detonated, destroying the ship.

If the aviation fuel storage tanks have been hit, there is a fire, adding two to the D6 roll for the severity of the fire. Also, add 2 when rolling on the Fire and Flooding Reduction table.

The player has the option of flooding/gas purging the Ammo/Fuel stowage areas. This automatically puts out the fire, but the carrier cannot fuel or arm any aircraft for the rest of the game.

• *Battery.* Some of the sub's battery cells have been damaged. This reduces the submarine's submerged endurance because the damaged cells are lost. To figure the percentage of submerged maximum endurance lost, roll D6*5% (max loss of 30% per battery critical). Split the loss proportionately between charged and depleted cells.

• *Bridge.* The main conning station has suffered a catastrophic hit. It takes D6/2 Tactical Turns (one turn on small craft) to correct casualties and re-man the bridge. After the casualty has been corrected, all changes to course and speed take two Tactical Turns to execute (normal execution on small craft). There is a fire critical hit, subtracting two from the severity roll, in the bridge/control room.

If the ship is fitted with a navigation radar, it is lost.

Submarines lose all fire control solutions, and come to periscope depth. Submarines broach (involuntarily surface) for that Tactical Turn on a roll of 1 on D10.

Carriers cease flight operations for D6/2 Tactical Turns.

On small craft, the captain has been hit. If more than one captain is aboard, or if the commodore is embarked, roll randomly to see who is hit.

• *Cargo.* Some of the ship's cargo has been destroyed. If possible, allocate cargo to a hold/tank, then determine which hold or tank was hit. Refer to the cargo damage table on page 14-3 to see what the results are.

On small craft, one-quarter of the cargo is destroyed.

• *CIC*: The ship's command space has been destroyed. All weapons that do not have a local control mode (either being able to fire from the mount itself or a secondary control space) are out of action. All sensors are lost, except for the navigation radar, which is located on the bridge.

• *Communications*. One of the ship's communications spaces has been hit. Roll D6 on the following table:

1 - 2: Long-range radio communications
3 - 4: Short-range radio communications
5 - 6: Aircraft radio communications

Loss of long-range comms prevents the ship from communicating with units beyond the horizon. Losing short-range communications prevents ships from using radio with other ships in the same formation. Aircraft radio is necessary to communicate with any planes, whether it is a destroyer controlling interceptors or a cruiser talking to its helicopter or a carrier marshalling aircraft for landing.

• *Control:* The sub's control room has been hit. If the Critical hit is from the Minor Damage column, roll D6: 1-3 Bridge, 4-6 CIC critical hit. If the critical hit is from the Major damage column, apply both.

• *Engineering.* The ship's propulsion plant has been damaged. Reduce speed to the next lower level on the Damage and Speed Breakdown chart. A fire critical hit, subtracting two from the severity roll, has started.

In addition, the player rolls D6. For the first Engineering critical, a roll of 1 means the electrical load has been lost for D6 Intermediate Turns. For the second Engineering critical, it's 1-3 on a D6, and 1-5 for the third and all successive Engineering critical hits.

Loss of all electrical power is an immediate "mission kill." All of the ship's weapons no longer function, except manually operated machine guns or autocannon in local control, and all sensors are down. The ship also coasts to a stop. In addition, the loss of all electrical power hampers damage control, thus all fire and flooding repair rolls have a +2 modifier.

• *Flight Deck.* Roll D6. Hits are either forward (1-2), amidships (3-4) or aft (5-6). Catapults or arresting gear in those locations are destroyed. Hits forward prevent aircraft launches but VTOL takeoffs are allowed from undamaged parts of the flight deck. Hits aft prevent planes from landing.

If aircraft are stowed in the location which is hit (forward for landing, aft for launch), roll D6 to see how many are hit. Treat each plane hit as an aircraft critical hit.

