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Current Doctrine Submarines

USF 25(A)

Prepared By
COMMANDER SUBMARINE FORCE, PACIFIC FLEET
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USF 25(A)

SUBMARINE FORCE, PACIFIC FLEET

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Current Doctrine Submarines (USF-25(A))

Chapter I

Section 1
Basic Considerations

Foreword

Doctrine may be defined as a compilation of principles, applicable to a subject, that have been developed through experience or by theory, that represent the best thought of the unit concerned, and **that indicate and guide but do not bind in practice**. Its purpose is to provide that understanding within a force that generates mutual confidence between the commander and his subordinates in order that timely and effective action will be taken by all concerned in the absence of instructions. It permits intelligent initiative on the part of the subordinate, the most desirable quality in all echelons of command.

1101. The fundamentals of Submarine Doctrine are derived from the War Instructions, U.S. Navy; General Tactical Instructions, U.S. Navy; Current U.S. Fleet Doctrine and Tactical Orders. Nothing in this publication shall be construed to conflict with the above basic instructions.

1102. The submarine is a weapon available to the naval command in the conduct of a campaign, designed and operated to attack or observe enemy surface or sub-surface craft without prior detection and without requiring support from other types. The essence of successful submarine

attack lies in its unseen and unheard execution, resulting in surprise. The primary assets of the submarine are its ability to carry torpedo attacks to close range, objectively to point where enemy target can not successfully maneuver to avoid; to lay mines in waters controlled or under observation by the enemy where surface mine layers can not operate without hazard or detection; and to obtain positive or negative information regarding enemy locations or movements under conditions which take advantage of their inherent qualities. Any use of the weapon which does not take full advantage of these qualities when such are needed in the theatre of operations, is a sacrifice of available potentialities.

1103. During probable long periods before fleet action occurs, submarines may be usefully employed in the following tasks:

a. Patrol. (Including commerce destruction).

b. Scouting.

c. Screening.

d. Mining.

e. Reconnaissance.

f. Services to aircraft.

g. Escort (under exceptional circumstances only).

h. Delivering important mail or personnel.

1104. The primary task of the submarine is to inflict maximum damage on enemy ships and shipping. This task shall be carried out at every opportunity unless expressly forbidden. When submarines are used for scouting, observation, reconnaissance, etc., their operation orders should expressly state whether or not they are to attack.

1105. In battle, submarines initially unfavorably situated and not able to attain a favorable attack position, should be disposed in position to attack the enemy battle line upon reversal of the action, or to sink damaged enemy vessels left astern.

1106. In battle, submarines may, through threat or actual attack, serve as the anvil against which own battle line may attack the enemy battle line.

1107. In the exercise of control of the sea or in defense of our own land positions, bases, and sea areas, the primary employment of submarines should be as patrol units for individual attack, and in the service of information, when this cannot better be performed by other types.

1108. Individual submarines, in order to be able to deliver their submerged attacks with full effect, must be so disposed as to permit freedom of movement within their own disposition and with minimum interference from own surface forces. Concentrated groups of submarines appear to be most effective against large convoys without air escort or when air escort is light.

1109. Submarines should not be employed in purely defensive operations for which surface vessels are equally adapted.

1110. In screening operations, submarines are suitable for distant screens only. If used as a close screen, they are, because of the potential necessity of submergence, liable to foul own formation.

1111. Attack by torpedo is the primary task of the submarine and main objectives are those enemy units most capable of inflicting damages to our own forces. Attacks on other types may be made when they do not jeopardize the opportunity to carry out the primary task. Submarines may carry both mines and torpedoes, or either.

1112. The most serious limitations of the submarine are: (1) vulnerability to damage from gun fire when in the surface cruising conditions and, (2) low maximum speed, low cruising radii and time endurance while submerged, coupled with the fact that usually several hours must be spent on the surface recharging storage batteries when the limits of this endurance are reached. Once a submarine has been located by the enemy, he knows the submarine cannot get very far away without coming to the surface.

1113. Those officers who are not thoroughly familiar with the type, when called upon to utilize or direct submarine operations, must guard against misconceptions as to capabilities or weaknesses which they may have gained through observing them under artificial or abnormal circumstances. Submarines may be able to execute assignments successfully in some geographical locations and weather conditions which would have been impossible of accomplishment under other situations. Conversely, failure to accomplish the mission in one instance must not be used conclusively in forming an opinion that the same assignment could not have been accomplished under more favorable circumstances for taking advantage of the inherent qualities of the submarine.

1114. There is probably no form of warfare in which the quick decision is more essential than in certain phases of submarine war; nor is there any form of warfare more susceptible to failure through mistakes, indecision, or hesitation on the part of the individual commanding officer. Full and complete service of information, coupled with anticipation and freedom to exercise initiative, is essential to the most effective use of the type.

1115. Under present limitations of communications while submerged and at low submerged speed, anticipation is particularly important to submarine operations with our own fleet against the enemy fleet. Once the submarine is submerged, these operations cannot deviate from a prearranged general plan and must therefore be conducted in accordance with doctrine. Once the plan has been put into execution, any extensive movement for adjusting position is impossible to accomplish. The weather-beaten canard the submarines are vessels of opportunity becomes a fact, unless opportunities are made and fully utilized in employing the inherent assets of the submarine. As long as the number of submarines available for use in connection with a fleet action remains limited, it is not enough to treat them merely as an intelligent mine field.

1116. The service of information must provide for furnishing own forces liable to make contact, with the location of friendly submarines. Instructions for submarines entering friendly waters must be explicit as to course to be steered and time to make rendezvous

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with escort vessel; such instructions must be disseminated also to local defense forces at sea in that area. Except under very unusual circumstances, our own submarines may be expected to keep clear of friendly vessels and dispositions and will avoid areas occupied by own surface ships. If they should find themselves in the immediate presence of friendly surface craft, they may be expected to avoid revealing their presence. In this circumstance, if required to surface in an emergency, they will make emergency identification signals with the submerged signal gun. If able to make fleet speed, but not able to dive, our submarines may be expected to drop back into fleet formation or disposition for protection. Own submarines may be expected to keep clear of off shore areas during execution of sortie and entry plans. To do this, they must be kept informed of fleet movements.

1117. Submarine attack is perforce a single attack. Such attacks by two or more submarines may be coordinated when movements of the enemy are predictable or are restricted to narrow limits by other factors. These conditions are usually satisfied when it is evident that the enemy is approaching a specific objective. Such objective may be stationary, as when the enemy is approaching a geographical location in order to establish a base, or to attack one of our bases, or is returning to one of his own bases. Or the objective may be moving, as when the enemy fleet is approaching own fleet for attack. In these circumstances, coordinated attacks are necessarily from open formation. They resolve themselves into individual attacks by two or more submarines, when the submarine line covers a wide front normal to the enemy advance in order to provide for contingencies of freedom of enemy movement. If the enemy approach is positively known to be confined to narrow limits, the submarine line can then be parallel to the direction of advance, and the coordinated attack becomes a series of individual attacks. Using a submarine line normal to the line of enemy advance, has the disadvantage of offering comparatively few opportunities for attack. Using a line parallel to the advance, introduces the possibilities of no attack in case the estimate of expected enemy movement does not conform to the narrow limits needed for this type.

In case sufficient submarines are available, combinations of the two systems may be used, or they may resort to a series of attacks under either system. It is axiomatic that the success of a submarine coordinated attack is dependent upon the service of information and the proper functioning of attack doctrine. To allow freedom of movement and initiative by individual commanding officers, the coordinated attack must be made from open formation. For communication purposes in the dissemination of information, it is desirable to retain a close formation as long as possible before deployment for attack. Hence, directives must permit sufficient time to assume the attack formation and for orienting lines and adjusting positions, if such become necessary. This points to the necessity for latitude in directives and encouragement of initiative in the echelon of submarine command. Submarine operations can be coordinated with, but not closely combined with, those of surface ships or aircraft. If such coordination is desired, slow submerged speed and lack of reliability in communications while submerged, place the burden of coordination on the other units involved, and this becomes too restrictive upon them. In advancing submarines on the surface during daylight, complete control of the air over them must be maintained in order to deny knowledge of their presence to the enemy and to prevent enemy planes from forcing them down, thus reducing speed of advance. When knowledge of their presence by the enemy is of no consequence, maintenance of surface speed can be accomplished by escort, either by own aircraft or by surface ships, with sufficient anti-aircraft protection. In cases where submarines remain on the surface under air escort, control of the air overhead by the escorts must be absolute. Otherwise, the submarines will be forced to dive to avoid both enemy and friendly planes due to the impossibility of differentiation at long ranges. If used in connection with fleet battle, a submarine losing contact, or a unit which definitely knows that the enemy fleet has gone by without presenting favorable opportunity for attack, may be expected to trail or to take position on the enemy's retirement line or between him and his most probable base.

1118. Although normally it is of primary importance that Submarine endeavor to carry out their operations undetected, contingencies may arise where it will be to the advantage of the O.T.C. that submarines reveal their presence to cause enemy confusion, or the avoidance by him of certain areas. Initiative, rather than directives, may dictate the use of this type of tactics.

1119. If submarines performing reconnaisance or scouting missions take advantage of favorable opportunities for attack, this will reveal their presence and possibly jeopardize them in making contact reports. When attack is not desired, orders should so specify.

1120. In avoiding detection by aircraft, running deep, as well as the careful use of periscope, must be considered. If it is desired to conceal their presence, submarines should remain submerged during daylight hours, in areas exposed to air scouting by the enemy. Otherwise, a submarine should submerge at first sight of any plane. Small fast planes are hard to see, making submergence before detection difficult. Aircraft may pick up a submarine not only from wakes, slicks, and feathers, but from sighting the outline of the hull, even at considerable depth. In calm tropical waters with

bright sunlight, submarines are often visible at depths in excess of 100 feet. In other waters, ability to see a submarine is greatly reduced. Overcast weather and many scattered clouds favor the submarine. Oil slicks, or air bubble slicks, not only reveal the presence of a submarine, but give its definite position.

1121. The development of supersonic sound equipment has increased the chances of detection of submarines by surface craft. Submarines will make every effort to attack without coming within range of a supersonic screen, but they can be expected to attempt penetration in order to attack enemy heavy ships. The performance of supersonic equipment is best in a uniform medium usually found well offshore in deep water with choppy surface. Poorest performances are obtained in coastal waters and are due primarily to the prevailing temperature gradients of the water caused by currents, tides, seasonal variations and the surface layers of a glass sea being heated by the sun. When it is necessary to penetrate a supersonic sound screen, the submarine may be expected to run as silently as possible at minimum speed with bow or stern towards screen so as to present the smallest possible target. Water conditions in the particular area of operations will be a guiding factor in evasive tactics. The opportunity to cross the wakes, or run under heavy ships, increases the chances of remaining undetected. In comparison with surface craft, except those especially designed, the submerged submarine is the perfect listening ship. Sound equipment and training of submarines should be developed so as to take full advantage of this factor and thereby convert listening equipment into an asset instead of allowing it to continue primarily as an anti-submarine device.

1122. The maximum surface speeds of our submarines are approximately as follows:

O, R and S-type -- 11 knots.
Narwhal(SS167) to *Cuttlefish*(SS171), incl., -- 16 knots.
Porpoise(SS172) and subsequent submarines -- 20-21 knots.
Barracuda(SS163) -- 9 knots.

The above speeds can be made only if all the following conditions are fulfilled:

a. All main engines in submarine developing full power on propulsion.

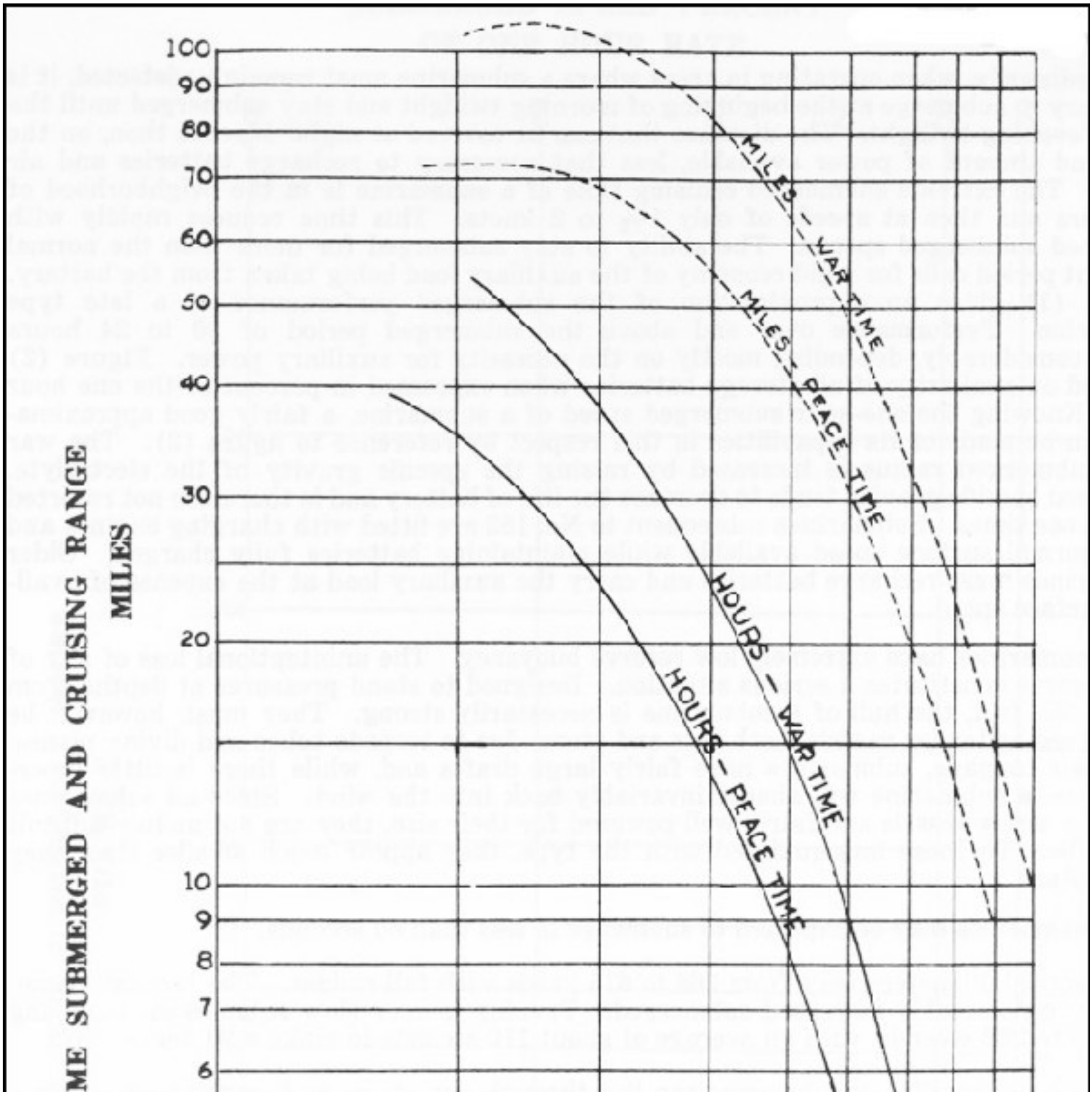
b. Smooth sea.

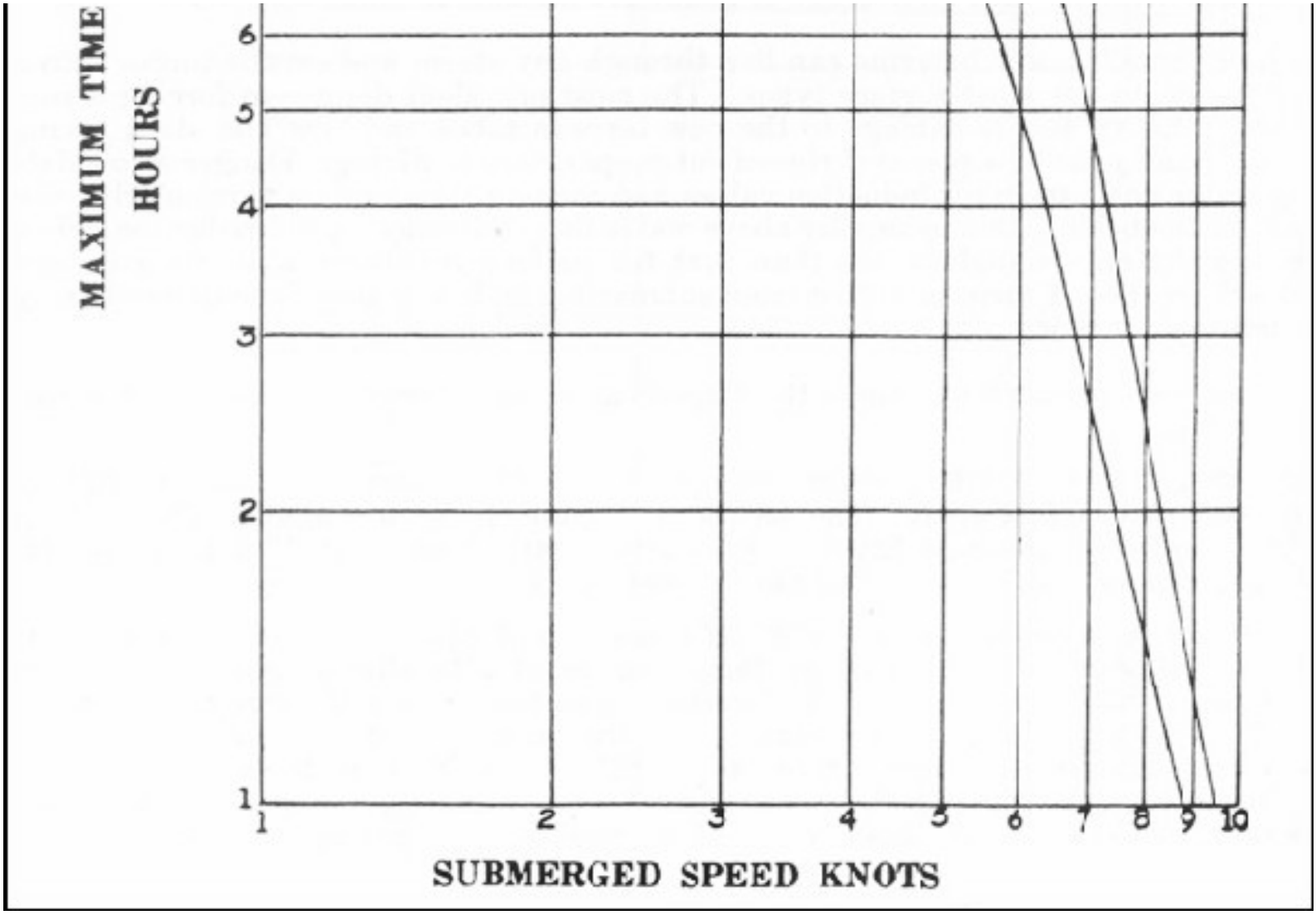
c. Clean bottom.

d. Normal condition of loading (no reserve fuel on board).

Actually a submarine rarely operates under all of the above conditions. For instance, engine power is limited to 80% of full power for normal cruising. One main engine must normally be reserved for the charging of batteries which reduces the number available to place on propulsion from 4 to 3 for four engine submarines and 2 to 1 for two engine submarines. In present day operations,

submarines operate in the emergency surface condition, that is, with fuel ballast tanks full of fuel or water. Taking the above factors into consideration, the maximum cruising speeds we can expect from our submarines under average conditions of sea and bottom fouling are about 4 or 5 knots less than the maximum speeds listed above. Cruising ranges of all modern submarines are high, averaging about 12,000 miles. Surface speeds must be slow to realize these long radii.





Maximum Time Submerged and Cruising Range vs. Submerged Speed Knots

1123. Ordinarily, when operating in areas where a submarine must remain undetected, it is necessary to submerge at the beginning of morning twilight and stay submerged until the end of evening twilight. The distance that can be covered at night depends then, on the time and amount of power available, less that necessary to recharge batteries and air banks. The extreme submerged cruising time of a submarine is in the neighborhood of 36 hours and then at speeds of only $1^1/2$ to 2 knots. This time reduces rapidly with increased submerged speeds. The ability to stay submerged for more than the normal daylight period calls for rigid economy of the auxiliary load being taken from the battery. Figure (1) gives an approximation of the submerged performance of a late type submarine. Performance over and above the submerged period of 20 to 24 hours varies considerably, depending mostly on the necessity for auxiliary power. Figure (2) is based on similarity of all storage batteries when expressed in percent of the one hour rate. Knowing the one-hour submerged speed of a submarine, a fairly good approximation can be made of its capabilities in this respect by reference to figure (2). The war time submerged radius is increased by raising the specific gravity of the electrolyte. Increased specific gravity tends to decrease the life of battery

and is therefore not resorted to in peace times. Submarines subsequent to No. 162 are fitted with charging engines and have normal surface speed available while maintaining batteries fully charged. Older submarines must recharge batteries and carry the auxiliary load at the expense of available surface speed.

