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of PENTANA-TYPE COMPANIES in MOBILE OPERATIONS

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VOLUME III

ARTILLERY SUPPORT

U. S. ARMY
COMBAT DEVELOPMENT
EXPERIMENTATION CENTER
FORT ORD, CALIFORNIA

FINAL REPORT [redacted]

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This volume reports on the requirements for and employment of artillery in support of a PENTANA-type combat group, as determined during the subject field experiment. An artillery platoon of four weapons, simulating a battery of eight tubes, was employed in support of the PENTANA-type rifle company during simulated combat operations against a mechanized Aggressor task force. Conclusions are based on the fire mission data and military observations obtained in the field.

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VOLUME III

REPORT OF

ARTILLERY EXPERIMENT

PREFACE

ARTILLERY

A brief resume of the conditions, environment, and limitations of the Controllability Experiment is given in the preface and abstract to Volume I of this report and the statements therein should be reviewed prior to the study of Volume III, Artillery.

The integration of Artillery Support objectives into the Controllability experimental environment of mechanized forces and relatively unlimited availability of nuclear fires imposed limitations on requirements for non-nuclear fires.

The experimental battery, envisioned as organic to the combat group, consisted of eight tubes with a capability of being separated into two platoons of four (4) moritzers, with each platoon having a fire control capability. Due to limitations in the number of personnel available to support the experiment, this battery was simulated by an artillery platoon of four weapons. This platoon operated under centralized battery control and simulated the fires of the entire battery when the supported company was faced with frontages of less than 8,000 yards. When operating over extended frontages of more than 8,000 yards, the platoon was attached to the company it supported and represented only a platoon capability. In addition, division artillery weapons were limited to a nuclear capability in order that the maximum requirements for fires would be placed on the organic combat group battery.

The conclusions reported herein were reached by the direct analysis of data as applicable and the extrapolation of data to the combat group level where required.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

SECTION I

(CONFIDENTIAL-MODIFIED HANDLING AUTHORIZED)

ARTILLERY

OBJECTIVES 1 & 2a

1. a. Objective 1:

To determine the overall requirements of the combat group for accurate, timely, and continuous artillery support over frontages which vary from relatively narrow to very broad, taking into consideration increased lethality of artillery ammunition and availability of nuclear devices.

b. Objective 2a.

To determine within the framework of the conditions outlined under Objective 1 the capability of the combat group artillery battery to support the combat group.

2. Indicators:

In determining the capability of the combat group artillery battery to support the combat group attention has been directed toward the following areas of study:

a. Maximum rate of fires.

b. Spread of ranges.

c. Communications.

d. Types of targets.

e. Employment of nuclear devices.

3. Presentation of Data:

a. Maximum Rate of Fire:

Figures 1 through 8 present a tabulation by 10 minute intervals of the number of missions and average number of rounds per missions required to support each experimental company in each situation for all record courses. The maximum requirement during any 10 minute period during the entire experiment was 6 missions averaging 16 rounds per mission or a total of 96 rounds.

b. Spread of Ranges:

Figure 9 through 17 indicate the spread of ranges at which artillery missions were fired during the experiment. Ninety-seven per cent of the total missions fired were fired at ranges of 15000 meters or less.

c. Communications:

The data presented in the basic report reveals an insignificant number of communication failures between the artillery battery or platoon and their fire control elements or the supported elements.

d. Types of Targets:

Figures 18 through 20 indicate the types of targets against which non-nuclear artillery was employed. During the conduct of the experiment, 49% of the missions fired were at suspected locations of the enemy, 39% against armored vehicles, 8% against personnel in the open, and 4% at known observation posts.

e. Employment of Nuclear Devices:

The number of non-nuclear versus nuclear missions for the four record courses is contained in Figures 21 through 23.

4. Discussion:

a. General:

(1) All elements of the combat group were "played" in the experiment; however, data collection was limited to the actual requirements for support of one company of the combat group.

On the ground, these requirements were satisfied by one platoon of artillery performing missions of general support, direct support, or in an attached status. The objectives of the experiment must be considered in the light of this selected sample of requirements generated.

(2) Certain assumptions under which the experiment was conducted and which directly influenced the objectives sought must be borne in mind throughout consideration of the discussions and conclusions which follow. These assumptions include:

(a) The range of the organic artillery weapon was 15000 meters.

(b) The rate of fire of the organic artillery weapon was 150 rounds per piece per 30 minutes.

(c) Nuclear munitions were available in unlimited quantities.

(d) Overall artillery support requirements of the combat group were directly proportional to the artillery support requirements of the experimental company.

(3) Furthermore, certain environmental conditions were established during the conduct of the experiment:

(a) No request for attack with nuclear devices was denied. Non-nuclear ammunition was available in unlimited quantities.

(b) Infantry troops habitually rode in light armored vehicles; dismounted ground action was rare.

(c) Indirect non-nuclear artillery fire was ineffective against tanks, light armored vehicles or against troops therein. This is true whether HE, WP or improved fragmentation ammunition is considered.

b. Maximum Rate of Fire:

Missions fired by the platoon or battery, as the case may be, have been grouped by ten (10) minute firing periods to highlight the effect of the firing requirement on the supporting unit. The selection of the ten (10) minute time span is a matter of convenience and does not necessarily imply a restriction on rates of fire. The basic capability assumed for the artillery pieces played was 5 rounds per weapon per minute when the firing period did not exceed 30 minutes. The four tube platoon in support of the experimental company at the time maximum fires were required could have provided 200 rounds in the 10 minute period against the maximum requirement for 96 rounds as indicated in the presentation of data. This same platoon could therefore have simultaneously supported another company with identical requirements. It is reasonable to assume that the other platoon of the battery could have provided like support for two other companies. The conclusion from the experiment is that the rate of fire of the battery would never have been exceeded in support of four companies. The operational environment wherein all troops had 100% armor-protected mobility and the assumption that indirect artillery fire and mortar fire are ineffective against tanks and light armored vehicles tended to disincline company commanders to use non-nuclear artillery and mortars. For example, the 81mm mortar vehicles had been equipped with 106mm recoilless rifles for AT defense of the 81mm mortar platoon. Experimental usage of these weapons evolved to the point where the mortar platoon was employed in an antitank role. Only three mortar missions were fired during the eight record runs.

c. Spread of Ranges:

Only 3% of the missions required in support of the experimental company were in excess of the 15000 meter range assumed for the artillery under consideration. The artillery was positioned to provide identical support to the three other companies whose support by the battery was assumed or the one other company whose support by the platoon was assumed. When considered in context with the effects of these fires (discussed in paragraph e following) it is not considered that these requirements generate either a requirement for increased range of the combat group artillery or a requirement for supporting non-nuclear fires.

d. Communications:

Under the conditions of the experiment the communications capability of the battery or platoon was completely satis-

factory from the standpoint of range capability and mechanical reliability. Military observers attribute a great portion of the mechanical reliability of communications to the aggressive, imaginative employment of maintenance effort within the tested organization.

e. Type of Targets:

The casualty assessment tables employed in the experiment provided that non-nuclear fires against armored vehicles or personnel buttoned up in armored vehicles were ineffective. Limitations in the number of experimental personnel occasioned far less than optimum control and fire marking for the play of smoke. Based on these considerations and the data presented, the artillery fires had a positive effect on only 12% of the targets (the 8% against personnel in the open and the 4% at known observation posts). Of the remainder of the targets, the artillery fires served only to harass and cause the mechanized elements to button up. Within these limitations the commanders in free play generated requirements which when extrapolated to group requirements were within the range and rate of fire capabilities of the experimental battery.

f. Employment of Nuclear Devices:

In the employment of nuclear devices combat group artillery battery acted merely as a requesting agency. The battery did not have a nuclear capability. Analysis of the data presented indicates that the experimental companies used an average of 45.9 nuclear devices per record run. The total number employed in all record runs was 367. The data further indicates that the use of nuclear devices tended to increase markedly on a week-to-week basis. As the use of nuclear devices increased the use of non-nuclear artillery decreased. This decrease is attributable to the experimental framework, wherein non-nuclear artillery fire was ineffective against armor; therefore, nuclear devices remained the only potential multiple-kill means available to the commander.

5. Conclusion:

Within the experimental environment of the Controllability Experiment (completely mechanized Experimental and Aggressor forces and relatively unlimited availability of tactical nuclear munitions) the combat group artillery battery

was capable of providing the non-nuclear artillery support required by the combat group as indicated by the following statistics:

a. Maximum requirement of the experimental company during any 10 minute period—96 rounds.

b. Maximum requirement of the combat group for a 10 minute period based on four companies requiring the maximum support generated by the experimental company—384 rounds.

c. Capability of the combat group artillery battery for a 10 minute period—400 rounds.