Damage to flight decks can also cause damage in the hangar deck. If the carrier has an armored flight deck, only armor piercing bombs may penetrate and cause hangar damage. If the bomb can penetrate, roll D10. On a 1-5 there is no hangar damage, on a 6-10 aircraft in the hangar are hit. Roll D6 to see how many aircraft are hit as well. Treat each plane hit as an aircraft critical hit.

• *Flotation.* This reduces a small craft's speed by one level on the Damage/Speed Breakdown Chart. Size class F boats take five, and Size class G boats take four. When a small craft has no flotation hits left, it sinks.

• *Hangar:* D6 aircraft are destroyed. Roll for each one using the Aircraft critical hit rules.

• *Hull Deformation.* Shock has deformed or dished in part of the sub's pressure hull. Because the hull cross-section has lost its circular shape, it can no longer withstand the maximum design depth. The submarine must come to Intermediate Zone I as fast as it can. If a submarine chooses to stay at a depth greater than Intermediate Zone I there is a 25% chance per depth zone below Zone I of the hull failing (treat as a hull penetration). A second hull deformation critical hit restricts the submarine to Shallow. The chance of the hull failing increases to 30% per depth zone below Shallow. A third hull deformation critical hit is treated as a hull penetration critical.

• *Hull Penetration.* The submarine's hull has been ruptured and it experiences uncontrollable flooding. If the submarine is at Shallow or Intermediate Zone I it has a 50% chance of making it to the surface so the crew can abandon ship. The sub will then take D10*2 Tactical Turns to sink. If the submarine is at deeper depths, she sinks with the loss of all hands.

• *Personnel.* One of a small craft's six crew factors is incapacitated:

1st Loss: No effect

2nd Loss: One weapon of 20mm or less must be abandoned and cannot be used for the rest of the battle.

3rd Loss: One additional (two total) weapon of 20mm or less, or one weapon of 23mm or larger, must be abandoned. Increase the D6 roll by 2 for the severity of all fires.

4th Loss: The boat must stop all weapons fire and make every possible effort to escape combat at maximum possible speed. Increase the D6 roll by 2 for the severity of all fires. Reduce the chance of correcting fires by 2 on the D10 roll (add 2 to the die).

5th Loss and higher: Boat leaves the area at current speed. Increase the D6 roll by 2 for the severity of all fires. Reduce the chance of correcting fires by 2 on the D10 roll.

• *Rudder.* The ship's steering or control surfaces have been damaged. Surface ships roll D6:

1 - 3: *Jammed:* The rudder is jammed in whatever direction the ship is currently moving. If the ship is steering evasively or otherwise maneuvering with both left and right rudder, roll randomly for the direction of the jam: 1-2 port, 3-4 straight, 5-6 starboard.

4 - 6: *Disabled:* The ship's steering engine has been hit. Maximum speed is reduced to 1/3 of the ship's undamaged speed. Maximum course changes after moving the required advance are reduced from 45° to 15°.

Submarines also lose depth control. A submerged submarine has a 5% chance times its speed to involuntarily change depth. Roll before each Plotting Phase. If the submarine does accidentally change depth, roll D10. 1-5 it goes up one level, 6-10 it goes down one level. The submarine will not exceed crush depth. A submarine which is at periscope depth and goes up one level will broach, but will automatically dive the following turn, unless another 'up' roll occurs.

• *Sensor.* One of the ship's sensors is destroyed. This also includes the ship's countermeasures (jammer and decoys are counted separately) and periscopes for submarines. Most subs have two.

• *Weapon.* One of the ship's weapons has been knocked out. Find out which one by a random die roll. This includes elevators, catapults, arresting gear, and anything else listed as a weapon for a ship in Annex A.

Once the affected weapon mount has been determined, if it has a director, Roll D10. On 1-2, the mount's director is destroyed, on a 3-10 (die roll result 0), the mount is destroyed.

If a mount is hit, all the tubes/barrels/cells in that mount are out of action. Note that some weapons have several groups of tubes or cells. Most submarines will have two torpedo tube "mounts" in the bow as port and starboard "nests." One side can be knocked out while the other is still operational. Many vertical launch systems will have groups of cells, and only one group is knocked out by each critical hit.