1124. Submarines have extremely low reserve buoyancy. The unintentional loss of any of this reserve constitutes a serious situation. Designed to stand pressures at depths from 200 to 450 feet, the hull of a submarine is necessarily strong. They must, however, be considered as tender vessels, both bow and stern, due to torpedo tubes and diving planes. For their tonnage, submarines have fairly large drafts and, while there is little superstructure, a submarine will almost invariably back into the wind. Since all submarines are twin screw vessels and fairly well powered for their size, they are not unduly difficult to handle. To those unacquainted with the type, they appear much smaller than they actually are.

1125. Submarines may be expected to submerge in less than 60 seconds.

1126. Tactical diameters vary from 268 to 615 yards with full rudder. The tactical diameters are considerably increased submerged. Turning is very slow submerged, requiring from 70 to 202 seconds, with an average of about 110 seconds to make a 90 degree turn.

1127. Properly handled, a submarine can live through any storm and can be forced into a sea much too heavy for most surface types. The most prevalent danger in forcing a submarine into a heavy sea, is damage to the bow torpedo tubes and bow and stern diving planes, particularly the bow planes if rigged out preparatory to diving. Danger also exists of taking water down main air induction valves and conning tower hatch particularly with the sea abaft the beam. Due to smaller above water line resistance, speed reduction, when heading into the sea, is slightly less than that for surface vessels of same tonnage and speed. Performance of torpedoes fired from submarines in heavy seas or long swells may be expected to be erratic.

1128. (a) A submarine's primary weapon is the torpedo and under some circumstances the torpedo tube mine.

(b) The deck gun and machine guns are secondary offensive weapons used against lightly armed or unarmed surface craft. The deck gun is available for use against shore objectives when feasible. Guns now fitted on submarines vary from 3" to 6" with maximum effective gun ranges of 5,000 to 10,000 yards, respectively.

(c) Utmost caution must be used in resorting to a gunfight with any enemy. Submarines are vulnerable to gunfire while on the surface. An enemy attacking by gunfire should be evaded by use of high speed and evasive maneuvers on the surface if practicable. When enemy gunfire appears accurate, submergence is the best form of defense against such attack. When submerged, a submarine can be attacked only with depth charges, torpedoes, mines, various forms of the "mouse-trap" or by ramming. Flat-nose projectiles are generally ineffective. All these forms of explosives

must be placed close, to cause

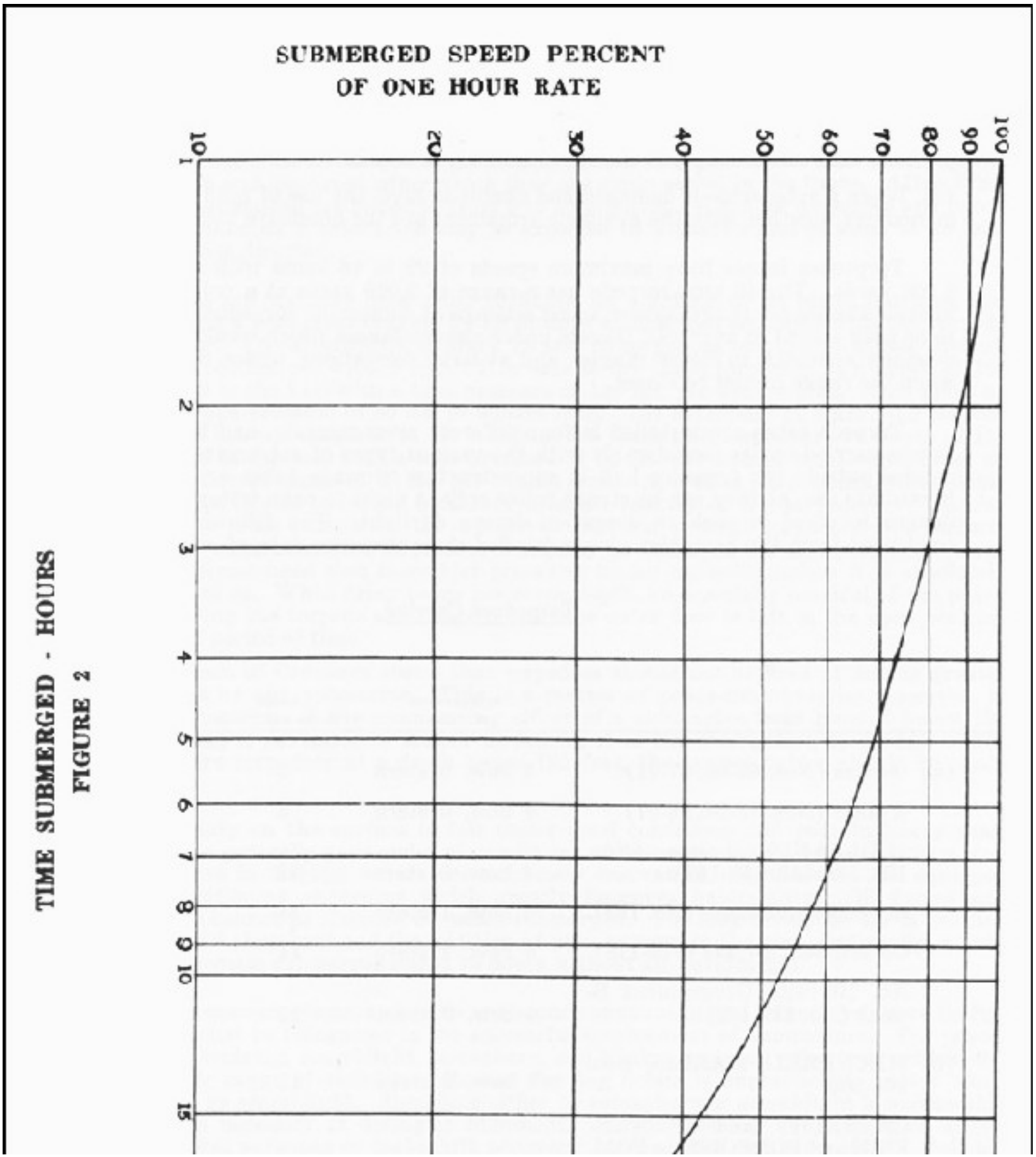


FIGURE 2

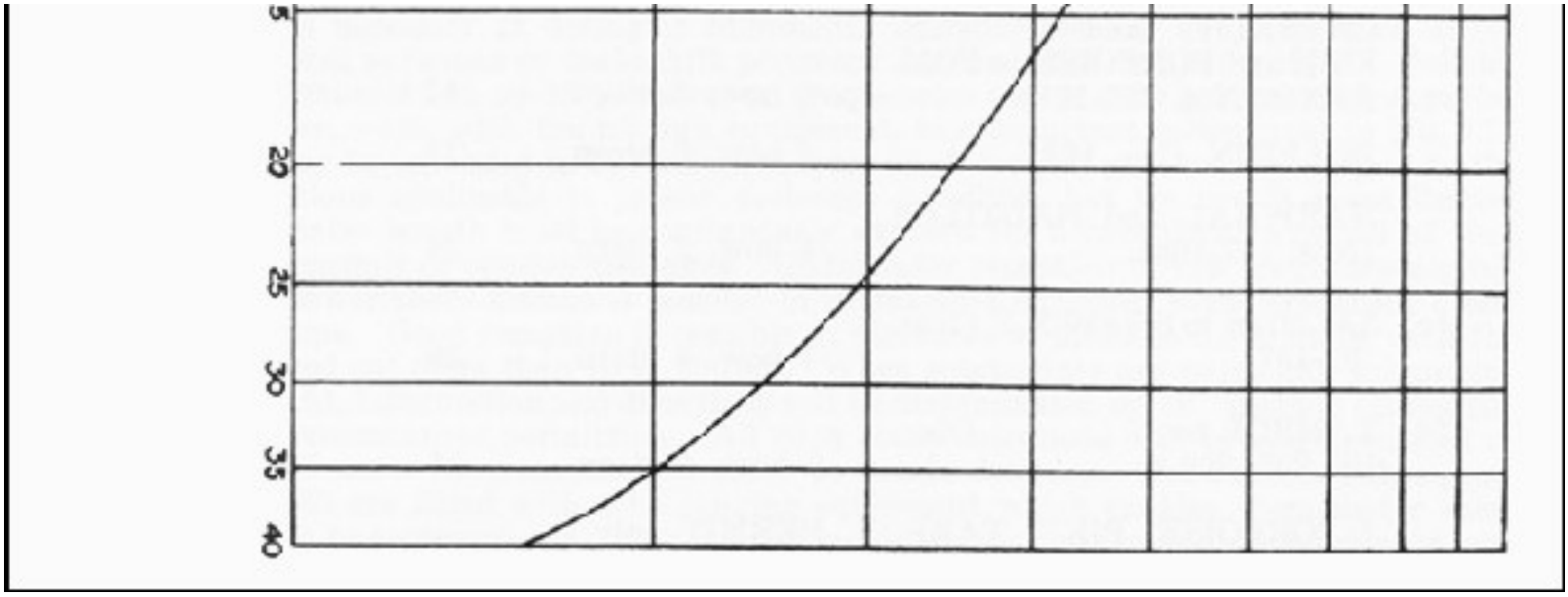


Figure 2
Submerged Speed Percent of One Hour Rate

material damage, but may have adverse psychological effect on the crew even when no material damage is done. The destruction of any part of the watertight integrity of the pressure hull will usually put the submarine out of commission.

(d) When a submarine is damaged and unable to dive, the use of high speed and evasive maneuvers together with the available armament are the defensive measures to be taken.

1129. Torpedoes in use have maximum speeds of 29 to 46 knots with ranges of 3,500 to 6,000 yards. The 46 knot torpedo has a range of 9,000 yards at a reduced speed of 31.5 knots. The longer range, slower speed settings of submarine torpedoes are very unlikely to be used except at anchored targets under circumstances which would preclude the submarine's approach to closer ranges; and at large formations, under rare circumstances, when the range cannot be closed.

1130. Torpedo tubes are installed in four different arrangements, and the number of torpedoes carried outside the pressure hull in superstructure stowage tubes are not available for immediate use, as they can be struck below only at night in calm water on account of the danger involved in such an operation during daylight. The following table has been condensed from the pamphlet giving detailed characteristics data of submarines.

Torpedoes Carried

Type	Arrangement of Tubes	Inside Racks and Tubes	Super-structure Stowage Tubes	Super-structure Torpedo Tubes

(a) O-class (Nos. 63-65, 67-71).	4 bow, 0 stern	8	0	
R-class (Nos. 78-84, 86-97).	4 bow, 0 stern	8	0	
(*Holland*) S-class (Nos. 123, 125-146, 153-158).	4 bow, 0 stern	12	0	
Government S-class (No. 159).	4 bow, 1 stern	14	0	
Government S-class (116-118).	4 bow, 1 stern	14	0	
No. 105 and Government S-class (No. 119-122).	4 bow, 0 stern	12	0	
(b) *Mackerel, Marlin* Nos. 204-205	4 bow 2 stern	12	0	
Cachalot and *Cuttlefish* and *Porpoise* to *Pompano* (Nos. 170-181).	4 bow, 2 stern	16	0	*2
Dolphin (No. 169).	4 bow, 2 stern	16	3	
Narwhal and *Nautilus* (Nos. 167-168)	4 bow, 2 stern	24	10	4
(c) *Salmon* to *Seawolf* (Nos. 182-197).	4 bow, 4 stern	20	4	
(d) *Tambor* to _____ (Nos. 198-203, 206 to _____).	6 bow, 4 stern	24	0	

* *Porpoise, Pike, Tarpon, Permit* only.

1131. When at sea, torpedoes in the tubes are habitually kept fully ready for war shots, except for flooding tubes. At least one complete replacement set is kept ready for reload in the racks. As soon as conditions permit, torpedoes in tubes, which have been flooded, are withdrawn and inspected, after which they are again sealed in the tubes. After firing torpedoes, a submarine can reload in from 5 to 10 minutes. When all torpedoes and mines have been exhausted, a submarine may be expected to withdraw and proceed to its base unless otherwise directed.

1132. (a) Torpedoes are normally fired using periscope for sighting, or on sound bearings, and may be fired on a generated bearing by all modern submarines equipped with the torpedo data computer. The afterbodies of Mark 14 and 15 torpedoes and modifications thereof, are tested to 135 lbs. per square inch. It is safe to fire these torpedoes at a depth of 180 feet measured to the keel with a tube pressure of 135 lbs. per square inch. This gives an effective ejection pressure of 40 lbs. per square inch. In S-class submarines, when firing below periscope depth, to insure necessary ejection velocity of the torpedo, two impulse tanks must be cross connected. It is believed that our present torpedoes will perform satisfactorily when subjected to pressures slightly in excess of the test pressure. However, it is recommended that these test pressures be not exceeded unless it is

absolutely necessary to do so. When firing below periscope depth, be especially mindful of the possibility of flooding the torpedo afterbody if the tube outer door is left in the open position for too long a period of time.

(b) The Bureau of Ordnance states that torpedoes should not be fired at depths greater than 120 feet by any submarine. This is a matter of peace-time practice, however, in actual war operations if the commanding officer of a submarine finds himself below 120 feet and deems it advisable to launch torpedoes, it is his prerogative to do so. When required to fire torpedoes at a depth below 120 feet, the poppet valves should be made inoperative.

1133. Habitability on the surface is fair under good conditions and poor in heavy seas. Habitability is generally poor under all conditions of extensive submerged operations, and prolonged dives in tropical waters are extremely enervating. Submarines are equipped with air-conditioning apparatus which greatly improves habitability. Oil fumes and battery gases cannot be disposed of, when submerged. For long dives, the air is purified by use of a CO^2 absorbent and the addition of pure oxygen to the air. Ordinarily, a submarine may remain submerged about 15 hours without air purification.

1134. Visual communications, and radio and sound communications submerged, have limitations which must be recognized in the successful employment of submarines. For peace-time surface cruising, searchlight, semaphore, and blinker are used effectively within the limits of their range of visibility. Receipt for flag hoists is impracticable except when accomplished by searchlight. Signalling either by semaphore or searchlight is undesirable whenever the necessity of diving is imminent. Submarines are equipped with either housing vertical antennas or makeshift periscope antennas for use submerged. Reliable two way communication up to 50 miles, on frequencies above 2000 kcs. may be expected with the latter, while with the modern equipment, in submarines subsequent to No. 171, this range may be extended to 100 miles. Exposure of vertical antennas is subject to the same restrictions applicable to proper periscope handling, but its use is more limited because a greater length must be continuously exposed for a considerable period of time in order to transmit or receive messages. Underwater reception of low frequency signals from a high power shore station is possible in submarines equipped with permanent direction-finder loops. Good reception is possible at distances of 2,000 to 3,000 miles with the loop submerged not more than 15 to 20 feet. When submarines are patrolling submerged during daylight, information and directives will be disseminated by "F" method on regular schedules, circumstances permitting. All such communications will be retransmitted at night after all units have surfaced in order to insure delivery. Submarines subsequent to Number 165 are fitted with echo-ranging equipment which enables them under some circumstances to communicate, when submerged, with each other and with friendly surface

craft. Their use, and the use of fathometers, should be avoided when it will facilitate detection by

enemy patrols. All submarines, subsequent to Number 165, have keel-mounted supersonic equipment available for use when on the surface for detecting the presence of other vessels during darkness or low visibility.

1135. A basic advantage exists in the use of small submarines in operations against enemy submarines. If surface craft, and even aircraft, are used exclusively for this purpose, the enemy submarine can remain on the surface for at least a portion of the time. On the other hand, if there is any possibility of own submarines being in the vicinity, the enemy submarine will have to remain submerged throughout daylight hours or risk the possibility of submarine attacks. This has the effect of forcing him to do all battery charging at night or in thick weather, and in addition reduces his effective speed of advance and reduces efficiency and morale of his crew. For this same reason, the mere presence of own submarines ahead of own fleet will serve to reduce effectiveness of enemy submarines, in maintaining striking position ahead of their own fleet.

1136. The history of submarine warfare indicates that even the occasional appearance of submarines in widely separated areas, serves a useful purpose in requiring the enemy to take defensive measures out of all proportion to the effort required to produce them. Establishment of convoy systems, with resultant reduction in the service of supply, and the extended dispersion and augmentation of anti-submarine units and measures, follow. This stratagem also serves to restrict and complicate the freedom of movement of the enemy's men of war.

1137. For those interested in counter measures against submarine warfare, the question of lookouts is of importance. Experience with surface vessels and aircraft engaged in target services to submarines during torpedo practices indicates that the pilot, observer or quartermaster who has had considerable experience looking for periscopes and knows what to look for, will invariably pick one up without false alarms long before the average lookout, not so trained and experienced. In the training and assignment of lookouts, the fact must be borne in mind that the proficient submarine approach officer strives to complete his observations within a few seconds for each exposure. Under these conditions, confirmation of a lookout's report by the officer of the deck or officer in charge of lookouts, is impracticable. The lookout must know what to look for and must be sufficiently alert and reliable that his reports do not need confirmation if false alarms with resultant confusion are to be avoided.

1138. Echo-ranging apparatus used as a listening device, is an excellent detector of torpedoes after they have been fired. Torpedoes make a distinctive sound and trained operators can track them with fair accuracy. This feature is especially valuable in detecting wakeless torpedoes.

1139. If one of our own planes sights an enemy submarine, the surest way to make him submerge is to attack. If, for any reason, it is desired to have enemy submarines remain on the surface rather than submerged, or if it is desirable to keep them from giving the alarm to other submarines on the surface in the vicinity, plane observation, when not accompanied by attack, should be made from maximum range.

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Section 2
Doctrine for the Operations of the Individual Submarine

1201. The primary objectives of submarines are enemy ships.

1202. The primary weapon of the submarine is the torpedo; the secondary weapons are the mine and gun.

1203. The ability of the submarine to deliver an attack successfully depends on remaining unseen and unheard until the attack is completed.

1204. Having started an attack, deliver it as soon as a satisfactory firing position is reached. Waiting for an improved firing position almost invariably jeopardizes the satisfactory position already attained and increases chances of detection.

1205. Attacks should be carried to as close a range as possible to insure hitting, keeping in mind arming distance of torpedo exploders.

1206. The number of torpedoes fired should be sufficient to insure destruction or crippling of the enemy. (see paragraph 4614).

1207. On attacks at short range a torpedo spread should be used to cover at least 80% of the target length.

1208. Should a submarine be unable to reach a close firing position, the torpedoes should be spread so that the target cannot avoid all of them. This principle also applies to sound attacks.

1209. In using multiple-speed torpedoes, the highest power setting that will insure the torpedoes reaching the target, should be used.

1210. Empty tubes should be reloaded immediately if the noise made in reloading is unlikely to draw immediate counter attacks.

1211. With radar operating, a submarine on the surface can usually detect enemy aircraft in sufficient time to dive to a safe depth. In clear water, in vicinity of the enemy, a submerged submarine must be particularly careful of periscope exposures, and running too shallow between periscope exposures.

1212. (a) The basic defense of the submarine against aircraft lies in quick and deep submergence followed by evading action.

(b) Against surface craft, quick submergence plus information gained of enemy action from periscope observations and sound are basic for evasion if the contact is at close range. Silent running should be employed.

(c) At night, and in some conditions of low visibility when the contact is not at close range, evasion may be accomplished most successfully by use of high surface speed and evasive tactics.

1213. With alert personnel and radars in operation submarines on the surface in reduced visibility are not subject to surprise attack.

1214. Submarines are in diving trim and ready to dive immediately at all times when at sea.

1215. Periscopes and periscope antennas should be exposed only at relatively slow speeds. After reducing speed, sufficient time should be allowed to permit the vessel to lose headway. This is one of the most important points in connection with the prevention of detection.

