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NAVAL GUNNERY - 1925

Lecture delivered by Commander Henry K. Hewitt, U.S.N.

at the

Naval War College
Newport, R.I.
24 July, 1925

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Introductory Remarks.

The subject of this talk covers such a broad field, that it is rather difficult to discuss it in an entirely satisfactory manner in the limited time available. I realize that the College is primarily interested in the general results which are obtainable with the armaments of the different types of ships, and in the development of new methods which serve to increase the effectiveness of our weapons. I shall therefore endeavor to confine myself to these subjects, but I shall be glad to answer any questions on points of interest to the College which I fail to mention, or which I may not discuss with sufficient clarity or detail.

In order, however, that you may have a general idea of the gunnery training that is being carried on, it is necessary that I outline to you the exercises laid down for the various types of vessels. This I shall do briefly, and then I shall pass on to the more advanced, and most interesting features of the year's gunnery work. The details will, or course, be found in the Annual Report of Gunnery Exercises, now in process of publication.

BATTLESHIP GUNNERY.

Short Range Battle Practice. The short range battle practice requires no special mention, except that the high standards of the preceding year were equalled, and in the average, were bettered. The tendency is, not toward exceptional scores in isolated instances, but toward a general all around excellent performance.

Night Battle Practices. The night practices were different from those of preceding years, in that two forms were fired, one at short ranges (3,000 - 6,000 yards) for the secondary battery, and one at long range (8,500 - 10,000 yards) for the main battery. Both of these practices are fired in division formation, in the case of the secondary battery, to save time in carrying out the exercise, and in the case of the main battery, to study the problem of illumination in formation.

In the secondary battery practice, star shell illumination was used for one battery and searchlight for the other. On the star shell run 40% of hits were averaged on the 40' x 140' battle target, with an average gun range of about 4,300 yards. On the searchlight run, 51% of hits were made at an average range of 4,000 yards. It is believed that the larger percentage of hits of the searchlight run is largely accounted for, not only by the lower average gun range of that run, but by the fact that the opening gun range was the minimum allowed range, whereas, for the star shell run it was a maximum.

In the main battery practice, the MARYLAND made the remarkable performance of 14 hits out of 24 shots at 9,500 yards on the 40' by 140' battle target, 58% of hits. The next best performance was that of the COLORADO at 10,000 yards, with 6 hits, 25%. Of the fourteen ships concerned, eight failed to hit the target. Of these, one fired no shots, on account of failure to see the target. To summarize, 31 hits (10%) were made with 308 shots, at an average range of 9,388 yards.

Ten percent of hits on the material target at this range, with reduced charge, is considered a most encouraging performance. The hitting space is only about 75 yards,

and the target is 5 mils wide. A battleship at that range would be 20 mils wide, and have a hitting space, with full service charge, of about 150 yards. It would be preferable, of course, both for analysis purposes, and to remove the "luck factor" in the competition, to use the constructive battleship target, but this is impossible owing to our inability to observe the fall of shot accurately at night.

The batten target is a most unsatisfactory night target, both for illumination and spotting. Star shell illumination is by silhouette. The battens let the light through, and do not silhouette. The only solution is to cover the battens with as much canvas as the wind and state of the sea will permit.

The methods employed in illumination and the general success of the illumination will be discussed later.

Torpedo Practice. There has been, and still is, considerable discussion as to the value of the torpedo on the battleship. As you undoubtedly know, the submerged tubes are to be removed from the older battleships, upon modernization, an action practically necessitated by the structural changes planned. There is considerable pressure to abolish torpedo practice altogether for battleships, but this is not consented to as long as the torpedo equipment is on board. However, consideration of the importance of torpedoes as compared with the other forms of battleship armament, has caused the reduction of torpedo work to a single practice. The practice laid down involves not only proper functioning of the torpedo material, but a control problem requiring a very quick estimate of the target course and speed. The results, on the whole, are not what might be expected if the torpedo personnel had more opportunity to run their torpedoes. The best score was made by the NEVADA, which, in six shots

fired, made four full hits, one partial hit (across the line), and had one curved run, the range being about 11,00 yards.

Long Range Battle Practice. Ammunition and gun replacement requirements permit of firing but one full charge main battery practice each year. Until 1924 it was customary to use the full charge for Long Range Battle Practice. However, it developed that the use of reduced charge only for Long Range Battle Practice might lead to false conclusions and the policy was finally adopted of alternating the full charge between Long Range and Force Practice. Long Range Practice this year was fired with full charge.

The outstanding feature of the recent long range battle practice was the firing of the five long range ships (MARYLAND & CALIFORNIA Classes) at 25,000 yards. Only once before had any ships fired a target practice at such a range, and this was the CALIFORNIA and TENNESSEE in 1922. The visibility in 1923 was such as to force these ships to fire at about 18,000 yards, while in 1924, the practice was fired with reduced charge.

