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GUNFIRE RULES

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Naval War College
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April, 1922.

C O N F I D E N T I A L

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Military Service.

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This revision of the Gunfire Rules for the Tactical Maneuver, together with a few other rules which interlock with them, is issued in advance of the complete revision of the Maneuver Rules.

A summary of rules and penalties for capital ship gunnery is included.

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SECTION F: GUNFIRE.

Tactical

Rule F-1.- Ammunition allowance per gun is:

- (a) for vessels of large, intermediate, or small size,
 - 15", 16" 110
 - 12", 13¹/₂, 14" 150
 - 8", 9¹/₂, 10" 200
 - 7¹/₂, 6", 5¹/₂ 250
 - 5", 4¹/₂, 4", 3" 300.

(b) for vessels of destroyer size, two-thirds the above;

(c) for vessels of submarine size, one-third,

Rule F-2.- (a) Director fire is assumed to be used for both main and secondary batteries of the following types and for no others:

- (1) Large and intermediate size fighting types, both first and second line;
- (2) Small fighting types, first line. (A-2.)

(b) A vessel receiving 50 percent or more of gunfire damage can no longer fire by director. (F-50.)

Rule F-3.- (a) Plane spot may be used for the main battery fire of ships using director fire (F-2), provided one observation plane for each ship using plane spot is in spotting position, can see the target, and is not engaged by enemy aircraft; and subject to Rules F-20 and F-48.

(b) To be in spotting position, a plane must be within ten thousand yards of the target, near the line of fire, and at a height of not less than one thousand nor more than five thousand feet.

(c) Plane spot may not be used for secondary battery fire.

Rule F-4.- (a) Kite balloon spot may be used for the main battery fire of any ship flying a kite balloon. (F-20, 50.)

(b) Kite balloon spot may not be used for secondary battery fire.

Rule F-5.-- (a) Except in special cases, to be determined by the umpire, and except as provided in Rule F-18, the positions of ships at the end of the move are considered to have been occupied during the entire move.

(b) For gunfire, range and target angle are measured at the end of the move.

Rule F-6.-- (a) The target angle is the angle between the line of fire and the keel line of the target ship. With target broad-side-on, target angle is 90; and-on, zero.

(b) For the purpose of determining whether hits are penetrative, the target angle will be recorded as an even multiple of 15 degrees.

(c) If the target angle as measured is not an even multiple of 15 degrees, it will be recorded as the next larger angle that is such a multiple. That is,

<u>for angle measured as</u>	<u>record as</u>
0-15	15
16-30	30
31-45	45
46-60	60
61-75	75
76-90	90.

Rule F-7.-- (a) Penetrative hits are hits which can penetrate the armor of the target ships under existing conditions of range and target angle.

(b) Limiting ranges for armor penetration are as given in the fire effect tables.

Rule F-8.-- (a) Range, for gunfire purposes, is the distance in thousands of yards, from firing vessel to target.

(b) Actual ranges of 0 to 1500 yards are considered as a range of 1; 1500 to 2500, as a range of 2; and so on.

Rule F-9.-- (a) The maximum range imposed on each type of gun by its mounting is as given in the fire effect tables.

(b) No distinction is made in the tables between director fire and pointer fire, but separate tables are provided for different spot conditions, and for penetrative and non-penetrative hits.

Rule F-14.- (a) For conditions other than normal, the normal fire effect is subject to a first and a second correction, each of them an increase or decrease of a number of tenths.

(b) The net effect of conditions which affect principally the rate of fire is taken as a first correction. Applying this first correction to the figure of normal fire effect, the result is taken as the measure of fire effect delivered.

(c) The net effect of conditions which principally affect the accuracy of fire is taken as a second correction. Applying this second correction to the figure of fire delivered, the result is the measure of fire effect inflicted on the target ship.

Rule F-15.- (a) During the move in which gunfire is opened, one or more salvos may be required for ranging before the target is straddled.

(b) As a first correction, the fire effect for the opening fire move is reduced as follows:

<u>Range</u>	<u>Reduction</u>
0-5	None
6-10	2 tenths
11-15	4 tenths
16-20	6 tenths
21-25	8 tenths
over 25	10 tenths.

(c) When establishing the range by indirect fire (F-48), the above penalties are increased by five tenths.

(d) During the move in which gunfire is opened, the fire of a vessel will be neither increased nor decreased by reason of the amount of fire she is under.

Rule F-16.- If a vessel, having established the range, ceases fire for one or more moves she must re-establish the range on again opening fire. (F-18, 48.)