VOLUME OF FIRE DATA

RECORD COURSE I

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
Situation 1			
0713 - 0723	4	16	8
0724 - 0733	1	16	2
0734 - 0743	2	16	4
0744 - 0753	1	16	2
0754 - 0803	0	0	0
0804 - 0813	0	0	0
0814 - 0823	0	0	0
0824 - 0833	2	16	4
0834 - 0843	1	16	2
0844 - 0853	1	16	2
0854 - 0903	2	16	4
0904 - 0913	0	0	0
0914 - 0923	1	16	2
0924 - 0933	0	0	0
0934 - 0943	0	0	0
0944 - 0953	0	0	0
0954 - 1003	1	16	2
1004 - 1013	0	0	0
1014 - 1023	0	0	0
1024 - 1033	1	16	2
Situation 2			
1250 - 1300	5	16	10
1301 - 1310	0	0	0
1311 - 1320	0	0	0
1321 - 1330	4	16	8
1331 - 1340	0	0	0
1341 - 1350	0	0	0
1351 - 1400	0	0	0
1401 - 1410	0	0	0
1411 - 1420	2	16	4

Figure 1

VOLUME OF FIRE DATA

RECORD COURSE I

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 2 (continued)		
1421 - 1430	0	0	0
1431 - 1440	1	16	2
1441 - 1450	3	18.6	7
1451 - 1500	3	13.3	5
1501 - 1510	2	12	3
1511 - 1520	5	17.6	11
1521 - 1530	1	24	3
1531 - 1540	3	16	6
1541 - 1550	5	16	10
1551 - 1600	5	16	10
1601 - 1610	1	16	2
	Situation 3		
1815 - 1825	4	16	16
1826 - 1835	4	16	16
1836 - 1845	5	16	20
1846 - 1855	0	0	0
1856 - 1905	0	0	0
1906 - 1915	0	0	0
1916 - 1925	2	24	12
1926 - 1935	2	16	8
1936 - 1945	0	0	0
1946 - 1955	0	0	0
1956 - 2005	0	0	0

Figure 1 (continued)

VOLUME OF FIRE DATA

RECORD COURSE I

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 4		
0013 - 0023	4	16	16
	Situation 5		
0855 - 0905	3	16	6
0906 - 0916	2	16	4
0917 - 0926	2	16	4
0927 - 0936	0	0	0
0937 - 0946	1	16	2
	Situation 6		
1426 - 1436	3	16	6
1437 - 1446	3	10.6	8
1447 - 1456	1	8	2
1457 - 1506	0	0	0
1507 - 1516	2	12	6
1517 - 1526	1	16	4
1527 - 1536	2	16	8
1537 - 1546	1	16	4
	Situation 7		
2010 - 2020	6	16	24

Figure 1 (continued)

VOLUME OF FIRE DATA

RECORD COURSE I

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0638 - 0647	1	12	1.5
0648 - 0657	1	12	1.5
0658 - 0707	2	16	2
0708 - 0717	3	9.3	3.5
0718 - 0727	1	16	2
0728 - 0737	0	0	0
0738 - 0747	3	9.3	3.5
0748 - 0757	1	8	1
0758 - 0807	0	0	0
0808 - 0817	1	8	1
0818 - 0827	0	0	0
0828 - 0837	1	8	1
0838 - 0847	2	16	2
0848 - 0857	1	4	.5
0858 - 0907	0	0	0
0908 - 0917	0	0	0
0918 - 0927	0	0	0
0928 - 0937	2	10	2.5
0938 - 0947	2	10	2.5
	Situation 2		
1313 - 1323	2	10	2.5
1324 - 1333	0	0	0
1334 - 1343	0	0	0
1344 - 1353	3	8	3
1354 - 1403	1	4	.5
1404 - 1413	1	12	1.5
1414 - 1423	1	12	1.5
1424 - 1433	1	8	1
1434 - 1443	0	0	0

Figure 2

VOLUME OF FIRE DATA

RECORD COURSE I

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 2 (continued)		
1444 - 1453	1	8	1
1454 - 1503	1	16	2
1504 - 1513	0	0	0
1514 - 1523	1	8	1
	Situation 3		
1733 - 1744	4	10	10
1745 - 1754	5	4.8	6
1755 - 1804	2	6	3
1805 - 1814	1	8	2
1815 - 1824	2	8	4
1825 - 1834	1	16	4
1835 - 1844	1	16	4
1845 - 1854	0	0	0
1855 - 1904	0	0	0
1905 - 1914	1	12	3
1915 - 1924	1	8	2
	Situation 4		
	NO MISSIONS		
	Situation 5		
0802 - 0813	2	8	4
0814 - 0823	1	8	2

Figure 2 (continued)

VOLUME OF FIRE DATA

RECORD COURSE I

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 5 (continued)		
0824 - 0833	3	8	6
0834 - 0843	1	8	2
0844 - 0853	0	0	0
0854 - 0903	0	0	0
0904 - 0913	1	8	2
0914 - 0923	0	0	0
0924 - 0933	5	8.8	10
	Situation 6		
1220 - 1230	1	8	2
1231 - 1240	3	4	3
1241 - 1250	1	4	1
1251 - 1300	0	0	0
1301 - 1310	2	4	2
	Situation 7		
1938 - 1948	3	5.2	4
1949 - 1958	0	0	0
1959 - 2008	1	4	1

Figure 2 (continued)

VOLUME OF FIRE DATA

RECORD COURSE II

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0905 - 0915	1	16	2
0916 - 0925	0	0	0
0926 - 0935	1	16	2
0936 - 0945	0	0	0
0946 - 0955	0	0	0
0956 - 1005	1	8	1
	Situation 2		
1219 - 1229	1	16	2
1230 - 1239	0	0	0
1240 - 1249	0	0	0
1250 - 1259	0	0	0
1300 - 1309	0	0	0
1310 - 1319	2	8	2
1320 - 1329	2	8	2
1330 - 1339	0	0	0
1340 - 1349	0	0	0
1350 - 1359	1	16	2
1400 - 1409	1	16	2
1410 - 1419	1	16	2
1420 - 1429	1	16	2

Figure 3

VOLUME OF FIRE DATA

RECORD COURSE II

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
Situation 3			
1734 - 1753	1	16	4
1754 - 1803	0	0	0
1804 - 1813	0	0	0
1814 - 1823	2	8	4
1824 - 1833	1	8	2
Situation 4			
2131 - 2141	3	16	12
2142 - 2151	4	16	16
2152 - 2201	2	12	6
2202 - 2211	4	8	8
2212 - 2221	2	8	4
Situation 5			
0828 - 0838	1	16	4
Situation 6			
1228 - 1238	3	16	12
1239 - 1248	1	16	4
1249 - 1258	0	0	0
1259 - 1308	1	16	4
1309 - 1318	1	16	4
1319 - 1328	1	8	2

Figure 3 (continued)

VOLUME OF FIRE DATA

RECORD COURSE II

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 6 (continued)		
1329 - 1338	0	0	0
1339 - 1348	3	16	12
1349 - 1358	3	14.66	11
1359 - 1408	1	16	4
1409 - 1418	0	0	0
1419 - 1428	1	16	4
	Situation 7		
	NO CONVENTIAL ARTILLERY USED		

Figure 3 (continued)

VOLUME OF FIRE DATA

RECORD COURSE II

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
Situation 1			
0734 - 0744	1	4	.5
0745 - 0754	2	12	1.5
0755 - 0804	1	8	1
0805 - 0814	1	4	.5
0815 - 0824	2	4	1
0825 - 0834	0	0	0
0835 - 0844	2	4	1
0845 - 0854	0	0	0
0855 - 0904	0	0	0
0905 - 0914	1	8	1
0915 - 0924	3	8	3
Situation 2			
1202 - 1212	3	4	1.5
1213 - 1222	0	0	0
1223 - 1232	0	0	0
1233 - 1242	0	0	0
1243 - 1252	0	0	0
1253 - 1302	2	8	2
1303 - 1312	1	8	1
1313 - 1322	0	0	0
1323 - 1332	0	0	0
1333 - 1342	0	0	0
1343 - 1352	0	0	0
1353 - 1402	0	0	0
1403 - 1412	1	8	1
1413 - 1422	0	0	0
1423 - 1432	0	0	0
1433 - 1442	2	6	1.5

Figure 4

VOLUME OF FIRE DATA

RECORD COURSE II

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 3		
1757 - 1807	1	4	1
1808 - 1817	0	0	0
1818 - 1827	0	0	0
1828 - 1837	1	4	1
	Situation 4		
2138 - 2148	3	4	3
2149 - 2158	2	4	2
2159 - 2208	0	0	0
2209 - 2218	3	4	3
	Situation 5		
	NO CONVENTIONAL FIRE		
	Situation 6		
1434 - 1444	1	8	2
1445 -1454	0	0	0
1455 - 1504	0	0	0
1505 - 1514	3	5.33	4
1515 - 1524	0	0	0
1525 - 1534	3	4	3
1535 - 1544	1	8	2

Figure 4 (continued)

VOLUME OF FIRE DATA

RECORD COURSE II

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 7		
1928 - 1938	1	4	1
1939 - 1948	1	8	2

Figure 4 (continued)

VOLUME OF FIRE DATA

RECORD COURSE III

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0928 - 0938	3	16	6
0939 - 0949	4	16	8
0950 - 1000	1	16	2
	Situation 2		
1244 - 1254	3	16	6
1255 - 1305	2	16	3
1306 - 1316	1	16	2
	Situation 3		
1709 - 1719	4	16	18
1720 - 1730	2	16	8
1731 - 1741	0	0	0
1742 - 1752	2	8	4
1753 - 1813	0	0	0
1814 - 1824	0	0	0
1825 - 1835	2	16	8
1836 - 1846	0	0	0
1847 - 1857	1	16	4

Figure 5

VOLUME OF FIRE DATA

RECORD COURSE III

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 4		
2130 - 2140	3	8	6
2141 - 2151	3	8	6
2152 - 2202	3	8	6
2203 - 2213	0	0	0
2214 - 2224	0	0	0
2225 - 2235	0	0	0
2236 - 2246	3	4	4
2247 - 2257	0	0	0
2258 - 2308	3	16	6
	Situation 5		
0846 - 0856	3	16	12
0857 - 0907	2	16	8
0908 - 0918	1	16	4
	Situation 6		
1107 - 1117	3	16	12
1118 - 1128	1	16	4
1129 - 1139	1	16	4
1140 - 1150	0	0	0
1151 - 1201	0	0	0
1202 - 1212	0	0	0
1213 - 1223	0	0	0
1224 - 1234	4	16	18
1235 - 1246	0	0	0
1247 - 1307	0	0	0
1308 - 1318	1	16	4
1319 - 1329	1	16	4