1216. The handling of the submarine by section watches, during surface and submerged operations, is standard practice.

1217. Vessels should take every opportunity to run "silent" at slow speeds. Development of sound apparatus will make such silent operations more and more essential in war.

1218. Batteries and air banks should be kept as fully charged as operations will allow.

1219. The necessity for efficient lookouts cannot be over-emphasized.

1220. In rough weather, diving is facilitated by having the seam on the beam or slightly abaft the beam.

1221. Before coming to periscope depth after running deep:

a. Thoroughly listen through 360° for external sounds.

b. Bring the submarine up smartly to periscope depth and quickly observer through 360°l; in low power.

c. If all is clear, follow this by a slower and more careful 360° search in high power.

In coming to periscope depth, control should be such as to permit immediate return to deep submergence.

1222. While cruising on the surface in daylight, the highest periscope should be manned, as an additional lookout station.

1223. Close at high speed to insure getting good firing position; at the same time, bear in mind possibility of sight and sound detection.

1224. If possible, choose the firing side according to sun and weather conditions, but do not delay getting in on this account.

1225. If water is clear and air screen is present or suspected, go deep between periscope exposures to avoid aircraft detection. This precaution is particularly important for vessels painted with the light camouflage paint. When the surface is choppy or in certain unclear northern waters this is probably unnecessary.

1226. Time between exposures depends on visibility, speed of enemy, and expected air and screen surface ship menace. Learn to rely on sound gear and reduce number of exposures.

1227. Get tubes ready for firing in plenty of time to avoid a last minute delay, but keep in mind the possibility of flooding torpedo afterbody.

1228. Always parallel periscope data with sound data. It may be necessary to go deep for firing. Keep proper setup on angle solver for use in case of failure of T.D.C.

1229. Firing bubbles must be avoided by efficient use of poppet valves. Too much, rather than too little, water should be allowed to enter the submarine.

1230. Regarding the safe depth at which to fire torpedoes, see paragraph 1134.

1231. Attention is directed to the following pertinent articles of F.T.P. 183, 188, and 143, which concern the employment of submarines:

F.T.P. 143, Articles 414(f), 825(b), 10142-10146, 1231-1233, 12129-12137, 12150-12154, 12209-12212, 12253, 12268, 12283, 12306, 12321, and 1254.

F.T.P. 183, Article 133.

F.T.P. 188, Chapter VI, Articles 1112, 1141, 1313, and the parts of the following applicable to submarine employment: Chapter VIII, Chapter IX, pages 9-1 to 9-27, Articles 1154-1159, 1323-

1330, Chapter XIV and Chapter XV.

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Current Doctrine Submarines (USF-25(A))

Chapter II

Section 1
Operating Procedures--Diving

2101. As a guide for standardizing procedure, the report "ship rigged for diving" indicates that:

a. The ship has been compensated for all changes in weight since last dive.

b. All hull openings have been closed except:

1. Conning tower hatch -- to provide access to conning tower from bridge.

2. Hull ventilation supply and outboard exhaust valve.

3. Main engine induction outboard valve -- to provide air to engines.

4. Forward engineroom induction hull flapper -- to supply air to forward engines when they are running.

5. After engineroom induction hull flapper -- to supply air to after engines when they

are running.

c. Safety and negative tanks have been flooded, flood valves left open, and vents closed. While diving and when submerged, the safety tank vent is never open unless one or more main ballast vents are closed. This provides for quick blowing of at least one tank or group at any time after the diving signal has been made and precludes the possibility of not being able to do this in case of possible malfunctioning of vent valve mechanisms.

d. The operation of all bulkhead watertight doors and bulkhead flappers have been tested.

e. Outboard battery ventilation outboard exhaust valves have been closed and checked by sighting valve disk and by checking mechanical indicator when installed.

f. Three high pressure air banks, charged to at least 75% capacity are cut in on the air manifold.

g. All operations of the procedure of rigging for diving have been checked by one or more officers.

h. Rapid and efficient communication between diving officer and all compartments has been established.

2102. Before leaving port the ship is rigged for diving. The ship is continuously kept compensated and ready to dive at any moment. The diving signal is two blasts in rapid succession on the diving alarm. Two blasts are used to prevent diving on accidental single blast.

2103. On the sounding of the diving signal, the following procedure is followed (item marked with an asterisk are executed simultaneously without further orders):

a. *Stop all engines, shift to battery, all ahead standard (or speed designated). Close outboard and inboard engine exhaust valves, close hull ventilation supply and exhaust valves and inboard engine air induction flappers and close conning tower hatch.

b. *Open engineroom doors and air lock doors if not already open.

c. *Open bow buoyancy vents and all main ballast tank vents except group designated to be kept closed. Vents on at least one main ballast tank or group of main ballast tanks may be kept closed until all hull openings are closed and there is definite pressure in the boat.

d. Rig out bow planes and place on full dive. Use stern planes as required to control angle.

e. When green lights on the board indicate all hull openings are closed, the diving officer directs the

f. Bleeding of air from the manifold and checks watertight integrity by means of the barometer. With air injection engines, necessary pressure for this test is assisted by bleeding down engine air compressors as soon as outboard openings are closed. With solid injection engines more extensive bleeding from the manifold is necessary to obtain positive results. Diving officer insures that barometer pointers are matched after engines are stopped and engineroom doors opened before starting to bleed in air, then

g. Diving officer reports "engine air induction outboard ventilation valves closed, pressure in the boat".

h. Each ship shall establish a standard diving procedure which habitually shall be carried out when orders to the contrary are not given. This shall include handling the vents, the depth at which to level off, blowing negative tank, handling speed, getting a trim and reports to the conning officer. The following is a typical standard diving procedure carried out when the diving alarm is sounded and no special orders are given.

"Clear the bridge" and diving alarm sounded simultaneously.

"All ahead full" set on annunciators.

All vents opened.

All engines stopped and secured and propulsion shifted to battery power.

When board shows engine outboard exhaust valves closed, close outboard engine and hull ventilation valves and lock closed in hand position.

When board shows conning tower hatch closed put pressure in the boat.

Lookout detailed rigs out bow planes.

At 45 feet close the vents and slow to 2/3 speed.

At 90 feet blow negative tank.

Level off at 100 feet, slow to 1/3 speed and adjust trim.

Close negative flood valve and vent negative tank.

Report to conning officer when trim is satisfactory.

All conversation and orders are thus cut down to a minimum during the process of diving. Any variation from the standard procedure can be made during the dive by the conning officer.

2104. Operation of the ship's ventilation system (opening hull valves and recirculating valves and running ventilation sets) on prolonged dives is left to the discretion of the diving officer who keeps the commanding officer informed.

2105. Ballast is shifted as ordered by the diving officer. Pumping of bilges to sea is never accomplished submerged without permission of the commanding officer because of the danger of leaving an oil slick. Bilges should be pumped into the expansion tank or any accessible fuel tank when necessary.

2106. When the commanding officer decides to surface, he orders the diving officer to "stand-by to surface" when time permits and other circumstances make the preparatory order advisable. At this order, the diving officer directs the starting up of the hydraulic plant if it has been shut down.

2107. When ship is to be surfaced pass the word to the engine room and maneuvering room watch instructing them which engines are to be put on the line, then give the order "Surface" to the diving officer. A surfacing signal on the diving alarm is optional but is not recommended when on war patrol where enemy A/S vessels may be present.

2108. Each ship shall establish a standard surfacing procedure which shall habitually be carried out, when orders to the contrary are not given. This shall include rigging in bow planes, blowing tanks, handling low pressure blowers, main engines lined up, manning the bridge and shifting from battery power to engines. A typical standard surfacing procedure is as follows:

"Stand by to surface."

Bow planes are rigged in.

Two main engines are "lined up."

Lookouts, equipped with binoculars, go to conning tower.

Hydraulic plant is started up and all vents closed.

All ahead standard.

When the order or signal **"Surface"** is given.

Blow safety and bow buoyancy tanks. (Main ballast tanks if dictated by circumstances).

Conning officer orders hatch opened and goes to bridge.

Start u plow pressure blower when ordered by the Commanding Officer.

Open engine air and hull outboard ventilation valve on order from the bridge. (When engine air induction valve is open engines are started and propulsion is shifted to the main generators automatically).

Flood safety and negative tanks as ordered by the Commanding Officer.

Secure low pressure blowers after fifteen minutes running.

- In order to perform all submergence with an absence of confusion and with rapidity and efficiency, conversation must be reduced to a minimum and men not on watch kept clear of the control room.

- All quick dives are made while the submarine is proceeding on one or more engines. The surface speed of the submarine determines her momentum and consequently affects the time necessary for her to reach periscope depth.

- For normal operation, submarines are kept in diving trim at all times when at sea so that extensive trim adjustments just prior to actual diving are unnecessary. It is normal practice to "ride the vents" prior to sounding the diving alarm if not already doing so. In this condition, the main ballast tank vents are closed, but all flood valves are open. By this operation, the submarine has taken considerable water in these tanks, and since her main flood valves are already open, is that much further advanced in her preparations for a quick dive. A peace-time practice has developed of always compensating light for normal operations. This is poor practice from the point of view of war training since most diving will be done with negative buoyancy in order to insure getting down in minimum time.

- In a heavy sea, the submarine will make a faster submergence if headed on such a course as will bring the sea on the beam, or slightly abaft the beam. In extremely rough weather, it is necessary to place the sea abaft the beam in order to get under.

- Normally the rudder id kept amidships during the dive in order to avoid slowing-down effect and tendency of horizontal component to pull stern under.

- Submarines are normally trimmed when submerged with a slight angle down by the head. This insures that the submarine will not have a natural tendency to assume an angle up by the bow and assists expeditious deep submergence form periscope depth when needed.

2115. To accomplish deep submergence most expeditiously in order to avoid collission or detection by air screen, an exact knowledge of how the particular submarine reacts for the maneuver is required. A cardinal principle common to all types is that **THE RUDDER MUST BE KEPT AMIDSHIPS.** Best speed combined with angle down by the head varies with types and is determined by experience. Planeing effect by the deck, combined with the tendency of resistance of conning tower fairwater to hold the bow up, may cause a slower speed than maximum to be most effective. Too much angle will reduce propeller thrust if stern is brought too close to surface and will expose stern to ramming if in close quarters. Too much speed at periscope depth will create turbulence which will increase possibilities of detection from the air. When increasing depth rapidly by means of the negative tank, care must be exercised in blowing this tank after sufficient downward momentum has been obtained to prevent blowing air through its flood valves when avoiding air screens or patrols.

2116. The time required for rigging for diving from the surface cruising condition varies with different types. Normally, in order to provide for careful checking of each compartment, about twenty minutes should be allowed. Under war conditions, the submarine rigs for diving before leaving port and remains in that condition until her return. This permits day or night readiness for diving without standby orders. Interior organization must provide for maintenance of integrity of this condition, or immediate restoration of it, upon sounding of diving alarm. Under these circumstances, it is good practice to have the ship rechecked at the beginning of each watch by the officer coming on watch.

2117. As standard procedure, each compartment should be provided with a check off list for rigging for diving. In the interests of safety, the interior organization should provide for checking each item by an officer, without trusting to memory, before the compartment is reported rigged to the diving officer. The checkoff system should provide for exercising care that nothing in the superstructure stowage may come adrift and reveal presence during depth charge attack.

2118. When running below periscope depth, it is standard practice to maintain at least 60 feet over the A frames. Sound equipment is manned at all times and particularly careful use must be made of it prior to returning to periscope depth from deep submergence. If circumstances warrant and permit, especially in unfavorable water for reliable sound reception, a turn through 90° at slow

speed should be made while listening carefully on all bearings. The transition period in coming to periscope depth must be accomplished quickly and with sufficient speed to maintain control and preclude possibilities of broaching. The lower conning tower hatch should at least be tended and under uncertain conditions, it and all watertight doors should be closed. All inboard valves and flappers and antenna trunk and bulkhead flappers should be closed in these circumstances. For peace-time operations or for recognition purposes in war time, use submerged signal gun as prescribed in other instructions. Upon arrival at periscope depth, a quick periscope observation is made through 360° in low power followed by more careful observations, duration and care of which are dependent upon circumstances.

2119. All depth gauges should not be cut into sea pressure at one time. when shallow gauges are in use, deep gauges should be cut out. This procedure reduces the possibilities of having all gauges rendered useless by a close depth charge or bomb.

Section 2
Operating Procedures -- Surface

2201. During peace-time when on the surface submarines are operated in accordance with the General Signal Book and General Tactical Instructions.

2202. Most surface operations of submarines during wartime may be expected to be independent or in open formations not particularly vulnerable to aircraft attack and from which submergence of all units may be effected. Deployment on line of bearing is most suitable for this purpose, but quandrantal or hexagonal deployments may be used. Chapter IV, Section 10 contains information on deployment.

2203. At all times at sea, under wartime operating conditions, the submarine must maintain the following conditions of readiness:

a. Readiness for quick dive at all times, which requires a sufficiently advanced stage of training that this can be accomplished by the section on watch.

b. Guns and ammunition, including machine guns, for anti-aircraft defense in the most advanced stage of readiness compatible with their preservation and readiness for quick dive.

c. All torpedo tubes loaded with torpedoes ready to fire and with one complete set ready for reload without further adjustments.

d. Readiness to fire torpedoes from the bridge, particularly during night and reduced visibility.

e. Bow planes kept rigged in.

f. Steering and engine control habitually from the conning tower or control room.

g. Main storage battery kept venting inboard (or into main induction on vessels so fitted).

h. The mast and periscopes habitually maintained in the housed position unless raised for short periods for particular purposes, in which case they should be housed as soon as reasons for raising them no longer exist.

i. Have superstructure free of gear. Deck gratings and superstructure access openings should be locked closed and tap welded to prevent accidental opening.

j. Sources of oil slicks and air bubble wakes eliminated before proceeding on a war mission. Serious defects in this respect can be ascertained by looking through eye ports and through own periscope at slow speed. If conditions permit, submarines shall be inspected from the air while submerged to periscope depth in the vicinity of the base before proceeding on a war mission. This is particularly important after extensive overhaul or after taking on reserve fuel. If such defects are not eliminated, the submarine is not ready for a war mission. Attention at all times must be given the external tightness of oil tanks and outboard oil fittings (such as filling and vent connections) and to the external tightness of all outboard air lines and connections. Care must be exercised not to foul (with oil from bilges) the line used for pumping water from variable tanks.

k. Whenever a reserve fuel tank is emptied, it is maintained full of its compensating water and flood valves not opened to sea until an opportunity is presented for flushing it out several times under conditions which will minimize possibilities of detection or of permitting residual oil in the vent lines to become well spread through the superstructure. Flushing is done normally at night and away from where it is expected the following day's submerged operations will be conducted. Lines, canvas, etc., are not stowed in the vicinity of vents for reserve fuel tanks in order to minimize possibilities of oil slicks from these sources.

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l. At all times when on the surface, sufficient way is kept on the ship to permit quick diving or maneuvering to avoid being rammed, or maneuvering to fire torpedoes without delay in case a suitable target approaches. Immediate submergence is required in order to avoid

bombing, gun or torpedo attack on own vessel if contact is made close aboard.

m. All operations, whether surface or submerged, are conducted as silently as possible in the vicinity of enemy surface or submarine craft when noise from exhaust, auxiliaries, etc., creates possible sources of detection.

n. Rigid economy of auxiliary power is in order whether on the surface or submerged.

o. Recognition signals shall be made known to, and passed on, by all bridge personnel. Recognition devices and signalling equipment shall be on hand. Recognition flares, when provided, should be kept ready at all times for identification of submarine to aircraft.

2204.

a. The ability of submarines to escape detection and make successful attacks at night depends to a large degree on the efficiency of the lookouts. Every effort shall be made to pick the best men possible for this duty and their training shall be carefully supervised. Lookouts of proven vision equipped with binoculars shall be stationed in accordance with existing instructions. All bridge personnel shall be tested for night vision and none showing unsatisfactory night vision shall be so employed.

b. For submarine operations, each lookout shall be a combined horizon, surface, and sky lookout. S-class submarines shall have a minimum of one lookout. Lookout station is the bridge. Fleet submarines shall have a minimum of three lookouts. Lookout station may be the signal platform above the bridge or on the bridge.

c. Rotate lookouts in order that no man has more than 45 minutes consecutively on lookout watch. Stagger the reliefs in order that only one lookout is relieved at a time.

d. At night all lookouts shall be properly dark adapted, by wearing red goggles, before relieving.

e. When a submarine is on patrol station and has a choice as to what course to steer, much can be done to improve the efficiency of lookouts by adjusting course and speed so that they are not blinded by wind and spray. On moonlight nights, the choice should be a course towards the moon, or away from moon.

Section 3

Operating Procedures -- Sound Equipment

2301. Sound equipment is manned at all times when submerged; and, if keel mounted, it is manned during reduced visibility, when on the surface, when speed permits and when contact with any craft (friendly or enemy) is possible.

2302. Enemy target propeller turn counts are taken whenever possible and are of valuable assistance in estimating target speeds. These should never be used conclusively and must not be used to supplant plotting or other methods of determining target speed for use in solving the torpedo problem. Changes of speed are readily detected by propeller count.

2303. Echo ranging during the conduct of an approach must be used with discretion and with full consideration of many factors. If it is certain that enemy craft lack the equipment necessary to detect transmission from own equipment on the frequencies used, it can then be used with impunity. Under these conditions, when approaching an unscreened target, echo ranging can no doubt be used effectively for checking course and speed, for solution of the torpedo problem, and for own maneuvers in conducting the final stages of the approach. The importance of obtaining a single ping range at about 2500-3000 yards in order to accurately determine target masthead height with which to correct speed data is obvious. Under these same conditions, periscope observations are usually available, but when the masthead height of the target has to be estimated, echo ranges may be more accurate than periscope ranges. If the target is surrounded by a screen, the problem of ranges through wakes left by screens will be difficult. The results must be evaluated before they are used conclusively if a valuable target has made herself subject to attack.

2304. Echo ranging by a submarine during an approach always presents the possibility of acting as an alarm to the enemy. An enemy vessel that hears the echo-ranging signal from a submarine may be able to maneuver to avoid attack. Conditions during the approach may make it highly probable that a periscope, when exposed, will be sighted by the enemy or that the enemy air patrol or screening vessels may force the submarine below periscope depth. Under these conditions, the advantage of using echo ranging to obtain an accurate range of the target during the final stages of the approach is unquestioned. In order to detect any underwater transmissions made by the submarine, the enemy must possess supersonic receivers tuned approximately to the frequency used, but not necessarily trained directly on the bearing of the submarine. Factors affecting the probability of the enemy detecting any echo-ranging signals are:

a. Speed -- The efficiency of supersonic receivers decreases rapidly as speed is increased above 15 knots.

b. The efficiency of enemy operations. -- Even well-trained listeners will become inefficient from fatigue after the equipment has been in continuous operation for several days.

c. The strength of the supersonic transmission which is primarily dependent on the range.

d. The condition of the water as affecting the transmission of sound in water. If echo ranging is resorted to, the submarine should make the least number of transmission possible and then only in the latter stages of the approach. Through training, it is possible that under favorable circumstances, a good sound operator can use bearings of the target's propellers to train the projector accurately on the hull so as to obtain an echo range with only one or two "pings'. If echo ranging is not attempted until ready for the final setup of the problem immediately before firing, the intelligence gained by enemy interception of the signal possibly may not be acted upon in sufficient time to affect materially the success of the attack.

2305. Uses of echo-ranging equipment installed in submarine other than during approach and attack include:

a. Rapid communications that are directional and limited in range.

b. Identification signals while on the surface during reduced visibility and when submerged.

c. Navigation when approaching an enemy coast during reduced visibility, particularly when it is known that navigational aids have been removed or extinguished.

d. Location of unwatched mine fields or submarine nets. Peacetime uses of the apparatus during reduced visibility include:

1. Station keeping in formation.

2. Locating and tracking passing vessels.

3. Locating icebergs and

4. Piloting near the coast when entering channels or uncertain waters.

Another peace time use is for search and communications in connection with rescue and salvage.

2306. To realize the capabilities of echo-ranging equipment for torpedo approach, it is important that the personnel concerned be properly trained and indoctrinated raining must include coordination

between the sound operators and the conning officer. The conning officer should be sufficiently conversant with the operation of the equipment in order that he may be capable of properly evaluating information obtained by the sound operator. Results of submarine echo ranging equipment in practice torpedo approaches are without doubt minimized by the majority of targets possessing similar equipment, by the mental alertness of the sound operators in the targets during these brief exercises, and by the confinement to an area as imposed by the problem. These artificial features are of value in providing strict conditions for submarine supersonic training, but should not influence any estimation concerning the true worth of echo-ranging equipment under war conditions. It is the best equipment currently available for its designed purpose and every possibility of its submarine application must be exhausted before its use is condemned.