Weapons that have been knocked out can be hit again. If the mount has already been knocked out, ignore the critical hit. No further damage is done.

If a weapon has explosive ammunition, roll D10. The mount's ammunition detonates on a roll of 0. The explosion of a belowdecks missile or gun magazine will destroy the ship. The explosion of a loaded torpedo tube or missile mount (Mk141 with Harpoon, for example), inflicts damage equal to the number of weapons on the mount divided by two, rounded down, but never less than one.

Example: A US Mk141 Harpoon launcher is loaded with four missiles. A mount detonation will inflict 4/2 * 40 = 80 points of damage.

A magazine can be flooded during the plotting phase, which will prevent a critical hit from detonating it.

14.6 Repairs. Damage cannot be repaired during a battle, except to stop fires and flooding. Some damage, especially to sensors and weapons, may be correctable after a battle. Damage to the ship's structure is not repairable, except in port. Some of the damage from flooding can be removed by pumping the water out once the battle is over.

To find the chance of repairing a system, take the ship's remaining damage points and divide them by the ship's original damage points. This is the Repair Roll. Roll D100 for each critical. A D100 roll less than or equal to the Repair Roll means the system has been repaired and is operational. Early attempts to repair, at the 6- or 12-hour points, halve the Repair Roll.

For example, a ship with 37 damage points left out of 100 original points has a 37% Repair Roll. Attempting to repair a system at 6 and 12 hours after the battle, the player has an 18% chance (37%/2) of fixing the problem. At the 24 and 48-hour points, he has a full 37% chance.

If a system is hit or damaged again before the roll is successful, compute the new roll and start over.

• *Aircraft*. In extended games, planes have a chance of being only damaged; see 14.9 for optional aircraft damage rules.

• *Bridge.* Repair Rolls are made at the 6, 12, 24, and 48 hour marks. Degraded operations are allowed D6/2 Tactical Turns after the critical hit was suffered. Two Tactical Turns are needed to change course and the aircraft land/launch rate is halved. Normal operations are allowed after the Repair Roll is successfully made.

• *Cargo.* Cargo cannot be repaired.

• *Engineering.* Make Repair Rolls 6, 12, 24, and 48 hours after the battle is over. Failure to successfully roll the 48 hour Repair Roll means that the system cannot be repaired at sea. Each repair roll removes one 25% reduction in the ship's speed, up to whatever is allowed by the ships damage points.

• *Flight Deck.* Make a Repair Roll at the 6, 12, 24 and 48-hour mark after the battle for each flight deck critical hit. Failure to successfully roll the 48-hour Repair Roll means that it cannot be repaired at sea.

• *Fire.* A fire may restart at the 6- (10%), 12- (5%), 24- (2%), and 48-hour (1%) marks. Find out the size of the fire by rolling D6-2 as described in 14.4. Use this procedure for all fires (except planes). Aircraft fires cannot restart.

• *Flooding.* Remove one half of the flooding damage points automatically (they pump the water out), but there is a chance of the patch popping. Subs must stay at Periscope depth or the patch pops automatically. The chance for surface ships equals the (sea state * 5) - (30 - maximum speed that day in knots)%.

Example: A ship with a flooding patch spends one Intermediate Turn at 20 knots in sea state 3. The chance of the patch popping is (3*5) - (30 - 20)% = 15% - 10% = 5%.

If the sea state were 6, the chance would be (6*5) - (30 - 20)% = 30% - 10%, or 20%. It pays to reduce speed in rough weather when you have holes in your ship.

• *Rudder.* During the battle, the player can attempt to unjam the rudder by rolling a D10:

Make the first roll D6 Tactical Turns after the critical hit is inflicted. In the first turn (after D6 Tactical Turns), the chance of unjamming is 20%. The next turn, it is 40%, and the third turn, it is 60%. If the rudder is still jammed after the third roll, it cannot be freed during the battle.