Rule F-17.- (a) When the fire is shifted to a target adjacent or near to the previous target a penalty is applied by reducing the fire effect, as a first correction, three tenths.

(b) When fire is changed to a target at a materially different range or on a materially different bearing the firing vessel will be subject to the rules for opening fire (F-15), but will in no case suffer a less penalty than prescribed in (a) of this rule.

Rule F-18.- (a) When, owing to the interposition in the line of fire of smoke, another ship, or other obstruction, the fire would be halted for all or part of a move, fire effect will be reduced, as a first correction, by a number of tenths proportional to the part of the move during which fire was masked.

(b) The masking of fire for one complete move or more will impose the additional penalty of reestablishing the range when fire is again opened. (F-15).

Rule F-19.- (a) If the fire of a ship's battery be divided on two or more targets, the guns firing on each target must be controlled as a separate group, except that

(b) A single group may fire on two targets which are close together and which have the same range and the same rate of change of range; as, for instance, on two adjacent ships in the same close formation.

Rule F-20.- (a) Vessels of the BB and CC types are assumed to have duplicate primary systems of fire control, and to be able, without loss of fire control efficiency, to fire their forward turrets as one group and their after turrets independently as a second group.

(b) A vessel of type other than BB or CC is assumed to have only one primary system of fire control, and cannot fire its battery in more than one group without loss of efficiency.

(c) If otherwise permitted, the fire of a group of guns being controlled by a primary fire control system may be handled by either plane spot or kite balloon spot; but plane spot may not be used for more than one group in a ship, and kite spot may not be used for more than one group in a ship.

Rule F-21. - (a) The fire of groups in excess of the number permitted by Rule F-20 (two for a BB or a CC, one for any other ship) can be handled only by local control.

(b) The fire of guns of 5"5 caliber or larger under local control will be penalized, as a second correction, as follows:

<u>Range</u>	<u>Penalty, tenths</u>
0-5	None
6-10	2
11-15	4
16-20	6
21-25	8
26 plus	10

(c) The fire of guns of 5" or smaller caliber will not be penalized for local control, as the fire effect tables for such guns are constructed for local control conditions.

Rule F-22. - (a) For torpedo defense, the complete battery of a ship may be divided quadrantly into four groups, and the fire of each group within its own arc may be handled independently of the other groups in the same way as if each group were in a separate ship.

(b) Under these circumstances, only local control can be used, subject to the penalty provided by Rule F-21.

Rule F-23. - (a) Concentration of the fire of more than one ship upon a single target without loss of efficiency is permitted only in the case of two adjacent ships in the same formation.

(b) If ships not adjacent ships in the same formation fire on the same target, the fire of each on that target will be reduced for non-adjacent concentration, as a first correction, two-tenths.

(c) Independently of the above, if more than two ships fire on the same target, the fire on that target of the two firing at the shortest ranges will be reduced for over-concentration, as a second correction, as follows:

<u>at range</u>	<u>penalty, tenths</u>
0-5	none
6-10	1
11-15	2
16-20	3
21-25	4
26 plus	5

of the one at the next shorter range, twice the above; of the next, three times; and so on.

Rule F-24.- Fire is considered effective when the range has been established and when the range is not greater than the maximum effective range of the guns firing. (F-10,11,15.)

Rule F-25.- (a) A ship is considered to be under normal fire when she is under the effective fire of a number of guns which in number and caliber are about equal to the broadside fire of an average ship of her own type.

(b) A BB or CC is under normal fire when eight to twelve guns of 12" or larger caliber are delivering an effective fire on her. (F-24, 30).

Rule F-26.- (a) A ship is considered to be under less than normal fire when she is under the effective fire of a number of guns which are of a caliber large enough to be suitable for the principal armament for a vessel of her own type, but are fewer in number than the broadside battery of an average ship of her own type.

(b) A BB or CC is under less than normal fire when two to seven guns of 12" or larger caliber are delivering an effective fire on her. (F-24,30.)

(c) A ship under less than normal fire will have her own fire effect increased, as a first correction, one tenth. (F-15.)

Rule F-27.- (a) A ship is considered to be not under effective fire when less than two guns of a caliber large enough to be suitable for the principal armament of a vessel of her own type are delivering an effective fire on her. (F-24,30.)

(b) A ship not under effective fire will have her own fire effect increased, as a first correction, three tenths. (F-15.)

