b. Bomb and Torpedo Expenditures

TABLE 43. ANNUAL ORDNANCE EXPENDITURES BY ALL CARRIER-BASED AND LAND-BASED AIRCRAFT
By Type of Ordnance

TYPE OF ORDNANCE	CARRIER-BASED							LAND-BASED				
	TONNAGES				PERCENT OF TOTAL*			TONNAGES			% OF TOTAL*	
	1942	1943	1944	1945	1942-3	1944	1945	1942	1943	1945	1942-3	1945
100-lb. GP	40	115	2,036	3,598	6.5	9.7	16.7	31	475	815	6.9	3.4
250-lb. GP	0	0	1,281	927	0.0	6.1	4.3	0	83	2,982	1.1	12.3
500-lb. GP	192	639	7,914	12,878	34.9	37.6	59.6	101	1,347	7,482	19.6	30.9
1000-lb. GP	279	426	3,944	1,336	29.6	18.8	6.2	182	2,555	7,652	37.1	31.6
2000-lb. GP	0	223	1,119	558	9.4	5.3	2.6	0	2,192	815	29.7	3.4
500-lb. SAP	0	0	624	160	0.0	3.0	0.7	0	0	93	0.0	0.4
1000-lb. SAP	0	113	1,401	209	4.8	6.6	1.0	0	0	294	0.0	1.2
Armor-Piercing	0	10	264	29	0.4	1.3	0.1	0	0	7	0.0	0.0
Napalim (Tank)	0	0	118	560	0.0	0.6	2.6	0	0	2,062	0.0	8.5
Other Incendiary	2	26	480	68	1.2	2.3	0.3	0	11	264	0.2	1.1
Fragmentation	8	2	335	957	0.4	1.6	4.4	0	48	1,257	0.7	5.2
Depth Bombs	8	50	668	36	2.4	3.2	0.2	6	19	368	0.3	1.5
Torpedoes	131	116	772	292	10.4	3.7	1.3	83	27	30	1.5	0.1
Mines	0	0	50	0	0.0	0.2	0.0	0	212	87	2.9	0.4
Type Unknown	52	0	46	0	*	*	*	156	320	0	*	*
TOTAL	712	1,720	21,052	21,608	100.0	100.0	100.0	565	7,289	24,208	100.0	100.0

*Percentages are based on totals of ordnance of known types only.

NOTE: 1944 ordnance expenditures, by type of ordnance, are not available from Op-23-V machine cards because of deficiencies in the coding system. The carrier-based expenditures for 1944 given herewith are from data compiled by ComAirPac OpIntel, and are believed reasonably complete and comparable. Similar land-based figures for 1944 are not available.

NOTES TO TABLE 43

This table, the first of seven on the subject of bomb expenditures by type and size of bombs, shows trends from year to year during the war.

Outstanding in the carrier data are the following trends from 1942 to 1945:

(a) Substantial increase in use of 100-lb. GP bombs, used largely in TBMs to secure maximum area coverage against targets susceptible mainly to fragmentation damage and small demolition charges.

(b) Increasing use of 250-lb. GP bombs, largely on SB2C wing racks, particularly in 1944.

(c) A trend toward concentration on use of the 500-lb. GP bomb as an all-purpose weapon, resulting partly from its heavy use by the increased VF complement.

(d) Substantial decrease in the use of heavy GP, SAP and AP bombs, from 44% of the total in 1942-43 to 11% in 1945.

(e) Increasing use of Napalm fire bombs and fragmentation bombs (particularly after introduction of the 260-lb. frag. bomb in 1945), and decreasing use of other special ordnance, such as torpedoes, incendiary clusters, and depth bombs.

In the data for land-based planes, though 1944 figures are not available, the same trends can be seen. The heavy 1945 use of depth bombs, SAP bombs, and incendiary clusters, represents largely a cleaning out of surplus stocks in the Solomons area.

TABLE 44. TONS OF BOMBS, CLUSTERS, TORPEDOES AND MINES EXPENDED BY VARIOUS MODELS OF NAVAL AND MARINE AIRCRAFT, 1945 ONLY
By Type of Ordnance

TYPE OF ORDNANCE	CARRIER-BASED#				LAND-BASED							
	F6F	FG, F4U	SB2C, SBW	TBM	F4U, F6F	SBD	SB2C, SBW	TBM	PB4Y	PV	PBJ	OTHER VPB *
TONS EXPENDED												
100-lb. GP	33	3	6	3548	69	86	23	218	179	12	179	49
250-lb. GP @	97	12	747	63	24	1345	92	0	236	66	1179	40
500-lb. GP	2402	893	2344	7235	2008	2347	563	584	375	63	1450	92
1000-lb. GP	455	226	573	82	2368	3667	60	48	32	11	1466	0
2000-lb. GP	0	0	0	558	22	0	0	66	10	0	717	0
500-lb. SAP	12	0	25	123	22	0	58	6	0	0	7	0
1000-lb. SAP	7	0	202	0	119	0	37	0	0	0	138	0
Armor-Piercing	1	0	28	0	2	0	0	0	0	0	5	0
Napalm (Tank)	373	119	0	0	1794	10	147	0	0	111	0	0
Other Incendiary	2	3	0	63	34	0	18	3	37	16	140	16
Fragmentation	300	55	102	500	44	610	87	77	4	0	429	6
Depth Bombs	7	1	0	28	25	0	96	39	3	6	183	16
Torpedoes	0	0	0	292	0	0	0	0	5	0	0	25
Mines	0	0	0	0	0	0	0	0	87	0	0	0
TOTAL TONNAGE	3689	1312	4027	12492	6531	8065	1181	1041	968	285	5893	244
PERCENT OF TOTAL TONNAGE												
100-lb. GP	0.9	0.2	0.1	28.4	1.0	1.1	1.9	20.9	18.5	4.2	3.0	20.1
250-lb. GP	2.6	0.9	18.6	0.5	0.4	16.7	7.8	0.0	24.4	23.2	20.0	16.4
500-lb. GP	65.1	68.1	58.2	57.9	30.7	29.1	47.7	56.1	38.8	22.1	24.6	37.7
1000-lb. GP	12.3	17.2	14.3	0.7	36.3	45.5	5.1	4.6	3.3	3.9	24.9	0.0
2000-lb. GP	0.0	0.0	0.0	4.5	0.3	0.0	0.0	6.3	1.0	0.0	12.2	0.0
SAP-AP	0.5	0.0	6.3	1.0	2.2	0.0	8.0	0.6	0.0	0.0	2.5	0.0
Napalm (Tank)	10.2	9.1	0.0	0.0	27.5	0.1	12.5	0.0	0.0	38.9	0.0	0.0
Other Incendiary	0.1	0.2	0.0	0.5	0.5	0.0	1.5	0.3	3.8	5.6	2.4	6.6
Fragmentation	8.1	4.2	2.5	4.0	0.7	7.5	7.4	7.4	0.4	0.0	7.3	2.5
Depth Bombs	0.2	0.1	0.0	0.2	0.4	0.0	8.1	3.8	0.3	2.1	3.1	6.5
Torpedoes, Mines	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	9.5	0.0	0.0	10.2

Carrier FMs, not shown here, expended 88 tons, as follows: 68 tons of Napalm, 8 tons of 100-lb. GP, 8 tons of 250-lb. GP, 4 tons of 500-lb. GP.
* Largely PBM
@ Including a small quantity of 300-lb. Army GP bombs.

NOTES TO TABLE 44

This table illustrates the ordnance-carrying advantages and limitations of individual models of aircraft, and shows how each model was used as an ordnance carrier during the last 7½ months of the war.

The principal fighter bomb loadings, accounting for 87 to 94 percent of their total bomb loads, were bombs of three types: the 500-lb. and 1000-lb. GP, and the fire bomb. The 500-pounder predominated among carrier VF, because of range and weight considerations, while the three types were nearly evenly matched among land-based VF. Only one other type of bomb, the 260-lb. fragmentation (usually with VT fuzing) enjoyed substantial use on fighters; this was largely in the fast carrier attacks on Japanese airfields in the last few months of the war.

VSB, in turn, were largely limited to bombs of 250 to 1000 pounds size, carrying no 2000-

pounders and few small bombs or clusters. Land-based SB2Cs were used to carry fire bombs, however, and both types of VSB carried 260-pound frag bombs on wing racks at the end of the war.

The TBM carried most of the Navy's 100-pounders, though that type constituted only 28% of its total load. Unable to carry effective loads of bombs of the 250 and 1000-lb. sizes, the TBM could carry any items of 100, 500 or 2000-lb. size, yet it was rarely used for such special items as 100-lb. or 500-lb. incendiary, fragmentation or butterfly clusters, and was insufficiently used to carry 100-pounders.

The versatility of the PB4Y and PBJ is well illustrated by the table. The PB4Y loadings of small bombs reflect the predominance of small vessels among its targets. The heavy fire-bomb loadings on PVs should be noted. These were largely used in strikes on isolated enemy positions in the Borneo area.

NOTES TO TABLE 45

This table analyzes bomb expenditures by type of target, for 1945 only. Inspection of this table permits the general statement that while bomb selection did vary somewhat with the varying requirements of different targets, the outstanding characteristic of the table is the sameness of the bulk of the loadings from column to column.