2307. Training of sound operators must be continuous to obtain best results. Ample opportunities are presented during all submarine operations underway. Of particular value to the listeners is experience gained during approaches, tactical exercises, and fleet problems.

During these occasions, sound training for all listeners includes:

a. Taking accurate bearings of target's propellers.

b. Tracking of target and (in submarine with two projectors) screening vessels.

c. Estimating propeller revolutions per minute.

d. Identifying type of target by listening to propellers.

e. Obtaining accurate echo ranges with only one or two "pings" after bearing of target has been found.

f. Distinguishing any changes by the target in course or speed.

g. Estimating ranges of target through intensity of sound received or from character or quality of propeller sounds alone.

If training in this latter procedure brings forth a solution to obtaining ranges by listening only, then echo ranging with its attendant dangers of enemy interception may be dispensed with during torpedo attacks. Two possible methods of estimating ranges through listening only should be developed: -- first, by audible means, operators should endeavor to estimate ranges through changes in sound intensity or from the character of propeller sounds to be verified by periscope observation when feasible so as to give operators necessary experience and also to check on accuracy; second, by utilizing electrical

means of measuring changes in sound intensity, using the decible meter. Readings of the decibel meter, plotted with accurate periscope ranges, will produce a range-decibel curve. Preliminary investigation indicates that at the beginning of an approach, it will be necessary to obtain an initial periscope (or supersonic) range at the instant the first intensity reading is taken in order to establish a point on the standard range-decibel graph which will give the slope of the curve for sound conditions existing during that particular run. Experience also indicates that intensity of propeller sound is affected by angle on the bow; however, it appears that for angles on the bow normally encountered during an approach (10°to 90°), this variation in intensity does not present an insuperable difficulty. It is hoped that standard range-decibel curves may be established in the near future.

2308. In addition to the use for approach purpose, one of the main wartime functions of all types of sound equipment will be for the purpose of determining of other craft in the vicinity of the target are clear of the approach and attack when they cannot be seen and when limitations of periscope exposures do not permit periodic panoramic views. Intelligent use of sound equipment by well-trained personnel is an important factor in reducing the length and frequency of periscope exposures. Future developments should be with this essential point in view. If at any time it appears to the operating personnel that the equipment furnished by the technical bureaus is inadequate or unsuitably adapted to the needs of the submarine service, it must be remembered that experimental and development personnel cannot progress unless they are kept fully informed of the problem from the submarine end and that there is no closed season against such development within the submarine service itself.

2309. Radio watches submerged with the probable necessity for continuous watch on sound equipment during war patrols by one, or even two operators, require an adequately trained force of competent ratings, exclusive of radiomen, for effective sound work. Accordingly, every opportunity should be taken to discover and develop prospective sound operators. Progressive training should be given all men, regardless of rate, showing sufficient aptitude and ability in sound technique. Experience has proven,a s in gunnery, that after once attaining proficiency by extensive training, sound operators cannot be expected to retain their efficiency without further continuous training.

Section 4
Radar

2401. Two types of radar are at present installed in submarines. Each is valuable for navigational purposes, as well as for their primary purposes. Every advantage of training personnel in radar

material, maintenance and operation should be grasped. Either one or both radars are in continuous operation when the submarine is operating on the surface.

2402. In operating radars due consideration must be given to the possibilities of the SD radar signal being picked up by the enemy. Intermittent use of the SD for 5 seconds at irregular intervals of not more than one minute is considered to be fairly safe procedure. Radars require warming up before being put in operation.

2403. While searching with SJ use power training. When contact is made shift to hand training and develop the contact by obtaining range and bearing. Shift to lobe switching as soon as possible. In applying radar information use both the TDC and plot. When the contact is enemy, develop the contact for attack. Take full advantage of visibility conditions, going to radar depth, when necessary, to avoid detection; and then to periscope depth to deliver the attack when the visibility permits periscope observations. In reduced visibility the attack may be carried out undetected with the submarine on the surface. This is more desirable and more effective than a submerged attack as the submarine retains the advantage of mobility and high speed.

2404. While tracking with the SJ radar make frequent 360° sweeps for other targets. Use the P.P.I.

2405. Success in radar tracking demands excellent interior communications. Frequent drills are required to develop the required standards of communications between the bridge, conning tower and plot. Special emphasis should be given to the instruction of talkers.

Section 5
Operating Procedure -- Submarine Patrol Instructions

2501. The duties of the officer of the deck as prescribed by Navy Regulations are supplemented as follows:

a. Keep the number of persons on the bridge at a minimum, requiring "Permission to come on the bridge" or "Permission to relieve the _____", in each case.

b. Allow only one relief lookout on the bridge at a time.

c. Keep lookouts alert, covering their own sectors, making reports using the proper phraseology.

d. Maintain the passageway to the hatch clear at all times.

e. Keep loose gear off the bridge.

f. The following rules in general apply on contacts:

1. Dive for aircraft contacts (except in friendly patrolled waters).

2. Turn toward a periscope forward of the beam and away from a periscope abaft the beam, going to flank speed in each case.

3. Turn away from small craft.

4. Turn toward a target, diving if necessary to avoid detection.

g. In friendly waters have recognition signals at hand.

h. Carry out the following routine:

1. Blow all sanitary tanks about one hour before diving.

2. Stow 20 mm guns about thirty minutes before diving.

3. Carry out diving procedure as outlined in ship's organization.

4. Run at depth and make periscope exposures as ordered by C.O.

5. When landmarks are available, keep ship's position cut in.

6. In making periscope observations first make a complete sweep in low power for aircraft and close surface targets. Follow this, if all clear, by a slow search in high power.

7. When a target is sighted, start the approach immediately.

8. At sunset "rig for red" below in all spaces forward of the forward engine room.

9. Have lookouts equipped and standing by.

10. Warm up SJ Radar.

11. Carry out surfacing procedure as outlined in ship's organization.

12. Start the evening routine after surfacing and after having received permission from the C.O. This normally consists of starting battery and air charges, pumping bilges, blowing sanitary tanks, dumping trash and garbage and rigging 20 mm guns.

2502. Keep the ship compensated at all times.

2503. The ship's organization should contain in detail instructions for all men on watch below decks.

2504. During daylight surface cruising keep one torpedo forward and one torpedo aft set to run at forty feet. (Reset to ten feet at night and alternate torpedoes which are set at forty feet). The O.O.D. shall at all items keep himself informed of condition of the tubes and those set at forty feet.

2505. Take full advantage of smooth weather, long periods of submergence, etc., for servicing torpedoes, overhauling and checking equipment, upkeep, greasing routine, etc.

2506. Even during long patrols, a smart ship will maintain high standards of cleanliness.

2507. The following are considered sound practice:

a. When surfacing with high pressure in the boat, close the lower conning tower hatch. The upper hatch can be opened as soon as the bridge breaks clear and the bridge manned. When pressure is equalized by the low pressure blower, open the lower conning tower hatch.

b. When cruising on the surface at too high a speed to have sound heads lowered, one sound gear flood valve can be left open and the sound gear manned to listen for "pingers". Pings are often picked up before sight contact is made.

c. Operation of one distiller twelve out of each twenty-four hours should provide sufficient fresh water.

d. Cut bridge watches short in bad weather.

e. Don't neglect greasing top side fittings periodically.

f. Don't fight it out on the surface with an armed enemy, unless you can stay out of the range of his guns.

g. Demand perfection in all dives and in maintaining depth control.

h. Take every precaution against taking heavy seas down the hatch. It is sure to cause a lot of damage and may put a great deal of valuable equipment out of commission. This precaution should especially be taken when surfacing in a heavy sea.

i. Pay especial attention, on patrol, to the galley, the quality of food, the cleanliness of all compartments and the cleanliness of personnel.

j. Require a smart, alert watch at all times.

k. When using the SD radar in enemy waters, turn on and off at irregular intervals, leaving it on 5 seconds and off 40 to 70 seconds.

l. Check the T.D.C. Daily by running a check problem.

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Chapter III

Section 1
Tasks
General Considerations

3101. The following expression of doctrine for all tasks covered pre-supposes:

a. That it may be modified by the issue of orders.

b. That it may be materially affected by varying and unanticipated conditions.

c. That all commanding officers appreciate the importance of information of the enemy and exchange of information relative to own operations, and that the making of contact reports, whenever possible, will be automatic.

d. That all commanding officers will be thoroughly acquainted with their mission in each situation and will, therefore, realize that a course of action which will further the accomplishment of one mission may not be the proper one under different circumstances.

e. That the importance of accurate navigation is obvious and that contact reference points used will be those most likely to locate the enemy.

f. That all concerned are familiar with the limitations of submerged operations, both in time and in area covered.

3102. Commanding officers must realize that the nature of submarine tactical operations places upon them greater responsibility and presents to them greater opportunity for exercise of initiative than is accorded commanding officers of other types; and that the responsibility for maintaining touch with their immediate or other designated tactical superior is correspondingly increased.

3103. The nature of submarine operations is such that a submarine commander will be confronted frequently with the necessity of choosing between offensive and defensive tactics. His action may be a compromise as circumstances seem to dictate, but upon his decision will depend largely his success in damaging the enemy and in preserving his own ship. In other words, he must weigh the probable damage resulting to the enemy against the probable risk to his own vessel. If there is a reasonable chance of inflicting serious damage to the enemy, duty requires that extreme risks be taken. On the other hand it would be folly to hazard ship and crews in an attack upon an unimportant enemy vessel whose destruction could little affect the issue. Prompt and correct decision in such cases can be attained only by self-training carried to the point of making decisions and action a simple part of the day's work.

3104. Particular consideration must be given to communications. Important information and directives will be passed to submarines on prearranged radio schedules.

Section 2
Procedure When Operating in Connection With Fleet Dispositions

3201. The accepted doctrine that submarine operations may be coordinated with, but not closely combined with those of surface craft, is the primary reason why no positions are prescribed for submarines in fleet approach, contact, and battle disposition. The duties and operations of submarines in connection with the destruction of enemy heavy ships are the same whether they are operating with the fleet or organized as independent units. When operating with other organizations in war, the duties of submarines must include the observance of certain precautions that are necessary in order to avoid being treated as hostile by own forces. At sea, submarines avoid passing through own fleet dispositions, surface or submerged. If through breakdown or casualty, passage on the surface through own fleet cannot be avoided, the submarine should be escorted a surface vessel and all task forces promptly informed. Even though in proper position or on assigned stations, submarines must be alert to the possibility that own surface vessels, aircraft and submarines may mistake their identity. If on the surface when units of own fleet are sighted under circumstances where visual recognition methods may not be effective within sufficient time, submergence is resorted to in order to avoid detection by them. When submerged, identification, if necessary and warranted by the circumstances, may be established by the use of underwater sound equipment or by recognition signals from the submerged signal gun. It may be expected that a submarine will never emerge in the vicinity of friendly surface craft except in an emergency, without first establishing its identity.

3202. When the fleet is in the approach disposition, submarines organized as a task group shall maneuver to reach favorable attack position undetected, at which time the doctrine for coordinated attack becomes effective. In order to orient position to take care of changing situations, submarines will remain on the surface, if practicable, until contact is made. During fleet approach formations, the submarine unit will usually be disposed well in the van of own main body, probably in a scouting line formation dependent upon information of the enemy fleet. If movements of the enemy have been determined sufficiently well for the submarine unit commander to plan a coordinated attack, the submarine unit will be maintained in a compact formation to provide for rapid communications. Deployment of submarine unit will be made as early as practicable, but it may be anticipated that absence of information will necessitate that deployment be accomplished only a short time before actual contact, necessitating the use of maximum surface speed in attaining position. The success or failure of submarines to reach favorable attack position during fleet approach may depend on whether or not enemy aircraft are encountered. A single plane sighted (friendly or hostile) will normally be sufficient cause for a submarine to avoid detection by submerging. Under the conditions of imminence of contact with the enemy main body, this will be influenced not so much by the vulnerability of submarines to air attack as by the loss of their primary asset, the surprise element. If their presence and position becomes known, enemy forces may be maneuvered to avoid contact. To overcome aircraft interference with the submarine surface approach, an escorting force of surface or aircraft, or a combination may be successfully employed under some circumstances. In order to effect an advance, taking full advantage of available surface speed, submarines may cruise with own battle line during daylight, breaking

off during darkness to gain attack positions ahead.

3203. There are no prescribed positions for submarines in fleet contact dispositions. By this time they have already concluded their attack or have abandoned it, and by doctrine, will have started trailing or taking up positions which may permit attack during the enemy's retirement. Contact scouting by submarines, if opportunities for such are presented, during approach and contact dispositions may be of tremendous value to the O.T.C.

3204. There are no prescribed positions for submarines in fleet battle dispositions unless, under special circumstances, they are previously disposed for use as an anvil. If the submarine attack has not been executed before the battle starts, submarines should seek

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positions ahead of the enemy battle line or in areas through which the enemy may be expected to pass. Otherwise, they should trail the enemy battle line in order to take advantage of any favorable change of course or to complete the destruction of disabled enemy heavy ships. If they find themselves in the immediate vicinity of a night engagement, the correct procedure for submarines is to resort to deep submergence.

3205. For tactical formation and the attack doctrine, see Chapter IV, section 10.

Section 3
Patrol

3301. Patrol operations may be ordered to accomplish one or more of the following missions:

a. To attack enemy lines of communication in a particular area or along a particular route or line.

b. To blockade an enemy coastline.

c. To establish control of a sea area.

d. To protect a fleet in an exposed anchorage.

e. To conduct an observation patrol.

3302. Ordinarily, patrol will involve offensive action. Depending, of course, on the area to be covered, the disposition of submarines should be such as to permit as many as possible to deliver attacks. In some situations, a coordinated attack plan may be desirable.

3303. Because of the difficulty of two-way identification, friendly surface vessels and aircraft ordinarily should not be assigned to patrol the same area with submarines.

3304. Patrol against enemy lines of communication includes the destruction of commerce. It may be expected that the convoy system will be used, especially at focal and terminal points. On the high seas, circuitous routing will be employed. The torpedo is the major weapon in these operations, as the submarine is not equipped with gun power to equal that which may be expected on modern merchantmen. The submarine gun may be employed against vessels known to be unarmed

or small vessels of minor resistant qualities. Operations in the vicinity of focal and terminal points will produce more targets, but the intensity of anti-submarine measures will also be increased. The principles of the submarine attack against commerce do not differ from those used against other types of vessels. Submarines operate singly in assigned sectors on the edge of focal and terminal areas and furnish information of enemy shipping to other submarines similarly employed. Submarine positions should be shifted frequently to cover variations in shipping routes as well as to evade concentrated anti-submarine effort in areas of operations discovered by the enemy.

3305. Operations in opposition to a joint overseas advance:

a. In opposing an overseas advance, submarines may be employed profitably in attrition operations against the enemy force during passage and in attacks at or near its destination. The physical objectives may be either combatant ships or auxiliaries. Of the latter, transports are especially valuable targets.

b. In such activities, submarines may work entirely unsupported, but their value will be increased if supplied with information by other forces or if the operations of other forces are coordinated with those of submarines.

c. Submarines operating unsupported or unassisted by other forces will have to locate the enemy first, then obtain positions ahead, concentrate, and attack. Search patrol, or observation is required for the first phase. This usually can be done best near the probable destination of the enemy because of the reduced area to be covered. However, the ideal method is to trail the enemy from his point of departure, and, from information supplied by trailing submarines, concentrate attack groups ahead along his assumed course.

d. A very probable type of combined operation will consist of cooperation between patrol planes and submarines, the former furnishing information upon which the latter may proceed to attack positions. The doctrine for such a combined operation is contained in Submarine and Patrol Plane Inter Type Tactical Bulletin.

Section 4
Scouting

3401. The object of all submarine scouting operations is to gain information of the enemy and transmit such information to the O.T.C. with the utmost dispatch.

3402. Since they are able to operate unsupported by other forces, submarines are valuable scouts in distant waters or in waters which are under enemy control. However, in waters patrolled by enemy submarines, or when within range of enemy planes, submarine scouts must remain submerged for protection during daylight. When restricted by such conditions, the area covered by each submarine scout is necessarily small, and communication except during darkness is limited to that obtainable with the vertical antenna, which has an effective range of about 100 miles. When on the surface, radio communication range of submarine is comparable with that of surface vessels.

3403. The scouting distance for submarines on the surface should be not greater than 20 miles and that for submarine submerged should be not greater than 12 miles. It is highly probable that submarines will have to conduct a submerged patrol during daylight hours unless own forces have control of the air.

3404. Unless otherwise ordered, submarines engaged in scouting operations communicate as directed in Article 3104. A relay vessel will be stationed in rear of the submarine scouting line when circumstances warrant.

3405. If possible, contact with enemy surface forces should be maintained until the mission is accomplished or until ordered

otherwise.

3406. Formation, deployment, and maneuvers of the submarine scouting line will be conducted in accordance with the General Signal book, and this Doctrine.

Section 5
Screening

3501. Submarines that can maintain fleet speeds may on occasions be employed for distant screening operations, the object of which is to protect the screened force by warning of approaching enemy forces and by offensive operations against them. Enemy air activity will serve to minimize the possibility of this type of employment.

Section 6
Mining

3601. The operations of a submarine mine layer are entirely defensive if only mines are carried. The submarine may be assigned to observation tasks or to offensive roles, if provided with torpedoes in addition to mines.

3602. Mining operations may be classed as tactical or strategical. Tactical mining consists of laying mines in the presence of the enemy, as in planting mines across the entrance of a harbor in which the enemy is located. Strategical mining consists of planting mines in areas not at the time occupied by the enemy, but in which he is expected to operate at some future time. If surface mine layers are available, they should be used for strategical mining where practicable and submarine mine layers should be conserved primarily for tactical mining.

3603. In the case of mining, accurate navigation is especially important in order that mines may be planted in the exact location desired.

3604.

a. Submarine mines should be planted with the following considerations in mind:

    1. A mine plant should consist of more than one field.

    2. Each field should contain a different number of mines.

    3. Mines in each field should be planted at irregular intervals.

    4. Mines should not be planted in a continuous line.

b. The extent of any one mine field should be limited to 10 or 12 mines, unless conditions make a larger field imperative.

c. Mine plants in shallow water of from 100 to 150 feet should be made during darkness to prevent discovery by aircraft. Plants made in depths over 150 feet can be made at any time as observation by aircraft at such depths is

extremely unlikely.

Section 7
Reconnaissance

3701. Observation and reconnoitering are special forms of scouting confined to specific areas. Bearing in mind the value of negative information, the object is the same as in all other scouting operations; namely, to gain information of the enemy without being detected. The submarine is especially valuable for these purposes because of its ability to remain unsupported for long periods in waters under enemy control.

3702. Submarines are capable of performing three the following[*] types of reconnaissance missions:

a. Visual reconnaissance through the periscope.

b. Photographic reconnaissance through the periscope.

c. Reconnaissance by landing party.

d. Radar frequency reconnaissance by search receivers.[*]

3703. The object of reconnaissance is to obtain all possible information concerning the locality under observation. This includes weather, navigational and hydrographic information, terrain, quantity and quality of defense installations, numbers and disposition of troops, or other specific information requested.

a. Periscope visual reconnaissance can be conducted at any time during daylight unless strong anti-submarine measures are encountered. The report of the reconnaissance should include a complete description of all important items observed and panoramic sketches of the locality showing the location of the major points of interest.

b. Periscope photographic reconnaissance is employed to supplement visual reconnaissance and to supply better information on the locality than can be shown on panoramic sketches. In addition, it is oftentimes possible to pick out items on a photograph that are invisible to the eye. Submarines will develop the photographs and supply immediately a fair interpretation of important objects that stand out in the photographs. For a complete and comprehensive interpretation of the photographs, they should be delivered to a regularly established photographic interpretation unit.

c. Landing party reconnaissance will be conducted at night by men sent ashore in rubber boats. These boats come in several sizes and hold from four to twelve men. They are charged with CO^2, four propelled by outboard motors or paddles, and constructed of tough fabric that will not tear when driven over coral reefs or rocky ledges. The submarine should approach the landing area as closely as possible, completely darkened and with minimum noise. If it is planned to anchor to await return of the landing party, the anchor should be backed out and arrangements made for slipping the cable if necessary. The landing party may be sent ashore and retrieved the same night or on the following night. The success of landing parties depends largely upon the care with which communications with them from the submarine are arranged. The use of visual signalling, even though blinker tubes are employed, is extremely hazardous except in very isolated areas. Underwater communication gives the best prospect of success. The landing party can be equipped with stethescopes to be placed in the water for listening and with a simple portable electrical transmitting device or with a bell and hammer. A comprehensive plan with all details carefully worked out and with alternative procedures specified should be made up for every

landing operation.

d. Radar frequency reconnaissance, by the use of special receivers and associated equipment, can be conducted for determining the presence of radar stations installed on enemy bases, ships and air-craft. This same equipment can be used as an early warning device, warning of the presence of radar search by the enemy, due to its great range.
RPM 1866.[*]

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* Text in green represents a "pen and ink" interim change.