The WEST VIRGINIA made 11% of hits on the constructive battleship target, while the 16" ships as a class averaged 6%. The CALIFORNIA and TENNESSEE made 2.4% and 0% respectively as compared with their previous performance at this long range of 7% and 11%. The TENNESSEE's failure is believed to have been due primarily to poor rangefinding and a fatal error in the receipt of the first air spot.

The 16" gun has been proved a most accurate weapon. The range dispersion obtained on this practice approximately equalled the excellent results of the calibration practices. It averages less at 25,000 yards, than does any other type at the 16,000 - 19,000 ranges, with the one

exception of the 12" - 45 Caliber of the UTAH Class, which it equals. It is almost one-half the dispersion of the 14" - 50 cal. (CALIFORNIA and TENNESSEE) at 25,000 yards, the average 16" gun pattern being 654 yards, while that of the 14" (at 25,000 yards) was 1171. In deflection also, the performance was excellent, the dispersion being 1 mil as compared to 2 mils for the other classes of ships. It might be stated further that this excellent performance speaks well for the accuracy of General Electric Fire Control system, with which the 16" gun ships are equipped.

The reduction of our pattern sizes is one of our most serious problems. As yet there seems to be no solution in sight. An analysis of dispersion performances covering the firings of the last seven or eight years shows that no particular improvement has been made in this respect. The average dispersions of ships, in their respective classes, are so consistent, except in the case of the 14" 50 cal. ships, as to lead to the belief that they are largely inherent to the particular type of gun, powder, or mounting, and are not entirely due to personnel performance. As before stated, the best gun is the 16" 45 mounted in two gun turrets. Next in order is the 12" 45. Then comes the 14" 45, with the two gun turret ships apparently as the best performers, then the two and three gun turret ships (NEVADA class) and finally the three gun turret ships (PENNSYLVANIA class). After the 14" 45 cal. comes the 12" 50 (ARKANSAS and WYOMING) and lastly the 14" 50 cal.

The 14" 50 cal., while having the highest average dispersion of all, is the least consistent in performance. The CALIFORNIA and TENNESSEE had large patterns on both

their 25,000 yard firings, but in 1923, at 18,000 yards, had a very small pattern. Of the IDAHO class, the IDAHO has a better record than the 14" 45 3-gun turret ships. But the NEW MEXICO and the MISSISSIPPI are very bad. The MISSISSIPPI's old guns have given most erratic results at the proving ground, but that ship seems to be shooting just as badly with her new guns.

The volume of fire obtained was about the same as that of the preceding two years, the average rate of fire being 1.12 S.P.G.P.M. The maximum was 1.40 S.P.G.P.M. and the minimum 0.86 S.P.G.P.M. It is believed that the loading time now attained can not be materially decreased with the present turret equipment. Improvement can, however, be made in the average fire control interval, that is, the delay from the moment guns are loaded and laid, until they are fired by the director. This can be accomplished by very careful training of director pointers, and by elimination of lost time in the plotting room. The analysis of this year's practice tends to show that, in fairly smooth water conditions, ships may fire on both rolls without loss of accuracy. The volume of fire may also be increased by getting out 100% of shots on each salvo. The reduction of fire due to delays and casualties has shown much improvement in recent years, but is still the approximate equivalent, in effect, of removing one gun from each ship.

Force and Advanced Practices. The force practice and the advanced practices will be discussed later in connection with advanced gunnery problems.

DESTROYER GUNNERY.

Destroyers fire an elementary torpedo practice, an elementary gun practice, a long range battle practice

combined with a torpedo practice (simulating a torpedo attack combined with a gun action against light forces), and a torpedo practice which requires the solution of the approach problem by the commanding officer, as if he were a squadron or division commander. A depth charge practice is held, simulating a submarine attack on a screened convoy. Live depth charges were used this year, almost 50% of which failed to function.

There are also three forms of division practice, each division of a squadron firing a different form. Two simulate division torpedo attacks, combined with gun fire against enemy light forces. The targets in one practice represent two light cruisers, and in the other, eight destroyers. The third practice simulates the gun fire of a division encountering or penetrating an enemy screen at night.

In addition to the foregoing, a squadron torpedo attack is delivered on the battle line during force practice, and three squadrons make attacks during the course of the Advanced Battle Torpedo Practices, which is a tactical problem involving practically all the combatant fleet units, except submarines.

In gunfire, the destroyers have exhibited a marked improvement in recent years. It is expected that the improvement will continue.

In torpedo work, material and personnel are both advancing in efficiency. On torpedo practices "B" and "C", fired at ranges of about 11,000 yards or more at a 1700 yard target, representing the interval of a three ship battleship division, about 53 1/2% of hits was made. Since the actual ships would occupy 600 yards of this interval, this would give an expectation of about 19% of hits. About

eighty percent of torpedoes crossed the line of the target formation.