Rule F-28.- (a) A ship is considered to be under concentration when under the effective fire of a number of guns which in number and caliber are more than the broadside fire of an average ship of her own type.

(b) A BB or CC is under concentration when more than twelve guns of 12" or larger caliber are delivering an effective fire on her. (F-24,30.)

(c) A ship under concentration will have her own fire effect decreased, as a first correction, three tenths. (F-15.)

Rule F-29.- (a) A ship is considered to be under secondary fire when under the effective fire of a number of guns smaller in caliber than would be suitable for the principal armament of an average ship of her own type.

(b) A BB or CC is under secondary fire when receiving the effective fire of four or more guns of 8" to 11" caliber, six or more guns of 5" to 7.5 caliber, or ten or more guns of 4" to 4.7 caliber. (F-24,30.)

(c) Independently of Rules F-25 to F-28, a ship under secondary fire will have her own fire effect reduced, as a second correction, one tenth. (F-15)

Rule F-30.- In applying Rules F-25 to F-29, the amount of ship gun damage, up to 49 percent, sustained by enemy ships will have no weight; but the fire of the battery of a ship which has received gun damage of 50 percent or more will be considered as the fire will of one-half the number of guns actually firing.

Rule F-31.- (a) A firing vessel which changes course will have her own fire effect for that move decreased, as a first correction, one tenth for each whole ten degrees of aggregate change two during the move.

(b) The umpire may impose the next greater penalty in case the change of course approximates the next greater change.

(c) If a firing vessel changes course both right and left in three minutes, the penalty prescribed in (a) of this rule will be doubled.

Rule F-32.- (a) If a target vessel changes course, the fire on her will be reduced, as a second correction, as follows, based on speed of target and net change of course during the move away, from the course at the beginning of the move, for ranges of 15 or less:

Penalty in tenths,
for target speeds of

Net Change	11-18	19-29	30 plus
15-29	0	1	2
30-44	1	2	3
45-59	2	3	4
60-74	3	4	5
75-89	4	5	6
90 plus	5	6	7

(b) Subject to (c), in the range is 16 to 20, the penalties prescribed in (a) will be increased two tenths; if the range is over 20, four tenths.

(c) With indirect fire, the penalty for target change course is doubled. (F-48.)

(d) No penalty will in any case be inflicted on the firing ship for target change of course unless the speed of the target ship is 11 knots or more, and the net change is 15 degrees or more.

Rule F-35. - If a firing vessel changes speed, her fire effect will be reduced, as a second correction, one tenth for each two knots of change during the move.

Rule F-34. - (a) If a target vessel changes speed, fire on her will be reduced, as a second correction, one tenth for each two knots of change during the move.

(b) With indirect fire, this penalty is doubled. (F-48.)

Rule F-35. - (a) Large rate of change of range reduces fire effect, as a second correction, as follows, based on range and amount of change of range during a three-minute move:

Range	Change	Penalty (tenths)
1-5	2	1
	3	3
	4	5
	5	7
6-20	2	2
	3	4
	4	6
	5	8
21 plus	2	3
	3	5
	4	7

(b) Change of range of less than 2 per move is not effective to reduce fire effect.

Rule F-36.- (a) When, owing to the relation between the course and speed of a firing ship and the direction and force of the wind, gun gases, funnel gases, or funnel smoke from the firing ship or other nearby ships may drift across the line of fire, the fire of such ship is penalized.

(b) The gas penalty, effective when gases, but no funnel smoke, so intervene, is the reduction of fire effect, as a second correction, one tenth. (C- .)

(c) The smoke penalty, effective if funnel smoke so intervenes, is the reduction of fire effect, as a first reduction, by day, three tenths; by night, five tenths. (C- .)

Rule F-37.- (a) When, owing to the character and direction of the sea and wind with relation to the course and speed of a firing vessel, spray is thrown over gun positions, the fire of such vessel may be reduced thereby.

(b) The spray penalty is operative when the wind has a force of four or more, and its absolute (not relative) direction is from 15 degrees or more forward of the beam on the engaged side, or from dead ahead. It reduces fire effect, as a first correction, two tenths.

(c) For ships using director fire (F-2), the spray penalty is not effective with regard to the fire of guns mounted on or above the main deck.

Rule F-38.- (a) When the character and direction of the sea are such as to cause a firing vessel to roll more than usual, the effect on ammunition handling and gun pointing may slow the fire.