After the battle, make Repair Rolls 6, 12, 24, and 48 hours later. Failure to successfully roll the 48 hour Repair Roll means that the rudder cannot be repaired at sea.

• *Sensor/Communications.* Make Repair Rolls 6, 12, 24, and 48 hours after the battle is over. Failure to successfully roll the 48 hour Repair Roll means that the system cannot be repaired at sea.

• *Weapon Mount*. Make Repair Rolls 6, 12, 24, and 48 hours after the battle is over. Failure to successfully roll the 48 hour roll means that the system cannot be repaired at sea.

14.7 Equipment Serviceability *(optional rule)***.** Just before beginning the game (or daily in a campaign game) roll D100 for the engineering plant, each sensor, and each weapons system on the ship. First rank navies experience failures at 2%. Second rank navies have failures at 5%.

The failed item cannot be repaired during the tactical game. During non-battle periods it can be repaired as a critical hit of that type using the Breakdown Repair Chance table. Systems not repaired within 48 hours cannot be repaired at sea.

At a forward base, systems could be repaired alongside a tender (+20% to each Repair Roll). At a more established port, or shipyard, add 30% to the Repair Roll.

Damaged aircraft also use the Breakdown Repair Chance table. If the plane cannot be repaired in 48 hours it cannot be repaired at sea. Land-based aircraft have 10% added to the Repair Roll, and are not subject to the 48-hour limitation.

Breakdown Repair Chance

Time Since Breakdown (hours)	6	12	24	48
First rank navies:	30%	35%	40%	45%
Second rank navies:	20%	25%	25%	25%

14.8 Search and Rescue *(optional rule, but it should be mandatory)***.** Players who want to realistically play the role of a naval commander should feel compelled to find and recover survivors from sunken ships and aircraft that have been shot down. The effect this can have on a longer game is dramatic.

These rules create a group of survivors which must be rescued. The exact number is not carefully modeled. More important is that fact that they exist and must be found and saved. This takes resources and time.

If an aircraft is destroyed, place a group of survivors near the spot where it goes down. Small aircraft will have crews of one to three, while medium- and large-sized planes can have up to ten or twelve men inside. If it is a passenger aircraft, it may have as many as thirty or more. Round numbers of survivors above ten to the nearest tens, e.g., twelve becomes ten, twenty-five becomes thirty.

If a ship is sunk, D6*10% of its crew survive. Magazine explosions or other spectacular destructions reduce the number to a D6% roll. If another ship is alongside or within 250 yards of the sinking vessel, and is stationary, increase the number of survivors by 20%.

Place a counter marking the location of the survivors on the spot where the ship is sunk or the plane goes down. In a short game, the counter is stationary, but if the survivors are in the water more than six hours, roll D6 for the speed of the current in knots, and randomly for its direction, consistent with the local geography.

Unless the ship or aircraft is in sight when it is lost (and the survivor marker is placed), the survivors must be searched for. At night or in poor visibility, this will be difficult even with their general location known.

When resolving sighting attempts, groups of less than ten men are treated as a size class G/Stealthy. Ten to thirty men are treated as a size class E/VSmall. Thirty to one hundred men are treated as size class D/Small, and one hundred or more are size class C/Small. Remember to apply the sighting modifier for no wakes (half range). Increase the size class by one if searching with FLIR, because of the excellent contrast between the survivors and the surrounding water.

Survivors in the water may be wounded, suffer from exposure, and may even be subject to shark attack. Even so, unless the environment is extreme (the North Atlantic in the Winter) survivors can last for many days or weeks if they have a little food or water. In a tactical game, survivor endurance does not need to be modeled.

Once found, a flying boat can land in the water, taxi over, and pick up ten or less survivors in D6 three-minute Tactical Turns. A hovering helicopter can winch up two survivors every Tactical Turn.

A ship can pick up many more survivors, D6/2 groups of 10 each Tactical Turn. It must be stationary and upwind of the survivors. This creates a lee for the recovery, and also ensures that the ship won't drift downwind from the recovery site.