On force practice, 13 actual hits out of 57 fired (23%) were made on the Battle Fleet battle line, six of these being received by one ship. Every effort was made by the battleships to dodge the torpedoes, but the criss-cross pattern, coming from ahead, and from both bows, made it impossible to escape them. This attack, however, was delivered at rather close ranges - from 8,400 to 5,000 yards.

On the advanced battle torpedo practice, with about five battleships in the target line, one squadron of destroyers firing 57 torpedoes (3 apiece) made 3 actual hits (5%) on the first day, and two squadrons, firing 76 torpedoes (2 apiece) made 7 hits (9%) on the 2nd day. These attacks were also delivered at rather short range under cover of smoke screens.

The destroyers have developed a very effective means of determining the proper torpedo course, without recourse to actual tracking, which is very difficult with destroyer range-finders. The attacking unit approaches at 27 knots, the speed of the torpedo, and by trial and error determines the collision course. When sufficiently close, torpedoes are fired down this collision course.

LIGHT CRUISER GUNNERY.

There is as yet insufficient data to discuss the gunnery capabilities of the light cruisers. These vessels carry out exercises similar in general nature to the destroyers, except that the long range gun practice is at much greater ranges. At present, these vessels are not carrying mines, and no mining practices are carried out.

The 6" 53 caliber gun with which these vessels are

armed seems to give very good results, the average patterns at 13000 yards, being about 400 yards. There is still some doubt as to the effectiveness of the twin mounts. Owing to the necessity of observing turret safety precautions, the rate of fire is necessarily slower than with the guns mounted in the open. There also appears to be some indication of greater dispersion between the two guns of the mount, than between adjacent singly mounted guns. With respect to the effectiveness of the lower quarter guns of these ships under the conditions of a general engagement, the comment of the OMAHA Observer on Advance Battle Torpedo Practice is of interest. He says "Six-inch guns #1 and #2 dipped under the water on the turns, and were out of commission throughout all runs".

SUBMARINE GUNNERY.

Submarines carry out two gun practices, short range battle and long range battle, and six torpedo practices, which progress from elementary and simple tactical situations to those of a more difficult nature. One practice is fired by the use of listening gear alone. Another is a section attack.

The performance of the submarines has improved materially during the past year. This is true in all forms of practices, despite the fact that the torpedo practices were more advanced than any heretofore attempted, and in the case of the gun practices, Long Range Battle was more difficult, and the roll and pitch factor of Short Range Battle was reduced. In torpedoes 61% of hits were made as compared to 51% in 1923-24. The percentage of circular runs was reduced from 13 to 5 and of lost torpedoes, from 6 to 4.

The section attack was not successful as far as the delivery of a simultaneous co-ordinated attack is concerned. A satisfactory solution of that problem is yet to be found, but the practices of this nature have stimulated thought and effort in that direction.

MINE LAYERS.

All mine layers in commission, and mine sweepers attached to the mine forces, are required to carry out mine-laying exercises simulating their most probable war-time functions. These have been, on the whole, most satisfactory, and it is believed that the mine forces are being maintained at full efficiency.

AIRCRAFT GUNNERY.

While reports have not yet been received from all aircraft units, the indications are that the results are not as satisfactory as those of the preceding year. Owing to the extensive fleet movements, the aircraft units attached to the fleet required considerable time for packing and transportation of planes, during which no exercises could be held. It is felt that too much time was lost at the beginning of the gunnery year, with the result that gunnery exercises were conducted too hastily at the last minute. The practices were also slightly more difficult than those previously prescribed.

The aviation personnel is, however, taking great interest in this branch of their work, as is evidenced by the many excellent constructive comments which have been received.

No torpedo practices whatever were conducted for the reason that these practices were postponed until the arrival of the torpedo squadron in Hawaii, and then it was found that, with Pearl Harbor occupied by fleet units, there

was not sufficient smooth water "run" for them to get off with their heavy load. This was very disappointing, since it was desired to study the tactics of a torpedo plane attack against a battleship division. This was well executed during the preceding year, except that the planes came in at very low altitudes (about 100 ft.) and would undoubtedly have been subjected to heavy gun fire both from battleships and screen. The exercise this year required the screen to be passed at an altitude of at least 3,000 feet.

The Advanced Bombing Practice was also not held due to non-receipt of the bombs. This practice was to have consisted of the dropping of 1,000 lb. live bombs on a fixed target by a close formation of bombers, flying at an altitude of at least 6,000 feet. The practice was designed to test the ammunition, and the ability of the planes to reach the required altitude, as well as to determine the efficiency of the planes in formation bombing.

The service still has no efficient bombing sights. The Bureau of Ordnance now has two models of the Norden gyro stabilized sight under test at Dahlgren. It is hoped that the test will be successful, and the sights soon be issued for service use.

ANTI-AIRCRAFT GUNNERY.