(b) The roll penalty is operative when the sea is from a direction between 15 degrees forward of abeam and 30 degrees on the quarter. It reduces fire effect, as a first correction, in tenths as follows:

<u>Sea</u>	<u>Penalty</u>		
	<u>For vessels of size</u>		
	<u>Large</u>	<u>Int.</u>	<u>Other</u>
Moderate	3	4	5
Rough	4	5	6
Heavy	5	6	7

(c) For vessels using director fire (F-2), the roll penalty is two tenths less than the above.

Rule F-39.- (a) When the character and direction of the sea are such as to cause a firing vessel to pitch more than usual, the effect on gun laying will reduce the fire effect.

(b) The pitch penalty is operative when the sea is from a direction 20 degrees or less from ahead. It reduces fire effect, as a first correction, in tenths, as follows:

<u>Sea</u>	<u>Penalty</u>		
	<u>For vessels of size</u>		
	<u>Large</u>	<u>Int.</u>	<u>Other</u>
Moderate	1	2	3
Rough	2	3	4
Heavy	3	4	5

Rule F-40.- (a) When the character and direction of the sea are such as to cause a firing vessel to yaw more than usual, the effect on gun laying will reduce the fire effect.

(b) The yaw penalty is operative when the sea is from a direction 30 degrees or less from astern. It reduces fire effect, as a first correction, in tenths as follows:

<u>Sea</u>	<u>Penalty</u>		
	<u>For vessels of size</u>		
	<u>Large</u>	<u>Int.</u>	<u>Other</u>
Moderate	3	4	5
Rough	4	5	6
Heavy	5	6	7

Rule F-41.- When both main and secondary batteries of turret ships are firing on the same side, the fire effect of the main battery at night will be reduced for battery interference, as a first correction, three tenths; and the fire of the secondary battery firing on that side, day or night, will be reduced, as a first correction, five tenths.

Rule F-42.- (a) If depth charges are dropped near a firing vessel, in such positions and with such depth settings that their splashes will be in or cross the line of fire, the fire effect of such vessel may be reduced.

(b) The fire of vessels using director fire is not affected by depth charges with settings of 75 feet or more. (F-2.)

(c) The fire of vessels not using director fire is affected by depth charges with settings of less than 150 feet.

(d) Subject to (b) and (c) of this rule, depth charge explosions which are in or cross the line of fire during a move reduce the fire effect for that move, as a first correction, by a number of tenths equal to the number of such depth charges divided by their distance from the firing ship in thousands of yards.

Rule F-43.- (a) When a vessel is firing into the glare of the sun, the accuracy of her fire is reduced.

(b) The sun glare penalty is operative during the two hours after sunrise and the two hours preceding sunset, when the target bears within fifteen degrees of the sun.

(c) The sun glare penalty reduces fire effect, as a second correction, two tenths.

Rule F-44.- (a) Visibility conditions better than normal will not increase fire effect.

(b) When the range of visibility is less than under normal day visibility conditions, neither maximum range or maximum effective range can exceed the range of visibility. (F-9, 11.)

(c) Under such conditions of reduced visibility, including night conditions, the figures finally allowed as fire effect inflicted cannot exceed the following number of tenths of normal fire effect:

- (1) At extreme range of visibility, 5
 (2) At 1000 yards less than (1), 6
 (3) At 2000 " " " (1), 7
 (4) At 3000 " " " (1), 8
 (5) At 4000 " " " (1), 9

(D- , F-45,46,48.)

Rule F-45.- (a) When the target ship is silhouetted against the eastern horizon before sunrise or the western horizon after sunset, the firing ship will not be penalized for reduced visibility.

(b) This rule applies only during the twilight period, and when the target ship bears within 45 degrees of the sun. (D- .)

Rule F-46.- (a) When the target ship is illuminated by star shell, the firing ship will not be penalized for reduced visibility. (D- .)

Rule F-47.- (a) When a ship, other than the target ship, is (at the end of the move) within the area where the salvos of the firing ship are falling, she is liable to damage by enfilade.

(b) This is allowed for by awarding damage to a ship so enfiladed amounting to a certain number of tenths of the fire delivered (F-14) by the firing ship, without reducing the measure of fire effect inflicted on the target ship.

(c) To be subject to enfilade, a vessel must be in or very near the line of fire, and within 1500 yards of the target ship, in which case enfilade damage is inflicted on her as follows, in tenths of fire delivered against the target ship:

<u>Distance from target</u>	<u>Enfilade</u>
0-500 yards	6 tenths
501-1000 "	4 "
1001-1500 "	2 "

(d) In the case of 6" caliber or smaller firing at vessels of destroyer or submarine size, the above amounts of enfilade are reduced two tenths.