Recovery is slowed by high waves. Reduce the die roll by one for every sea state level over two. For example, in sea state 4, the die roll would be (D6-2)/2.

A ship can hold as many survivors as its own crew or passenger complement. Practically, this will have a long-term effect on the ship's performance and endurance, but in a tactical game, these can be ignored.

If survivor rules are used, rescuing survivors should count as part of the players' victory conditions. Resolving actions and results can be very subjective, but search and rescue is an important factor in real naval battles.

14.9 Aircraft Damage Resolution (*optional rule)*. Normally a 50/50 killed/damaged roll is made after the battle, because historically many of the aircraft that were "shot down" did make it back, even though they took no further part in the fight. This is definitely the best procedure in most games, both for simplicity and to mirror historical doctrine. Pilots who chased down cripples to finish them off abandoned their comrades still in combat, and also ignored other enemy aircraft that could still accomplish their mission.

If players want to finish off stragglers, they have to know they are not dead (yet), which means a damage roll must be made immediately after the hit. Resolving this during the combat will definitely slow play down, and if large numbers of aircraft are involved, it could bring the game to a crashing halt.

Either use the 50/50 roll to generate a simple destroyed/damaged result, or each time an aircraft is hit, roll on the following table:

1 - 5: Destroyed
6: Critical damage
7 - 8: Heavy damage
9 - 0: Light damage

Destroyed: People hear a large untidy noise. Pieces fall off. There is a large IR bloom, following which it disappears from radar. It immediately ceases to move forward and falls to the earth. It's dead, Jim.

Critical: The only thing keeping this plane in the air is the pilot's ignorance of how badly damaged it really is. It cannot use any speed over cruise. All weapons systems, sensors, and defensive countermeasures are down. Its Maneuver Rating is 0.5/0.0, depending on whether it is lightly or fully loaded (hint!).

Heavily damaged: This aircraft's ability to fly is severely impaired. It cannot use any speed over cruise. All weapons and sensors are down. Its Maneuver Rating is halved, minimum 0.5/0.5.

Lightly damaged: This plane can no longer accomplish its mission. Roll D6 on the following table:

1: Pilot wounded. Cannot attack, Maneuver Rating reduced by 1/3.

2-3: Engine damaged. It cannot use any speed over cruise. Maneuver Rating is halved.

4-5: Aircraft structure damaged. It cannot use any speed over cruise. Maneuver Rating is 0.5/0.5.

6: Offensive weapons system damaged. It cannot release any ordnance offensively. There is a 50% chance that it cannot jettison any ordnance, either.

The first hit imposes the listed casualty. Later hits add to the severity of the damage:

• Any hit on a Critically damaged aircraft kills it.
• Heavy Damage to a Heavily damaged aircraft kills it.
• Heavy Damage to a Lightly damaged aircraft makes it Critically Damaged.
• Light Damage to a Heavily damaged aircraft makes it Critically Damaged.
• Light Damage to a Lightly Damaged aircraft, if it is not the same type of damage, makes it Heavily Damaged. If it is the same result, ignore it.

If players use the 50/50 system, treat all damage as Heavy damage, i.e., a second hit kills the aircraft.

Obviously, this ruthlessly oversimplifies the many horrible things that can happen when aircraft and exploding warheads interact, but it will define how an aircraft that has been "hit" behaves after a battle.

After resolving its damage, the players continue their turn with damaged aircraft behaving as indicated. In most cases, damaged aircraft will head in the general direction of away, but a plane with light damage resulting in a sensor or weapons hit might stay in the fight, to help distract or decoy their opponent. This happened historically.

Common sense should apply. If somebody wants to follow a "kill" to finish him off, then they are out of the fight. If a player with a crippled plane wants to stay in the fight ("I'm already dead, so I might as well suck up another attack"), activate the secret autopilot that takes control of the plane and heads it toward home.

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