Section 8
Services to Aircraft

3801. Certain fleet submarines, in which modifications to ballast tanks have been made, are capable of carrying gasoline, lubricating oil, and minor supplies for aircraft. Planes can be fueled underway in the open sea under favorable conditions as well as in protected roadsteads. A squadron of patrol planes can be serviced rapidly and efficiently. Thus, submarines may be used to support seaplane flights to and from outlying points where surface tenders are not available or cannot be maintained. Information as to what submarines are equipped for this service, together with their characteristics, can be obtained from the submarine command.

Section 9
Lifeguard Missions

3901. A new mission brought on by the present war is that known as "lifeguard duty". The main purpose of this mission is the rescue of downed aviators in the vicinity of some enemy position, which has been bombed by a friendly task force. In addition, when inclement weather is encountered in the vicinity of the target, the submarine may also be used as an aid to aircraft navigation.

3902. Important points that will aid any submarine assigned to such a mission are given, as follows:

a. Submarine should ascertain the nature of the mission, the force involved and its disposition.

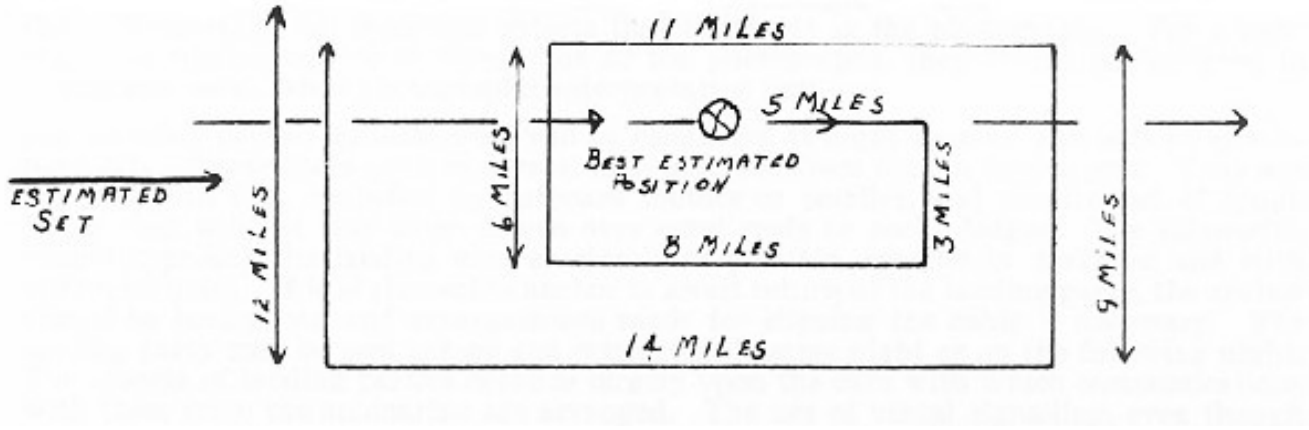
b. Complete and thorough study of the entire operation should be made. Provisions should also be made in case any change or extension of the Operation Order is effected.

c. The voice transmitter set, to be used with aircraft, should be carefully tested and checked prior to departure.

d. Be prepared to furnish accurate navigational information in a simple, abbreviated form to flights of planes during inclement weather.

e. The best searching speed is about 15 knots. However, if numerous white caps are present the speed should be reduced sufficiently to permit the lookouts to cover their areas carefully, since it is difficult to pick up a small yellow raft against a white cap background.

f. A successful method of searching that was used by a submarine recently assigned this type of mission which resulted in the picking up of six aviators is presented. This method is known as the spiral-rectangle method, with the long axis along the extended set.



NOTE--The distance between successive legs of the spiral should be reduced to two miles in rough weather.

g. It is difficult to determine the nationality of a pilot who is wearing a helmet. Therefore, before approaching too close, make the pilot remove his helmet for identification purposes. This may save your personnel from being shot.

h. Remember that life rafts drift faster than submarines when approaching them for recovery. Also, excess backing power will wash the life raft away from the submarine.

i. The rescue party should be kept to a minimum and usually not more than three men are required for recovery. One of the handiest pieces of recovery equipment is a life ring securing to a heaving line.

j. Be sure Pharmacist's Mate knows how to treat "immersion foot" or "immersion leg" in accordance with latest medical instructions. Red Cross survivor kits should be carried as they are extremely useful in cases of rescued pilots.

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k. During night search do not under estimate the distance to a Very's Star. Stars which appear to be three or four miles away have been found to be actually eighteen or twenty miles away. A whistle blown through the megaphone from bow to bow during night cruising may be of assistance in awaking a pilot on a raft and, thus, allow him to fire a signal light.

3903. It must be remembered that even though our air groups are striking enemy air bases, the enemy will undoubtedly have some aircraft available and will attempt to strafe or bomb submarines employed in this type of mission. Therefore, all lookouts must be particularly alert during this type of work.

3904. Friendly aircraft will be employed as a screen for submarines on lifeguard duty whenever possible.

3905. When a report of a downed aviator is received, the submarine must exert all within its power and endurance to continue the search until ordered otherwise.

3906. A good average to use for drift is 4% of the wind velocity when calculating possible positions of downed aviators.

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Current Doctrine Submarines (USF-25(A))

Chapter IV

Section 1
Attacks -- General

4101. Employment of the principle of surprise is the basic requisite of a successful submarine attack. This essential must be obtained by painstaking attention to every detail of operation that will enable the submarine to avoid being discovered by being sighted, heard, or otherwise located.

4102. The basic attack unit is the individual submarine. Close or rigid formations are not ordinarily suitable for submarine attacks because each submarine must normally maneuver independently to attack.

4103. The objectives of submarine attack are enemy ships and shipping. If a choice is offered, priority is as follows: CV, BB, ACV, AO, any man of war larger than a DD, AP, AK, DD. However, no worthwhile target should be passed up in the hope of securing a better one.

4104. Submarines will attack individual ships of a formation. Only under exceptional circumstances or during a night attack will torpedoes be fired at a formation without using an individual ship target.

4105. Every decision concerning the approach and attack should be based on the assumption that the

enemy suspects the presence of submarines and has taken the following defensive measures:

a. Is zigzagging at moderate to high speeds.

b. Has protective screens of aircraft and surface vessels, the latter equipped with listening or echo-ranging apparatus, or both, and

c. Will maneuver to avoid submarines or torpedoes sighted.

4106. In conducting the approach and attack, use must be made of all facilities furnished. Readiness for every eventuality must be maintained. Even when conducting the approach by periscope, the sound equipment must be in use in order that, if forced to deep submergence, the attack can be completed by sound alone.

4107. Definitions:

a. Approach -- The maneuvers of a submarine to reach a favorable attack position.

b. Attack -- The maneuvers of a submarine after approach to reach a firing position. Attack is concluded by torpedo fire.

c. Retirement -- The maneuvers of a submarine after concluding attack to avoid counter-attack and clear other attack units.

d. Approach course -- The course taken from contact to reach the attack position.

e. Normal approach course -- The course which, at right angles to the bearing of target, closes the range.

f. Attack course -- The course from the attack position to reach the firing position.

g. Firing course(s) -- Heading(s) on which torpedo fire occurs.

h. Angle on the bow -- Relative bearing of submarine from the target ship measured to starboard or port from the target ship's head from 0° to 180°.

i. Track angle -- The angle at the point of intercept between the target ship's track and the reversed direction of the torpedo track. It is measured to starboard or to port from the target's ship's head from 0° to 180°.

j. Sight Angle -- The angle between the bearing of the target at the instant of firing and the

torpedo track. Sight angle is not used as such in submarine torpedo control, but it should be understood for a full understanding of other terms.

k. Correction for parallax -- An angular correction applied to calculated sight angle in angled shots to compensate for the error due to the separation of the torpedo tube from the periscope. In firing on sound bearings, parallax is the angular correction applied to compensate for the error due to the separation of the torpedo tube from the sound receiving instruments combined algebraically with the angular correction applied to compensate for the error due to the distance between the center of the target ship and the propellers thereof, and the angular correction caused by the movement of the target while the propeller sound is traveling to the sound receivers.

l. Correction for advance and transfer -- An angular correction applied to a calculated sight angle in angled shots to compensate for the advance and transfer of the torpedo in turning to its final track.

m. Gyro angle -- An angle applied in the mechanism of a torpedo gyro before firing which causes the torpedo, immediately upon launching, to turn through an angle and steady on a course differing from the direction of the torpedo tube axis at the moment of firing. Gyro angle is referred to the axis of the submarine, measured from 0° clockwise through 360°.

Examples:

	Gyro Angle
Straight shot from bow tube	0°
Straight shot from stern tube	180°
90° right angle shot from bow tube	90°
90° right angle shot from stern tube	270°
90° left angle shot from bow tube	270°
90° left angle shot from stern tube	90°

n. Periscope angle -- The angle between the fore and aft line of the ship and the line of sight of the periscope when the periscope is correctly set for existing conditions. It is the algebraic sum of the sight angle, the gyro angle, the correction for parallax, and the correction for advance and transfer of the torpedo. It is set on the periscope azimuth circle as an angle measured clockwise from the ship's head (0°) through 360°.

o. Salvo -- A number of torpedoes fired from a submarine at small intervals at the same target.

p. Volume of fire -- The number of torpedoes in a salvo.

q. Spread -- A spread consists of a salvo of torpedoes fired to hit at different points along the length of the target or its length extended. There are three forms of spread:

1. Longitudinal spread. A pattern formed by firing a succession of torpedoes along a practically identical track. The submarine steers a constant course and uses the same periscope and gyro angles, but fires at different points of aim on the same target.

2. Divergent spread. A fan-like pattern formed by a succession of torpedoes fired at the same point of aim but with gyros set to such angles that torpedoes cross the target track at different points. This is not to be confused with the change in gyro angles necessary to make all torpedoes of a salvo hit the target at the same point.

3. Parallel spread. A pattern formed by firing torpedoes simultaneously from bow and stern tubes with gyro angles set so that the torpedoes run parallel.

r. Spread angle is the additional gyro angle, over that required for hitting the same point of a moving target, set on the torpedo to make any type of spread.

s. Advance is the perpendicular distance between torpedo final course and a line through the tube muzzle parallel and in the same direction as the torpedo final course.

t. Intercept Point is the intersection of torpedo and target tracks.

u. Large parallax exists when the advance of the torpedo is opposed to the general direction of the target's course.

v. Small parallax exists when the advance of the torpedo is in the same general direction as the course of the target.

w. Submarine speed is the speed through the water as determined by underwater log. (Those submarines which have no underwater logs determine their speed in accordance with definition in F.T.P. 183).

Section 2
Initial Contact

4201. When the first knowledge of the near presence of the enemy is obtained from a contact report, proceed to attain a position ahead of, and out of sight of, the ship or force (including any screens) reported. Proceed on surface as long as it can be done without discovery by ship or plane. If unable to reach a position ahead of the enemy, take up one in an area he is expected to pass through or one astern, where he may be attacked, if he reverses course.

4202. To avoid discovery by an aircraft screen, the submarine should dive when from thirty to forty miles ahead of a large force. (See Article 1122).

4203. When smoke, a ship, or a force is sighted, the first action of the submarine should be directed toward avoiding being sighted. Determine the direction of movement of the ship or force sighted and proceed at once to gain a position ahead for attack. Establish the hostile nature of the force contacted as soon as practicable. Do not abandon the attack until it is clearly evident that an attack position cannot be reached.

4204. Endeavor to make a contact report if other submarines are in the vicinity, but in doing so, do not jeopardize the success of the attack by operations which may lead to discovery unless the primary task is information.

Section 3
Approach

4301. During the approach, the task of the submarine is to gain undetected and without delay, a position ahead of the enemy.

4302. The above requires the use of aggressive tactics -- tactics in which, consistent with remaining undiscovered, speeds and courses are promptly taken that will most quickly and most surely place the submarine in position for a successful attack.

4303. During the conduct of the approach, the problem of avoiding discovery by enemy surface vessels and aircraft is a major consideration. It is therefore necessary that the following precautions be given the most careful attention:

a. Avoid sound screens, if possible, or penetrate them by use of tactics outline in Chapter V.

b. Run deep between periscope exposures or when making high speed in order to avoid detection by aircraft.

c. Expose periscope at slowest practicable speeds only, using minimum exposure of periscope compatible with sea conditions and reducing time and number of exposures as much as circumstances will permit.

d. Use silent running speeds in vicinity of sound screens.

e. Exercise extreme vigilance to guard against oil and air leaks.

Section 4
Operating Procedures to Avoid Detection

4401. The following procedures cover cardinal principles for effective periscope handling when it is necessary to avoid detection from that source:

a. Consistent with condition of the sea and with possibilities of air patrol overhead, the periscope must be used as sparingly as practicable regardless of the range of the target. Extensive training is necessary to become proficient in making rapid and accurate observations. Frequent time studies by the individual officers concerned constitute the best means of determining this proficiency. In an attack, the situation which usually demands the longest exposure is the last observation just prior to firing and this coincides with the time that discovery is most likely and also most undesirable. However, correct firing bearings are essential to torpedo hits. It is good practice to fire all torpedoes with periscope continuously on the point of aim, correcting the T.D.C. set-up between each shot of a salvo of torpedoes. Periscope should then be housed immediately.

b. After running at high speeds, ample time must be allowed for deceleration before exposing periscope. The periscope should be exposed only at the slowest possible speed. Backing may be used to increase deceleration; do not back longer than thirty seconds at one time as depth control may be affected or the additional wake may be sighted from the air.

c. All periscope exposures should be as brief as possible consistent with circumstances and the obtaining of accurate data, the latter being particularly important at those points considered essential for the speed plot. Two or more brief exposures of less than 30 seconds are preferable to a long exposure. The minimum amount of periscope should be exposed and a change of depth of over one foot should be reported to the conning officer.

d. The periscope should be trained to the approximate bearing of the target before it is exposed.

e. Upon completion of the observation, the periscope must be lowered promptly.

f. Quick panoramic views should be made in low power, followed by a more searching observation in high power when not engaged in the final stages of the attack, particularly when there is a possibility that all ships in the vicinity have not been located.

g. Consistent with sea conditions and circumstances, expose only sufficient periscope to observe efficiently. This becomes increasingly important as the approach progresses. This requires good trim and close coordination between conning and diving control.

h. With our present system and installation of periscope operating switches, periscope exposures are considerably shortened by having someone, other than the observer, operate the periscope hoist control.

i. Observations at three minute intervals or multiples thereof have the advantage of simplifying manual plots, but lose their effectiveness when they are allowed to become restrictive to the approach officer.

j. Periscopes should be run all the way down when in close proximity to screening vessels and when trying to avoid detection from the air.

k. Except when being used by a lookout, periscopes are completely housed when running on the surface and so kept until reaching periscope depth after the diving signal has been sounded. It should be standard practice to house periscopes fully on surfacing as soon as safety considerations permit. It must be remembered that a periscope projecting above the horizon, can be picked up with good binoculars at surprisingly long ranges.

4402. Under current conditions of experience and development, the following procedure has been found most effective to penetrate supersonic screens and to escape when once detected:

a. In the absence of positive information to the contrary, it should always be assumed that enemy vessels, and especially destroyers and light cruisers, are equipped with supersonic echo-ranging and listening equipment.

b. Any screen should be assumed to be augmented by air patrol. If detected by the latter, the

problem of the supersonic screen becomes much simpler.

c. In penetrating supersonic screens or passing through areas covered by patrols so equipped, the submarines should be guided by the following general principles:

    1. Performance of echo-ranging equipment varies with localities and water conditions, being best in deep water with no temperature gradient, current strata, etc., and with a slightly choppy sea. Performance is least effective in smooth shallow water. Water conditions in the particular area of operations should be ascertained by the submarine and full advantage taken of any favorable conditions.

       Other things being equal always avoid a supersonic screen if practicable. The hazard of penetration must be accepted if destruction of the screened vessel warrants. This may be frequently accomplished undetected. In the case of a valuable enemy heavy ship target, an attempt to outflank the supersonic screen should not be made if it jeopardizes the opportunity to drive home the attack, and in this case, penetration of the screen must be attempted at all costs.

    2. Full use of own sound equipment must be made to intelligently avoid or penetrate supersonic screens and patrols. Effective sound range should be determined from predicted sound range tables in order to act intelligently to avoid detection by supersonic screens.

d. When arriving within contact range of the supersonic screen, maintain steady minimum speed with all unnecessary auxiliaries secured. Run with one or both propellers at the silent running speed determined by sound tests. Avoid speed changes. Present smallest possible target by heading toward or away from the screen. Cross the wakes of advanced screens to assist in penetrating inner screen. Avoid using own echo-ranging equipment unless certain that it will not be detected by equipment available to the enemy.

e. If the submarine has been detected by a hostile ship, the need for stealth is at least temporarily non-existent and evasive tactics should be adopted. Detection is usually indicated by steady bearing and high speed of the surface vessel accompanied by strong rapid supersonic signals remaining trained on the submarine.

f. If detection is positively indicated, a quick turn at high speed to a course normal to the enemy may make him miss astern. At this point, own supersonic equipment may be useful for maneuvering to avoid and for confusing enemy signals if they are on approximately the same frequency. If practicable, time the turn so that when it is detected by the enemy, it will be too late for him to follow. Once inside the enemy's turning circle, an escape may be made in the ensuing confusion. Try to keep own and enemy's wakes between the submarine and her pursuers. If known, take advantage of blind spots in his equipment.

g. Extreme depth in itself, unless there are accompanying advantageous water conditions (temperature gradients) at lower levels, is ineffective in escaping a supersonic screen.

h. As soon as the pursuit has been shaken off, proceed as before and attempt to avoid further detection.

i. Depending on the mission and other circumstances that the submarine commanding officer must evaluate, close pursuits may warrant the use of torpedoes against pursuing craft.

j. For avoiding screens and patrols fitted with sound equipment other than echo-ranging, the submarine should make full use of its own listening gear for tracking purposes. Minimum speed, together with hand operation of all possible auxiliaries, is in order under these circumstances. Lie on the bottom if practicable. If located, run at high speeds when the enemy is coming in to attack, and stop and coast when he stops to listen. In the past, deliberate oil slicks and blowing of debris out of torpedo tubes or garbage ejectors has been an effective means of shaking off pursuit.

k. If convoy or heavy ships are present, attempt to get close to them as escorting vessels probably will not drop depth charges near them.

l. A persistent enemy may remain in vicinity 24 hours or longer; therefore, conserve the battery by balancing or bottoming, when practicable.