The latter characteristic results in large part from the relative inflexibility of loading arrangements on fighter and dive bomber aircraft. The former were limited to one or two bombs per plane, and clusters were generally excluded by safety considerations; the VSB were limited to 3 or 4 bombs per plane and here again clusters were excluded and other types of bombs limited. Only the TBM, PB4Y and PBJ were widely flexible as to variety of ordnance which could be carried with minimum sacrifice of their total load. Under these circumstances, the fact that bomb expenditures varied between types of targets as much as they did, is evidence that selection of attacking aircraft and type of bomb was to some extent consciously directed toward the requirements of the targets. That selection was not perfectly adapted to target requirements goes without saying; specific cases have been covered at length in analytical reports by Op-23-V and ComAirPac. It is important to note, however, that even the closest attention paid to scientific selection of ordnance will be of little value if plane design seriously limits the variety of useful ordnance that can be carried.

Attacks on airfield targets show evidence of conscious planning in the high use of 100-lb. GP bombs and fragmentation bombs reported, and the comparatively small use of bombs larger than 500 pounds. The first two types are recommended for attacks on parked aircraft, and GP bombs of 100 or 500 pound size are recommended for runway cratering and destruction of buildings. The heavy reported use of 1000-lb., 2000-lb., and SAP bombs probably largely reflects deficiencies in operational planning and in bomb supply; the use of over 50% 500-pounders may reflect in addition the plane loading problem referred to above.

The category of other military land targets is so large and internally diverse that little comment can be made, other than to point out the extensive use of fire bombs, and the relatively light use of small bombs against targets which are frequently small and difficult to hit, yet vulnerable to fragmentation effect.

Likewise little comment can be made with respect to the miscellaneous categories of land targets, other than to point out the small variation between the three columns, and to suggest that industrial targets (included in "other land") frequently require a large proportion of heavy bombs.

The record with respect to armored warships shows a commendable restraint with respect to the use of ineffective small bombs, but a rather inadequate use of the 2000-lb. GP bombs, which have been adjudged superior to SAP and AP bombs for glide and dive attack on most types of armored vessels. The 500-pounders, which made up over one-third of the tonnage, were probably largely ineffective. The heavy use of fragmentation bombs to neutralize A/A may be noted. The light use of torpedoes results from the fact that most attacks in 1945 were made on ships in harbor.

Attacks on unarmored warships were distinguished by a commendable concentration on 500-lb. GP bombs. The use of heavier GPs was permissible, but SAP and AP bombs are wasteful against these targets, and torpedoes have a rather small chance of hitting fast maneuvering small vessels of these types.

(Cont. on next page)

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TABLE 45. NUMBER OF BOMBS, CLUSTERS, TORPEDOES AND MINES, AND THEIR PROPORTION TO TOTAL TONNAGE, EXPENDED ON TARGET BY ALL NAVAL AND MARINE CARRIER AND LAND-BASED AIRCRAFT, 1945 ONLY
By Type of Ordnance and Type of Target

TYPE OF ORDNANCE	LAND TARGETS					SHIPPING TARGETS					TOTAL
	AIR-FIELDS	OTHER MILI-TARY TARGETS	LAND TRANS-PORTA-TION	HARBOR AREAS	OTHER OR UN-KNOWN LAND	WARSHIPS BB,CA, CL,CV, CVL	WARSHIPS CVE,DD DE,PC, ETC.	MERCHANT SHIPS Over 500 Tons	MERCHANT SHIPS 500 Tons or Under	UN-KNOWN SHIPS	
NUMBER OF BOMBS											
100-lb. GP	37,483	38,439	2,261	2,388	2,870	157	298	1,240	3,123	0	88,259
250-lb. GP*	4,291	20,927	1,424	737	1,136	60	314	1,046	1,173	0	31,108
500-lb. GP	24,205	38,618	3,126	3,405	3,538	1,575	1,281	3,959	1,463	260	81,430
1000-lb. GP	2,915	11,953	788	493	587	704	67	432	28	6	17,973
2000-lb. GP	379	620	89	78	79	39	39	16	34	0	1,373
500-lb. SAP	69	619	43	72	8	26	108	61	0	0	1,006
1000-lb. SAP	205	395	4	86	0	143	51	108	0	11	1,003
Armor-Piercing #	6	0	9	10	0	21	15	9	0	0	70
Napalm Bombs	356	5,051	71	267	146	0	0	0	31	0	5,922
Other Incendiary	1,066	2,222	81	222	414	0	2	152	698	1	4,858
Fragmentation	7,090	10,617	264	589	489	623	10	114	111	13	19,920
Depth Bombs	452	1,127	53	252	88	0	0	14	120	0	2,106
Torpedoes	0	0	0	0	2	110	59	138	10	3	322
Mines	0	0	0	0	0	0	0	0	0	96	96
TOTAL BOMBS @	78,517	130,588	8,213	8,599	9,357	3,458	2,244	7,289	6,791	390	255,446
TOTAL TONNAGE	11,577	24,912	1,657	1,702	1,707	1,070	566	1,650	810	165	45,816
PERCENT OF TOTAL TONNAGE											
100-lb. GP	16.2%	7.7%	6.9%	7.0%	8.5%	0.8%	2.6%	3.8%	19.3%	0.0%	9.7%
250-lb. GP*	4.7	10.5	10.7	5.5	8.4	0.7	6.9	7.9	18.1	0.0	8.5
500-lb. GP	52.3	38.8	47.2	50.0	51.8	36.8	56.6	60.0	45.2	39.4	44.4
1000-lb. GP	12.6	24.0	23.8	14.5	17.2	32.9	6.0	13.0	1.7	1.8	19.6
2000-lb. GP	3.4	2.5	5.4	4.6	4.6	3.6	6.9	1.0	4.2	0.0	3.0
500-lb. SAP	0.1	0.6	0.7	1.1	0.1	0.7	4.8	0.9	0.0	0.0	0.6
1000-lb. SAP	0.9	0.8	0.1	2.5	0.0	6.7	4.4	3.3	0.0	3.6	1.1
Armor-Piercing #	0.0	0.0	0.3	0.3	0.0	1.0	1.2	0.3	0.0	0.0	0.1
Napalm Bombs	1.3	9.0	2.1	7.4	3.4	0.0	0.0	0.0	1.9	0.0	5.7
Other Incendiary	0.7	0.6	0.6	0.8	1.8	0.0	0.0	0.4	4.3	0.0	0.7
Fragmentation	6.8	4.7	1.7	3.8	3.2	6.5	0.2	0.8	1.5	0.6	4.8
Depth Bombs	1.0	0.8	0.5	2.5	0.9	0.0	0.0	0.2	2.6	0.0	0.9
Torpedoes	0.0	0.0	0.0	0.0	0.1	10.3	10.4	8.4	1.2	1.8	0.7
Mines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.8	0.2
TOTALS	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* Includes a small number (about 1100 bombs) of Army 300-pound GP bombs.
\# Largely 1000-lb.
@ Counting clusters as one bomb each. It is estimated that the 4,858 "other incendiary" units were almost entirely clusters, averaging 25 individual incendiary bombs apiece, or a total of about 120,000 bombs. Possibly 1/3 of the fragmentation units were 6 - bomb clusters, raising the total of frag bombs to over 50,000.

NOTE: Total tonnages in this table differ somewhat from those in other sections of this report, in which tonnages were based on total bomb-tonnage of all types, rounded to a whole number of tons for each separate mission.

(Continued from preceding page)
The selection of bombs against merchant vessels appears to have been excellent. However, more 1000-lb. GP bombs and torpedoes could well have been used against large vessels, and SAP bombs eliminated. The excellent selection of small GP bombs, incendiary and fragmentation clusters (largely by VPB) against small vessels, should be especially noted.

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TABLE 46. REPORTED ORDNANCE EXPENDITURES OF NAVAL AND MARINE SBDs AND TBFs, 1942-1943 *

TYPE OF ORDNANCE	CARRIER-BASED				LAND-BASED			
	SBD		TBF		SBD		TBF	
	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total
100-lb. GP	38	4.0%	105	9.0%	177	5.9%	300	8.0%
250-lb. GP	0	0.0	0	0.0	38	1.3	32	0.9
500-lb. GP	167	17.5	622	53.4	216	7.1	920	24.4
1000-lb. GP	640	67.0	18	1.5	2,588	85.6	18	0.5
2000-lb. GP	0	0.0	223	19.2	0	0.0	2,184	58.1
SAP and AP	91	9.5	0	0.0	0	0.0	0	0.0
Fragmentation	3	0.3	2	0.2	0	0.0	0	0.0
Incendiary	0	0.0	19	1.6	0	0.0	4	0.1
Depth Bombs	16	1.7	32	2.7	3	0.1	0	0.0
Torpedoes	0	0.0	144	12.4	0	0.0	102	2.7
Mines	0	0.0	0	0.0	0	0.0	200	5.3
TOTALS	955	100.0%	1,165	100.0%	3,022	100.0%	3,760	100.0%

* Figures for these two planes given in this table account for 87% of all tonnage expended by Naval and Marine aircraft during these two years.