Considerable interest was aroused in anti-aircraft gunnery during the past year, partly due to the air service propaganda, and partly due to the fact that, for the first time, the anti-aircraft practices were made to count in the gunnery competition. Consequently, better, and more definite results were obtained. The towed sleeve target was hit on about 48% of the practices held. The weight has been doubled for the coming year and still better results are

expected. While many ships have taken much interest in this work, it is believed that, in the assignment of personnel, the anti-aircraft battery has often been slighted, and the practices have frequently been carried out in too perfunctory a manner. It is human nature to devote the most effort to that which brings the greatest reward.

The anti-aircraft fire control equipment is still very crude and is largely improvised by the personnel afloat. Not all ships have proper anti-aircraft rangefinders. This condition is being remedied as rapidly as funds permit. The new 5" anti-aircraft gun with an anti-aircraft director will be installed in the MARYLAND class in the near future. If found satisfactory, these batteries will later be supplied to other ships. Those connected with anti-aircraft gunnery feel confident that with improved equipment, and the development of improved methods, the aircraft bomb threat can be met.

Another form of attack which must be guarded against and which is receiving attention, is that of a low flying fast fighting plane, using machine guns or light bombs. An attack of this nature might be particularly serious to an airplane carrier. The logical defense appears to be the machine gun, perhaps mounted in multiple mounts. It is difficult to simulate such an attack, even with a towed sleeve target. The Battle Fleet has, however, been requested to carry out some experiments with this end in view, and it is hoped that an anti-aircraft machine gun practice may be developed.

When single ship anti-aircraft fire has been developed further, it is hoped to devise a division anti-aircraft practice, to determine the practicability of coordinated fire from several ships on a formation of bombers.

ADVANCED GUNNERY.

Force Practice. Among the more advanced features of gunnery, I shall discuss first, the force practice. This is the culminating practice of the year for battleships, and is the nearest approach to an actual engagement of the battle line which can be obtained in a target practice. It involves the simultaneous use, by a battleship force, of main, secondary, and anti-aircraft batteries, while maneuvering to avoid torpedoes fired by an actual attack squadron of destroyers. Shifts of fire distribution are required, and, in addition, casualties are simulated, particularly that of gas attack.

This practice was carried out by three battleships of the Scouting Fleet off Guantanamo, and by ten battleships of the Battle Fleet, plus the WYOMING, off San Pedro. While both practices were good, the latter is the more interesting, because a considerably greater number of ships were involved. This is the practice which I will describe to you with the aid of the slides and the reel of motion pictures.

(Slides 1 and 2)

To carry out the practice so that the torpedoes cross the line during the gun fire, and so that the secondary battery targets are set adrift at just the right moment, requires a very difficult coordination of several widely separated units. The coordination was excellent, except that the torpedoes reached the line just prior to "Commence firing". This was not, however, without effect, since the battleships were forced to maneuver at a moment when every effort was being made to obtain and set the correct range. It is probable, also, that the stable zenith directors, which were required to be used, were somewhat disturbed by the radical changes of course made. This should be considered

in noting the fall of shot of the opening salvos.

The torpedo pattern apparently centered on Battleship Division Five, which was leading the line, and in attempting to dodge, the division was thrown into confusion. The WEST VIRGINIA and MARYLAND each received one hit, the COLORADO three, the TENNESSEE six, and the CALIFORNIA one. The CALIFORNIA was probably the point of aim. (Slide 3) The effect of the maneuvers was to cause the COLORADO to drop back on the MARYLAND, and to blank her fire until about two minutes after "Commence firing" had been executed. When the MARYLAND did open, she fired nearly over the COLORADO's quarter-deck.

The results of gun fire at Force Practice are always indefinite, due to the difficulty of plotting the fall of such a large number of shot, and of allocating them to the proper ships. Of the 672 main battery shots fired, forty-four, about 7%, were plotted as hits, but some shots that were hits may not have been plotted. Thirty-five material hits were made on the battle target. Thirty-eight 5" hits were made on the 40' x 25' x 25' pyramid targets, five of the six targets being hit.

Aircraft Observation. The efficiency of aircraft observation is now well known, and all ships place great dependence upon it. A fleet which has it will have a tremendous advantage over one to which it is denied. The difficulties, where a large number of firing ships and targets have been concerned, have been in the communications, and in insuring a mutual understanding as to targets between planes and ships.

Prior to this year the observation planes were not based on the ships, and there was no personal contact between plane observers and the ships for which they observed.

Planes, in pairs, were assigned targets counting from each flank of the target formation, or that part of it brought under fire. The planes for each so-called fire "zone" had prescribed wave lengths and signature letters known to the ships. When assigned a target, the ship set its receivers for the planes who would observe that particular "zone".

This system was used on the force practice of 1924. It proved to be a failure with the radio equipment then in use. Ships had great difficulty in tuning in quickly, and particularly when shifting target, the new planes were not picked up in time to be of any value. Neither the wave length of plane transmitters, nor the calibration of the battleship receivers seemed to be sufficiently permanent.