4403. When exposed to air scouts and patrols, further limitations are placed not only upon the use of the periscope itself, but on maintaining the ship at deep depth by use of slow speed. Early submergence to avoid being sighted on the surface is essential, particularly near basses and ahead of large formations. The chances of the submarine sighting the plane first and escaping discovery by diving is much less when the type of plane to be encountered is fast and small. Patrol type planes, although they have ample speed, are usually visible much farther than small observation planes. Clouds and ceiling may work adversely against visibility from the plane, but there have been instances in the case of large cumulus clouds where planes have been able to hover undetected and observe opposing forces. If mere knowledge of presence is to be a consideration, the fact must not be disregarded that absence of the close approach of the plane does not indicate necessarily that submarine on the surface has not been observed and reported. If absolute security against detection is to be maintained under conditions where it is possible to encounter aircraft, the only safe means of accomplishing this is to remain submerged below 100 feet during daylight hours. Submarines are sighted from planes not only as a result of wakes, slicks, and feathers, but also by sighting the outline of the hull either from the dark green shadow cast or by color contrast

due to growth at the waterline, turbulence and light-colored objects about the ship. Sides near the waterline must be kept free from marine growth. Submarine decks must be kept the same color as the sides in order to avoid a contrast which will facilitate discovery by planes when the submarine is on the surface at night. The larger the submarine, the closer the main deck is to the surface, and the higher the speed the more easily the submarine may be picked up from the air under any condition. In bright sunlight and with smooth sea, submarines are more readily discovered than when it is overcast and the sea is choppy. Unless some obviously poor periscope handling has already revealed the submarine's presence, the aircraft pilot or observer who is particularly adept at picking up submarines usually has his eye first attracted by a small spot of lighter color than the surrounding sea, and this is frequently out of the corner of his eye, as with picking up lights on the horizon at great distances. Under ideal conditions in tropical waters with bright sunlight, submarines can be sighted at depths down to at least 20 feet. The aircraft does not have to pass directly overhead to sight the submarine when the sea is calm. Cloudiness, whitecaps, and more nearly opaque temperate waters serve to reduce possibilities of detection, but there are no conditions under which the submarine can afford to completely disregard care and caution in avoiding menace from the air. Submarine officers should avail themselves of every possible opportunity to observe craft similar to their own from the air under various conditions so that they will fully realize the possibilities of detection under similar circumstances. Any procedure such as flooding tubes through the muzzle doors, which will permit the escape of air bubbles, must be avoided when air patrols are in the vicinity. For successful operations in the vicinity of aircraft, the submarine must be adept at changing from periscope depth to deep submergence, and vice-versa, accomplished in the minimum of time and this minimum at slow speed.

4404. Adherence to the following procedures will reduce possibility of detection from the air:

a. Maintain a keel depth of not less than 140 feet except when it is necessary to use the periscope for observation.

b. Refrain from pumping bilges to sea or blowing heads or sanitary tanks while submerged during daylight. Bilges must be pumped to compensating tanks. Heads should be pumped with hand pumps.

c. Conning officer should make periodic observations through periscope for air leaks.

d. When circumstances permit, go from periscope depth to deep submergence at slow speed using a small angle to avoid showing a propeller wash. If quick deep submergence is necessary, negative tanks should be used.

Section 5
Daylight Attack By Single Submarine

4501. The attack itself commences when the submarine has reached a position within effective torpedo range of the objective and terminates with the firing of torpedoes. The attack should be conducted by aggressive tactics and by employing the same methods used as in the approach to avoid detection.

4502. Whether the attack will be conducted by periscope or sound, or both, will depend upon the weather conditions, type, disposition, and tactics of screens, and number, disposition, and maneuvers of the enemy target.

4503. During the attack phase, the submarine commanding officer must be prepared for any eventuality so that no maneuver of the enemy will deny an opportunity to fire torpedoes. He must be ready to go deep to avoid being rammed, intentionally or inadvertently, and yet be able to fire by sound.

4504. A commanding officer of a submerged submarine must assume that a critical situation exists when he finds his vessel in a sector on either bow of a ship and within such a radius, at the relative speed of approach obtaining, that danger of ramming exists before he can increase depth. In these circumstances, having due regard to distance from enemy track, speed of enemy, estimated time since last change of course of hostile ship, factors affecting the rate that depth can be increased, and any other special conditions, a submarine commanding officer shall not hesitate when he considers it necessary for the safety of his vessel, to go immediately to deep submergence.

4505. Multi-speed torpedoes should be kept set continually to the highest speed which will reach the target under the conditions existing.

4506. Torpedoes should be carried to such a firing position that they may reach the target at the highest torpedo speed setting and with such a short torpedo run that the target cannot avoid the torpedoes, but not so close that the torpedo will not settle to its set depth (See paragraph 4613). This also affords the greatest natural coverage of errors. Since close attack also increases the chances of detection and consequent destruction, the commanding officer must weigh thoroughly the advantages of close range firing as compared with firing at the first suitable target within range of his torpedoes.

4507. The depth setting of torpedoes will depend upon the type and draft of the target and the type of exploder mechanism of the torpedo.

4508. The best time to fire within effective range is as soon after a change of course by the target as the control problem can be worked out.

4509. The best chances of hitting are with small gyro angles.

4510. Small and large parallax shots, when it is necessary to use large gyro angles, or when accurate ranges are not obtainable, present reduced chances of hitting. In addition, small parallax shots from bow tubes and large parallax shots from stern tubes lengthen the attack and thus increase chances of discovery. However, for sound attacks, these forms of fire have certain advantages and also place the submarine in good position to maneuver subsequent to attack.

4511. Track angles will be chosen to provide the best chances of hitting, considering the amount and direction of the most probable errors in estimating enemy courses and speed and the probable maneuvers of the target to avoid, and to afford a firing position best protected against discovery or ramming, and best calculated ot facilitate escape.

4512. The minimum spread used should cover at least 80% of the target length.

4513. Firing torpedoes on different tracks to hit the same point of a moving target is not considered firing a spread. A spread is fired only when the torpedoes are aimed to hit at different distances from the same point of aim.

4514. In countering change of course of the target just before firing, maneuver the torpedo (by change in gyro angle) or shift from bow to stern fire (or vice versa) rather than maneuver the slower moving submarine. If in firing position, accept the change in track angle and fire on bearing with periscope angle corrected for the new track angle.

Section 6
Tactical Procedures of the Normal Individual Attack

4601. The submerged approach consists of the maneuvers that a submarine makes in attempting to gain most favorable position for firing torpedoes at an enemy target. The attack itself consists of the maneuvers from this point until torpedoes have left the tubes and are on their way toward the target. Once established in the desired scene of war operations, our older submarines are offensively as potent as the newer ones. As long as defensive and offensive surprise rests primarily in submergence, the facilities do not become out of date with submarines as with other weapons of other types. Tube for tube, the older submarines have nearly as much offensive power as the newer ones. With lack of modern instruments, correct procedure is more important in the older types, but it must be remembered that with perfection and installation of modern

instruments the data automatically obtained from them can not be expected to be of increased value unless fairly accurate and correct data are put into the instruments. In contrast to other types of war vessels, the success of the submarine attack is dependent upon the commanding officer alone, provided he is ably supported by his organization and that it is well trained to function and serve his approach and attack methods. Unless the commanding officer of a submarine is an efficient and aggressive approach officer, the submarine is not dangerous to the enemy.

4602. Doctrine, definitions, and some procedures for approach and attack are contained herein. Type procedure is contained in the Manual of Interior Control (F.T.P. 98). Whether for individual or coordinated attack, procedure of the individual submarine is the same, except in the latter case, maneuvers are in some instances more restricted. Current doctrine for submarine approach and attack specifies that this be accomplished aggressively. This means that the approach officer places his vessel in a favorable position for attack at close range undetected and in as short time as possible. This normally calls for a driving in approach where the angle on the bow is small, and assuming the collision course at highest practical speeds as long as it remains large.

4603.

a. Standard commands for torpedo control are essential for the same reasons as other types of standard phraseology and the following are prescribed:

1. "Make ready the (bow) (stern) tubes." This orders all designated tubes flooded and made ready in all respects for firing. Only certain numbered tubes may be designated if desired.

2. Set gyro angle(s) _____ degrees." Specific angles are ordered for individual tubes when necessary. This order is used when ships are not supplied with, or are not using, the automatic or "follow the pointer" angle-setting equipment. The order provides for relative settings being received in the torpedo rooms so that necessity for conversion by the torpedo personnel is obviated.

3. "Set spread angle _____ degrees." this orders spread angle to be set when using divergent spreads on submarines equipped with and using the automatic or "follow the pointer" gyro-setting equipment.

4. "Out gyro spindles." Used when automatic disengaging feature is not installed.

5. "Order of firing (giving numbers of tubes in desired sequence)."

6. "Standby." This is used as the preparatory order for firing and should not be appended by the words "to fire" in order to obviate the contingency that the latter

only is heard and the torpedoes are fired prematurely.

7. "Fire _____ (number of tubes)."

b. On modern submarines the above is varied as follows:

1. "Make ready tubes no. _____".

2. "Set depth _____ feet".

3. "Order of tubes forward (aft) _____".

4. "Gyros cut in forward (aft)".

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5. "Standby forward (aft)".

6. "Final set-up".

7. "Final bearing".

8. Fire one" etc.

c. It is important to avoid confusion that, during the approach and attack, a definite order is followed in which the ship's head, target bearing, angle on the bow, range and other attack data are given.

d. Observe gyro angles closely. Keep the C.O.informed of gyro angles. when gyro setters are energized get a mark between T.D.C. and torpedo room.

e. Check "gyro angle set" lights prior to firing.

4604. Doctrine prescribes that when a choice can be made without jeopardizing their effectiveness, the approach and attack are made with wind and sea astern, from direction of the sun, on the side away from the moon, with the target silhouetted against rising or setting sun and on the side least protected by screening vessels. Except for the last which is obvious in itself, these considerations are amplified and explained as follows:

a. With the wind and sea astern, the periscope is more difficult to detect due to little or no

spray and reduced feather and wake effect. Lookouts from enemy ships are not as efficient when looking into the wind. In a heavy sea, more speed will probably be required to maintain depth control, but under these conditions, discovery of periscope wake is almost impossible regardless of speed. In cases of extremely heavy seas or long ground swells, the commanding officer must give consideration to whether or not the attack is best executed from periscope depth or on generated bearings or by use of sound equipment from deep submergence.

b. If the sun is behind the periscope and at an altitude of 45 degrees or less, the bright sun outlines the enemy more clearly and estimation of course and speed are favorable to the submarine. Also, under these conditions, the periscope is most difficult for enemy lookouts to detect when looking directly into the sun.

c. During low visibility, the periscope is usually most effective in low power with the conning tower darkened. If attacking submerged during twilight, better vision is obtained when looking in the direction of the moon or of the sun just before rising or after setting.

4605. When on war patrol, it is standard procedure to carry all torpedo tubes loaded with torpedoes fully ready. Torpedo fire-control facilities should be kept in the state of readiness compatible with that of the torpedo armament itself. The tubes themselves are prepared for firing with the exception of flooding and opening impulse air stop valves. Current doctrine prescribes that at night or in low visibility during daylight, except when conducting training exercises at sea, all tubes in each nest are kept fully prepared for firing except flooding the tubes and opening outer doors (see paragraph 1131). Depth setting should be as required for the expected target, and gyro setting should be on zero with spindles disengaged except for those ships which have automatic retracting devices. As soon as conditions permit, torpedoes which have been in flooded tubes should be withdrawn and inspected, after which, they are again sealed in the tubes. At least one complete reloads of "fully ready" torpedoes is maintained in the racks with remaining torpedoes in an advanced stage of adjustment. After and extended war cruise, all unfired torpedoes will be taken to the base or tender for examination and adjustment. Submarines will, in all probability, be loaded from the base or tender with a minimum of "fully ready" torpedoes sufficient to load all tubes. "Fully ready" torpedoes must be checked in accordance with current instructions.

4606. At all times tube control stations necessary for firing are manned, and it is normal procedure to have them combined with the ship control stations.

4607. The organization for battle stations submerged provides adequate personnel to perform the following duties:

a. Supervision and preparation of tubes for firing.

b. Setting of gyro angles and spreads as directed by control.

c. Setting of torpedo speed and depth as directed by control.

d. Venting of tubes inboard where poppet valves are not installed and preparation to fire by hand should this become necessary.

e. Making final last minute adjustments to torpedoes in racks in order to be prepared to perform reload expeditiously after firing.

f. Manning of all sound equipment which can be used in the approach with best talent available.

g. Rapid and infallible interior communications.

4608. Standard procedure provides a control organization capable of obtaining data for conducting the approach and attack and determining the torpedo firing data. Personnel of the organization are so trained that they can interchange positions and duties. This serves the dual purpose of providing for casualties and to enable the control party to function more intelligently by virtue of being able to visualize the entire picture of the approach and attack. Duties of individuals of the control party will vary according to the type of control equipment provided and the number of officers available. The following are essential functions of the control party:

a. Observe screening vessels briefly for the purpose of avoiding them and observe the target to determine bearing, range, angle on the bow and estimated speed and, on occasions, to note changes of target course.

b. Determine target course; distance off target track; range; various combinations of own course. Track angle; and gyro angle for situations existing, anticipated, or planned; expected target range and torpedo run; and spread angle.

c. For the particular attack and target, determine volume of fire, whether or not divided fire is in order, torpedo speeds and depth settings, track angles, gyro and spread angles, torpedo run and identity of target if silhouettes are available.

d. Determine firing intervals, firing bearings, speed corrections for depth, parallax corrections, and sound firing bearings.

e. Operate periscope control switches as directed by the approach officer. Operate battle order transmitter and firing key.

f. Transmit orders and record data and times primarily for plotting purposes.

g. Utilize sound equipment to fullest advantage to obtain target data and to avoid screening vessels.

4609. Normally the control party comprises the following:

a. The commanding officer, as approach officer, stationed in conning tower or control room at highest periscope.

b. Executive Officer as assistant approach officer.

c. One officer as T.D.C. operator.

d. Engineering officer as diving officer maintaining depth control.

e. One officer as Mk. VIII angle solver operator and assistant on T.D.C.

f. One officer to maintain the plot.

g. One officer in each torpedo room. (If available).

h. Radar operators, talkers, fire controlman, recorders, sound operators, as required.

4610. The following items of control apparatus and aids have been developed to expedite calculations and minimize errors in the solution of the mathematical computations incidental to the approach and attack:

a. Submarine attack course finder.

b. Mark 1 angle solver (for straight shots).

c. Mark 6 and Mark 8 angle solver.

d. Torpedo data computer.

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e. Tube nest indicator.

f. Periscope stadimeter and telemeter scale.

g. Periscope stabilized azimuth.

h. Range-keeper.

i. Telemeter range table or slide rule lor range omnimeter.

j. Distance to track table (or slide rule).

k. Azimuth line--speed table.

l. Spread tables.

m. Voge diagram.

n. Speed--distance--time tables.

o. Speed correction tables for depth.

p. Firing interval table.

q. Stop watch.

r. Plot.

s. Speed vs. RPM and draft tables of enemy's vessels, if available.

t. Parallax tables for sound firing except on ships equipped with sound bearing converter.

u. Submarines equipped with Torpedo Data Computer and automatic gyro setting--Target bearing transmitter for firing straight or curved shots in surface condition at night or during reduced visibility. Other submarines--night pelorus.

v. Sound equipment.

w. Radar.

All, or only a portion, may ber available to the individual submarine, depending upon type, space, and personnel available. It is categorical and it must always be borne in mind that most

instruments, including the modern automatic ones, are dependent upon estimated data and such instruments in themselves cannot rectify personnel errors. For the successful approach against unfamiliar targets, the seaman's eye still remains a most valuable adjunct and the experienced approach officer will instantaneously detect any significant errors in his final setup.

4611. The above instruments and aids are used to determine and apply the following information obtained from periscope observations, radar, or sound equipment:

a. Bearing of target, by periscope observation, radar or sound equipment.

b. Course of target, by estimated angle on bow, relative and true bearing of target, using attack course finder.

c. Range to target by periscope telemeter or stadimeter, radar, or echo ranging.

d. Speed of target by plot, either manual or automatic. Speed estimates by plot are adjusted or confirmed by estimation of bow waves and stern wakes, smoke, and general knowledge of tactical situation and type of target. RPM turn counts determined by sound operator, although not to be used conclusively, are valuable in assisting estimations of target speed and changes of speed. The range-keeper and torpedo data computer are of value in assisting speed estimate by analyzing changes in range and bearing of target. Estimating speeds from other vessels in formation may be useful, but must be used with

caution. If enemy system of visual speed indicators is observed and analyzed, circumstances permitting, this information should be disseminated to other submarines liable to make contact.

e. Distance off track tables or slide rule entered with angle on bow and range.

f. Volume of fire and depth setting of torpedoes, determined by circumstances guided by doctrine, advisability of divided fire, type of target, type of exploder.

g. Point of aim, rifle principle at center of target for close range, periscope firing when data can be expected to be accurate and discovery has not caused target to maneuver to avoid. Spread when, and in manner, called for by the specific situation under other circumstances.

h. Spread angles, determined from spread tables with entering arguments of torpedo run and difference in gyro angles.

i. Firing interval, determined from firing interval tables which are gyro angle tables for firing salvos with proper interval when torpedoes are all fired to hit the same point of aim, or firing interval diagram.

j. Torpedo speed correction for depth, determined by table or diagram.

k. Track angle, determined by attack course finder or torpedo data computer.

l. Gyro angle for desired track angle, determined by attack course finder.

m. Predicted run of torpedo, estimated from plot or determined from Mark 6 or Mark 8 angle solver.

n. Periscope firing bearing, determined by angle solver or torpedo data computer.

o. Sound firing bearings, periscope firing bearings as obtained, corrected for parallax of point of aim and propeller sounds and offset of sound projector from periscope by parallax tables or computed by the sound bearing converter or torpedo data computer. Sound bearing converters eliminate necessity for use of parallax tables.

p. Generated firing bearing, continuously determined by torpedo data computer for either periscope, radar, or sound firing bearing. In ships fitted with torpedo data computer and tubed nest indicators, the gyro angle, track angle and torpedo run are continuously being computed for the existing situation of bearing of target, range of target, own course and speed, and enemy course and speed. The computed gyro angle is set on the torpedo continuously either automatically or by follow the pointer, spread angles being superimposed as desired.

4612. Doctrine prescribes use of the highest torpedo speed which will reach the target under conditions existing. The only conditions when lower speed settings would be used are against large formations when it is seen that it is impossible to close to favorable attacking position, and against anchored targets when conditions prevent closing to short range, and on torpedoes prepared for circular run. High speed is essential in a torpedo in order to reduce the time required to cover the distance from submarine to target; the higher the speed, the less time elapses, and consequently the target has less time to maneuver to avoid. Submarines firing by sound from deep submergence and using Mark 6-1 exploder mechanisms should set torpedo depth to hit target.

4613. Current doctrine for approach and attack provides that the latter be executed at the shortest possible range consistent with chances of discovery, insuring that torpedoes are at set depth, to take advantage of greatest coverage of errors, and to permit target least time to maneuver to avoid

torpedoes, or ram. With marks 10, 11, 14, and 15 torpedoes and modifications, and with Marks 3, 4, 5, and 6-1 exploder mechanisms, this minimum range is currently 500 yards.

4614. The volume of fire will depend upon the importance of the target, its life in torpedo hits, whether a spread is necessary, the type of torpedo fire, the number of tubes installed, the supply of torpedoes on hand or available at the base, and whether reduction in strength

or reduction in speed of the enemy is desired. Sufficient torpedoes should be fired to destroy or seriously cripple the enemy ship. Serious damage to one ship is generally preferable to moderate damage to one or more. If necessary to fire at other than an individual ship target, shoot all loaded tubes. The following table is to be used as a guide:

Target	Life In Torpedo Hits	Required No. Torpedoes To Insure Sinking Target. 50% Hits With Spread	Recommended Volume of Fire With Spread
BB, CC	7	14	10 (all tubes)
Large CV	5	10	10
Small CV	3	6	6
CA, Large CL	3	6	6
AV, Large Aux., Med. CL, Merchant, Small CL, Small Aux.	2	4	3 or 4
DL, DD	1	2	3
SS	1	2	3

NOTE:--The above table is simply a guide and is in no way mandatory. It is the opinion of most submarine officers that any combatant ship is worth a full nest torpedo salvo. It is also a known fact that in areas normally low in ship contacts, a submarine is justified in firing sufficient torpedoes regardless of target to cause a sinking. In like manner, in an area where targets are known to be numerous Commanding Officers must use their torpedoes with discretion and care in order to inflict the utmost damage to the enemy.

4615. Volume of fire is subject to considerable variation due to circumstances. Expected life of prospective target in torpedo hits is a variable quantity, depending on where hits are made--in

machinery spaces, in vicinity of propellers, under magazines, whether ship is cruising or at anchor, how unexpected the attack, etc. Serious damage to one target is preferable to moderate damage to two or more. Some circumstances, particularly just before main engagement and if the attack is close enough to be certain of success, may dictate divided fire in an effort to reduce speed of the entire unit. Some circumstances, for example, a coastal patrol submarine with rare opportunities for attack, might demand firing a full nest of torpedoes on a spread at an enemy submarine approaching one of our main bases. On the other hand, if circumstances indicate the necessity of conserving torpedoes for probable future contacts with primary objectives, minimum expenditures or none at all may be made on secondary targets. In other words, current doctrine with regard to volume of fire may be modified by:

a. Whether primary objective or not.

b. Whether primary objectives are definitely out of reach of attack.

c. Special importance of target for political or economic reasons.

d. Number of targets available.

e. Number of torpedoes remaining for reload.