NOTES TO TABLE 46

The above figures for the Navy's two principal bomb carrying planes of 1942-43 present an interesting contrast with the data for 1945. The overwhelming concentration on the heaviest types of bombs in 1942-43 is not believed to have had any especial justification in the nature of the targets attacked, which were principally airfields and lightly constructed military land targets. This concentration may have resulted in part from the difficulties of bomb supply to forward areas, or from operating conditions which favored the loading of the smallest possible number of bombs. It is believed, however, that the primary factor was the absence of any science of ordnance selection, or of any standard doctrine in the field; the first steps by the Navy to organize the study of bomb damage and to produce a doctrine for ordnance selection were taken in late 1943 and were not effective until 1944. Thus field commanders in the South Pacific and elsewhere were free to follow the path of least resistance - loading the fewest bombs - and the then current "blast" theory of bomb damage (which favored the largest bomb available, and ignored the desirability of using a larger number of smaller bombs to increase the probability of getting hits, on such targets as were susceptible to damage by smaller bombs).

It will be noted that the carrier forces, although they had among their targets a larger percentage of armored warships and others requiring larger bombs, were less inclined to emphasize large bombs than the land-based airforces. Neither made much use of fragmentation or incendiary ordnance. By contrast with 1942-43 the ordnance selection in 1945 exhibited exceptional improvement, for which credit may be assigned to an increasing awareness of the importance of correct ordnance, and an increasing volume of information concerning the science of ordnance selection.

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TABLE 47. ORDNANCE EXPENDITURES OF ALL CARRIER-BASED AIRCRAFT, BY TYPE OF ORDNANCE AND BY OPERATION, 1944

(Figures are in tons)

TYPE OF ORDNANCE	MARSHALLS	TRUK, MARIANAS	PALAU, YAP, WOLEAI	HOLLANDIA	SECOND TRUK, PONAPE	MARIANAS, BONINS, PALAU	PALAU, YAP	PHILIPPINES, BONINS	RYUKYUS FORMOSA, PHILIPPINES	PHILIPPINES	TOTAL MINOR OPERATIONS 1944
	Jan.-Feb.	Feb.	March-April	April	April-May	June-August	Sept.	Sept.	Oct.	Nov.-Dec.	
100-lb. GP	243	15	49	123	57	664	238	192	288	144	23
250-lb. GP	85	14	27	51	26	337	152	140	260	185	4
500-lb. GP	741	197	203	352	185	2607	698	878	1070	762	221
1000-lb. GP	218	117	133	154	161	1479	281	565	462	281	93
2000-lb. GP	144	13	18	25	92	367	55	170	100	115	20
500-lb. SAP	*	*	*	23	53	193	50	36	179	51	39
1000-lb. SAP	*	124	79	2	158	524	119	74	223	86	12
Armor-Piercing	0	31	51	0	5	51	0	0	106	13	7
Napalm (Tank)	0	0	0	0	0	0	70	0	0	2	46
Other Incendiary	0	16	14	34	34	247	0	46	58	17	14
Fragmentation	39	17	10	33	10	153	24	21	13	15	0
Depth Bombs	106	0	0	22	24	347	77	18	22	16	36
Torpedoes	0	66	35	0	0	61	0	72	354	136	48
Mines	0	0	50	0	0	0	0	0	0	0	0
TOTAL	1576	610	669	819	805	7030	1764	2212	3135	1823	609#

* Included with 500-lb. GP, or 1000-lb. GP, respectively; amounts are believed to be small.
\# Total includes 46 tons of unknown types.

NOTE: These data are from compilations prepared by ComAirPac OpIntel, with minor adjustments, and are believed reasonably complete and accurate.

NOTES TO TABLE 47

The above table, taken from AirPac sources, shows the carrier ordnance expenditures for individual operations and groups of operations during 1944.

The most significant characteristic of the ordnance data, when so arranged, is the relatively high expenditure of small bombs during short operations, and the greater expenditure of heavy bombs during extended operations or the later phases thereof (including (a) the Truk and Marianas strikes which were the second phase of the Marshalls operation, (b) the Second Truk strikes which were the second phase of the Hollandia operation, (c) the Marianas operation as a whole, and (d) the Philippines strikes of September which succeeded the Palau operations). The reason for this was principally early exhaustion by some carriers of the limited allowances of small bombs; this required substitution, in the latter phases of the operation, of the large bombs which were carried in excess of reasonable needs, and these were then used regardless of the requirements of the targets. This situation was corrected in 1945 by altering the carrier allowances in favor of small bombs, and by replenishing bombs at sea during extended operations.

TABLE 48. ORDNANCE EXPENDITURES OF ALL CARRIER-BASED AIRCRAFT, BY TYPE OF ORDNANCE, MONTHLY, 1945

TYPE OF ORDNANCE	January		February		March		April		May		June		July-August	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
100-lb. GP	331	14	252	20	856	27	887	18	665	19	523	28	85	2
250-lb. GP	101	4	106	8	236	7	244	5	132	4	16	1	90	2
500-lb. GP	1318	57	696	55	1692	53	3066	61	2401	68	1058	57	2649	60
1000-lb. GP	249	11	57	5	62	2	209	4	85	2	39	2	636	14
2000-lb. GP	35	2	16	1	12	*	211	4	18	1	8	*	260	6
500-lb. SAP	72	3	0	0	23	1	13	*	30	1	23	1	0	0
1000-lb. SAP	42	2	0	0	80	3	56	1	0	0	0	0	32	1
Armor-Piercing	17	1	0	0	2	*	10	*	0	0	0	0	0	0
Napalm (Tank)	0	0	109	9	85	3	193	4	87	2	97	5	2	*
Other Incendiary	2	*	0	0	16	1	4	*	44	1	1	*	1	*
Fragmentation	28	1	19	2	42	1	42	1	53	2	104	6	689	15
Depth Bombs	8	*	0	0	1	*	12	*	5	*	7	*	4	*
Torpedoes	109	5	0	0	72	2	111	2	0	0	0	0	0	0
TOTAL	2312	100	1255	100	3179	100	5058	100	3520	100	1876	100	4448	100

* Less than $\frac{1}{2}$ of one percent.

NOTES TO TABLE 48

The principal trend to be noted in the 1945 carrier ordnance expenditures is the shift from 100-lb. and 250-lb. GP bombs to the 260-lb. fragmentation bomb in the last three months of the war. These bombs, with the new VT fuzing, were used by all types of planes against such primary targets as grounded aircraft and A/A guns. Heavy bombs received scant use in 1945, except in the heavy anti-shipping strikes of January and July. In the latter month armored warships were the principal targets, and 21% of total tonnage consisted of 1000 or 2000-lb. bombs.

NOTES TO TABLE 49: (see next page).

Torpedoes accounted for 12% of the total weight of bombs, torpedoes and mines expended by Naval and Marine aircraft against enemy shipping during the war. In carrier-based attacks they accounted for 14%, in land-based attacks only 5%.

In shipping attacks by carrier VTB torpedoes represented 29% of the total weight of heavy ordnance carried, and in shipping attacks by land-based VTB only 15%. The proportion of torpedos to total weight of ordnance carried by VTB against shipping declined throughout the war, as indicated by the following figures:

Year	% of Torpedoes to Total Ordnance Expended on Shipping, by Weight	
	Carrier VTB	Land-Based VTB
1942	73%	94%
1943	68	5
1944	32	3
1945	16	0

Torpedoes constituted over one quarter of the total weight of ordnance expended against armored warships, slightly over 10 percent of expenditures against unarmored warships, and slightly less than 10 percent of expenditures against large merchant vessels. Nearly half of the total torpedo expenditures were directed against armored warships.

The table shows, monthly, the targets against which torpedoes were expended, and the types of planes carrying them. All but 3% of total aircraft torpedo expenditures were by VTB, largely TBFs or TBMs.

TABLE 49. AERIAL TORPEDOES EXPENDED ON TARGETS, MONTHLY

MONTH	TOTAL NO. OF TORPEDOES EXPENDED	NUMBER DROPPED BY			NUMBER DROPPED, BY TARGET TYPE			
		Carrier VTB	Land-Based VTB	VPB	WARSHIPS Armored	WARSHIPS Unarmored	MERCHANT VESSELS	DATA NOT AVAILABLE
1942 - February	9	9	0		9	0	0	
March	13	13	0		0	0	13	
May	64	64	0		64	0	0	
June	24	17	4	3	21	0	3	
August	12	12	0		11	0	1	
September	5	0	5		5	0	0	
October	32	8	24		23	5	4	
November	48	8	40		39	0	9	
December	7	0	7		7	0	0	
1943 - January	15	0	15		0	6	9	
February	3	0	3		0	3	0	
July	4	0	4		0	0	4	
November	77	73	0	4	59	14	4	
December	44	43	0	1	35	0	9	
1944 - January	56	48	6	2	16	16	6	18
February	67	66		1	14	16	36	1
March	35	35			0	16	16	3
June	22	22			20	1	1	0
August	39	39			4	11	19	5
September	72	72			0	0	70	2
October	354	354			239	13	74	28
November	136	136			34	13	89	0
1945 - January	109	109		0	3	28	78	0
March	73	72		1	0	10	60	3
April	114	111		3	103	9	2	0
May	12	0		12	4	4	2	2
June	8	0		8	0	8	0	0
July	6	0		6	0	0	6	0
TOTALS	1,460	1,311	108	41	710	173	515	62