This year the planes were based on the ships, and the observers became part of the ship's regular organization. In daily flights and communication exercises, communication was perfected, and receiving sets were well calibrated to the particular transmitters of the ship's own planes. The planes always were to observe for their own ship. This system of course requires a thorough understanding by the observer as to his own ship's target. This was, and is, to be accomplished by, first a thorough knowledge by the observer of the fire distribution doctrine, secondly two way communication, by which the ship will designate its target to the observer upon opening fire, and shifting fire, and thirdly by the use of colored spotting projectile, which will be discussed later.

This system was most successful on force practice, and has been most enthusiastically commented on by all those afloat who were in a position to judge of its value. It has been adopted as standard by the fleet.

Eighteen ships with two planes, each with a separate

wave length, require thirty-six channels of communication for gunnery observation. When the other necessary channels for simultaneous communication are considered, it is doubtful, with present radio limitations, if any such number will be available. It may be necessary to reduce each ship to one channel for this purpose, and have the 2nd plane act as a stand-by, sending an observation only in case the 1st plane fails.

Colored Spotting Projectile.

Colored spotting projectile were fired this year, at both the long range and the force practices, by the 16 ships (MARYLAND class). They were most successful. Not only are the splashes distinguishable from the air, but also from the firing ships at 25,000 yards. As a result of the first test, Battleship Division Five had orders to disregard time sector restrictions in case of a concentration, and did so on Force Practice without confusion. Next year a three-ship concentration will be held as an advanced practice, using the colored splashes. It is also hoped to have the spotting projectile for all ships on the next force practice.

In assigning colors for the service projectile, it is planned to give the flag of the O.T.C., which may come in at any part of the line, a distinctive color. Four other colors will then be assigned to divisions, each ship having a color in accordance with its regular position in the division formation. In this way, no two ships firing the same color are apt to be in concentration or on adjacent targets. The fewer the colors required, the more distinct each color may be made.

Gas Defense.

For a number of years, the wearing of gas masks at Force Practice has been a requirement. This year, in order

to make the test more realistic and to ensure that masks were worn by all personnel, the fleet was directed to release a certain amount of chloracetophenone (tear gas). As a result of preliminary tests, the fleet decided it to be unsafe to release this gas for the following reasons:-

(a) There were in some cases not sufficient masks on board of suitable sizes for all personnel.

(b) Many masks were found to be defective.

(c) There were no efficient optical masks for the use of director and gun pointers, safety officers, rangefinder operators, etc.

While the gas was not used on the actual practice, it is believed that the preliminary tests served as a valuable gas defence training. They will also, it is hoped, serve as a stimulus toward remedial action. The development and supply of proper gas defense material has been limited by shortage of funds.

Indirect Fire.

Indirect fire methods were given a test this year on a practice fired by the TENNESSEE. Owing to the re-gunning requirements of the Bureau of Ordnance, it was necessary to use reduced charge, giving a maximum range of about 23,000 yards. In order to make the target completely invisible to the firing ship, the practice was fired over an uninhabited island. (Slides) Not only was the target invisible on the actual practice, but the outlines of the island itself could hardly be made out through the haze.

The principal errors of indirect fire have always been those of deflection. Observations made of such deflection errors on indirect fire exercises have shown the curve of errors to be composed of (a) a more or less steady creep,

(b) oscillations with periods of from 5 to 20 minutes, (c) irregularities from salvo to salvo, (d) jumps occurring on turns. Most of these errors are due to oscillations and irregularities of the gyro compass, which are not sufficiently large to affect navigation materially, but are large enough to throw the salvos off the target, when indirect fire is being used.

The deflection performance on this practice was the best of any practice of this nature yet held, and is most encouraging. It may have been due, to a large extent, to the fact that the firing ship was on a steady course for one hour prior to opening fire. The average error of the M.P.I. in deflection was about 150 yards, and the maximum was 250 yards. On a previous practice, the M.P.I. shifted 1,000 yards from one side to the other.

In range, the target was straddled on the third salvo. The first salvo was 2700 yards over, the 2nd, 900 yards short. The M.P.I. of the 3rd was 25 yards short 121 yards left. (Slides) The target was straddled in range in 10 out of 14 salvos. Nearly 2% of hits were made.

Training of other ships than that firing the advanced practice is obtained through the means of indirect fire exercises. All ships are required to make actual use of the stable zenith director on Force Practice in order to enforce maintenance of this instrument, and training in its use. This director has many advantages in favor of its use even when direct fire is possible.

Indirect fire has not yet been tested against a moving target. For this a radio controlled target is a necessity.

Effect of Changes of Course Upon Gunfire.

Turns of Firing Vessel.