Rule F-46.— A vessel firing by director and by kite balloon or plane spot may fire by indirect fire on targets not visible from the firing ship, subject to the following restrictions:

(a) With kite balloon spot:

(1) Indirect fire may only be used to fire over smoke screens that are not more than six thousand yards from the firing ship, and that are nearer to the firing ship than they are to the target.

(2) In establishing the range by such indirect fire, the penalty for the open-fire move is increased by five tenths. (F-15.)

(b) With plane spot:

(1) Plane spot may not be used to establish the range by indirect fire, but, the range having been otherwise established, fire on a target which ceases to be visible from the firing ship may be continued by plane spot and indirect fire, provided only that the requirements for plane spot (F-3) are met, and subject to the second restriction,

(2) If for any cause the fire effect for a move is zero, the range is lost and the fire effect thereafter is zero until the range is again established by direct fire or kite spot.

(c) Using indirect fire, the penalties for target change of course or speed are doubled. (F-32,34.)

Rule F-49.— (a) Damage to ships is classed as (1) gunfire damage, due to gunfire or bombs, and (2) underwater damage, due to torpedoes, mines, or bombs.

(b) Only gunfire damage is effective to reduce gunnery efficiency.

(c) For each ten percent of gunfire damage received, fire effect is reduced, as a first correction, one tenth.

Rule F-50.— (a) A vessel receiving gunfire damage of 50 percent is subject to the following additional penalties:

(1) Can no longer use director fire, plane spot or kite balloon spot; (F-2,3,4.)

(2) Loss of kite balloon and any planes on deck;

(3) Can no longer fly planes off or on;

(4) Loss of one-half per deck torpedo tubes on each side;

(5) Loss of 20 percent of original maximum speed.

(b) A submarine receiving 50 percent damage from all causes is thereafter unable to submerge.

Rule F-51. - A vessel receiving gunfire damage of 70 percent is subject to the following additional penalties.

(1) Loss of all deck tubes;

(2) Loss of an additional 50 percent of original maximum speed.

Rule F-52. - A vessel receiving 80 percent of damage from all causes can not make more than five knots.

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Other extracts from revised Maneuver Rules

Rule A-1.- (a) Actual types of ships will ordinarily be used in the maneuver.

(b) The normal organization of forces and the data of individual ships will be as given in the current War College publications containing this data: "Blue Fleet", etc., and Tactical Data Sheets.

(c) The data on suppositions types will be stated in the problem.

Rule A-2.- (a) Surface vessels are classified as to size as follows:

<u>Size Class</u>	<u>Displacement, tons.</u>
Large	20,000 plus.
Intermediate	8,000 - 19,999.
Small	3,000 - 7,999.
Destroyer	200 - 2,999.
Submarine	199 - minus.

(b) All submarines are classed as being of submarine size.

Rule A-3.- Displacement will ordinarily be taken as normal surface displacement.

Rule G-26.- Each torpedo hit inflicts underwater damage in amount equal to three 14" penetrative hits.

Rule G-18.- (a) A vessel receiving 50 percent or more of gunfire damage loses one-half of her deck torpedo tubes on each side.

(b) A vessel receiving 70 percent or more of gunfire damage loses all deck tubes.

Rule G-19.- A vessel receiving 50 percent or more of underwater damage loses all submerged tubes.

Rule H-8.- A vessel striking a mine receives underwater damage equal in amount to three 14" penetrative hits.

SUMMARY

of

GUNFIRE PENALTIES

as referred to on Fire Sheets and in Summary of Rules.

For penalties or increases that are always the same whenever they apply, the amount in tenths is as noted on the Fire Sheets and in the Summary of Gunfire Rules for Capital Ships, Day Action.

Penalties that vary in amount according to conditions are, in tenths, as follows.