4616. When using Mark 3, 4, and 5 exploder mechanisms, torpedoes are set to hit below the armor belt of armored targets. In absence of specific information regarding the particular target and when using these types of exploder mechanisms, it is standard procedure to set torpedo depths as follows:

a. For BB's, CC's -- 20 feet.

b. For CA's, CV's, large auxiliaries, transports, and merchant ships -- 12 feet.

c. For CL's, small auxiliaries, transports, merchant ships, and SS's -- 10 feet.

d. for DD's -- 6 feet.

With the above exploder mechanisms for night firing, depth settings are kept at a minimum for expected targets unless (and until) target is identified.

4617. When using the Mark 6 exploder mechanism set torpedo depth in accordance with the latest

instructions from the Force Commander.

4618. Selection of straight orr curved fire may be forced by circumstances outside the control of the approach officer. The torpedo, in lieu of the submarine, must be maneuvered to satisfy rapidly changing situations. Straight (or nearly straight) torpedo shots should always be chosen when firing by periscope or generated bearings from recent periscope observations when adequate time and room for maneuvering exist and when required volume of fire is small enough to permit. Target practice results throughout the years confirm the fact that the straight shot is the better shot when feasible. Advantages and disadvantages of straight (or nearly straight) fire are:

a. **Advantages:**

1. Accurate torpedo tactical data.

2. Small likelihood of torpedo course error.

3. Error in torpedo run has little effect on control problem.

4. Length of torpedo run has small effect on control problem.

5. Simple control problem.

b. **Disadvantages:**

1. Requires considerable time and room to maneuver for submarine having bow tubes only.

2. May result in long range shot if restricted as to whether bow or stern nest is used.

3. May require considerable waiting for target to come on line of sight, but less so than with small parallax shots from bow tubes or large parallax, from stern tubes.

4. May permit firing of only one tube nest.

4619. (1) Angled shots should be chosen when:

a. Target maneuvers shortly before firing bearing is reached and it is necessary to change track and allow time for new setup.

b. Circumstances are such that maneuvering for straight or small angled shots would jeopardize or prevent the attack.

c. Firing small parallax shots on listening bearings.

d. When necessary to obtain required volume of fire.

(2) Advantages and disadvantages of angled shots are:--

a. **Advantages:**

1. Permits shortening time for target to come on firing bearing when firing large parallax from bow tubes or small parallax from stern tubes.

2. Requires less time to shift track angle for favorable shot when target makes last minute change of course.

3. Permits firing from almost any position relative to target having favorable track angle.

4. Permits maneuverability for safety while retaining power to strike.

5. Especially desirable for firing on listening bearing.

6. Permits firing both tube nests simultaneously or as nearly so as desired.

b. **Disadvantages:**

1. Complicated control problem.

2. Available torpedo tactical data not too accurate or consistent.

3. Possibilities of torpedo course errors.

4. Allowable error in estimated torpedo run is small for short ranges.

5. Short torpedo run makes control problem more difficult.

(3) When large angled shots are required by the exigencies of the situation, the types chosen which will insure successful, undetected, close range firing of torpedoes so that they will hit the

target. Considering risk of discovery with resultant possible evasive tactics and reduced chances of hitting, the following order is to be favored in choosing large or small parallax shots:

a. Stern tube -- Small.
b. Bow tube -- Small.
c. Bow tube -- Large.
d. Stern tube -- Large.

In general, except when necessary volume of fire requires it, avoid large angle, large parallax shots. This type of shot requires accurate data to hit and is a poor wartime shot for it must be made from a position vulnerable to detection.

4620. Track angles should be chosen to provide best chances of hitting, considering the amount and direction of the most probable errors in estimating enemy course and speed, when such choice does not jeopardize chances of executing the attack. In addition to this, where there is any latitude in the choice of firing position, consideration must be given to possible maneuvers of the targets, position and possible maneuvers of screening vessels, best position to avoid discovery, ramming and depth charge attack, and easiest position from which to start retirement or another attack, should multiple targets be present. In general, track angle less than 90° permit earlier firing and therefore, less chance of being discovered. Track angles greater than 90° give better protection against ramming, afford more coverage of course errors and maneuvers of the target to avoid torpedoes, and facilitate escape. Ninety degree track angles are best for hitting the target when both course and speed have been accurately determined. One essential consideration for submarine torpedo fire is that the torpedo run be the minimum possible down to the 500 yard limitation. Minimum run to target gives minimum opportunity to avoid. Errors in lateral distance at the intercept point increase rapidly with increase in time of torpedo run. For a constant speed torpedo and correct course estimate, the allowable enemy speed error is inversely proportional to the time of torpedo run to target track, or in other words, the shorter the torpedo run, the larger the allowable enemy speed error. The most desirable track angle is that in which the target course is perpendicular to the firing bearing, or in other words, when submarine is exactly abeam of the target. For this optimum track, considering course errors only, some sacrifice is made in that the torpedo run is lengthened, and the greater the enemy torpedo speed ratio, the greater the increased torpedo run. Track angles between 70° and 110° are considered best for all around coverage. However, when in favorable position to fire, adjustments of course or gyro angles for changes in track angles should not be made if they will delay getting off the shot. When they delay getting off the attack, too much consideration must not be given to choice of track angles, particularly on a long target at close range. When distance off track is less than 500 yards, it will be necessary to choose small or large track angles in order to obtain necessary torpedo run. If a choice is permissible, in a heavy sea, choose such track as will permit torpedoes to run parallel to the sea or at right angles to its direction.

4621. Spreads are always used.

4622. The minimum spread should cover at least 80% of the target length. Even this is considered to be small spread, where the range and track are most favorable and the target speed, course, and range are accurately known. This would insure a high percentage of hits under these conditions. Normally these data are not too accurately known and spreads to cover as much as 200% of the target length should be fired, depending upon how well the problem is solved. When using any spread, sufficient torpedoes should be fired to ensure the number of torpedo hits necessary to sink the target.

4623. Parallel spreads can be fired only from submarines having both bow and stern tubes.

4624. Various spreads are fired using the following procedures:

a. Divergent spread is obtained by using spread angle or by swinging the submarine. The use of the latter method is less desirable than the former because of the lack of control and the possibility of missing shots. The divergent spread is simple to accomplish

with modern gyro setting mechanisms. It is more difficult to evade than the longitudinal spread. Divergent spreads require rapid calculation of spread angles which are subject to error unless torpedo run is accurately known.

b. Longitudinal spread is obtained by firing all shots in succession with parallel tracks with the same gyro angle, using different points of aim on the target. Longitudinal spread is the simplest to apply of all spreads and is used principally with periscope firing. An advantage of the longitudinal spread is that spread density is not dependent upon torpedo run.

c. Parallel spreads consist of simultaneous fire from each nest with supplementary and opposite gyro angles. The torpedoes from each nest are separated by the distance between nests plus the sum of torpedo advances. This type of spread is undesirable because of the large gap between the torpedoes from bow and stern nests. A special circumstance might make it useful against two ships of the same formation. Parallel spreads and the reasons for not using them under other than exceptional circumstances, are not to be confused with simultaneous fire from each tube nest with high angle gyros, wherein the torpedoes do not follow parallel courses.

4625. Procedure for tactics of the approach and attack must be based on the assumption, until definitely established otherwise, that the enemy will be:

a. Zigzagging at moderate to high speeds.

b. Protected by aircraft and surface screens, the latter equipped for listening or echo ranging, or both.

c. Ready and alert to maneuver to avoid submarines or torpedoes sighted or otherwise detected.

4626. To await visual contact requires unusual diligence on the part of the lookouts under most conditions of expected enemy alertness. Normally, when in the vicinity of formations and primary objectives, it can be expected that the submarine will be forced down by air patrols long before visual contact is possible. One exception to this, which makes for an ideal situation, occurs in cases of contact at, or just after, dawn if the service of information and circumstances during the night have permitted surface running and enabled the submarine unit to arrive at a position within a few miles ahead of the enemy and close to his probable track. The approach begins with visual contact with the target or advanced screens and continues until the attack starts. The object of the approach is to conduct the submarine, under restrictions of avoiding discovery by judicious use of periscope, speed, depth and course under the principles given heretofore, so that she will arrive at a position ahead of the enemy target. Then, with normal expectations that the enemy will continue his base course, he cannot escape attack if detection is not effected. The submarine then pushes home the attack to a position from which the torpedoes are launched and such that it will be impossible for the enemy target to avoid regardless of maneuvers he may make. The opportunity to make the approach will probably not be given by the enemy if discovery is effected before submergence. On the other hand, the opportunity to make the approach will not be presented unless the submarine reaches a position ahead of the enemy. Hence, a certain amount of judgement is necessary to determine the extent to which surface running can be resorted to in adjusting position. High surface speed works to the advantage of the submarine in these situations. If unable to reach a position ahead of the enemy, correct procedure is to take sup station in an area he is expected to pass through, or to trail so that attack may be made in the event he should reverse course. When endeavoring by running submerged, to reach position ahead to start the approach, unless the target is a primary objective, conserve sufficient battery to remain submerged during the remainder of daylight and to get clear after the attack. During the early stages of the approach, if other submarines are in the vicinity, endeavor to make contact report. In doing so, do not jeopardize the success of the approach and attack by maneuvers which may lead to discovery, unless the primary task is information.

4627. If the first vessel sighted develops to form part of an advanced screen, penetrate or flank it in an endeavor to reach a position astern of the center of the screen.

4628. From this position, the submarine proceeds on the reverse course of the screen until contact with the enemy target is made. If, at this point, enemy course in undetermined, head toward the target

and ascertain whether bearing is changing to right or left. Then, endeavor to gain a position in an area ahead of the target. This is accomplished by first turning about 40° to the side toward which the enemy's bearing is changing. This course is continued at speeds and depths commensurate with the situation until the inner screen, if present, comes into view.

4629. The approach officer determines the enemy course as soon as practicable and, if the angle on the bow is zero, the correct procedure is to continue heading toward the target. If the angle on the bow is 15° or less, head 30° to 45° ahead of the target and continue closing. If the angle on the bow is more than 15°, assume normal approach course in order to get ahead of the target.

4630. With due consideration to enemy's base course and changes of course due to zigzagging, an advantage accrues in reaching position ahead, as quickly as possible under the circumstances, in that during the later portion of the approach and during the attack, slow speeds may be utilized minimizing danger of detection and permitting full use of own sound equipment. In case the inner screen is not patrolling its station, it may be assumed to be a sound screen. If observed to patrol at high speeds, it can be assumed to be most probably not a sound screen. Early differentiation between zigging screens and patrolling screens should be made since this has considerable influence on the conduct of the later stages of the approach and attack.

4631. The amount of high speed running during the approach and attack is influenced by the situation, the remaining power in the storage battery, the remaining hours of daylight, the probable retirement requirements, and the necessity for clearing the area rapidly to get out contact reports. Under normal procedure, these become secondary if the target is an enemy heavy ship, except when information is essential to furtherance of the general plan.

4632. During the conduct of the approach, consideration is given to the desired heading for the attack. If possible, the submarine is steadied on this course before the attack position is reached. Depending on the necessity of penetrating an inner screen, or on the anticipated amount of th next expected course change of the target, a decision must be made before reaching the attack position whether to use straight or angled fire, and in the latter case, whether it will be small or large parallax. This decision is governed by the situation existing, and is influenced by the required volume of fire and whether bow or stern fire is desired or optional. When necessary volume permits, the simplest attack is the normal approach for bow tube fire. Speed up to close the target if it changes course away; cross over and fire with stern tubes if the course change is toward, which course change places the submarine too close to the target's track.

4633. When the predicted run of a torpedo is not accurately known, particularly at ranges under 1500 yards, large gyro angle shots are undesirable. At longer ranges, the error in estimated torpedo run becomes minimized, because the average torpedo speed over the entire run reaches a nearly constant value.

4634. If conditions permit, and in order to avoid firing on a knuckle when using periscope firing,

torpedoes should be fired as soon as possible after the commencement of a new leg of a zigzag. This is most easily accomplished by increasing or decreasing the track angle.

4635. The proficient approach officer is prepared for last minute maneuvers on the part of the target. If the change in course is not too great and a track angle has been selected which gives good coverage for errors, accept the change and fire without change in set-up. When coming in to the attack position, the approach officer should know approximately how much the average expected change of course toward or away will throw torpedoes ahead or astern of the point of aim and adjust the latter accordingly when he finds he is firing on a knuckle, particularly when firing a longitudinal spread.

4636. Submarine approach and attack cannot be conducted under precise stipulations. The enemy movement and his screens, and the varying situation as seen by the approach officer at each periscope exposure, affect the decision as to form of attack and firing range.

Target speed exerts considerable influence upon the tactics of the approach. If known to be of low or moderate speed, the correct procedure is to head for the target and close the range as quickly as possible, commensurate with the distance off the track. If of high speed, the primary consideration is to get ahead and then allow the target to do the closing of the range.

4637. (a) Approaches against targets well protected by surface and air screens may have to be conducted from deep submergence, especially in the latter stages. The approach and attack from deep submergence require the highest degree of coordination between the sound and torpedo control personnel. The best method of attack developed to date is to place the submarine on a course normal to the estimated base course of the target, which is approximately the reverse of the target's initial bearing, and to fire straight shots from the bow or stern tubes as the target passes the submarine's position. Success in this type of attack depends largely on the good judgement of the commanding officer in estimating the target course, speed and range from the information available to him. If good information on the target's speed has been obtained from periscope observations before deep submergence is necessary, the problem is much simplified. The amount of any speed change after deep submergence can be estimated by the change in propeller turn count. It must be borne in mind that no single sound bearing can be considered accurate. Ranges should be taken sparingly and by the single "ping" method. Spreads should always be fired to allow for errors bound to exist in the target's course, speed and range. Correction must always be made for the parallax between the target's propellers and the M.O.T., the parallax between the periscope and the sound receivers, and the change in bearing of the target from the time the sound is generated by the propellers until the torpedo is fired. These corrections are made by the Torpedo Data Computer, Mark 2 and 3 and by the sound bearing converter for vessels equipped with the Torpedo Data Computer, Mark 1.

(b) The approach described in (a) above is not recommended except under the heaviest surface and air escort with the smoothest sea conditions. Under other conditions it is probable that the most likely and successful approach and attack will be made using the periscope carefully and sparingly and running at deep submergence between periscope exposures.

4638. (a) Whenever circumstances permit, after firing one tube nest, the submarine should be maneuvered to fire the other tube nest at the same or another target. The attack should be made if practicable.

(b) Except under most favorable sea conditions, discovery at the time of firing torpedoes is almost inevitable. The submarine must resort to retirement procedure immediately after the attack and so continue at least until the reload is completed. Retirement procedure is a defensive action, but prolonged pursuit or certainly of successful depth charge attack by pursuers may warrant offensive action. Since evidence of the location of the firing point may continue for some time, that particular spot must be vacated immediately. Offensive action should be taken whenever practicable against escorts of such a size as to warrant torpedo fire. This may relieve or reverse a desperate situation. Retain the initiative by staying at periscope depth as long as practicable consistent with reasonable chances of escape. Necessity for prompt transmission of contact reports will also influence offensive action against light screening vessels. Follow the procedure given heretofore for avoiding supersonic and air screens during the retirements. If there is no further possibility of attack on primary objectives and if pursued by supersonic screens, seek areas with temperature gradients, or areas with backgrounds unfavorable for enemy sound detection, if such exist in the vicinity of operations. To escape from air attack alone, run at a safe depth below 100 feet at slow speed and cross wind. Make high submerged speed when propeller and depth charge noises of surface craft are greatest. Take advantage of wakes and under-running ships astern of the target.

4639. Reload all tubes that were fired as soon as practicable, in order to be ready for another attack if the opportunity is presented. If circumstances permit and require it, all reloads should be made below 100 feet. Follow necessary procedure to avoid leaving a bubble wake during the reload.

4640. The best training for proper procedure in the conduct of the approach and attack and in proper periscope handling, is afforded by practice approaches and battle torpedo practices. In addition, the frequent use of the attack teacher[*] and drills of the entire control party in making quick changes in control problem set-ups will be found most valuable in enabling the party to visualize changing situations and to insure rapid and correct new solutions. Use of the attack teacher becomes valueless unless correct procedure in allowing for deceleration and brevity of periscope exposure is followed. Poor technique and bad habit, if allowed to develop in the attack teacher, will be continued at sea. Its use becomes most important when supervised by a capable observer

who offers constructive criticism. The entire control party should be used in the approach at the attack teacher. In addition to its use for approach purposes, the attack teacher is most valuable in developing ability to obtain ranges and angles on the bow with the shortest possible exposures. This is accomplished by using various targets, ranges and angles, and by gradually decreasing exposure length -- timing them with a stop watch.

Section 7
Twilight Attack

4701. A submerged attack, just before evening or after morning twilight or during twilight, may offer excellent possibilities of success, particularly when the target is between the light and the submarine. In such a case, the approach is practically safe from detection. Pains should be taken not to get in too close, since distances usually are over-estimated under such conditions. Light is the determining factor in choosing the side for attack. If the submarine is on the light or unfavorable side upon contact, the submarine should cross the enemy bow if possible.

Section 8
Night and Low Visibility Attacks

4801. When sight or radar contact on a possible enemy ship is made go to stations for tracking immediately. Warm up all main engines and be prepared for flank speed. Track contact and determine his course, speed and disposition. The plans for the attack are dependent upon visibility conditions, time and locality. Remain on the surface, in order to maintain the advantages of mobility, until there is a possibility of detection. When detection is possible, go to radar depth. When target can be seen through the periscope clearly enough to make the attack, go to periscope depth and deliver the attack.

4802. While on the surface take into consideration all manners of possible detection, including silhouette, wake, smoke from engines, etc.

4803. Do not unduly delay the attack. It may be possible to make a series of attacks. Complete enemy convoys have been destroyed by one submarine in a series of attacks.

4804. Submarines have been sighted on bright moonlight nights at 12,000 yards range; and at radar depth submarines have been sighted at 4,000 yards. The possibility of the enemy having radar

must always be considered.

4805. In bright moonlight a target at long range is farther away than is usually estimated; as range decreases it is usually closer than estimated.

4806. If the enemy consists of more than one ship, plot his disposition and endeavor to pick out the escorts, determining the type patrol the escort(s) is conducting. If any of the enemy ships are pinging have sound men keep on pingers. (They are probably escorts).

4807. In case of a contact at low range in low visibility, the O.O.D. Should act immediately in accordance with doctrine. The execution of the attack and diving the ship should be immediately carried out by the O.O.D.

4808. During night surface tracking, approaches and attacks, require lookouts to continue to search **own** sector.

4809. After attack is delivered take evasive action and prepare for further attacks.

4810. It is essential that the commanding officer should have very definite instructions for his officers of the deck and it is imperative that they use their initiative immediately in attack, using straight bow or stern shots where possible.

4811. Sight angles should be made up in advance for several possible conditions of range, track angle and speed, and memorized by the officer of the deck.

4812. Keep the torpedo data computer lined up ready for instant energizing with the following preliminary data:

a. Input own course and speed automatic.

b. Enemy speed 10 knots.

c. Estimated maximum range of visibility.

d. Target bearing set on zero and angle on the bow set on zero.

4813. Keep the announcing system energized with a microphone on the bridge.

4814. Supplement radar bearings with target bearing transmitter bearings.

Section 9
Attack On a Formation

4901. Such attacks generally differ from normal procedure against an individual ship in that there is choice of targets and the necessity of penetrating multiple screens.

4902. The selection of an individual ship as target should be governed by the following directives in order of importance:

a. Choose a ship of the type designated by doctrine or otherwise as a primary objective.

b. Choose the nearest suitable ship, or one in the nearest unit.

c. Choose the leading ship of a column, or a flank ship in line or line of bearing.

4903. Fire at any suitable target rather than fail entirely to fire, provided such action will not frustrate your mission or that of other submarines in the vicinity.

Section 10
Tactical Formations and the Coordinated Attack

41001. These tactics are at present undergoing revision. They will be promulgated at a later date.

Section 11
Retirement

41101. Attack shall always be assumed to result in discovery at the time of, or shortly after, firing and procedure shall be regulated accordingly.