Figure 5 (continued)

VOLUME OF FIRE DATA

RECORD COURSE III

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 7		
1623 - 1633	2	16	8
1634 - 1644	5	16	20
1645 - 1655	3	16	12
1656 - 1706	4	16	18
1707 - 1717	1	16	4

Figure 5 (continued)

VOLUME OF FIRE DATA

RECORD COURSE III

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0834 - 0844	1	8	2
0845 - 0855	0	0	0
0856 - 0906	1	8	2
	Situation 2		
1136 - 1146	1	4	.5
	Situation 3		
1739 - 1749	2	8	4
1750 - 1800	0	0	0
1801 - 1810	1	8	2
	Situation 4		
2246 - 2256	3	32	8
	Situation 5		
0815 - 0825	1	4	1
0826 - 0836	0	0	0
0837 - 0847	0	0	0
0858 - 0908	0	0	0
0909 - 0919	0	0	0

Figure 6

VOLUME OF FIRE DATA

RECORD COURSE III

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 5 (continued)		
0920 - 0930	1	8	2
0931 - 0941	1	8	2
0942 - 0952	1	8	2
	Situation 6		
1306 - 1316	2	8	4
1327 - 1337	0	0	0
1338 - 1358	0	0	0
1359 - 1409	1	8	2
	Situation 7		
1729 - 1739	1	8	2
1740 - 1750	0	0	0
1751 - 1801	0	0	0
1802 - 1812	0	0	0
1813 - 1823	0	0	0
1824 - 1834	0	0	0
1835 - 1845	1	8	2

Figure 6 (continued)

VOLUME OF FIRE DATA

RECORD COURSE IV

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0803 - 0813	2	16	4
0814 - 0823	0	0	0
0824 - 0833	0	0	0
0834 - 0843	0	0	0
0844 - 0853	0	0	0
0854 - 0903	1	16	2
0904 - 0913	1	16	2
0914 - 0923	0	0	0
0924 - 0933	0	0	0
0934 - 0943	1	16	2
0944 - 0953	1	16	2
0954 - 1003	2	16	4
1004 - 1013	1	16	2
1014 - 1024	1	16	2
	Situation 2		
1253 - 1303	1	16	2
1304 - 1313	1	16	2
1314 - 1323	1	16	2
1324 - 1333	0	0	0
1334 - 1343	1	16	2
1344 - 1353	1	16	2
1354 - 1403	1	16	2
1404 - 1413	2	16	4
1414 - 1423	1	16	2
1424 - 1433	3	16	6
1434 - 1444	1	16	2

Figure 7

VOLUME OF FIRE DATA

RECORD COURSE IV

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 3		
1728 - 1738	1	16	4
1739 - 1748	1	16	4
1749 - 1758	2	16	8
1759 - 1808	2	16	8
1809 - 1818	0	0	0
1819 - 1828	1	16	4
	Situation 4		
2113 - 2123	3	4	3
2124 - 2133	2	4	2
2134 - 2143	2	4	2
2144 - 2153	2	4	2
2154 - 2203	2	4	2
2204 - 2213	2	4	2
2214 - 2223	5	4	5
2224 - 2233	2	4	2
2234 - 2243	2	4	2
2244 - 2253	1	4	1
	Situation 5		
0821 - 0831	2	16	8
0832 - 0841	4	16	16
0842 - 0851	3	16	12
0852 - 0901	0	0	0
0902 - 0911	2	16	8

Figure 7 (continued)

VOLUME OF FIRE DATA

RECORD COURSE IV

Company A

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 6		
1119 - 1129	4	16	4
1130 - 1139	2	16	8
1140 - 1149	5	16	20
	Situation 7		
1459 - 1509	2	16	8
1510 - 1519	1	16	4
1520 - 1529	1	16	4
1530 - 1539	2	16	8
1540 - 1549	1	16	4
1550 - 1559	4	16	16
1600 - 1609	0	0	0
1610 - 1619	1	16	4

Figure 7 (continued)

VOLUME OF FIRE DATA

RECORD COURSE IV

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 1		
0801 - 0811	2	24	3
0812 - 0821	1	16	2
0822 - 0831	1	8	1
0832 - 0841	1	8	1
0842 - 0851	0	0	0
0852 - 0901	0	0	0
0902 - 0911	1	8	1
	Situation 2		
1158 - 1208	1	8	1
1209 - 1218	0	0	0
1219 - 1228	0	0	0
1229 - 1238	1	8	1
	Situation 3		
	NO MISSIONS		
	Situation 4		
2135 - 2145	3	4	3
2146 - 2155	5	4	5
2156 - 2205	4	4	4
2206 - 2215	5	4	5
2216 - 2225	4	4	4
2226 - 2235	4	4	4
2236 - 2245	4	4	4

Figure 8

VOLUME OF FIRE DATA

RECORD COURSE IV

Company B

Time	Nr of Missions	Av Nr Rds/Mis	Av Rds Per Gun
	Situation 4 (continued)		
2246 - 2255	2	4	2
2256 - 2305	2	4	2
2306 - 2315	2	4	2
2316 - 2325	1	4	1
	Situation 5		
	NO MISSIONS		
	Situation 6		
	NO MISSIONS		
	Situation 7		
1403 - 1413	1	8	2
1414 - 1423	1	8	2

Figure 8 (continued)

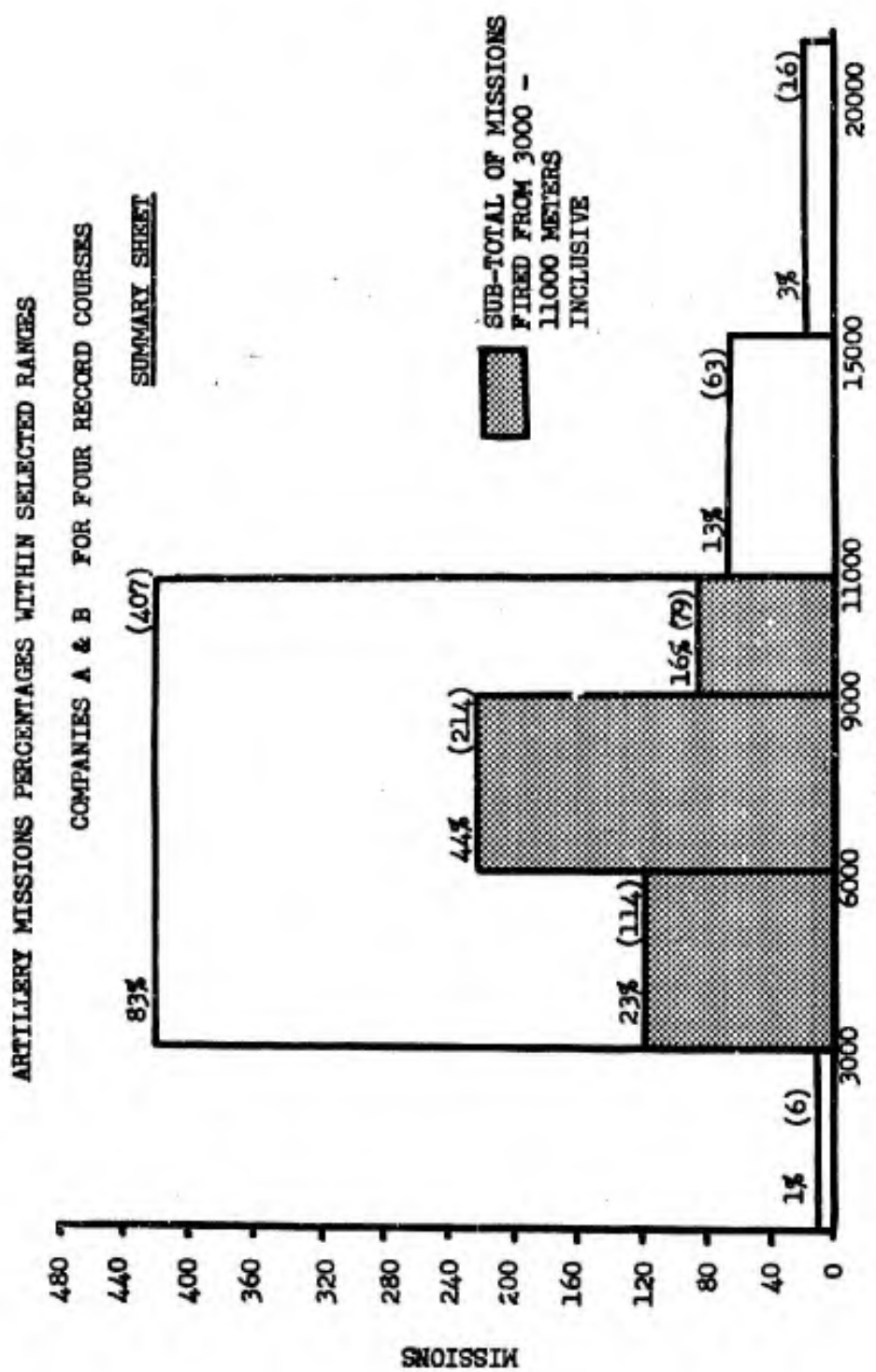
ARTILLERY MISSIONS PERCENTAGES WITHIN SELECTED RANGES
COMPANIES A & B FOR FOUR RECORD COURSES
SUMMARY SHEET
SUB-TOTAL OF MISSIONS FIRED FROM 3000 - 11000 METERS INCLUSIVE
MISSIONS
RANGE IN METERS
1% (6)
23% (114)
44% (214)
16% (79)
13% (63)
3% (16)
83% (407)
0
40
80
120
160
200
240
280
320
360
400
440
480
3000
6000
9000
11000
15000
20000