(a)	<u>Range</u>	<u>Penalty</u>	(b)	1 for each 10° of aggregate change if both right and left, double this.
	0-5	None		
	6-10	1	(c)	<u>number of explosions crossing line of fire distance from ship, in 1000's of Yds.</u>
	11-15	2		
	16-20	3	(e)	Proportional to fraction of move for which fire masked.
	21-25	4		
	26 plus	5		

(d)	<u>Penalty for ships of size</u>			(f)	1 for each 10% gun damage.	
	<u>Sea</u>	<u>Large</u>	<u>Int.</u>	<u>Other</u>	(g)	1 for each 2 kts. change.
	Moderate	1	2	3		
	Rough	2	3	4		
	Heavy	3	4	5		

Roll, director fire, d
 pointer fire, d+2
 Pitch, d
 Yaw, d+2

(h)	<u>Net change</u>	<u>Range 1-15, speeds</u>			
		<u>11-18</u>	<u>19-29</u>	<u>30 plus</u>	
	15-29	0	1	2	For range 16-20, increase by 1.
	30-44	1	2	3	21 plus, increase by 2
	45-59	2	3	4	No penalty if speed less than 11; or change less than 15.
	60-74	3	4	5	
	75-89	4	5	6	
	90 plus	5	6	7	

(i)	<u>Range</u>	<u>Change</u>	<u>Penalty</u>	(j)	<u>Distance from target</u>	<u>Enfilade</u>
	1-5	2	1		0-500	.6
		3	3		501-1000	.4
		4	5		1001-1500	.2
	6-20	increase by 1.			For 6" or smaller on dest. or sub., decrease by .2.	
	21 plus,	increase by 2				
	no penalty for change less than .2					

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NAVAL WAR COLLEGE
Newport, R.I.

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Confidential

MEMORANDUM

Subject: Proposed changes in War College Fire Effect System.

Due to the apparent inadequacy of the present War College Fire Effect System, a short outline of the major factors involved in any such system and a proposed method of evaluating them has been prepared for consideration.

It has become evident that there is no great benefit to be derived from a simple revision of the basic tables and the subsequent Fire Effect Tables and Diagrams.

In such a limited revision new values may be obtained for Fire Effect and Life, as defined in the present system. These values would probably be more accurate than they are at present. Nevertheless they would still be theoretical, due to the many unknown factors involved. Favorable ranges may become unfavorable and conversely. The only other possible effect would be to make the Tactical Games longer or shorter, depending on whether the new values are less or greater than they are at present.

The greatest flaw in the present system seems to be due to the use of LONG RUN results. The fire effect obtained represents not what might occur in any single combat between two ships of similar type, but an average of what might occur in several hundred such combats. The element of chance is practically neglected.

Another flaw in the present system is in the method of application of gun fire penalties. These penalties are applied directly to the fire effect. It is obvious that they have a direct effect, only on the rate of fire and on the accuracy of fire.

A strange relation exists between the accuracy of fire and the percent of hits. It is possible for a ship to have a con-

trol error double that for another ship of the same type and still get the same percent of hits. (See Target Practice Reports 1929-30 LRBP the WEST VIRGINIA with a control error in range of 510 yards got 5.4 percent hits, the COLORADO with an error of 165 yards got 5.6 percent hits. The errors in deflection were approximately equal).

These flaws can be rectified considerably. Instead of applying penalties to fire effect, they can be applied directly to the rate and accuracy of fire. From these corrected values, the number of hits per move may be obtained. Then by introducing a chance element, the location of the hits may be decided. For this purpose the target may be divided into sectors equal in size to the smallest vital sector.

Chance numbers may be assigned the various sectors, depending on the ratio of the sector size to whole target size. A number taken from a chance machine will determine the location of a hit.

By use of modified penetration tables, decisions can be made as to whether the hit can penetrate the protection and as to the probable damage that should occur from such a hit; also, its effect on the fighting characteristics of the target.

In the proposed system it should be understood that the chance element applies only to the location of hits, not to the probability of hitting.

For example, by using chance in this manner, it might be possible for a ship to have full effective fire and be unable to move, or it might not be able to fire a single gun and still be capable of maintaining its original maximum speed.

Another departure from the present system is the elimination of the LIFE value, as such. The element of chance is too great to determine an absolute value of LIFE for any ship. In its place is substituted weighted hit values determined by:

evaluating the expected destructive effect on the various sectors. The only sectors in which progressive damage need be fully considered are the water line belts, and the above-water non-vital parts.

Consideration of weighted hit values brings forward another factor which has been neglected in the present system; the effect of turret, barbette, and irregular armor on the protection of the ship. These can be fully considered in the proposed system.

The proposed system may seem somewhat complicated, particularly in regard to scoring. It is certain that scoring will require more attention to details. Actually, however, only one additional step seems to be required. This is necessary in order to bring in the chance element. Some of the factors, such as damage and the effect of damage, can be handled by check off, or casualty lists. Location of damage may be plotted on actual target silhouettes, prepared beforehand. These silhouettes will not only be of interest in critiques, but will bring to light certain definite characteristics of BLUE, RED and ORANGE ships.