NOTE: 1944 totals are from AirPac data, and 1944 breakdowns by type of target are approximate only. No torpedo expenditures were reported for months not listed above.

c. Rocket and Ammunition Expenditures

TABLE 50. NUMBER OF ROCKETS EXPENDED ON TARGETS, MONTHLY.
By Model of Aircraft, For Land-Based and Carrier-Based Aircraft,
and by Type of Carrier

A. CARRIER-BASED

MONTH	CV-BASED				CVL-BASED		FAST CARRIER TOTAL	CVE-BASED				
	F6F	F4U,FG	SB2C	TBM	F6F	TBM		FM	F6F	F4U, FG	TBM	TOTAL
1944-January				0			0				228	228
February				0			0				142	142
March				144			144				14	14
April				491			491				0	0
May				134			134				0	0
June				525			525				642	642
July	1,331			1176	0		2,507	56	0		1,373	1,429
August	156			169	0		325	0	713		0	713
September	1,927			607	1,238		3,772	4	0		3,906	3,910
October	3,586			417	781		4,784	0	0		1,304	1,304
November	2,137			0	354		2,491	0	0		0	0
December	2,739		43	150	335		3,267	0	0		4	4
1945-January	5,587	0	0	233	1,601	0	7,421	2,475	0	0	2,319	4,794
February	3,574	1,542	384	624	693	330	7,147	2,871	0	0	2,327	5,198
March	3,887	7,210	492	826	2,955	693	16,063	5,965	92	0	4,737	10,794
April	3,461	3,147	2058	982	4,018	502	14,168	9,038	4,828	0	12,836	26,702
May	2,991	1,860	850	341	1,936	190	8,168	1,603	3,331	268	8,827	14,029
June	505	252	170	343	538	41	1,849	6,230	2,097	1121	7,736	17,184
July	6,043	4,737	315	46	2,210	113	13,464	0	48	130	96	274
August	3,088	3,359	266	0	1,631	0	8,344	95	6	43	0	144
TOTALS	41,012	22,107	4578	7208	18,290	1869	95,064	28,337	11,115	1562	46,491	87,505

B. LAND-BASED

MONTH	F4U,FG	F6F	FM	SBD	SB2C	TBM	PBJ	PV	TOTAL
1944-February						154	0	0	154
March						94	0	0	94
April						28	0	0	28
May				232		0	0	6	238
November						0	283	59	342
December						0	129	164	293
1945-January	0	0			0	295	194	39	528
February	25	0			0	261	40	175	501
March	0	122			12	195	0	261	590
April	3,277	0			89	346	382	219	4,313
May	3,334	227			92	2,127	716	1,022	7,518
June	4,523	518			234	924	425	477	7,101
July	3,099	53			473	120	537	47	4,329
August	941	0	144		64	64	245	0	1,458
TOTALS	15,199	920	144	232	964	4,608	2,951	2,469	27,487

No rockets were expended during months not listed above.

TABLE 51. ROCKET EXPENDITURES ON TARGETS, 1945
By Plane Model, Carrier-Based and Land-Based, and by Target Type

TARGET TYPE	CARRIER-BASED					LAND-BASED				TOTAL
	F6F	F4U	FM	SB2C	TBM	F4U, F6F*	TBM, SB2C	PBJ	PV	
Airfields	29550	11944	7594	1210	14914	3539	123	141	4	69,019
Other Military Targets	13462	6472	16871	2743	24525	10803	3973	1128	1788	81,765
Harbor and Waterfront	1746	738	688	217	827	1004	768	154	77	6,219
Land Transportation	1128	595	1186	96	1678	410	265	66	48	5,472
Industrial	1167	1227	108	74	227	0	24	88	78	2,993
Other and unknown land	698	296	780	0	1056	89	24	21	8	2,972
Armored Warships	295	154	0	32	0	0	0	0	0	481
Unarmored Warships	1340	368	114	100	83	0	0	114	92	2,211
Merchant, over 500 tons	3759	1178	195	31	217	96	0	563	30	6,069
Merchant, under 500 tons	1818	681	741	32	591	322	119	204	115	4,623
Ships, Type unknown	157	16	0	0	24	0	0	60	0	257
TOTAL	55120	23669	28277	4535	44142	16263	5296	2539	2240	182,081

* Includes 144 by FM

NOTES TO TABLE 50

The gradual increase in the use of rockets, as their combat use spread to more squadrons and more types of planes, is clearly indicated above. The first substantial use of rockets by fast carriers, CVEs, and land-based aircraft, came in each case with the appearance of rocket-equipped fighter squadrons, on CVs and CVLs during the Guam and Palau campaigns of July and September 1944, on CVEs during the Lingayen operation. Rocket-equipped land-based Marine fighters did not appear until the beginning of the Okinawa campaign. Fighters accounted for 65% of the aircraft rockets fired at the enemy; CVE TBMs fired 60% of those expended by bombers.

Noteworthy are the expenditures for April 1945, when carriers alone fired nearly 41,000 HE rockets at enemy targets, largely on Okinawa. 116,000, or 55% of all rocket expenditures for the war, were against targets in the Ryukyus area; all but 5,600 of these were fired at land targets. Other areas heavily attacked with rockets were Japan (31,000), the Philippines (19,000), and the Bonins, principally Iwo Jima (15,000).

NOTES TO TABLE 51

1945 aircraft rocket expenditures accounted for over 85% of the Naval total for the war. Thus the above table, for 1945 only, gives a nearly complete picture of the use of rockets by Naval planes. 45% of all rocket expenditures were against military land targets, such as guns, defenses, personnel, stores, etc. Another 38% were expended against parked aircraft, hangars, and other airfield targets. About 7% were expended against shipping, 10% against miscellaneous land targets.

Fast carrier fighters made the bulk of the rocket attacks on airfields and shipping; CVE FMs and TBMs made most of the attacks on other military land targets, though CVE planes also heavily attacked airfields (particularly in June 1945) and fast carrier F6Fs were quite active against military targets. SB2Cs made few rocket attacks, in comparison with other plane models. Bombers in general made relatively few rocket attacks on shipping, reserving their primary effort for bomb-carrying.

Land-based planes used rockets primarily against military installations in the Okinawa area, though fighters in the later stages of that campaign made rocket attacks on airfields in Kyushu and the Southern Ryukyus.

TABLE 52. MONTHLY EXPENDITURE OF ROCKETS, BY ALL NAVAL AND MARINE CARRIER AND LAND-BASED AIRCRAFT, BY TYPE OF TARGET, 1945

BASE, MONTH	AIR-FIELDS	OTHER MILI-TARY TARGETS	HARBOR AREAS	LAND TRANS-PORTA-TION	OTHER & UN-KNOWN LAND	WARSHIPS		MERCHANTMEN		SHIPS, UN-KNOWN TYPE	TOTAL
						Ar-mored	Unar-mored	Over 500 Tons	Under 500 Tons		
CARRIER-BASED	65,224	64,077	4,223	4,684	5,608	481	2,005	5,382	3,864	197	155,745
January	4,388	2,716	489	1,115	443	0	704	1,587	775	0	12,217
February	3,236	7,957	180	208	265	8	102	239	150	0	12,345
March	9,066	11,473	1,473	522	1,319	4	727	1,265	1,008	0	26,857
April	12,296	24,331	937	1,229	642	112	53	438	832	0	40,870
May	9,941	10,509	375	360	552	0	0	100	339	21	22,197
June	13,560	4,572	12	184	455	0	0	160	90	0	19,033
July	7,147	1,983	430	726	1,128	297	159	1,158	534	176	13,738
August	5,590	536	327	340	804	60	260	435	136	0	8,488
LAND-BASED	3,823	17,683	2,000	788	327	0	206	691	804	16	26,338
January	0	100	250	0	8	0	46	124	0	0	528
February	25	153	243	0	24	0	16	24	16	0	501
March	18	112	297	0	0	0	92	22	49	0	590
April	206	3,747	0	321	0	0	6	10	23	0	4,313
May	557	5,966	127	401	183	0	0	96	188	0	7,518
June	1,032	4,841	649	54	80	0	14	138	293	0	7,101
July	1,651	1,934	358	12	24	0	32	166	136	16	4,329
August	334	830	76	0	8	0	0	111	99	0	1,458
TOTAL	69,047	81,760	6,223	5,472	5,935	481	2,211	6,073	4,668	213	182,083

NOTES TO TABLE 52

This table traces the pattern of rocket attacks in 1945. Primary carrier rocket targets in January were the airfields of the Philippines, Formosa, China and Indo China, though land targets in the Lingayen area were also heavily hit by the CVEs and shipping in the China Sea by the fast carriers. In February the emphasis in rocket attacks shifted to land targets at Iwo, with the Tokyo airfields a good second. In March a considerably stepped up attack was directed at airfields in Kyushu and the Ryukyus, at Okinawa defenses before the invasion, and at shipping in Kyushu ports.