FIGURE 9

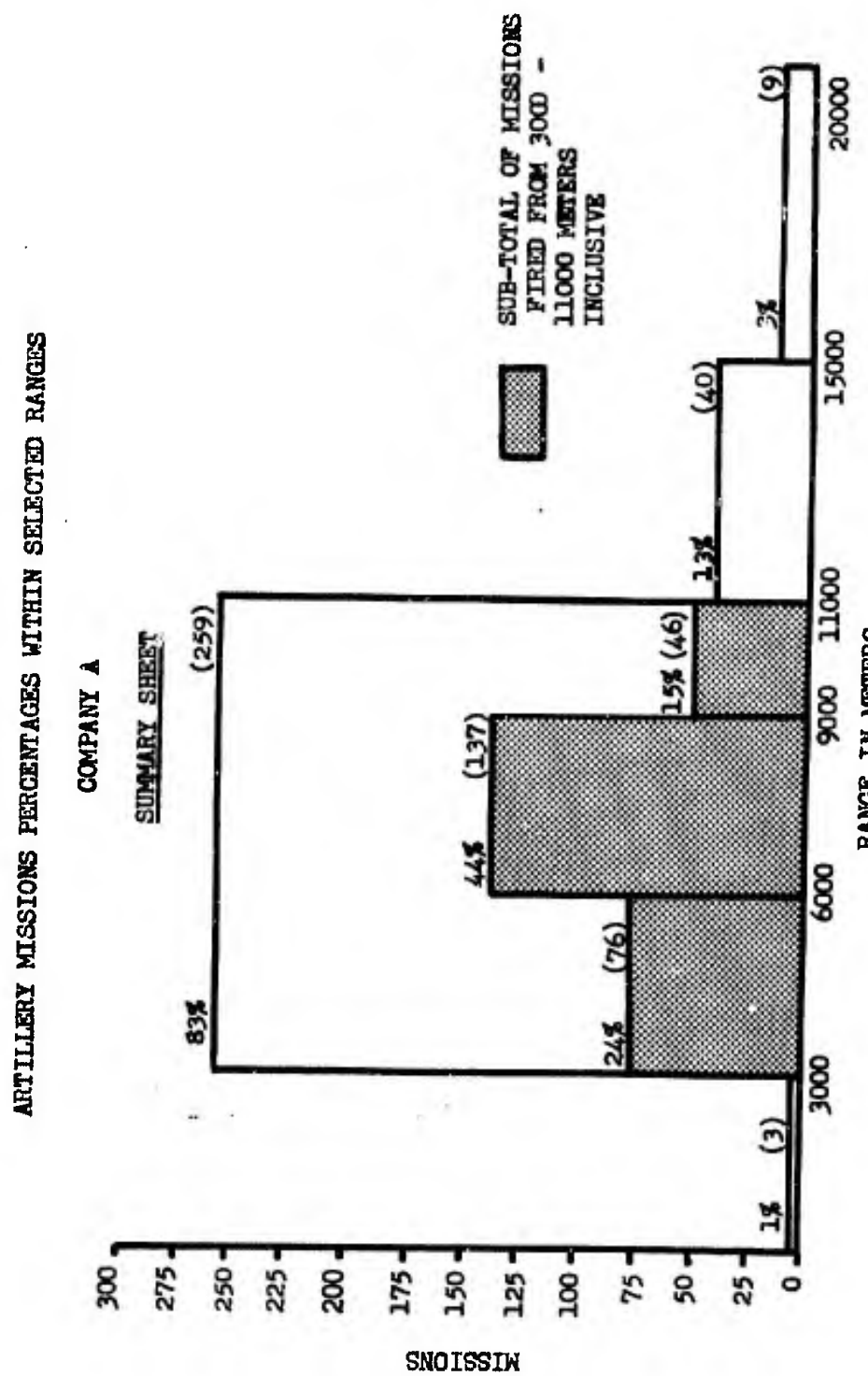
ARTILLERY MISSIONS PERCENTAGES WITHIN SELECTED RANGES
COMPANY A
SUMMARY SHEET
SUB-TOTAL OF MISSIONS FIRED FROM 3000 - 11000 METERS INCLUSIVE
MISSIONS
RANGE IN METERS
300
275
250
225
200
175
150
125
100
75
50
25
0
3000
6000
9000
11000
15000
20000
1%
(3)
24%
(76)
44%
(137)
15%
(46)
13%
(40)
3%
(9)
83%
(259)