In 1923, the PENNSYLVANIA fired a practice involving continuous gun fire during a change of course of 180°. This year a similar practice was fired by the CALIFORNIA. The PENNSYLVANIA was required to use the stable zenith director, and got off the target in range due to errors introduced by the turn in this instrument. The target was, however, held in deflection, with a maximum error of the M.P.I. of 64 yards. The CALIFORNIA, using the regular top director stayed on in range, but got off in deflection. Approximately the same methods were used by each ship.

Careful analysis of the CALIFORNIA's practice seems to indicate that the failure to stay on in deflection was due, first, to an error of the director trainer on the first salvo of the turn, second, to a plotting room error on the following salvo, and finally, by spots made as a result of the previous errors.

During a turn, if the ship remained on an even keel, if the correct ship speed were kept constantly set on the range-keeper and the generated deflection were constantly introduced into the director system, the present rangekeeper would care for all changes due to the turn. The ship, however, lists during the turn, and causes a trunnion tilt error, which, in the case of the CALIFORNIA, necessitated a correction of as much as 12 mils when firing over the bow. This correction varies with the amount of heel, and with the angle of train, being a maximum dead ahead and astern, and zero abeam. (assuming that the standard plane remains horizontal in the fore and aft direction.) The tilt correction has been handled by previously observing the list of the ship with the rudder angle and speed

to be used, computing a table of corrections for, say, every 10^{0} or 15^{0} of train, and setting these corrections on the rangekeeper as progressive spots as the ship swings around. Until a tilt correction indicator or computer is supplied, all ships should obtain this data at battle speeds for different rudder angles.

The conclusions drawn from these practices are that fire may be maintained during a turn with no loss in volume of fire, except that due to the omission of two, or at the most, three salvos from one group of turrets, while they are swinging around to pick up the target on the opposite side. There should be little, if any, loss of accuracy in fire by a ship thoroughly prepared to meet such a problem. The introduction of a counter-march one year for long range battle practice is being considered.

Small turns of 30^{0} are regularly made at Long Range Battle Practice, without distrubance to the fire of well trained ships.

Turns of Target Vessel.

Data as to the effect on gunfire of large turns made by targets can not be obtained with towed targets. A radio-controlled target is necessary. An experiment of this nature was made with the ex-IOWA, but was not entirely satisfactory, due to the delay in reporting the target change of course to the plotting room. Analysis of the practice indicated that the target would probably have been straddled throughout the turn had information been given more promptly.

As a matter of general principle, it is believed that radical changes of course will not affect a ship's own fire control as much as that of the enemy. The fire control has accurate information as to own ship's movements, often in advance. Information as to target movements is always

delayed, and then must be based on an estimate.

Secondary Batteries, Battleships.

The primary purpose of battleship secondary batteries is to repel torpedo attacks in action. Destroyers are now delivering successful attacks at ranges outside of 11,000 yards, making it necessary to stop them well beyond of this range. The results of secondary battery long range battle practice, fired at 14,000 yards against slow moving targets, are, while capable of improvement, rather unsatisfactory (4 - 6% of hits). Actual tactical maneuvers have shown that very few guns bear on attacking squadrons, particularly on the engaged side during main battery fire. The IOWA firing indicated that the secondary battery will be subjected to heavy damage as soon as enemy major caliber hitting is established. It is apparent that we must either break up torpedo attacks with our own light forces, or else be forced to turn away. It might be said that this is an argument, both for the building of light cruisers, and for the perfection of our gun fire during countermarches.

The efficiency of the secondary batteries of the older ships can be greatly increased by raising the control stations, and by installing the directors in the control stations. Unfortunately, this necessitates rebuilding the masts. In an action, or in any practice where targets must be shifted quickly, the ships with separate director stations are greatly handicapped. The director must be under the immediate control of the control officer. This has been fully demonstrated by the advanced secondary practices, fired by two divisions of ships at targets representing an attacking squadron.

The general doctrine controlling the distribution of secondary battery fire has been given as thorough a test as

practicable in target practice, and appears to be satisfactory.

Illumination of Night Targets.

The searchlight, as a method of target illumination, has been practically superseded by the star shell. The searchlight has a short range, it is difficult to keep on when there is any motion on the ship, the beam is quickly diffused if there are any particles of moisture in the atmosphere, and the light furnishes a point of aim to an enemy. It will probably never be used except possibly in the case of an emergency at close range.

The first 5" star shell supplied to the service was a blunt point projectile, which has a range, with a 15° elevation, and 21 sec. fuse setting, of about 6,000 yards. This has now been superseded by a long point projectile which, with an elevation of 20°, and a 45 sec. fuse setting, has a range of about 14,000 yards.

Early star shell experiments indicated that the best illumination occurred when the stars burst 1,000 yards behind the target and about 1,500 feet high. To keep the burst so placed requires a continual change of fuse settings and sight settings as the range changes. This is practically impossible with the ship darkened, without an automatic fuse setter, which is not yet provided.