April witnessed the greatest rocket offensive, mostly in support of ground forces on Okinawa, but with heavy attacks on Kyushu and Ryukyus airfields also. In May the close support requirements relaxed, and land-based planes took over the major share of this duty, but airfield attacks continued. In late May and June, after withdrawal of the British Task Force covering the Southern Ryukyus, and of the U.S. fast carrier force, the CVE force diverted its major attention to airfields, while the Marine planes ashore provided the bulk of the air support.

July and August were devoted almost entirely to attacks on Japan, in which airfields and shipping were the primary rocket targets.

TABLE 53. AIRCRAFT AMMUNITION EXPENDITURES ON TARGETS (IN THOUSANDS OF ROUNDS), 1945
Carrier-Based and Land-Based, by Target Type, Monthly

BASE, MONTH	AIR-FIELDS	OTHER MILI-TARY TARGETS	HARBOR AREAS	LAND TRANS-PORTA-TION	OTHER & UN-KNOWN LAND	WARSHIPS		MERCHANTMEN		SHIPS TYPE UN-KNOWN	TOTAL
						Ar-mored	Unar-mored	Over 500 Tons	Under 500 Tons		
CARRIER-BASED	12,471	7,378	842	826	868	376	656	1708	992	8	26,125
January	1,580	342	110	176	58	11	251	688	205	0	3,421
February	1,077	992	25	72	117	5	90	131	102	0	2,611
March	2,374	2,008	294	108	251	85	169	414	292	0	5,995
April	2,349	2,606	191	164	126	27	33	110	186	0	5,792
May	1,242	676	35	24	53	0	2	27	48	1	2,108
June	1,500	338	12	27	25	0	0	16	18	0	1,936
July	1,108	367	123	192	162	234	53	227	122	7	2,595
August	1,241	49	52	63	76	14	58	95	19	0	1,667
LAND-BASED	1,438	9,155	844	1,149	259	1	105	707	2,377	124	16,159
January	174	240	105	205	30	0	6	14	139	0	913
February	294	1,480	162	136	148	0	7	56	163	0	2,446
March	135	1,596	114	139	13	0	35	90	227	0	2,349
April	182	2,090	91	261	2	0	19	61	287	0	2,993
May	111	1,845	70	158	23	0	3	217	397	0	2,824
June	236	1,018	97	87	21	1	4	124	402	124	2,114
July	240	643	179	158	22	0	29	113	560	0	1,944
August	66	243	26	5	0	0	2	32	202	0	576
TOTALS	13,909	16,533	1,686	1,975	1,127	377	761	2415	3,369	132	42,284
COMPARATIVE TOTALS, 1944	6,782	22,824	230	1,241	863	456	715	2253	1,627	0	36,991

NOTES TO TABLE 53

The pattern of ammunition expenditure differed from that for rocket expenditure, as a comparison of the above table with Table 52 will illustrate. Airfield targets consumed a higher proportion of the strafing efforts of carrier aircraft than of their rocket expenditures. The reverse appeared to be true in the case of land-based aircraft. In the case of shipping targets also, carrier aircraft appeared to rely more on strafing than rocket fire, while for military land targets rockets were used more heavily. These tendencies probably reflect the larger rocket loadings generally carried by CVE planes against military targets, plus extensive strafing of parked aircraft, airfield A/A and ship A/A by fast carrier VF. The heavy use of rockets against harbor areas, versus strafing against transportation targets, by land-based planes, may also be noted.

Carrier planes devoted their principal strafing to airfield targets, with other military targets second. Land-based planes put military targets first, merchant shipping second, and airfields a poor third. The remarkable strafing record of land-based planes against small merchant vessels reflects principally the work of PB4Ys, which during 1945 expended 1,679,000 rounds in missions against merchant vessels of under 500 tons, including 436,000 rounds in July 1945 alone.

The comparative data in the bottom lines of the table show trends in strafing between 1944 and 1945. Major increases from 1944 to 1945 may be noted with respect to airfields, harbor areas, and small vessels, and a decrease with respect to military targets. Part of this decrease, and part of the airfields increase, may have resulted from differences in classification, since in 1944 airfield buildings and guns were sometimes classified under military targets. The growing importance of harbor areas reflects the movement of the war to sectors where substantial ports and facilities were found.

TABLE 54. AIRCRAFT AMMUNITION EXPENDITURES ON TARGETS
(IN THOUSANDS OF ROUNDS), DURING 1944
Carrier-Based and Land-Based, by Type of Carrier, and by Type of Target

TYPE OF TARGET	CARRIER-BASED						LAND-BASED				TOTAL
	CV-CVL			CVE							
	F6F	SBD, SB2C	TBF, TBM	FM	F6F	TBF, TBM	F4U, F6F	SBD, TBF	PB4Y	Other VPB	
Grounded Aircraft	1786	104	79	119	144	11	81	2	41	2	2,369
Airfield Runways	2463	258	230	98	66	16	679	432	40	131	4,413
Defense Installations, Guns	3897	422	304	848	420	203	2950	1071	55	198	10,368
Personnel, Bivouac Areas	464	64	118	619	158	100	2016	407	8	410	4,364
Buildings, Storage Areas*	2707	403	376	386	273	115	2368	993	32	439	8,092
Docks and Waterfront	95	8	19	3	11	0	62	17	0	15	230
Roads, Bridges, Vehicles	138	33	19	55	323	25	410	216	4	18	1,241
Industrial Facilities	132	53	19	5	0	0	19	4	2	2	236
Urban Areas	94	10	21	8	6	13	199	12	3	85	451
Other and Unknown Land	79	2	12	27	3	3	4	13	21	12	176
Armored Warships	251	36	29	96	20	22	0	0	2	0	456
Unarmored Warships	507	54	45	24	7	5	23	1	42	7	715
Merchant, over 500 tons	1330	234	159	44	32	6	98	50	213	87	2,253
Merchant, under 500 tons	560	44	58	83	83	11	404	89	149	146	1,627
TOTAL LAND TARGETS	11855	1357	1197	2168	1404	486	8788	3167	206	1312	31,940
TOTAL SHIP TARGETS	2648	368	291	247	142	44	525	140	406	240	5,051
TOTAL, ALL TARGETS	14503	1725	1488	2415	1546	530	9313	3307	612	1552	36,991

* Including airfield buildings and buildings of unidentified types, but excluding barracks.

NOTES TO TABLE 54

Herein is shown, for 1944 only, a more detailed breakdown of the types of targets strafed, plus data on the amount of strafing by each type of plane.

TABLE 55. SORTIES, BOMB TONNAGE, AND LOSSES IN NIGHT ATTACKS BY NAVAL AND MARINE AIRCRAFT, FOR ENTIRE WAR
By Plane Model, Land-Based and Carrier-Based

BASE, PLANE MODEL	PLANES TAKING OFF	PLANES ATTACKING TARGETS	TONS OF BOMBS ON TARGETS	OWN LOSSES ON ACTION SORTIES			PLANES LOST PER 100 SORTIES		PERCENT OF NIGHT SORTIES TO TOTAL SORTIES
				To Enemy A/A	To Enemy A/C	Operational	Enemy	Oper.	
LAND-BASED	5164	4973	2796	37	3	32	0.8	0.6	3.8
PB4Y	102	92	78	1	0	4	1.0	3.9	2.8
PBJ	1306	1278	747	4	0	3	0.3	0.2	15.6
PV	449	377	310	2	0	6	0.4	1.3	16.7
PBY	997	1058	870	6	1	5	0.7	0.5	72.2
PBM	165	142	58	9	0	1	5.5	0.6	32.6
PB2Y	64	56	74	0	0	0	*	*	45.1
F6F	1327	1300	268	3	0	2	0.2	0.2	32.0
F4U	74	70	9	1	1	1	*	*	0.1
SBD	121	110	31	2	0	1	1.7	0.8	0.3
TBF, TBM	559	490	351	9	1	9	1.8	1.6	5.3
CARRIER-BASED	636	582	204	12	0	12	1.9	1.9	0.4
F6F	301	267	19	4	0	8	1.3	2.7	0.5
F4U	17	16	0	0	0	0	*	*	0.2
FM	4	4	0	0	0	0	*	*	#
SBD	23	23	12	1	0	0	*	*	0.4
TBF, TBM	291	272	173	7	0	4	2.4	1.4	0.8
GRAND TOTAL	5800	5555	3000	49	3	44	0.9	0.8	2.0

* Not computed; less than 100 sorties.
# Less than 0.05.

(a) Night Attack

Tables 55 and 56 give brief statistical data on Navy and Marine night attacks on targets. While the number of sorties attacking targets at night was only 2 percent of total attack sorties by Naval aircraft, the total volume is more impressive than might ordinarily be thought, amounting to 5,800 sorties and 3,000 tons of bombs, largely by land-based planes. For some types of aircraft, mainly the flying boats, land-based F6F night fighters, and to a lesser extent PVs and PBJs, night attacks constituted a major portion of their offensive activity.

For the PBY, too slow and volnerable for day attack on defended targets, night work constituted a profitable and principal employment. The 1,058 attacks made by PBYs on 997 sorties were divided between ship and shore targets. Black Cats from New Guinea flew low level night bombing missions against Jap ships in the Bismarck Sea area in the winter of 1943-44, and Black Cats in the Solomons cooperated with PT-boats in spotting and attacking Jap barges and shore installations. PBYs were also used for night heckling raids on Jap bases throughout the South and Southwest Pacific, and for minelaying, and were still pursuing Jap shipping as far west as Celebes in late 1944.