FIGURE 10

ARTILLERY MISSIONS PERCENTAGES WITHIN SELECTED RANGES

COMPANY B

SUMMARY SHEET

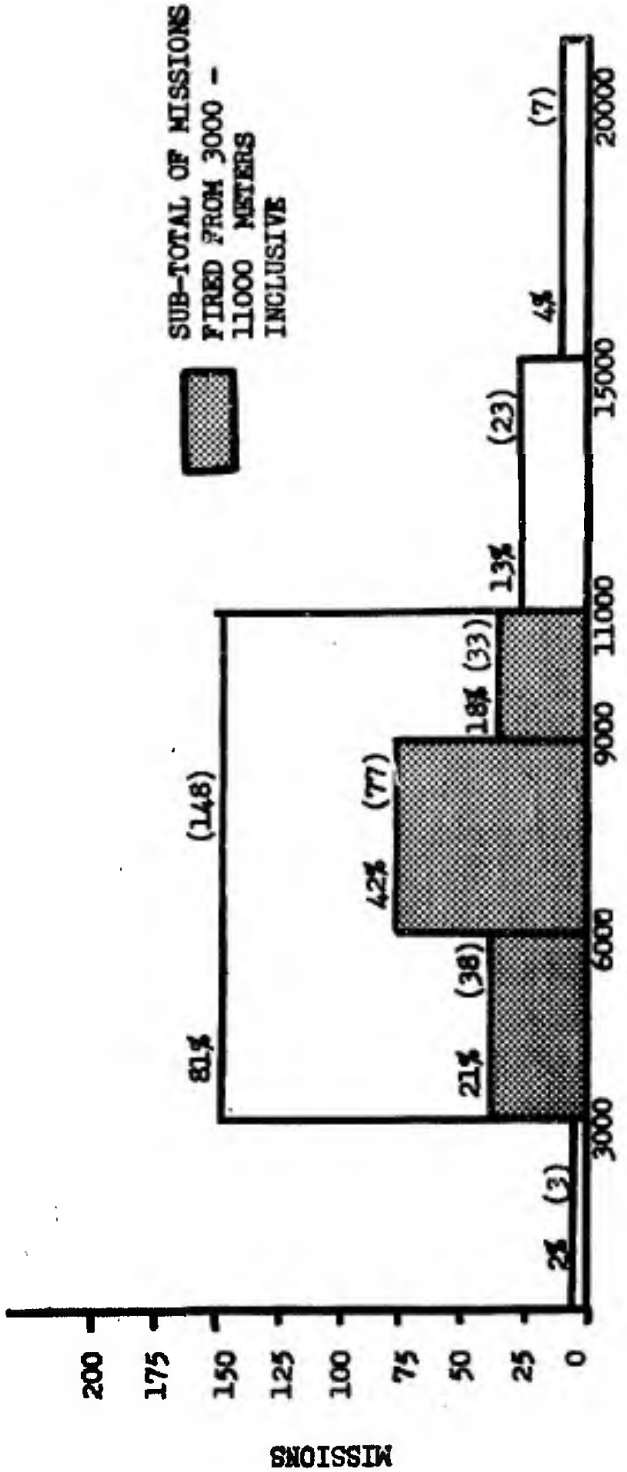

FIGURE 11

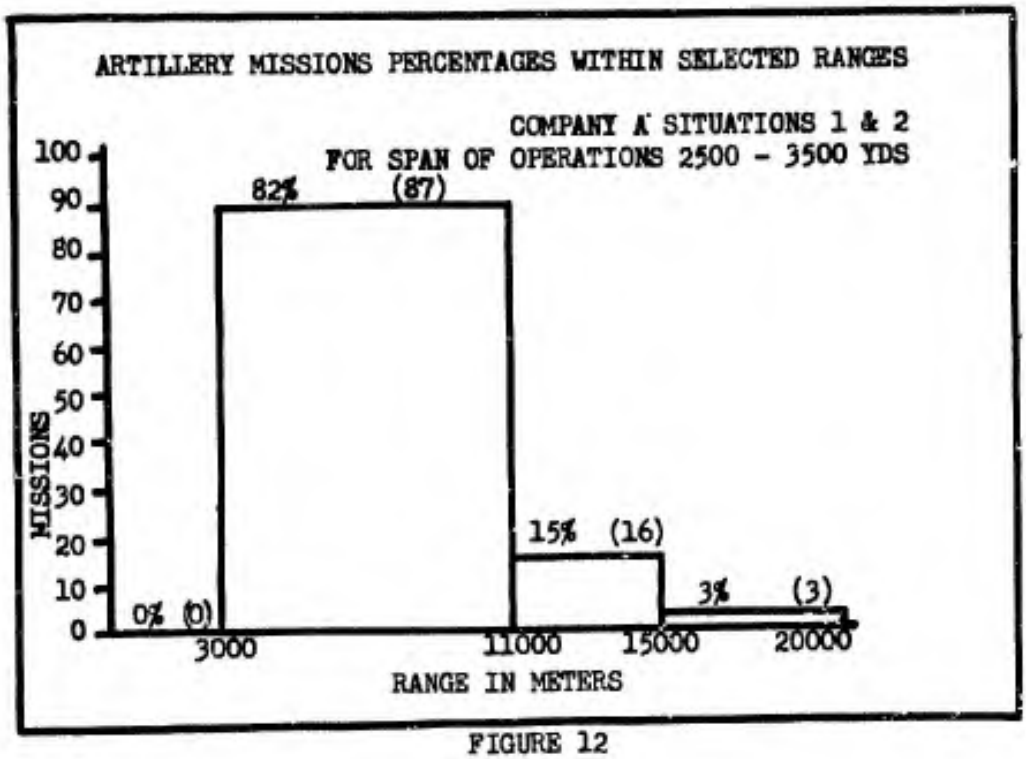

FIGURE 12

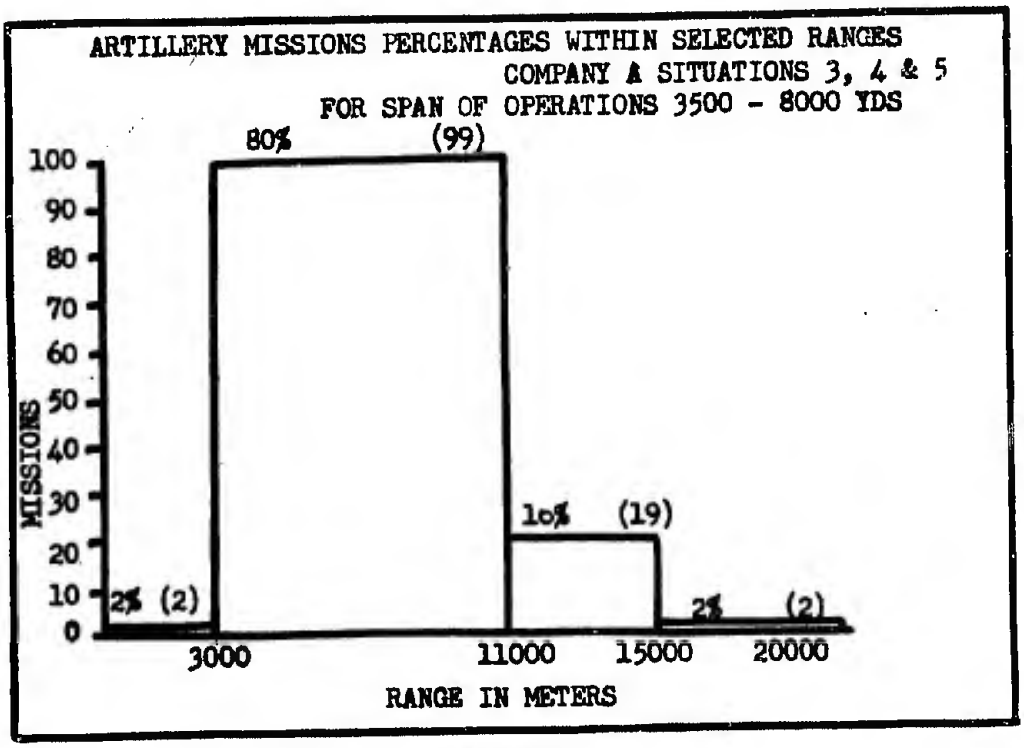

FIGURE 13

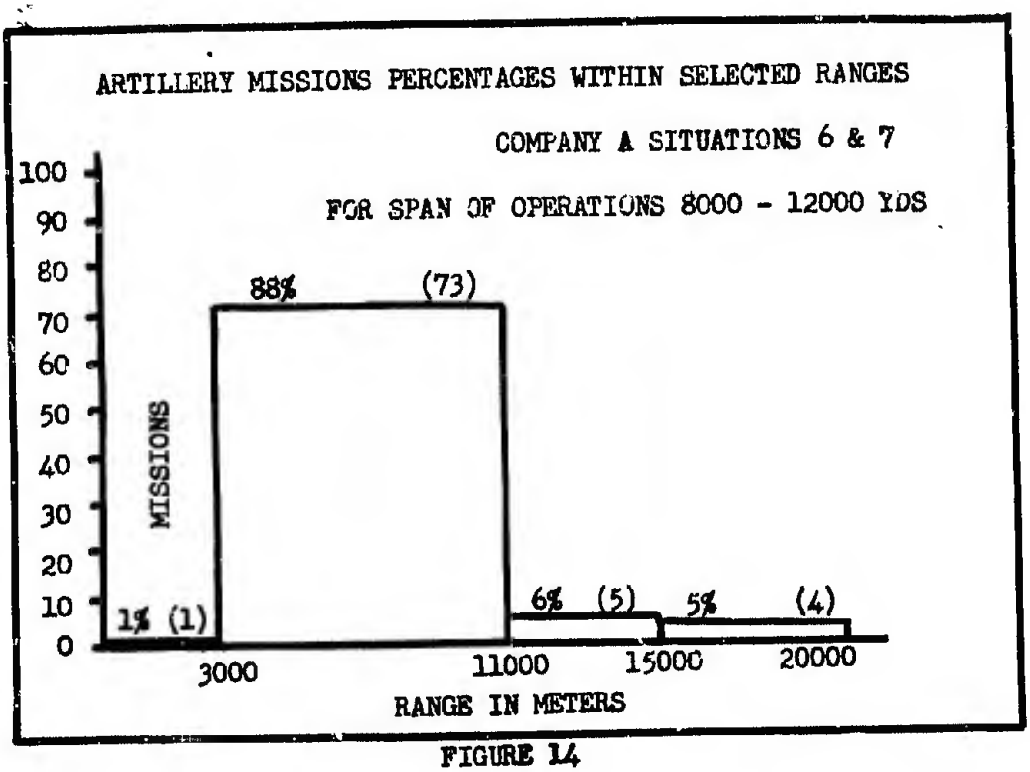

FIGURE 14

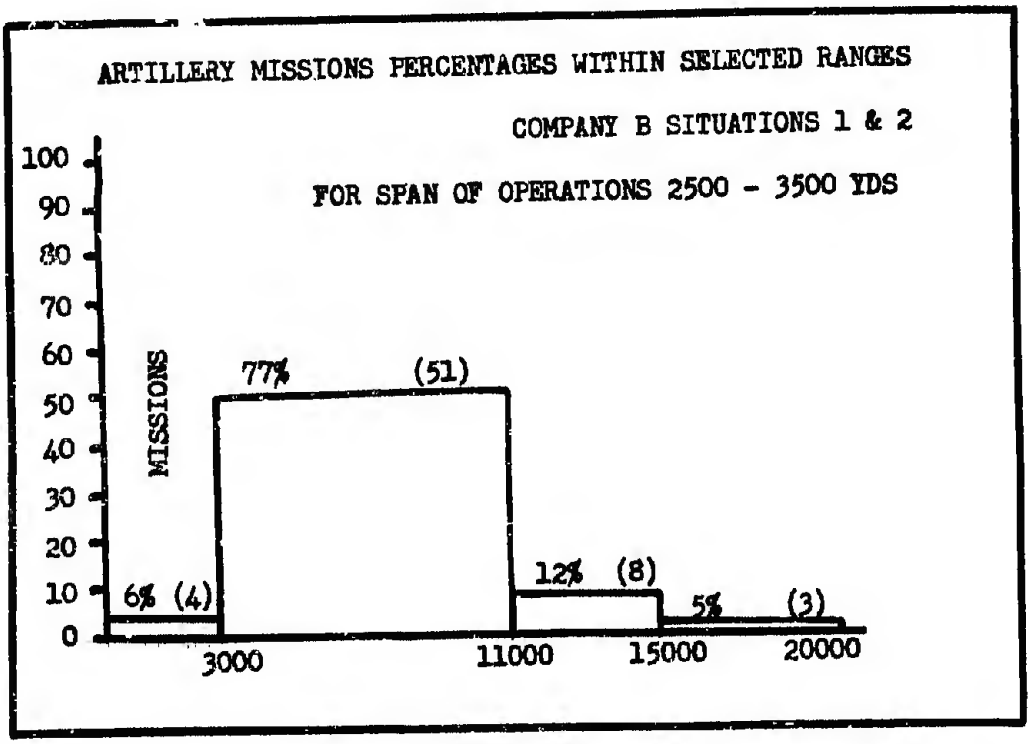

FIGURE 15

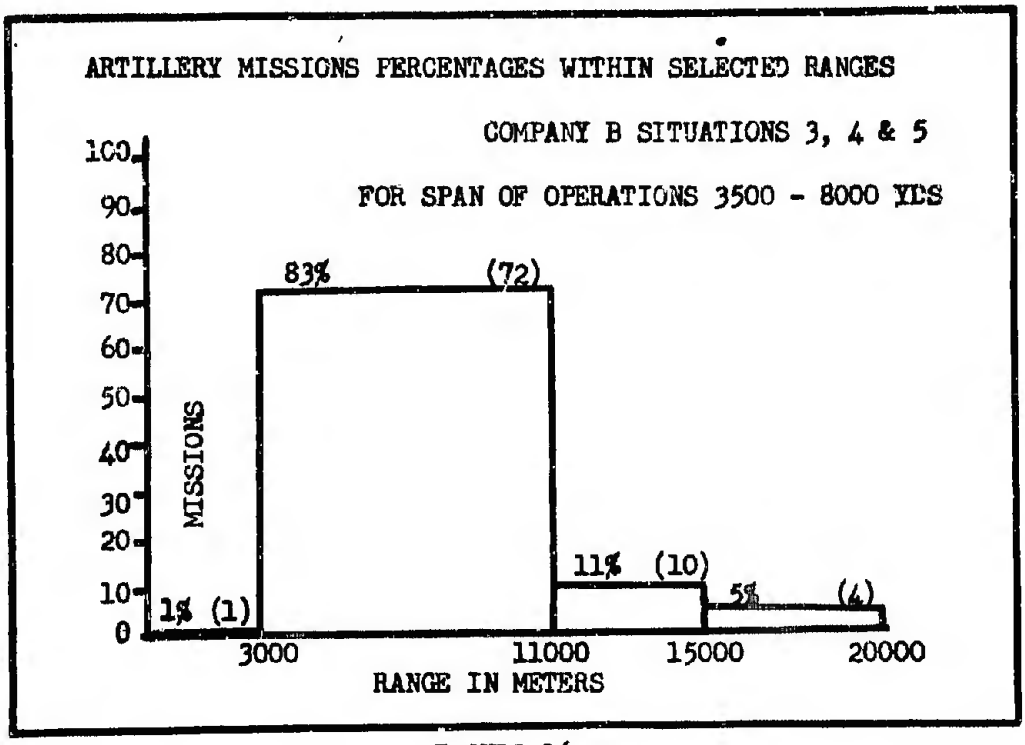

FIGURE 16

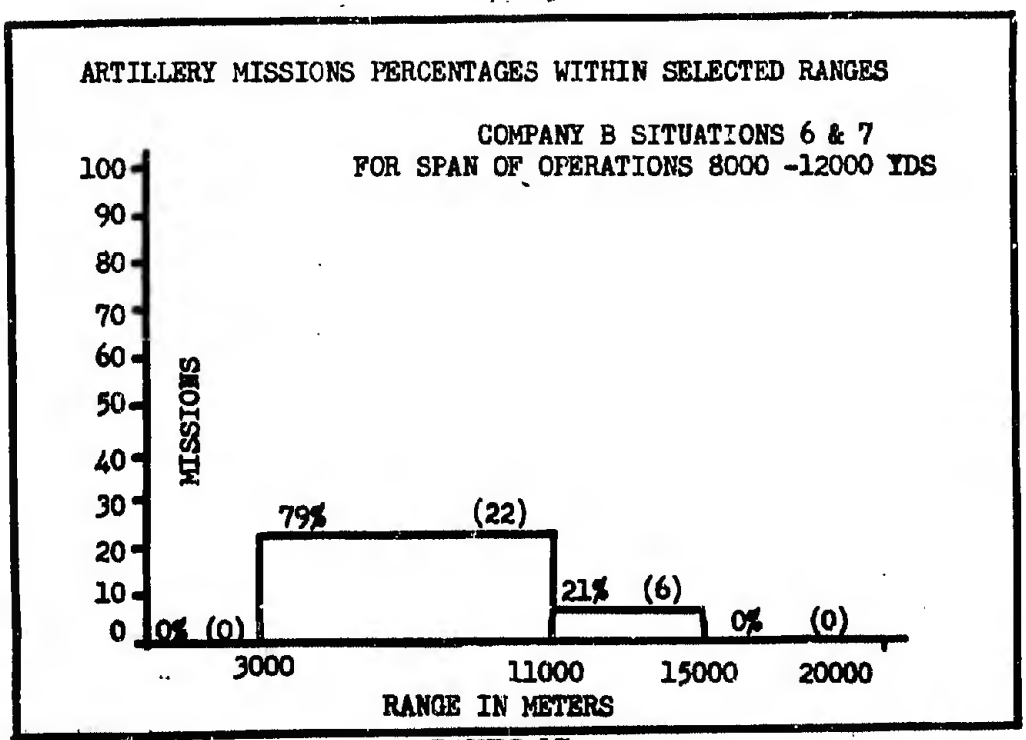