The amount of detail required for the introduction of the chance element may be varied from time to time, depending on scoring facilities and the relative importance of certain details. Further study and application will tend to simplify the method.

It is believed that by the addition of one member (preferably a member of the Staff) to the scoring detail, in the capacity of DAMAGE DIRECTOR, the time required for scoring will not be any greater than it is for the present system.

The thesis of the proposed system is, "The results of Battle can no more be represented by a set of formulas than the results of War".

A complete outline cannot be made until each of the various elements has been thoroughly investigated. For this reason, the basic outline indicates only the elements considered necessary for such investigation.

Before further work is undertaken to develop this system, comment regarding its soundness and practicability is desired.

T. S. Cameron
T. S. Cameron,
Lieutenant, U.S.N.

Approved for study
and consideration.

J. W. Wilcox, Jr.
J. W. Wilcox, Jr.,
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Chief of Staff.

Basic outline of the various elements to be considered in the determination of the expected effect of naval gun fire.

There are four major factors to be considered in evaluating the probable effect of gunfire.

- I Probable number of hits.
- II Probable location of hits.
- III Probable damage to sectors hit.
- IV Probable effect of damage on target fighting characteristics.

I

The probable number of hits depends on:

- (a) Accuracy of fire.
- (b) Volume of fire.

(a) Accuracy of fire is determined by Dispersion and Error of MPI, which are affected by

- (1) Range
- (2) Type of firing ship and armament.
- (3) Method of Control.
- (4) Efficiency of personnel.
- (5) Efficiency of material.
- (6) Variations from normal Battle conditions

(See attached sheet for normal Battle Conditions).

(b) Volume of fire is affected by:

- (1) Time.
- (2) Number of guns firing.
- (3) Range.
- (4) Type of firing ship and armament.
- (5) Method of control.

- (6) Efficiency of personnel.
- (7) Efficiency of material.
- (8) Variations from normal Battle conditions.

II

Probable location of hits depends on chance. The chance of any hit being made on any particular sector of the target depends on the ratio of the virtual sector size to virtual whole target size.

III

Probable damage to sectors hit depends on:

- (a) Protection of sectors.
- (b) Size and character of sector.
- (c) Destructive effect of projectile on material and personnel.

IV

Probable effect of damage on target fighting characteristics depends on the importance of the damaged sectors to target,

- (a) Armament.
- (b) Armament control.
- (c) Maneuverability.
- (d) Floatability.
- (e) Communications (internal and external).

NORMAL BATTLE CONDITIONS

1. Range has been established.
2. Firing ship undamaged.
3. Target under effective fire normal concentration.
4. Ship under effective fire normal concentration.
5. Target of type similar to firing ships.
6. Full main battery firing.
7. No other batteries firing.
8. Ship not being attacked by aircraft.
9. Ship has no list.
10. Axis of target approximately normal to line of fire.
11. Ship using Direct, Director, Fire, primary spot.
12. Range not obscured.
13. Firing ship does not maneuver.
14. Target does not maneuver.
15. Rate of change of range is small.
16. Rate of change of bearing is small.
17. Sea is smooth.
18. Visibility is normal.
19. Ship not affected by glare.
20. Target is not silhouetted.

SUMMARY
of
GUNFIRE RULES

FOR CAPITAL SHIPS, DAY ACTION.

The following summary of gunfire rules applies only to capital ships in day action.

It is not intended as a complete summary of all gunfire rules, but only as a ready reference for those already familiar with the rules. For more complete understanding, see the F rules referred to.

Penalties and increases that do not vary are of the amount given, in tenths. For the amounts of variable penalties see the Summary of Gunfire Penalties. Figures in parentheses indicate whether first or second correction.