Further experimental firings with the blunt nose projectile proved that if the star were fired at 15° elevation with full fuse setting, it would give satisfactory illumination for any target from about 6,600 yards down to 2,000. This, of course, greatly simplified control, and was adopted as a standard in the Battle Fleet. The only difference was that, in the case of the shorter ranges, the burst was further behind the target, and, if the

relative bearings were changing rapidly, or there was a high cross wind, the target would not remain so long in the ray of illumination.

The same is true, only to a greater extent, with the longer range star shell. Here it seems advisable to establish three or four illumination zones, with fuse settings and sight settings to correspond. Upon opening fire, ships will always fire spread salvos to locate the target, shifting to the nearest zone when the range has been determined with accuracy.

This year was the first test of star shell illumination by ships in formation. It was feared that there might be confusion in the identification of own star shell bursts, at the long ranges, but the targets were at five hundred yard intervals and no trouble of this nature appears to have been experienced.

The illumination of a division fire sector by single ship firing spreads is believed to have possibilities, and in fact many advantages. It was actually tried by one division on the rehearsal of Night Battle "A", but failed, owing to material failures on the illuminating ship. The division then shifted to single ship illumination for the actual practice.

Destroyers are supplied with star shell both for the 4" and the 5" 23 caliber gun. The 4" star is much superior, but when used on the engaged side, reduces by 1/3 the number of guns firing service projectile. Doctrines for the control of the star shell, very similar to those in use in the Battle Fleet, have been evolved. Apparently here there is some confusion in identifying bursts for the Commander Destroyer Squadrons, Battle Fleet, recommends star giving different cloud burst for each ship of a division.

There has been some experimentation with the use of flares dropped by planes for target illumination. Owing, however, to the unreliability and poor quality of the flares so far supplied, little has yet been learned. It seems probable that, if planes can drop a line of flares behind a target formation, the night main battery range may be increased to 20,000 yards.

Another possible means of increasing the night main battery range may be the use of light screening vessels to fire star shell. The difficulty here would be to get the illuminating vessels to place the star correctly; that is, on the line of sight from firing ships to targets, beyond the targets. Considerable thought has been given to this question, but the problem in designing such a practice is that of a suitable target. Here again we need a radio-controlled target.

The Advanced Battle Torpedo Practices, two of which are held when the fleet is assembled, are in reality tactical exercises, and, as such, have no real place in this talk. They are, however, of such general interest, that I feel a few words in regard to them will not be out of place. The fleet is divided into two forces, one of which has a superiority of capital ships, and light cruisers, while the other has a superiority in destroyers. Each force is required to seek a decisive engagement. The force having the destroyers is allowed to deliver an actual attack, each vessel of the attacking squadron firing two or three torpedoes. Dummy mine fields are laid by the mine forces.

While the maneuvers of both days were interesting, the most spectacular feature appears to have been the co-ordinated attack of the 11th and 12th squadrons (Battle Fleet Destroyers) made under cover of a smoke screen, and

supported by a division of three light cruisers, and by an advance wing battleship (the long ranged CALIFORNIA). The destroyers drove in to very close range, but could not be made out by the attacked battleships until just as the destroyers turned to fire. Similarly, the battleships were visible only to the squadron leaders until the firing point was reached. Enemy course and speed for director setting was transmitted by signal. Very valuable tactical information was actually transmitted to commanders of the forces by aerial observers.

I cannot do better, in giving you a general idea of the lessons of these practices than to read you the following excerpts from the report of the Commander-in-Chief, U. S. Fleet:

"The Commander-in-Chief is gratified with the results of these practices and cannot too strongly emphasize the value of such practices in the training of the Fleet for war. These practices, simulating as they do the tactics of a major fleet engagement, clearly emphasize the outstanding need of Our Navy at the present date -- namely, MORE LIGHT CRUISERS. The fire of the secondary battery of battleships in the arcs of train sharp on either bow is limited by the structural design of the ships, and, therefore, a destroyer attack pressed home from this quarter at a time when the main battery is engaged against an enemy battle line, has chances of success, unless such an attack can be broken up by our own light forces prior to its arrival at an advantageous point from which to fire torpedoes.

"Conversely, <u>light cruisers must be available</u> to support an attack by our own destroyers against the head of an enemy battle line if such attack is to

succeed. In this connection, it must be borne in mind that the two major foreign navies at the present time are decisively stronger in light cruisers than the United States.

"These practices also confirm the Commander-in-Chief in his belief that destroyer leaders must be provided for the use of Squadron Commanders in order that proper handling of their tactical units may be effected. The need of the fleet in this respect is held next in importance to that of light cruisers and airplane carriers.

"The value of air forces in tactical scouting before visual contact between fleets was made, and later, during the battle, in reporting mine fields and movements of enemy ships behind smoke screens, was clearly demonstrated during these practices. The Commander-in-Chief has noted, however, that failures to get off, breakdowns, etc. must always be expected with planes, and that the effective air strength at the time of action will be appreciably less than the total air force carried in the fleet.