PBMs and PB2Ys made a number of night attacks, largely on shipping (plus two PB2Y long-range night raids on Wake), but these two plane types were largely used for anti-sub patrol and sector search in quiet areas, and thus flew far fewer night attack missions.

PBJ night missions fell into two principal classes: night heckling missions over Rabaul and Kavieng, constituting the bulk of the sorties, and night rocket attacks on shipping, principally in the Bonins area. PV night missions were principally attacks on the Northern Kuriles, flown over the 600 miles from Attu under difficult weather conditions. PB4Ys flew few night missions; a few heckling sorties over Rabaul, and some minelaying flights.

The number of night missions by single-engine land-based planes is surprisingly large. Those by TBFs were predominantly for minelaying in the Solomons area, but included also night heckling attacks and shipping attacks there, and in 1945 some heckling missions at Okinawa.

The F6F night missions were flown almost entirely by Marine night fighter squadrons. Those from November 1944 to March 1945 were flown against Palau and Yap, in preparation for those in subsequent months in the Okinawa area, where substantial support was given our ground forces by regular heckling missions over enemy lines.

(Cont. on next page)

TABLE 56. NUMBER OF NAVAL AND MARINE AIRCRAFT ATTACKING TARGETS AT NIGHT
By Plane Model, Carrier-Based and Land-Based, Monthly

MONTH	CARRIER-BASED				LAND-BASED									GRAND TOTAL
	F6F	TBF TBM	Other	Total	F6F	F4U	SBD	TBF TBM	PBY	PBJ	PV	Other VPB*	TOTAL	
1942 - May							0	0	3				3	3
June							0	0	5				5	5
August							3	0	0				3	3
September							17	1	0				18	18
October							30	3	0				33	33
November							7	0	0				7	7
December							7	0	0				7	7
1943 - January							0	0	2			0	2	2
February							4	1	9			0	14	14
March								129	7			11	147	147
April								48	0			2	50	50
May								105	0			0	105	105
June								2	6			3	11	11
July								9	16			7	32	32
August	9	18	11	38				25	5		1	0	31	69
September	31	30	12	73				0	10		3	2	15	88
October	0	6	0	6				0	28		9	0	37	43
November	0	24	0	24				37	43		14	2	96	120
December	0	0	0	0				0	53		18	4	75	75
1944 - January	0	0	0	0		2		6	135	0	25	19	187	187
February	1	13	0	14		0		29	60	0	22	16	127	141
March	0	0	0	0		0		27	83	56	43	3	212	212
April	20	0	1	21		4		10	17	80	35	6	152	173
May	0	0	0	0		0	36	0	74	92	90	15	307	307
June	27	0	3	30	6	4	6	0	55	105	50	9	235	265
July	12	0	0	12	0	37		0	63	117	10	8	235	247
August	1	0	0	1	2	9		0	83	108	17	21	240	241
September	1	0	0	1	8	0		0	93	68	0	0	169	170
October	12	4	4	20	13	0		0	69	26	23	0	131	151
November	4	0	0	4	259	12		0	51	70	16	3	411	415
December	31	17	0	48	7	0		0	36	36	0	18	97	145
1945 - January	5	15	0	20	24	0		0	31	47	0	2	104	124
February	4	8	0	12	202	2		0	17	102	0	1	324	336
March	24	33	0	57	147	0		0	2	32	0	29	210	267
April	61	38	12	111	115	0		17	1	81	0	47	261	372
May	18	47	0	65	181	0		41	0	77	0	37	336	401
June	4	4	0	8	241	0		0	1	86	0	17	345	353
July	2	15	0	17	95	0		0	0	74	0	5	174	191
August	0	0	0	0	0	0		0	0	21	1	3	25	25
1942 Total	0	0	0	0	0	0	64	4	8	0	0	0	76	76
1943 Total	40	78	23	131	0	0	4	356	179	0	45	31	615	746
1944 Total	109	34	8	151	295	68	42	72	819	758	331	118	2503	2654
1945 Total	118	160	12	290	1005	2	0	58	52	520	1	141	1779	2069
GRAND TOTAL	267	272	43	582	1300	70	110	490	1058	1278	377	290	4973	5555

* Including 92 by PB4Y, 142 by PBM, 56 by PB2Y.

Carrier night offensive missions were flown largely by VF(N) and VTB(N), which came aboard in early 1944 and in September 1944 respectively, although pre-dawn attacks accounted for a number of sorties flown earlier. The number of night attacks flown increased greatly in the Okinawa operation, as a night CV and a night CVE made available full night air groups for regular neutralization attacks on enemy airfields and attacks on shipping.

Surprisingly low loss rates were reported for night operations by land-based F6Fs and PBJs. PBYs, considering their vulnerability in minimum altitude attacks, and PVs, considering the difficult conditions of the North Pacific, also reported remarkably low losses. Carrier loss rates, though higher than the day rates, were not excessive considering the hazards involved and the value of the work done.

TABLE 57. NIGHT AERIAL COMBAT RECORD, FOR LAND-BASED AND CARRIER-BASED NAVAL AND MARINE AIRCRAFT, MONTHLY

MONTH	LAND-BASED				CARRIER-BASED			
	Own Aircraft On Mission	Own Aircraft Engaging In Combat	Enemy Aircraft		Own Aircraft On Mission	Own Aircraft Engaging In Combat	Enemy Aircraft	
			Engaged	Destroyed In Combat			Engaged	Destroyed In Combat
1943 - July	18	8	15	2	0	0	0	0
November	6	6	8	8	3	3	4	2
December	7	7	10	7	0	0	0	0
1944 - January	12	7	6	3	0	0	0	0
February	7	7	7	5	1	1	1	0
March	1	1	1	1	0	0	0	0
April	16	7	6	2	2	1	3	1
May	17	3	3	1	0	0	0	0
June	2	2	3	0	7	5	7	7
July	0	0	0	0	9	5	4	4
August	3	3	4	1	2	1	1	0
September	0	0	0	0	2	1	1	1
October	2	1	1	1	17	12	10	10
November	0	0	0	0	2	1	1	1
December	3	3	4	3	18	5	6	5
1945 - January	0	0	0	0	4	3	4	4
February	0	0	0	0	3	2	2	2
March	0	0	0	0	9	7	12	11
April	21	7	7	5	55	33	36	33
May	31	20	26	25	20	12	17	16
June	23	20	23	23	0	0	0	0
July	9	9	10	9	0	0	0	0
August	3	3	3	3	10	3	8	6
TOTAL	181	114	137	99	164	95	117	103

(b) Night Air Combat

U.S. Naval and Marine aircraft during World War II shot down a total of 202 enemy aircraft at night and lost only 7 planes in night aerial combat, or 1/29 of the enemy losses in the same actions. If operational losses on missions involving night combat are included, 15 enemy planes were destroyed per own plane lost. It should be noted that the chance of over-optimistic claims of enemy aircraft destroyed in night combat is negligible, since most enemy planes crash in flames visible for miles, and usually only one or two aircraft are engaged at a time.

103 of the enemy planes were shot down by carrier night fighters, or planes acting as night fighters, 90 by land-based night fighters, and 9 by patrol bombers.

Of the 7 losses to enemy aircraft, only one involved a carrier-based F6F(N), and only 2 involved land-based F6F(N)s, which became the standard night fighters for land and carrier use, and accounted for three-fourths of the enemy planes destroyed in night combat.

The first night fighters consisted of a small Marine squadron of PVs converted to night fighters, sent to the Solomons in late 1943 to discourage the nightly "Washing Machine Charlie" raids. This squadron accounted for 11 enemy planes between November 1943 and May 1944, including 7 float planes and 4 bombers, and lost one plane in air combat. It was supplemented by a Navy squadron of F4Us equipped with intercept radar gear. This squadron accounted for 4 floatplanes and 4 bombers, with no air combat losses. Another F4U (N) squadron (Marine) brought down two Bettys in the Marshalls, with one loss.

After these three squadrons all land-based night fighters were the new F6Fs with AI intercept gear, and all were in Marine squadrons. Their first night air combat was in October 1944, when they knocked down a float plane in the Palau area, and in December, when they destroyed 3 Jap fighters in the Philippines. They had no further night combat until April 1945, when the three Marine VF(N) squadrons sent to Okinawa began their campaign which resulted in the destruction, in a 4-month period, of 64 enemy aircraft, against 2 air combat losses and 1 operational loss sus-

(Cont. on next page)

TABLE 58. NIGHT AERIAL COMBAT RECORD, BY PLANE MODEL, FOR ENTIRE WAR

BASE, PLANE MODEL	OWN AIRCRAFT ON MISSION	OWN AIRCRAFT ENGAGING IN COMBAT	ENEMY PLANES ENGAGED		ENEMY PLANES DESTROYED		OWN LOSSES ON MISSION	
			Bombers	Fighters and F/P	Bombers	Fighters and F/P	Enemy A/C	Operational
CARRIER-BASED	164	95	79	38	69	34	2	4
F6F	149	85	70	36	62	33	2	4
F4U	5	4	7	0	5	0	0	0
FM	4	4	0	1	0	1	0	0
TBF, TBM	6	2	2	1	2	0	0	0
LAND-BASED	181	114	63	74	51	48	5	2
F6F	87	61	39	32	38	30	2	1
F4U	17	13	7	5	6	5	1	1
TBF	9	3	1	2	0	0	0	0
PV(N)	15	13	10	7	5	6	1	0
PB4Y	14	10	4	16	2	6	1	0
PBJ	30	8	1	8	0	0	0	0
PBY	8	5	0	4	0	1	0	0
PBM	1	1	1	0	0	0	0	0
TOTAL	345	209	142	112	120	82	7	6

tained in these engagements.