	<u>Increase or Penalty</u>	<u>Rule</u>
DIRECTOR FIRE: used up to 49% gun damage.		2,13,50
frees main deck guns from spray penalty		37
reduces roll penalty by 2		38
frees all fire from depth charges set		
75 plus		42
necessary for indirect fire		48
PLANE SPOT: better than top spot at ranges 9 plus		
better than kite spot at ranges 19 plus		
Can be used for main battery up to 49% gun		
damage with one plane per ship		3,13,50
for divided fire, for one group only		19
for indirect fire, cannot establish range		48
KITE SPOT: better than top spot at ranges 9 plus		
poorer than plane spot at ranges 19 plus		
Can be used for main battery up to 49% gun		
damage one kite balloon per ship.		4,13,50
for divided fire, for one group only		20c
for indirect fire, open-fire penalty increased		
by 5		15,48
used only over smoke screen distant 6 or less,		
range at least twice this distance		48
LOCAL CONTROL: used for third and fourth groups		
if fire is divided into more than		
two groups		19-21
used for all groups in torpedo defense		22
penalty for 5"5 or larger caliber	(2) 2a	20
for 5" or smaller caliber	0	20
OPEN FIRE: if target visible, at any range		
within maximum range of gun	(1) 2a	9,44-46,48
SHIFT FIRE: to target near old target	(1) 3	17
to target not near old target,	(1) 2a	17
but not less than	(1) 3	17
ESTABLISH RANGE: at any range where fire		
effect is more than zero		10,48
penalty open-fire here, by direct fire	(1) 2a	15,46
by indirect fire, kite spot only.	(1) 2a+5	48

EFFECTIVE RANGE: as given in fire effect tables, but not outside visibility range. 11

EFFECT OF ENEMY FIRE: when under effective fire of

Caliber	Number	Under -- fire		
12" or larger	8 to 12	normal	0	25
	2 to 7	less than normal	(1)1	26
	0 to 1	no eff. fire	(1)3	27
	13 plus	concentration	(1)3	28
8" to 11"	4 plus)			
5" to 7"5	6 plus)	Secondary	(1)1	29
4" to 4"7	10 plus)			

In applying this, if enemy ship has gun damage 50% or more, divide number of her guns by two. 28

CONCENTRATION: two adjacent ships in same formation 0 23
of ships not adjacent ships in same formation (1)2 23
and, if more than two ships, for the third, (2)2a 23
fourth, (2)2a
fifth, (2)3a
etc.

GAS: if gas, but no funnel smoke, from firing ship or near-by ships, crosses line of fire, (2)1 36

SMOKE: if funnel smoke (coal burner at any speed, or oil-burner within two kts. of maximum speed) (1)3 36

DEPTH CHARGE: if depth charge explosions in line of fire, (1)c 42
with setting less than 75 ft. affect director fire,
with setting less than 150 ft. affect pointer fire.

SPRAY: wind 4 or more, from ahead to 15° for'd of beam on engaged side (1)2 37

ROLL: sea from 15° for'd of beam to 30° on quarter 38
for director fire, (1)d 38
for pointer fire, (1)d+2 38

PITCH: sea 15° or less from ahead (1)d 39

YAW: sea 30° or less from astern (1)d+2 40

FIRE MASKED: proportional to fraction of move. (1)e 18
if for 1 move or more, must re-establish range. (1)2a 18

CHANGE COURSE: for change right or left, (1)b 31
if change is both right and left (1)2b 31

TARGET CHANGE COURSE: speed 11 plus, change 15° or more, (2)h 32
if indirect fire (2)2h 32,48

	Increase or Penalty	Rule
<u>CHANGE SPEED</u> : 2 kts. or more during move	(2)g	33
<u>TARGET CHANGE SPEED</u> : 2 kts. or more during move	(2)g	34
if indirect fire	(2)2g	34,40
<u>BATTERY INTERFERENCE</u> : main and secondary fir- ing same side, secondary battery only penalized	(1)5	41
<u>SUN GLARE</u> : two hours after sunrise or before sunset, target within 15° of sun	(2)2	43
<u>VISIBILITY</u> : better than normal does not in- crease gurfire. poorer than normal, limits gunnery effect at ranges within 4000 yds. of range of visibility		44
<u>SILHOUETTE</u> : half-hour before sunrise or after sunset, target within 45° of sun, fire not reduced for visibility.		45
<u>STAR SHELL</u> : fire on target lit by star shell, not reduced for visibility.		46
<u>ENFILADE</u> : damage in tenths of fire delivered on ship near line of fire, and within 1500 yds., of target; for fire of 6" or smaller on dest. or sub., within 1000 yds.	j	47
<u>INDIRECT FIRE</u> : requirements for:		48
(1) director fire (less than 50% gur damage)		
(2) Kite spot over smoke screen not over 6000 yds. away, with target farther away than smoke screen; or		
(3) plane spot.		3
Restrictions on:		
(1) in establishing range by kite spot,	(1)2a*5	15,48
(2) plane spot cannot establish range.		
(3) penalties for target change course or speed are doubled.		
(4) plane spot, zero effect for one move loses all fire until re-established.		