"There was confusion and lack of detail in many of the reports received from the planes. This was partly due to the fact that there is lack of standardization in reports to be made and methods of making them. Steps are being taken to remedy this defect in the future training of the fleet air force. This failure in its broader aspects, however, emphasizes the fact that aviators, in order that their service may be of maximum value to the fleet during battle, must first of all be Naval officers with a clear understanding of Naval problems and tactical situations.

Such knowledge can only be obtained by continued training in the fleet.

"These practices are particularly instrumental in developing the advantages, and also, the possible dangers, connected with the use of smoke screens and floating mines. It is hoped that during the coming year further training may be had in the development of these two types of tactics. The success of both depends to a very large measure on accurate coordination between widely separated units of the fleet, and while these practices showed both success and failure in the use of smoke screens and floating mines, it is believed that further training and development of tactical doctrines is necessary to develop sound opinions as to their real tactical values.

"The signals in existing publications regarding mine laying and reporting of mined areas were found inadequate in many respects. The revision of these signals has been initiated, and recommendations in this matter will be submitted in separate correspondence.

"The Commander-in-Chief is of the opinion that the use of destroyers for unsupported daylight attack during high visibility is unsound. Once the major action has begun, however, the attack must be pressed home with all available forces. Unsupported attack by light forces during the night preceding the day on which major action is expected, and also at all times during conditions of low visibility is sound.

"Referring to the recommendations that the war instructions be modified to permit the use of torpedoes at enemy light cruisers when they interpose to

prevent destroyer attack on the enemy battle line, the Commander-in-Chief feels that such a doctrine would lead to confusion regarding the primary mission of destroyers, namely, to attack the enemy battle line with torpedoes. Due to the small draft, high speed, and maneuvering ability of light cruisers, it is not considered advisable to make them normal torpedo targets, and the use of torpedoes against such vessels should be rare. The real support against enemy light cruisers must come from our own fast wing and light cruisers, and our deficiency in the latter type should be remedied at the earliest practicable date.

"It is recommended that next year's practices be outlined along the same general lines as those of this year. The requirement that smoke screens and mine laying be used should be retained."

Miscellaneous.

The need of a radio controlled target for the solution of many of our gunnery problems has been mentioned. We had one, of slow speed, but for reasons of policy it was sunk before full value was obtained from its use. Such a target is needed, not to ascertain material damage, but for the study of fire control problems. With projectile specially constructed so as to do a minimum of damage, there is no reason why a battleship target of this sort should not be retained for some time. The NORTH DAKOTA has been designated for this purpose, but so far the necessary funds for converting her to radio control have not been available. Every effort should be made by all concerned to obtain this appropriation. A destroyer also should be utilized to give us a high speed target, but the destroyer would be hard to keep afloat if seriously hit.

All of our practices are fired at slow speed towed targets, which may give very false impressions. We very much need targets which can be towed at battle speeds. Several targets of the hydroplane principle were built and tested. They towed well, but were too weak structurally to stand the strain, and finally broke in two. What is left of one is still, I think, on the torpedo station wharf. Since this failure, there have been no funds to go ahead with the work. This is a most important matter, and should not be overlooked.

Before closing I would like to say a word as to gunnery schedules. My outline has, I think, given you some idea as to the gunnery work that must be done. Unfortunately our personnel turnover, in officers as well as enlisted men, is such that a one year gunnery cycle is practically imposed upon us. Should the cycle be increased to two years, we should want the same amount of gunnery work per year, but we would progress to more advanced practices. Twelve weeks per year is officially allotted to gunnery exercises. Surely that is not too big a proportion for this all important factor of our work. It is ample, provided it is utilized only for the actual rehearsal and carrying out of target practices. Gunnery <u>training</u> should be continuous and concurrent with other activities. The best possible gunnery training is afforded when vessels cruise in company at sea. The lack of such a cruise prior to the last Long Range Battle Practice had its effect on the rangefinding and rangekeeping work.

When two or more practices are fired in the same gunnery period, it becomes necessary to <u>train</u> for a practice during a period which should be devoted exclusively to <u>firing</u> it. It is during such intensive gunnery periods that

the cry "too much gunnery" arises. This year, for instance, the Battle Fleet fired practically all of its practices between October and February, which, when overhaul, training and holidays are taken into consideration, made for a rather crowded schedule. From then until next October (7 months) there is not a shot to be fired, except possibly an anti-aircraft practice upon the return to Hawaii. I realize perfectly that there are many other considerations which regulate fleet employment, and it is far from my intention to criticize the formulation of the schedules. What I do wish to emphasize is that, from the gunnery point of view, the ideal schedule is that which provides for short gunnery periods, just long enough for one practice, distributed approximately uniformly throughout the year. There should be a period after each practice, when the lessons of the practice may be carefully digested and applied. This ideal is not, of course, entirely practicable, but, for the good of gunnery, it is hoped that it may be approached as closely as possible.