The first carrier night fighters to engage in combat were a pair of standard F6Fs, guided by a radar-equipped TBM, which intercepted a Jap bomber attack in the Gilberts area in November 1943. One of the F6Fs (piloted by Cdr. O'Hare) was shot down by the Japs, and the TBM reversed the concept of the team by shooting down two of the Japs.

In early 1944 these makeshift teams were replaced by 4-plane teams of AI-equipped F6Fs (and for a few months some AI-equipped F4Us) assigned to each CV. These planes accomplished little in night combat until the Marianas campaign, when they shot down 11 Jap planes. In September a night air group equipped with F6F(N)s was placed aboard the CVL INDEPENDENCE, and during the five months of its service its planes shot down 15 Jap planes at night, while the CV teams accounted for 5 more. This group was succeeded by a CV night group aboard ENTERPRISE, which in its 5 months of intermittent service made 18 night kills, and was in turn succeeded by a third group which in August brought down 6 Jap planes.

During the Okinawa campaign the brunt of the night-fighting was borne by the CV night fighter teams, which brought down 11 Japs in March, 27 in April, and 6 in May. In all, carrier-based single-engine VF(N) destroyed 60 Jap planes in night combat during the Okinawa campaign, and land-based night fighters an additional 64. These 124 planes were brought down at a cost of four losses, combat and operational.

Attention is invited to the large proportion of enemy planes destroyed to enemy planes engaged, especially in actions involving the F6F and F4U. Once our night fighters came within shooting range of the enemy planes, few escaped.

As would be expected, over half of the total enemy planes destroyed were twin-engine fighters or bombers, or flying boats. Of the single-engine types destroyed at night, half were float planes (See Table 59).

95
68
163:3

TABLE 59. TYPES OF ENEMY AIRCRAFT DESTROYED BY NAVAL AND MARINE AIRCRAFT IN NIGHT AERIAL COMBAT, FOR ENTIRE WAR

PLANE MODEL, BASE	SINGLE-ENGINE FIGHTERS	SINGLE-ENGINE BOMBERS	FLOAT PLANES	TWIN-ENGINE BOMBERS OR FIGHTERS	FLYING BOATS	OTHER OR U/i	TOTAL
F6F, Carrier	12	7	11	48	13	4	95
F6F, Land-Based	12	5	12	37	0	2	68
F4U, Carrier	0	0	0	5	0	0	5
F4U, Land-Based	0	2	4	5	0	0	11
FM, Carrier	0	0	0	1	0	0	1
TBF, Carrier	0	0	0	2	0	0	2
PV(N)	0	1	7	3	0	0	11
PB4Y	1	0	4	1	1	1	8
PBY	0	0	1	0	0	0	1
TOTAL	25	15	39	102	14	7	202

TABLE 60. MONTHLY RECORD OF PB4Y AND PBM PATROL AIRCRAFT, 1945

MONTH	SQUADRONS IN ACTION		TOTAL ACTION SORTIES	SORTIES ATTACKING SHIPS			ENEMY AIRCRAFT		OWN LOSSES#		
	No. of Sq'dns	Planes on Hand	TOTAL FL'TS		Merchant Ships				To Enemy		Total, All Causes
				War-Ships	Over 500 Tons	Under 500 Tons	Engaged	Dest. in Combat	A/A	A/C	
January	9	130	1,491	56	4	5	20	16	10	1	0	8
February	9	124	1,167	175	4	25	59	84	26	6	0	13
March	18	260	2,976	334	17	65	93	63	25	7	1	27
April	20	281	3,471	359	16	39	144	46	10	4	0	25
May	21	296	3,323	541	9	82	217	124	41	15	3	35
June	22	302	3,491	443	14	62	175	112	20	10	3	38
July	22	284	3,733	472	16	48	202	59	10	7	1	36
August	17	236	2,593	188	4	14	92	37	8	4	1	16
TOTAL			22,245	2,568	84	340	1,002	541	150	54	9	198
Monthly Average*	17	239	2,781	342	11	45	134	72	20	7.2	1.2	25

* On 8 months basis for non-action items, 7½ months for action items.
\# Total losses include 56 on ground, 11 operational on action sorties, and 68 operational on non-action flights, in addition to the losses to enemy action listed.

Attention has been paid, in previous sections of this report, to the air combat record of PB4Y patrol planes, and to the substantial proportion of their attack effort which was directed against shipping. Unfortunately, in those analyses the PB4Y record was somewhat smothered under the much larger figures covering action by carrier planes and by the large number of land-based single-engine planes. Thus this brief additional section is provided to give full credit to the long range search planes for their combat achievements.

Emphasis herein is placed on 1945, and on PB4Ys. PBMs, included in one of the tables, turned in many noteworthy performances during 1945, and in 1944 PB4Ys performed, on a smaller scale, with even greater individual brilliance then in 1945. The 1945 figures, however, present a more impressive set of data, and fuller detail can be provided.

Table 60 above gives 1945 monthly data for all PB4Y and PBM squadrons which reported action during the respective months. Not all squadrons in the Pacific are included, since during each month there were some which flew only negative patrols. The squadrons included were based in the Philippines, the Marianas, and ultimately at Iwo and Okinawa.

Average squadron strength was 14 aircraft, and each plane on the average made 11 or 12 flights largely sector searches of 600 to 1000 miles, per month. A squadron normally flew 2 to 5 sectors daily, each covered usually by single planes, sometimes by 2-plane teams. Occasionally additional anti-shipping search and attack teams were sent out; rarely were larger strike missions flown.

As the table indicates, 7 out of 8 flights were negative with respect to action with the enemy, but the average plane attacked targets or engaged enemy aircraft once or twice a month. The majority of their attacks were on enemy shipping - large merchant vessels and warships when they were sighted, small vessels when nothing larger was available - and land targets were normally attacked only in sectors where shipping had entirely disappeared.

Starting with attacks in the Philippines and the Bonins area in January, the planes worked up to the Ryukyus, the Formosan coast, the North China Coast, the Yellow Sea and the Coasts of Korea, and the shores of Kyushu, Shikoku and Southern Honshu, as new forward bases became available. From the Philippines they also worked down the South China coast, to Indo China, Malaya, and Borneo. Initially in each area a substantial residue of large vessels remained, but as attacks mounted those which were not sunk were withdrawn, or kept in harbor by day, so that the bulk of the vessels remaining at sea were the small coastal types of 50 to 300 tons on which the Japs had in the end to rely for supplying their distant forces and returning vital materials to Japan.

These were the vessels the search planes attacked, usually in single plane bombing and strafing attacks at 50 to 200 feet altitude. When such tactics are used, accuracy is such that bomb tonnages dropped are no measure of the results obtained. In a study of reports on 870 PB4Y mast-

head attacks on ships of all sizes, it was found that 370 attacks, or over 40%, resulted in hits, and that over 18% of all bombs dropped were hits. These figures do not include any measure of the hits by small incendiary bombs normally dropped in clusters on the smaller vessels, or of the effect of strafing. Dozens of small vessels were destroyed by fires caused by incendiary hits or strafing alone, and most of the smaller vessels attacked could be sunk by a direct or under-water hit by one 100-lb. or 250-lb. bomb.

During 1945 PB4Ys alone dropped over 4,000 bombs, plus over 500 incendiary clusters, in attacks on probably 600-800 different vessels, and expended over 2,000,000 rounds of ammunition in strafing these vessels. It is probable that as a result of the 1945 PB4Y and PBM attacks some 300-500 of these vessels were sunk. (No final evaluation or assessment of the claims regarding small vessels has yet been made). The effect was to cripple the remaining Japanese sea transport in most areas, and to cause withdrawal of many vessels not yet sunk, because of the danger of attack, and because of fuel shortage resulting from the sinking of tankers.

Table 60 shows the steady building up of anti-shipping attacks in 1945, to the peak operations of May, June and July, largely in the Yellow Sea and off Korea and Japan itself. In June and July an average of 8 or 9 attacks on ships were made daily.