FIGURE 17

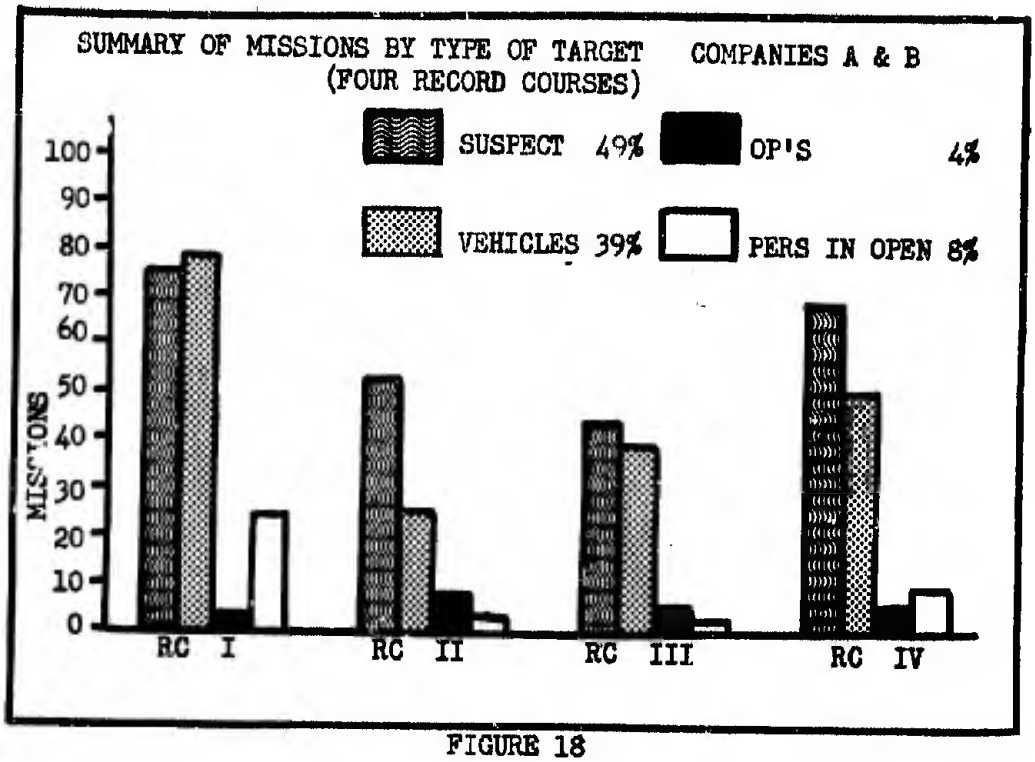

FIGURE 18

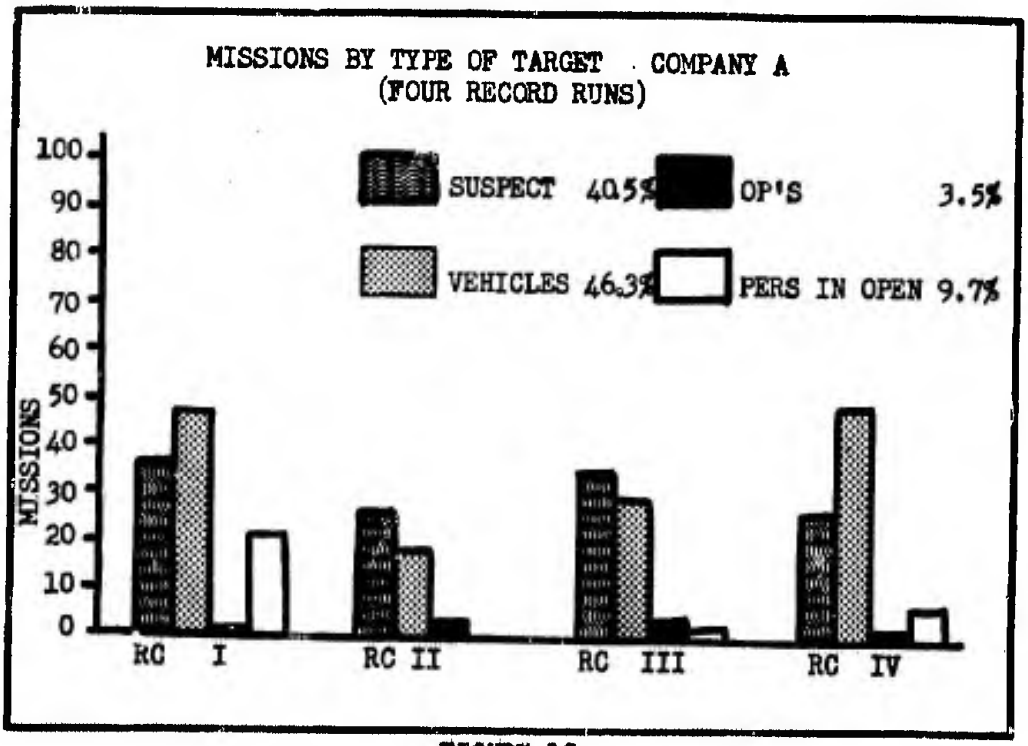

FIGURE 19

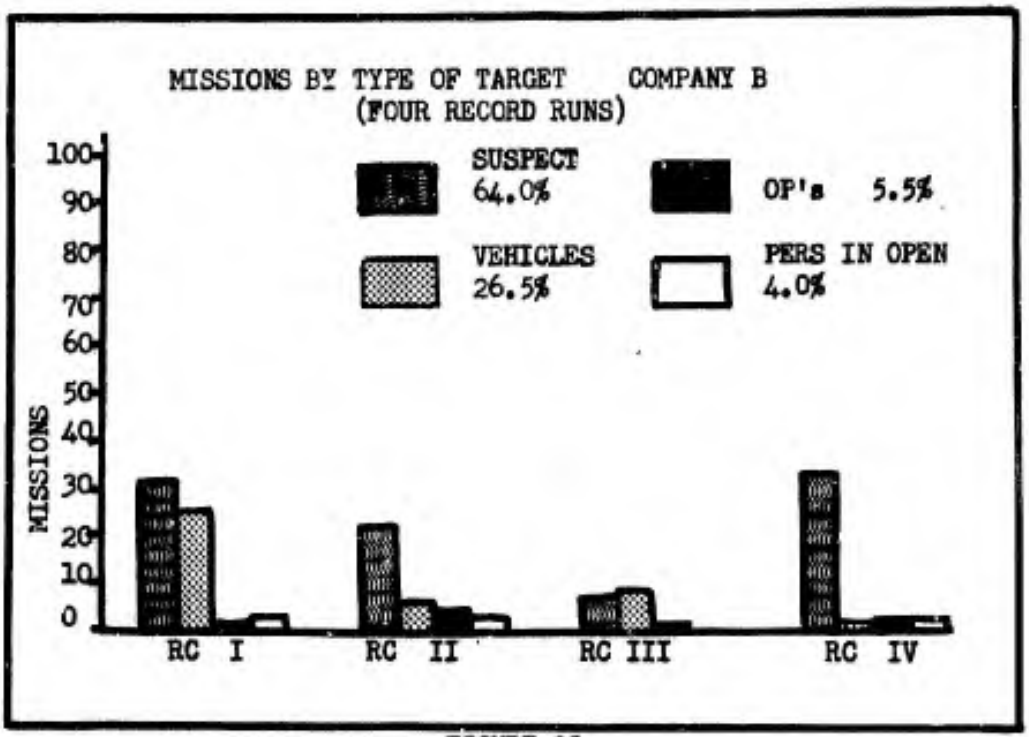

FIGURE 20

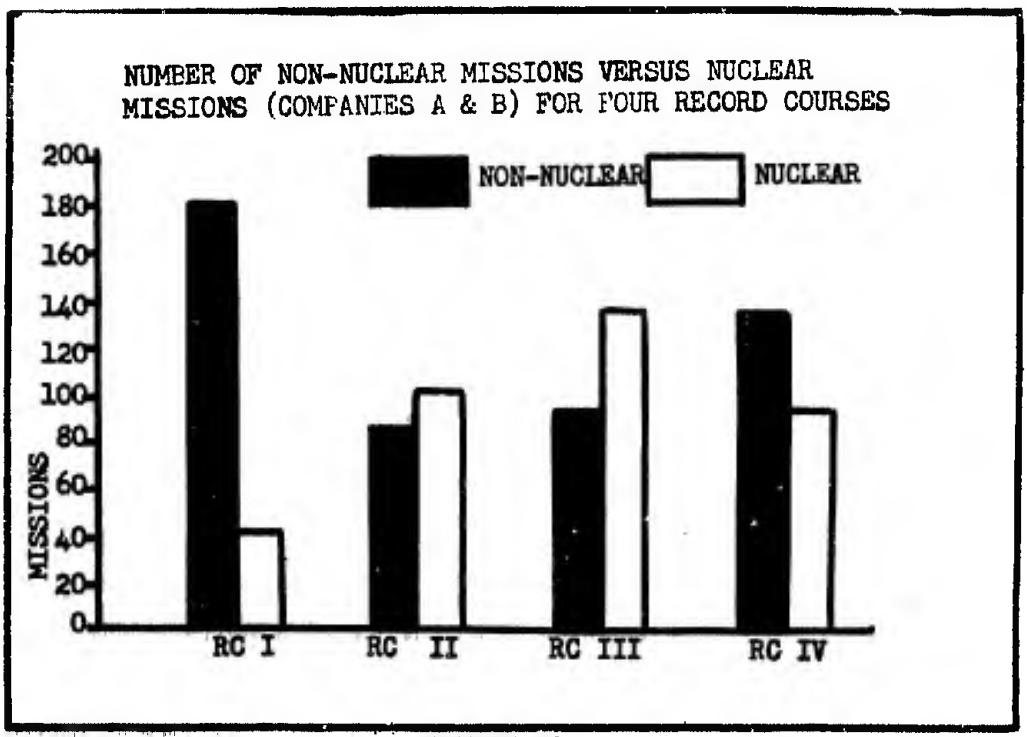

FIGURE 21

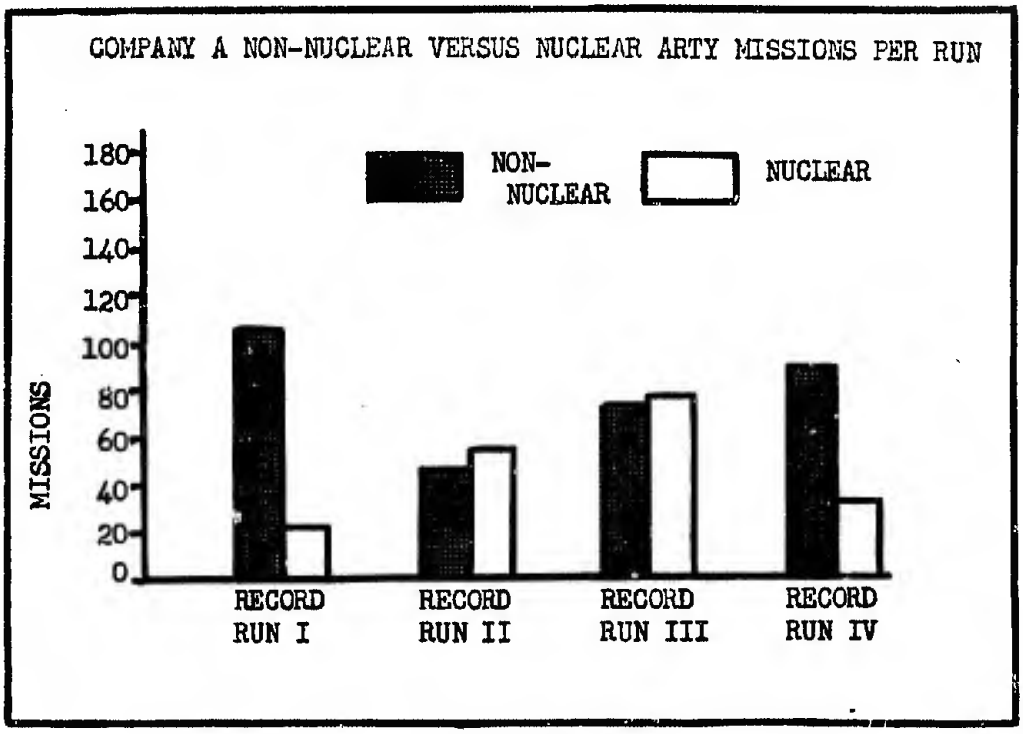

FIGURE 22

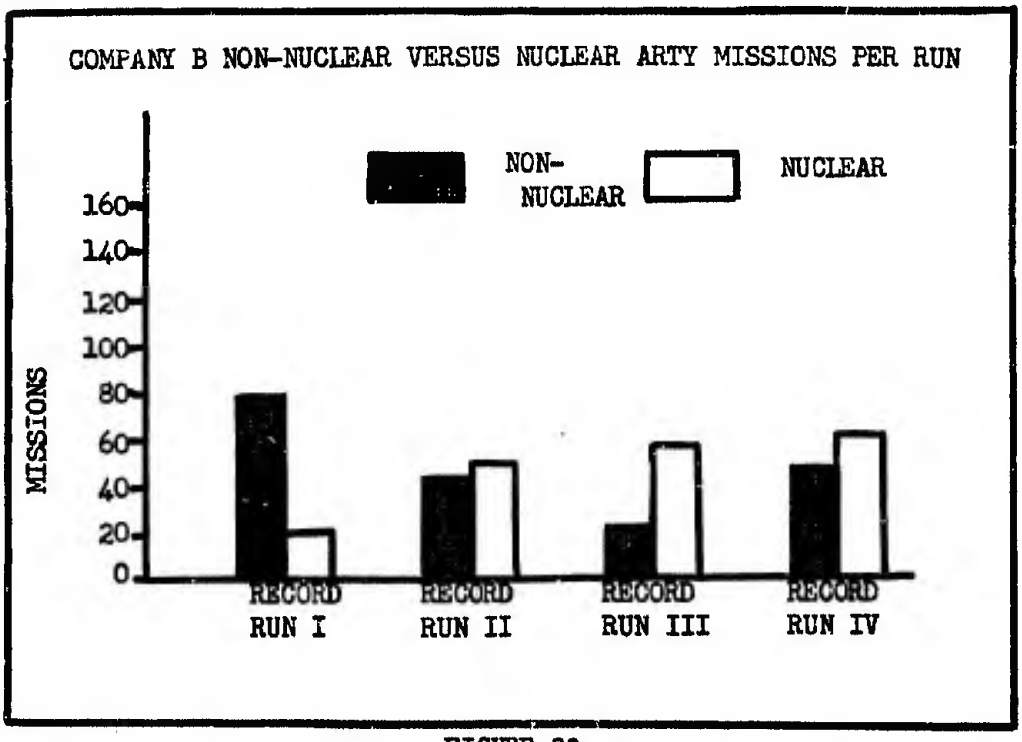

FIGURE 23

SECTION II

OBJECTIVE 2(b)

6. Objective:

To determine within the framework of the conditions outlined under Objective 1, the requirements for augmenting the combat group artillery battery with additional artillery organic to the combat group.

7. Indicators:

In examining the requirements for augmenting the combat group artillery battery with additional organic artillery, attention has been directed toward the following areas:

a. Maximum rate of fire.

b. Spread of ranges.

c. Nuclear devices.

d. Artillery versus armor.