41102. Inasmuch as discovery at the firing point is practically inevitable, submarines must get away from the firing point as quickly as circumstances permit, having in mind that the use of high speed may not be warranted immediately.

41103. Use courses that will most quickly clear the counter-attacking vessels or enable them to be evaded without being detected.

41104. Take full advantage of the enemy wakes.

41105. High speeds should be used when the noise of enemy propellers, and depth charge and torpedo explosions are greatest; slow speeds should be used during periods of quiet.

41106. Utilize listening gear to the fullest extent for keeping track of the enemy pursuit.

41107. Reload all tubes that were fired as soon as practicable, in order to be ready for another attack, if the opportunity is presented.

41108. Keep the initiative as long as possible. At night or when the sea is rough, the torpedo wake is quickly obscured. If air screens are not present, the submarine commanding officer can act most intelligently from a knowledge of the actions of the escorts gained by periscope observations.

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Footnotes

[*. The "attack teacher" was a mock-up of a submarine conning tower and control room, used for training submarine captains and crews at the Submarine School at Naval Base, Groton, CT.]

3101.

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Current Doctrine Submarines (USF-25(A))

Chapter V

Section 1
Defensive Measures -- General

5101. **Basic Defense --** The basic defense of the submarine lies in submergence. Submarines must be prepared for defense against:

a. Depth charge, mine, and other forms of underwater explosive attack.

b. Supersonic and listening screens.

c. Aircraft attack.

d. Torpedo fire.

e. Small surface craft.

f. Ramming.

Section 2
Basic Defense

5201. The following basic assumptions are doctrine for submarines making contact with other unidentified craft:

a. That all surface ships and aircraft will consider any submarine as enemy.

b. That all submarines should consider all surface ships and aircraft as enemies. Therefore, it is incumbent upon the submarine to submerge, if possible, otherwise to initiate identification.

c. That a submarine normally should not initiate the identification signal unless attacked or unless it is vital to establish her identify in order to carry out her assigned mission.

5202. (a) The basic defense of the submarine lies in submergence. By going deep and running at slow speeds, it is unlikely that a submarine will be picked up by aircraft unless the submarine leaves an oil slick or air bubble.

(b) Defense against surface craft lies in submergence if the enemy can not be evaded on the surface. Running silently at slow speed will reduce chances of detection by enemy sound listening gear. Observation of action taken by the enemy will lead to the most likely course for evasion.

Section 3
Defense Against Depth Charge, Mine, and Other Forms of Underwater Explosive Attack

5301. In general, defense against underwater explosive attack consists primarily of avoiding discovery, operating in a manner and at such a depth as to avoid striking the weapon involved, or so as to keep the total stresses below the strength of the already hydrostatically stressed hull, or outside the area of disturbance of the explosion.

5302. Generally-known mine fields should be avoided. When necessary to pass through them, they should be passed at a depth and time (dependent on the type of field, depth of water, rise and fall of tide, current, and surface patrols existent) so as to pass over or under the mine case.

5303. Explosive sweeps should be avoided by under-running.

5304. Net obstructions probably will contain contact mines and be protected by listening posts and surface patrols. They should be avoided.

5305. (a) Depth charge attack presents the gravest menace that submarines have to face in the open sea. To evade damage from this cause, operate to escape discovery either by being sighted or heard.

(b) If conditions are such that the submarine can remain at periscope depth, a well placed torpedo in the enemy ship may prove to be the best defense.

5306. Depth charge attack may be expected at any time when in the vicinity of enemy fleet or detachment, or when in waters patrolled and controlled by the enemy. Such attacks on the submarine may be made by light screening vessels, submarine chasers, patrol vessels or by aircraft. The depth charge attack is the most damaging to which a submarine may be exposed. For a successful attack by depth charge the surface ship must know the approximate position of the submarine. This can be ascertained only by:

1. Sighting part of the submarine or its wake.

2. Contact and tracking by means of sound equipment.

3. Sighting of the submarine by aircraft which communicates the position to surface craft, or conducts the attack itself, if equipped with aircraft depth charges.

5307. It may be expected that the following are the most valuable parts of the submarine susceptible to damage by depth charge attack:

a. Depth and steering control mechanisms. Contactors of electrical controls are not particularly resistant to shock.

b. Non-watertight motors offer no protection from incoming water.

c. Except for later reinforced type, battery jars are susceptible to cracking from shock of depth charge attack. Leaking electrolyte will collect in battery wells and cause grounds in addition to being a potential source of chlorine gas. Its prompt disposal must be provided for.

d. Leaks may be expected in the packing glands of the stern tubes, sound equipment shafts, etc.

e. Bow and stern planes, which may become jammed from shock.

f. Torpedo firing circuits, instruments, etc., may become temporarily disabled.

Recent experience has demonstrated that loose articles may become missiles creating an additional and unnecessary hazard when depth charges or aircraft bombs detonate close to the submarine. It is of greatest importance that miscellaneous gear, tools, manifold wrenches, etc., be properly secured to reduce the number of loose articles to a minimum.

5308. When subjected to depth charge attack, the following, which are based on wartime experience aboard as well as the opinions of experienced submarine officers, should be accomplished:

a. All sea chests secured and all sea and stop valves to outside connections closed. Sound gear sea chests may be kept open if equipment is being used for escape tactics, but prompt closing must be provided for, should extensive leaks develop. Watertight doors should be left open for ready communication.

b. Antenna lead-in tube flappers closed.

c. Personnel stationed near important electrical contact panels, circuits, and vulnerable installations in order that prompt repairs may be effected. All starting and control panels of auxiliary machinery should be made ready for easy access.

d. Watertight covers installed for important motors and panels which may become exposed to salt water leakage. In this connection, machinery under soft patches may be subjected to salt water leakage.

e. Be prepared to quick shift to hand control of bow and stern planes and vertical steering.

f. Spare flashlights available in each compartment in case normal and emergency lighting circuits go out. All personnel shall be equipped with pocket flashlights.

g. Facilities for disposing of acid, leaking into battery tanks.

h. Preparation and organization for rapid "jumping" of leaking cells.

i. If there is any doubt that marker buoys, deck gratings, etc., may become dislodged during depth charge attack, they should have been previously removed.

j. Torpedo tube outer doors should be closed to avoid damage to torpedoes unless making an attack and near firing point.

k. House periscope completely, unless being used at periscope depth.

l. Keep main ballast tank vents open. Keep safety tank vent closed.

m. Close depth charge switches.

n. Only depth gauges which are necessary for control shall be in use; others shall be cut off from sea pressure. This should be normal procedure whenever in water where depth charging may be expected.

o. Torpedoes in racks should be secured to prevent movement, in case ship takes large angles.

p. Operate as noiselessly as possible. Commanding officers should know which auxiliaries must be stopped for this purpose. If being hunted by ships equipped with listening equipment only, as contrasted to echo-ranging equipment, it is a cardinal principle that absence of acceleration or deceleration of propellers is essential. A slow steady speed under these circumstances is preferable to alternate stopping and starting. Course should be continuously changed. If being hunted by ships equipped with echo-ranging equipment, formation of knuckles, changes of speed and changes in course will provide best chances for evasion.

q. All personnel not on watch or specially stationed, get into bunks.

r. Each compartment should be provided with a tool kit containing a hammer, pliers, wrecking bar, and pipe plugs to fit the main pipes in that compartment.

s. Wrenches and hammers used should be silenced by taping with friction tape.

t. Stop battery blowers and seal battery wells. Care should be taken that hydrogen content in battery-well does not reach dangerous limits.

u. Depth to take in case of depth charge cannot be specified. This depends upon conditions existing at the time and must be left to the discretion of the commanding officer. It may be possible to stay at periscope depth to obtain information for escape or it may be

preferable to take deep submergence. It is always preferable for depth charges to explode above, rather than below, the submarine.

5309. Available data indicate the following in the case of a 300 pound depth charge: if it is detonated within 14 feet of the submarine it will probably rupture the pressure hull; within 28 feet, the submarine will be seriously disabled; within 60 feet, it will have a demoralizing effect on the crew which can be minimized by training, discipline and morale.

5310. Depth control will have considerable bearing on the success or failure of evasive tactics in connection with depth charge attacks. While deep submergence is a recourse available to assume the farthest position away from depth charges, it also enables the depth charge which is set for deep explosion to be effective at greater distances from the pressure hull. On the other hand, with the submarine at shallow depth and with depth charges exploding below, there is tendency to force the submarine up with possible complete broaching and exposure. Since all underwater explosive effects tend upward, if there is a choice, it is always preferable to have depth charges, mines, explosive sweeps, etc., explode above, rather than below, the submarine. A case is on record of a mine being exploded in direct contact with bow planes and the submarine still being able to return to port.

5311. Submarines operating in the vicinity of enemy ports or bases may expect that enemy harbors will be protected with anti-submarine nets and mine fields in conjunction with surface patrols. These areas should only be penetrated when the mission demands. Locations of swept channels and openings through barriers may be determined by observing, at periscope depth, the ingress and egress of enemy surface craft. Areas that are well lighted at night most probably indicate the presence of mine fields. The regular anti-submarine net can be expected to extend to the bottom, where the depth is 200 feet or less. It is probable that the net will be made of 5/8 to 3/4 inch steel wire with about 12 feet mesh. Some anti-submarine nets are made up of heavy steel bars designed to block passage. Another consists of chain and dangling wires primarily to foul submarine's propellers. Others are mine nets, in which a submarine struggling to free itself makes its presence known ashore, where shore controlled mines are exploded at proper places along the barrier. Either shore controlled or contact mine fields may be expected in the vicinity of nets. Nets may be expected to be patrolled by craft equipped with depth charges. If it is necessary to attempt penetration of a net or mine area, it should be done with the tide is running the strongest in the direction of advance. Net cutters, mine cable cutters and clearing lines should be in use, if available. The submarine should submerge until near the bottom, or to a depth below 200 feet; if there is a greater depth of water, then proceed at slow speed in an effort to penetrate without contact. It is best to strike nets as near their moorings as practicable, because there is less wire whose elasticity must be overcome, and because less surface disturbance will result. If it is found that penetration can not be effected, back clear before becoming broadside to the net, thereby fouling the propellers. If it is possible to do so, attempt penetration at night to provide for the contingencies that it may be necessary to surface in order to clear, after fouling a net. After passing the net, any unusual noise of cable or chain on the hull may be assumed to be from a

mine anchor. Attempt to clear by maneuvering at slow speed, in order to avoid pulling the mine down to contact detonation. Ingenious uses of various types of nets may be expected. For example, the mine net is non-rigid and folds around the submarine, as it moves forward. A mine in the net detonates, when contact is made. Avoid ordinary fishing nets and stake lines of the drifting type. If any portions of them are carried along by the submarine, they reveal the presence of the submarine. Rough weather and heavy storms usually cause considerable damage to anti-submarine nets and mine fields. It is therefore advisable to attempt to penetrate an area suspected of being so protected, immediately after a storm. In penetrating mine fields, great advantage accrues if it is known what type of firing mechanism is employed, i.e., whether contact or antenna type, how old the field is and hence how effective, the state of tide and tidal currents, and whether planted as an anti-submarine or general field. If it is known that the field is for general defense, safer penetration will be accomplished (most likely) by running under, at full speed and good depth. If an anti-submarine field exists and it is known that contact mines are used, better success will be obtained by attempting passage on the surface during high tide with strong tidal currents.

5312. **Harbor Defense.** There are five fixed defenses used in detecting a submarine attempting to enter a harbor:

a. The indicator loop.

b. The controlled mine loop.

c. The harbor defense listening gear.

d. The indicator net.

e. Supersonic set for boom gate vessels.

The indicator loop is a warning device, but the controlled mine loop provides a lethal weapon as well as a warning device. Both are operated by magnetic influence. They will probably be de-energized while channel is being swept by magnetic sweeps as the magnetic sweeps interfere with the detector instruments. Harbor defense listening gear consists of sensitive elements mounted on the sea bottom and controlled from the shore. Indicator nets offer no definite obstacle, but give visual notice of the presence of submarines. Supersonic sets for the boom gate vessels are for the purpose of preventing an entry into a protected harbor when it is opened for the entry of friendly ships.

5313. Submarines, even though degaussed by permanent degaussing or wiping should at all times avoid

charging or discharging in shallow uncertain waters, if it can be done, on account of fields set up which might affect magnetic mines or detecting loops.

Magnetic Mines

5314. The magnetic mine is a ground mine. Degaussing coils are installed to reduce the effective magnetic force of a ship and thereby protect it against magnetic mines. The current use of moored magnetic mines in depths of 300 fathoms has been reported. Such mines are known to be feasible in depths up to 500 fathoms. It is incumbent on the commanding officer to keep degaussing coils energized whenever there is any possibility of the presence of magnetic mines.

Acoustic Mine

5315. The acoustic mine has been developed during the present war. It is a ground type of mine carrying a very heavy explosive charge. A period delay mechanism requiring as high as twelve separate actuations, at least two minutes apart, is being used in some foreign acoustic mines. Instances have been reported where the second or third ship in column in a channel actuated the acoustic mine. The firing mechanism of this type of mine is actuated by sound energy radiating from a ship through the surrounding water. Propeller noises or supersonic "pings" may also actuate the acoustic mine.

Section 4
Defense Against Supersonic and Listening Screens

5401. The avoidance, or penetration, of a supersonic screen is dictated by the submarine's mission, the relative position of the submarine with respect to the line of the screen on initial contact, the position of the screen relative to the body screened, and the sound conditions in the area. These factors will determine whether it will be better, or necessary, to avoid the screen by a flank approach or to penetrate it by a direct approach.

5402. Information obtained, while operating with supersonic, equipped screens during the past few years, indicates that the following tactics are the best so far evolved for penetrating undetected, or for escaping from supersonic screens:

a. Endeavor to pass directly under a vessel of the screen on opposite course at slow speed and at depth of about 120 feet.

b. Keep bow or stern toward nearest screening vessel, thus presenting smallest possible target.

c. When there is a negative temperature gradient (cooling with depth) of 10 degrees difference between the surface and 100 feet, it may be possible to pass screens at periscope depth at a range of 2,000 yards or more.

d. When propeller sound of screening vessel indicates the screen has slowed for listening purposes, the submarine should use silent running speed.

e. Avoid high speed while in vicinity of screen except in attempts to escape, after being detected. Tracking of submarines is made difficult for surface vessels, and confusion to unseasoned personnel may be created, by large changes of course at speeds varying between three and seven knots. High speeds must be made in short bursts, or contacts can be easily maintained by the attacking destroyers. Submarine procedure, when detected, is to stand on at high speed on screen's course to create wake interference, then turn 90° (approximately) with from 10° to 15° rudder to remove submarine from disturbed area. For best results at this critical time, an alert submarine sound operator must gauge the proximity of approaching vessels by the intensity of propeller sound and rate of change of bearing, and keep the commanding officer continuously informed. When a surface ship is considered to be coming close, a sharp turn should be made to put attacking vessel astern followed shortly by a turn inside the enemy turning circle.

5403. If the submarine is detected prior to the time of delivering its attack or while observing the enemy, it shall use every effort to escape attack by the screen or its supports, while still accomplishing its task. Except with most favorable sea conditions, discovery at time of firing torpedoes is almost inevitable, and the submarine must begin escape tactics immediately thereafter.

5404. Tactics to avoid, penetrate, and escape the screen are based on knowledge of its presence, its location, and its movements. This information must be gained by utilization of all the submarine's listening facilities, by recording everything heard and plotting the data obtained and also estimating positions and movements of the screen. Thus a "sound-eye" view of the surface picture is gained, on which the submarine commander must base his moves.

5405. Vessels of the supersonic screens are capable of both echo-ranging and listening, but are most likely to resort to use of the echo-ranging facilities alone, although both will sometimes be employed together. Listening screens alone may be encountered. The submarine must be prepared for action against both types.

5406. The submarine commander must keep himself informed of sound conditions in the area of operations in order that full advantage may be taken thereof, both offensively and defensively. The effective echo range for any depth of projector and target down to 300

feet can be determined from range prediction curves, provided the local velocity gradient is known. For practical purposes, and in the absence of equipment to measure velocity directly, the velocity gradient may be obtained form standard curves using the measured temperature gradient corrected for constant pressure gradient and assuming negligible salinity gradient. (Reference:-- Pamphlet entitled "Prediction of Effective Echo ranges", revised September, 1941, issued by Commander Destroyer Division Fifty.)

Section 5
Defense Against Aircraft Attack

5501. The best protection against aircraft is to avoid detection when on the surface or when submerged. Once discovered, the submarine finds the best protection against attack by deep submergence.

5502. When the mission permits, submarines should dive before enemy aircraft are encountered. This applies particularly to twilight periods and when in the vicinity of a large force or an enemy base.

5503. The use of protective paint, low speed at shallow submergence and during periscope exposures, deep submergence between periscope exposures, short duration periscope exposures with minimum periscope exposed, and avoidance of oil and air leaks, all must be employed to prevent discovery.

5504. All planes sighted by a submarine must be considered to be hostile and to have sighted that vessel. Submarine should immediately submerge to a safe depth, which depth will depend upon the clearness of the water, the state of the sea, and the percentage of clouds in the sky. If unable to dive, resort must be had to anti-aircraft fire and rapid high speed, cross wind, zig-zagging.

5505. After being driven down by aircraft, or when their presence can be expected, take precautions to avoid coming up in their vicinity without ability to dive again immediately. Search with radar before surfacing.

5506. When faced with the choice of failing to reach an attack position, because of submergence to avoid unidentified planes, or of proceeding further toward the attack position on the surface, the decision must be reached by weighing the assigned attack mission against the importance of remaining undetected and the risk of damage to the submarine.

5507. Lighter-than-air craft are potentially dangerous, but alert submarine lookouts should provide

sufficiently early information to enable the submarine to avoid attack.

5508. Available anti-aircraft gun fire is used by submarines only if unable to dive for physical reasons (or the mission demands acceptance of the air hazard and requires maintenance of surface speed). In these cases the battery should be kept in condition for immediate use. The machine gun is the best defense against strafing attacks while high speed zigzagging is the only means of avoiding surface bombing attacks if unable to dive.

Section 6
Defense Against Small Surface Craft

5601. The offensive weapons of a submarine are torpedoes, mines, and guns. Submergence in time to avoid detection or attack, or both, is the best and therefore the primary means of defense. Evasion by use of high speed on the surface at night or in low visibility is preferable. Submarines will avoid engagement with aircraft when possible to do so.

5602. Unless the submarine is unable to dive, combatant ships should not be engaged by gunfire, except they be of the small patrol type (more dangerous because of their depth charges than because of their guns), definitely preventing the accomplishment of a vital mission. In the latter case, the probable chance and relative advantage of possible destruction of the patrol vessel must be weighed against the disclosure of the submarine's presence or position, and the probable damage that may be received. Gun attacks on important merchant vessels will normally not be made, as the submarine will usually find itself out-gunned and at a disadvantage. When engaging surface targets, endeavor to do so as a surprise and from a position that will be poorly protected by lookouts and where the minimum number of enemy guns can bear. Engage on bearings that will permit the best service to own guns.

5603. **Conditions of Readiness. Main Battery.** Keep telescopes installed at all times and guns boresighted for long range. Keep ammunition in magazine, but be prepared, when action is imminent, to advance ammunition as near gun(s) as permitted by readiness to dive without delay. In order to be prepared for surprise night gun attack, set deflection scale to compensate for drift and set range scale between 2,000 and 4,000 yards.

5604. In establishing and maintaining hitting range and deflection, use the simplest effective control methods against both aerial and surface targets.

5605. Against surface targets use ranging shots, spread in range, to establish hitting gun range. Maintain hitting gun range by spotting methods that cross and recross the target and that depend only on the determination of whether shots are short or over (in range).

5606. In general, procedure for submarine gunfire is very similar to local control of a single gun, or of local group control in the case of two-gun submarines, as on surface ships. The spotter and control officer are usually combined and communication with the battery should be as simple as possible. Absence of instruments and assistants, plus low spotting heights, complicate this problem.

5607. Considering the type of target against which a submarine may expect to effectively use its gun, ammunition supplied will normally be common and high capacity point detonating in such proportions as is found to be most useful from time to time. The high capacity point detonating projectile and fuse have been found effective against steel plating as follows:

3" up to 1" thickness
4" up to 1 1/2" thickness
5" up to 2" thickness
6" up to 2 1/4" thickness

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