PB4Y ATTACK RECORD, 1945, BY TARGET TYPE

TARGETS	Sorties Attacking Targets	Number of Bombs Expended						
		General Purpose				Incendiary Clusters	Other Types	Rounds of Ammo. Expended
		100#	250#	500#	1000# 2000#			
Warships	53	129	52	15	7	0	0	85,000
Merchant Ships, over 500 Tons	238	296	302	402	13	45	6	566,000
Merchant Ships, Under 500 Tons	840	1,953	813	160	7	503	25	1,676,000
Minelaying	49	0	0	0	0	0	96	124,000
TOTAL SHIPPING	1,180	2,378	1,167	577	27	548	127	2,451,000
Land Transportation	170	92	448	93	16	42	3	322,000
Airfields	125	273	36	421	19	25	13	85,000
Other Military Targets	161	363	155	278	4	67	3	214,000
Other Land Targets	133	477	79	131	8	65	5	126,000
TOTALS	1,769	3,583	1,885	1,500	74	747	151	3,198,000

The above table shows the ordnance expended in the attacks by PB4Ys alone, and illustrates the predominance of small bombs, incendiary clusters and strafing which were all that were required against the smaller targets, though, as will be noted, heavier bombs were used against the larger vessels. Normally, mixed bomb loads were carried, to permit a choice of bombs depending on the type of target met. Despite the 3 to 4 ton bomb capacity of the PB4Y, rarely were loads of more than 2 tons carried, and the normal load was usually about 2,500 pounds, because of the extra fuel required for long-range searches.

In the minority of attacks which were directed against land targets (in the absence of ships), land transportation (including railroads, bridges, trains, and trucks) was the favorite type of target. Airfield installations, miscellaneous military buildings, and harbor areas of small coastal villages, were the other principal targets attacked.

Table 60 also shows the monthly air combat record of PB4Ys and PBMs. The 292 patrol planes which engaged in combat met 541 enemy aircraft, and shot down 150, or nearly 30% of them. Losses in air combat were 9 planes, only 6% of the number of enemy planes destroyed, and only 3% of the number of our VPB engaging in combat. The best records were in February and March, when 51 enemy planes were shot down with only 1 combat loss.

Losses to antiaircraft fire in these low level attacks were slightly over 2% of the planes attacking. Operational losses were 1/3 of one percent of the total number of flights.

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APPENDIX

JAPANESE SHIPPING SUNK BY NAVAL AIRCRAFT

TABLE A. TOTALS FOR WAR, BY TYPE OF SHIP

TYPE OF VESSEL	SHIPS SUNK BY U.S. NAVAL CARRIER-BASED AIRCRAFT ALONE		SHIPS SUNK BY U.S. NAVAL LAND-BASED AIRCRAFT ALONE		SHIPS SUNK BY NAVAL AIRCRAFT IN COMBINATION WITH OTHER FORCES		TOTAL SHIPS SUNK BY, OR WITH AID OF, U.S.NAVAL AIRCRAFT	
	No.	Tons	No.	Tons	No.	Tons	No.	Tons
Battleships	5	184,000	-	-	1	30,000	6	214,000
Carriers, Large	5	136,600	-	-	-	-	5	136,600
Carriers, Medium	5	59,150	-	-	2	22,050	7	81,200
Carriers, Escort	1	17,000	-	-	-	-	1	17,000
Cruisers, Heavy	6	72,000	1	14,000	3	41,000	10	127,000
Cruisers, Light	6	33,535	-	-	2	10,340	7	43,875
TOTAL ARMORED WARSHIPS	28	502,285	1	14,000	8	103,390	37	619,675
Destroyers	28	45,415	5	8,115	8	10,450	41	63,980
Small Warships*	103	125,928	2	2,300	14	17,862	119	146,090
TOTAL WARSHIPS	159	673,628	8	24,415	30	131,702	197	829,745
TOTAL MERCHANT SHIPS, 1000 Gross Tons or Over	275	1,293,875	50	182,583	41	229,061	366	1,705,519
TOTALS	434	1,967,503	58	206,998	71	360,763	563	2,535,264

* Including a few large auxiliaries.

These data, though not compiled by Op-23-V, are inserted because of their interest in connection with the tables covering carrier attacks on shipping.

The data on ships sunk have been compiled by the Statistical Section of the Foreign Branch of ONI (Op-23-F44). They are based on a careful study of shipping reported sunk by Japanese sources, correlated with action reports from all Allied forces as evidence of the cause of sinking. Most of the figures included represent final assessments by a joint Army-Navy board; assessments have not been completed, however, and the data must thus be regarded as preliminary and subject to change. For this reason release of the detailed figures in a classification lower than CONFIDENTIAL is not authorized, though the totals may be quoted in round numbers as approximations, if an indication of their preliminary nature is given and they are not attributed to ONI or the joint assessment board.

Ships credited sunk by Naval aircraft alone represent largely instances where no other agent could have been responsible for the sinking. Ships credited sunk in attacks involving any combination of Naval aircraft with Army aircraft, Naval surface ships, or submarines, have generally been credited as effected by combined efforts, unless unequivocal evidence exists (as in the case of the Midway Battle) that Naval aircraft were the only agents inflicting damaging hits on the ships sunk. The data, in view of their compilation for intelligence purposes by a non-aviation office, and with Army representation in the assessment of the bulk of them, can be considered completely conservative with reference to sinkings by Naval aircraft.

It should be noted that merchant vessels of under 1000 gross tons are not included in these tabulations; assessments of such sinkings are not known to have been made on any comprehensive basis by any agency.

Rough but interesting measures of the effectiveness of Naval aircraft in sinking ships, in terms of tons sunk per sortie attacking, and per ton of bombs expended, can be obtained by comparing these data with attack data in the body of this report. A few of the overall figures

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TABLE B. MONTHLY TOTALS OF JAPANESE SHIPS SUNK BY U.S. NAVAL AIRCRAFT

MONTH	ARMORED WARSHIPS		UNARMORED WARSHIPS		MERCHANT SHIPS, 1000 GROSS TONS OR OVER		TOTALS	
	No.	Tons	No.	Tons	No.	Tons	No.	Tons
1941-December	-	-	2	1,892	-	-	2	1,892
1942-March	-	-	-	-	4	28,780	4	28,780
May	1	15,000	3	1,915	-	-	4	16,915
June	5	87,900	-	-	-	-	5	87,900
August	1	7,100	1	1,800	1	9,310	3	18,210
October	1	5,170	1	1,800	3	25,547	5	32,517
November	2	39,000	-	-	11	77,608	13	116,608
1943-January	-	-	-	-	1	6,732	1	6,732
February	-	-	-	-	2	10,386	2	10,386
May	-	-	2	3,300	1	1,917	3	5,217
July	-	-	4	14,200	-	-	4	14,200
October	-	-	1	1,315	-	-	1	1,315
November	-	-	1	2,000	1	5,824	2	7,824
December	-	-	1	492	10	42,300	11	42,792
1944-January	-	-	7	730	16	60,552	23	61,282
February	1	5,195	6	11,720	33	203,291	40	220,206
March	-	-	7	11,210	20	97,815	27	109,025
April	-	-	1	100	1	2,724	2	2,824
May	-	-	-	-	1	6,500	1	6,500
June	1	28,000	5	2,395	15	66,235	21	96,630
July	-	-	9	6,263	6	20,617	15	26,880
August	-	-	4	5,000	6	29,576	10	34,576
September	-	-	11	17,660	44	204,918	55	222,578
October	12	185,140	14	20,010	32	129,961	58	335,111
November	3	30,670	19	25,975	30	138,754	52	195,399
December	-	-	5	5,300	10	42,289	15	47,589
1945-January	-	-	21	21,840	52	293,609	73	315,449
February	-	-	1	440	2	11,105	3	11,545
March	-	-	5	3,104	19	38,843	24	41,947
April	2	51,000	7	10,250	-	-	9	61,250
May	-	-	2	880	11	42,059	13	42,939
June	-	-	1	100	3	6,400	4	6,500
July	8	165,500	15	36,334	29	91,937	52	293,771
August	-	-	5	3,445	2	9,930	7	13,375
1941-42 Total	10	154,170	7	7,407	19	141,245	36	302,822
1943 Total	-	-	9	21,307	15	67,159	24	88,466
1944 Total	17	249,005	88	106,363	214	1,003,232	319	1,358,600
1945 Total	10	216,500	57	76,393	118	493,883	185	786,776
GRAND TOTAL	37	619,675	161	211,470	366	1,705,519	564	2,536,664

NOTE: Above data include full tonnage of ships sunk by Naval aircraft in combination with other agents. No sinkings were reported in months not listed.

are given herewith:

Type of Enemy Vessel	Tons Sunk Per Sortie Attacking#	Tons Sunk Per Ton of Bombs#
Armored Warships	114	208
Unarmored Warships	43	125
Merchant Vessels*	111	284
TOTAL, all three types	98	238

Tons sunk includes half the tonnage of ships credited to Naval aircraft in combination with other agents.

* Sorties and Tons of Bombs are for attacks on vessels of 500 tons or over, Tons Sunk are vessels of 1000 gross tons or over.

Monthly comparisons may be made with Table 40, but in making comparisons note that Appendix Table B includes at their full tonnage ships sunk by Naval aircraft in combination with other agents.

SUBJECT INDEX TO TABLES

(All tables cover entire war period unless otherwise noted)

NOTE: Less detailed air combat data are also given in tables 1,2,3,4,8,10,14,15,17, and 18. Night air combat data are in tables 57-59.

NOTE: Own aircraft losses to enemy A/A are also given in tables 1,2,3,4,8,10,14,15,17,18,23,25, and 26. A/A losses in night action are in table 55.

NOTE: For enemy aircraft destroyed in air combat, see Aerial Combat Data section of index, and note thereto.
For enemy aircraft destroyed on ground, see Tables 3,4,14,25,26.

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