8. Presentation of Data:

a. Maximum Rate of Fire, Spread of Ranges and Nuclear Devices:

Detailed presentation of data in these areas is contained in the discussion of Objective 2a. The salient facts pertaining thereto developed during the experiment are:

(1) The maximum requirement imposed on the artillery in support of an experimental company in any 10 minute period was 96 rounds.

(2) Ninety-seven per cent of all missions required were within the 15,000 meters assumed range capability of the experimental artillery.

(3) The average number of nuclear missions per experimental run was 45.9.

b. Artillery vs Armor:

The week-by-week variation in numbers of missions versus type targets is contained in Objective 2a (Figure 18). Thirty-nine per cent of the targets engaged by non-nuclear artillery was fired against armored vehicles.

9. Discussion:

a. Maximum Rate of Fire:

As has been noted in the discussion of Objective 2a, the battery has a capability of firing at a maximum sustained rate of fire of 40 rounds per minute when the total firing period does not exceed thirty (30) minutes. It has, therefore, a capability of firing 400 rounds in a 10 minute period - or a capability of supporting from the standpoint of rate of fire four companies simultaneously requiring the 96 rounds maximum per 10 minutes generated by the experimental companies. On the basis of the data, therefore, there is no requirement for augmenting the combat group artillery with additional organic artillery.

b. Spread of Ranges:

As concluded in Objective 2a there does not appear to be any need for augmenting the combat group artillery with additional organic artillery in the hopes of so positioning the additional artillery to bring fires to bear on any or all of the 3% of the targets that were found in the experimental environment to be in excess of 15,000 meters from battery and platoon positions as they were emplaced in that experiment.

c. Nuclear Devices:

The indirectly fired nuclear devices delivered in support of the experimental companies were responsible for 62%

of the total vehicular casualties inflicted upon the aggressor. Nuclear devices were the sole means available during the experiment for inflicting multiple vehicular casualties.

d. Artillery vs Armor:

In 39% of the artillery non-nuclear missions that were fired against armored vehicles, the results obtained were negligible. In most instances the only value derived was that of forcing the armored vehicles to button up, thus limiting the vision of the driver and the vehicle commander. If non-nuclear artillery is to have a decisive role on the mechanized battlefield, it appears that a need exists for making available at the combat group level a type of artillery weapon and/or ammunition which can be fired at armor with more advantageous results.

10. Conclusions:

a. There is no requirement under conditions of nuclear plenty for augmenting the combat group artillery battery with additional artillery organic to the combat group whose ammunition does not include a nuclear capability.

b. There is a requirement for indirectly delivered non-nuclear munitions capable of effective employment against armor.

11. Recommendation:

It is recommended that increased research and development effort be directed toward the development of indirectly delivered non-nuclear munitions capable of effective employment against armor.

SECTION III

OBJECTIVE 2 (c)

12. Objective:

To determine within the framework of the conditions outlined under Objective 1 the requirements for additional artillery support for the combat group beyond that indicated in Objectives 2a and 2b.

13. Indicators:

In examining the requirements for additional artillery support for the combat group, attention has been directed toward the following areas:

a. Requirements for weapons of longer range.

b. Requirements for weapons of other caliber and characteristics.

14. Presentation of Data:

a. Requirements for Weapons of Longer Range:

Detailed presentation of data in this area is contained in the discussion of Objectives 2a and 2b. (Figures 9 through 17).

b. Requirements for Weapons of Other Caliber and Characteristics:

All targets, exclusive of armor, engaged by the

experimental companies were of a nature which lent themselves to destruction by light artillery of present day characteristics except for 3% beyond the maximum range. (Figure 9).

15. Discussion:

a. Requirement for Weapons of Longer Range:

Based on the assumptions that the artillery weapon organic to the combat group has a maximum range of 15,000 meters, and that requirements for security and the support of one or more companies make it advisable to position the artillery in some depth within the combat group area of responsibility, not more than two-thirds of the total range capability of the combat group artillery is available for engaging targets forward of the leading elements of the combat group. The limitation of range denies to the combat group a means of engaging targets at ranges greater than 10,000 meters forward of supported units by organic weapons. However, as only 3% of the artillery missions were requested at ranges greater than 15,000 meters, there does not appear a need for additional artillery with a long range capability to reinforce the combat group artillery battery.

b. Requirements for Weapons of Other Caliber and Characteristics:

The problems of the reduction of deliberate fortifications and built-up areas were not posed in this experiment. It is logical to assume, however, that the FENTANA Company may be required to engage targets other than armor, such as pill boxes and fortified bunkers, which may not lend themselves to destruction by light artillery of present-day characteristics. However, since there is no indication of any specific requirements for artillery other than what has been provided, it can be only concluded that no additional requirement exists since the maximum tube employment was not overburdened.

16. Conclusion:

Since only 3% of the artillery support requests generated within the experimental environment of the Controllability Experiment were beyond the range capability of the combat group artillery battery, there is no requirement for combat group operations per se, for artillery with a range capability of greater than 15,000 meters for reinforcement of the combat group artillery battery.

SECTION IV

OBJECTIVE 3

17. To determine the logistical support requirements generated by the combat group artillery battery.

For discussion, conclusions and recommendations see Volume II.

SECTION V

OBJECTIVE 4

18. Objective:

To determine the requirements for positioning of the combat group artillery battery to insure the accomplishment of the artillery support mission while achieving the required amount of security from infantry units without diverting the latter units from their primary missions.

19. Indicators:

In the consideration of the requirements for positioning of the combat group artillery battery to insure accomplishment of the support mission while achieving the required security from infantry units without diverting the latter units from their primary missions attention has been given to the following areas:

a. Displacements required and executed.

b. Spread of ranges of missions fired.

c. Involvement in self-defense activities.

20. Presentation of Data:

a. Displacements Required and Executed:

No requirement existed within the environment of the experiment for displacements in situations 1 through 5. Only six displacements of position occurred in the 8 record runs of the experiment during situations 6 and 7.

b. Spread of Ranges of Missions Fired:

A tabulation of the missions fired at the upper 1/3 limit of the range bracket of the experimental artillery is contained in Figure 24.

c. Involvement in Self-Defense Activities:

Observations by military observers recorded that during 16% of the total situation time artillery personnel devoted major attention to a self defense or security role. No instances were recorded in the experiment wherein security assistance was given by supported combat elements.

21. Discussion:

a. Displacements Required and Executed:

In accordance with the design of the experiment the combat group artillery battery was posed the problem of maintaining continuous artillery support under varied and frequently changing conditions. In Situations 1 and 2, in which the PENTANA Company performed at the narrow span of operations, the artillery battery was required to provide close support to four companies of the combat group. In Situations 3 and 5, in which the company performed at the intermediate span of operations, one platoon of the artillery battery was required to support the experimental company and one other company. The second platoon of the artillery battery was not in a position to render reinforcing support. In Situation 4 one platoon was in direct support of experimental company again with no reinforcement potential from the second platoon. In Situations 6 and 7, at the wide span of operations, one platoon of artillery was attached to the company. The second platoon was again not in a position to assist in support.

Responsibility for positioning in Situations 1 through 5 rested with the experimental control group; in Situations 6 and 7 the experimental company commander bore this responsibility. Displacement by the artillery within a situation was undertaken a total of six times during Situations 6 and 7. These displacements were required to insure the maintenance of continuous support and were not influenced by any consideration of unit security. Therefore, it can only be concluded that the requirements for positioning of the battery for the support role in itself did not have a deleterious effect on security.

b. Spread of Ranges of Missions Fired:

Examination of Figure 24 reveals that a total of 36 artillery missions were fired at ranges of 12000-15000 meters and 66 artillery missions were fired at ranges of 10000-12000 meters. Together these missions represent only 20% of the missions fired. Only 3% of the missions requested exceeded the range capability of the artillery from the positions occupied. It is not considered that these percentages are so large as to have warranted forward displacement in an effort to engage in the more effective range brackets. Such displacements, if warranted, might have jeopardized the artillery security to a greater extent than is indicated in the discussion contained in paragraph 4c below.

c. Involvement in Self-Defense Activities:

In general, the instances in which the security of the artillery was threatened occurred at the end of defensive situations when the supporting infantry had been defeated and overrun. Under similar circumstances in actual combat, continued artillery participation would not have restored the position and its withdrawal or displacement to another protected position could have been effected without jeopardizing the overall support requirement.

22. Conclusion:

In this experiment, the assumed 15,000 meter range of the combat group artillery weapon met requirements for positioning the combat group artillery battery to insure the accomplishment of the artillery support mission while achieving the required amount of security from infantry units without diverting the latter units from their primary missions.

ARTILLERY MISSIONS FIRED BETWEEN 10,000 AND 15,000 METERS

RECORD COURSE	CO	MISSIONS FIRED AT 10,000-12,000 METERS		MISSIONS FIRED AT 12,000-15,000 METERS		TOTAL MISSIONS
		TOTAL MISSIONS	PER CENT OF TOTAL	TOTAL MISSIONS	PER CENT OF TOTAL	
I	A	12	11%	8	8%	105
	B	9	12%	7	9%	75
II	A	17	36%	11	23%	47
	B	12	29%	7	17%	42
III	A	1	1%	0	0%	72
	B	2	11%	0	0%	18
IV	A	6	7%	3	3%	87
	B	7	15%	0	0%	46
TOTAL		66		36		492

Figure 24

SECTION VI

OBJECTIVE 5

23. Objective:

To determine the capability of the combat group artillery battery to acquire targets and to assist in the surveillance effort of the combat group.

24. Discussion:

Due to problems of control, lack of electrical target acquisition and surveillance equipment, and the fact that planes or helicopters for aerial observation were not included in the experiment, no conclusions concerning the capability of the battery to acquire targets or to assist in the surveillance effort of the combat group resulted from this experiment.

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