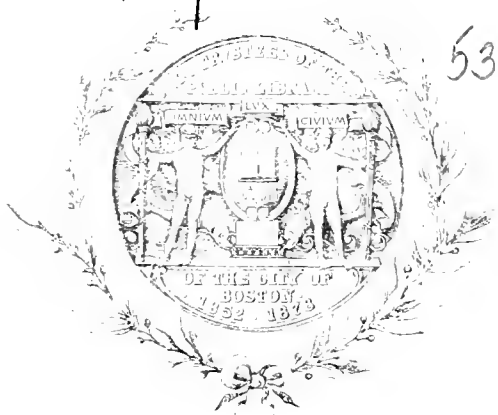

THE UNITED STATES

STRATEGIC BOMBING SURVEY

THE EFFECTS OF AIR ATTACK ON JAPANESE URBAN ECONOMY

SUMMARY REPORT

Urban Areas Division

March 1947

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This report was written primarily for the use of the U. S. Strategic Bombing Survey in the preparation of further reports of a more comprehensive nature. Any conclusions or opinions expressed in this report must be considered as limited to the specific material covered and as subject to further interpretation in the light of further studies conducted by the Survey.

FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from late President Roosevelt. Its mission was to conduct an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating the importance and potentialities of air power as an instrument of military strategy for planning the future development of the United States armed forces and for determining future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the Survey in Germany have been published.

On 15 August 1945, President Truman requested that the Survey conduct a similar study of the effects of all types of air attack in the war against Japan, submitting reports in duplicate to the Secretary of War and to the Secretary of the Navy. The officers of the Survey during its Japanese phase were:

Franklin D'Olier, *Chairman*.
Paul H. Nitze, Henry C. Alexander, *Vice Chairmen*.
Harry L. Bowman,
J. Kenneth Galbraith,
Rensis Likert,
Frank A. McNamee, Jr.,
Fred Searls, Jr.,
Monroe E. Spaght,
Dr. Lewis R. Thompson,
Theodore P. Wright, *Directors*.
Walter Wilds, *Secretary*.

The Survey's complement provided for 300 civilians, 350 officers, and 500 enlisted men. The military segment of the organization was drawn from the Army to the extent of 60 percent, and from the Navy to the extent of 40 percent. Both the Army and the Navy gave the Survey all possible assistance in furnishing men, supplies, transport, and information. The Survey operated from headquarters established in Tokyo early in September 1945, with subheadquarters in Nagoya, Osaka, Hiroshima, and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Pacific, and the Asiatic mainland.

It was possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement, and campaign by campaign, and to secure reasonably accurate statistics on Japan's economy and war production, plant by plant, and industry by industry. In addition, studies were conducted on Japan's over-all strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization, and the effects of the atomic bombs. Separate reports will be issued covering each phase of the study.

The Survey interrogated more than 700 Japanese military, government, and industrial officials. It also recovered and translated many documents which not only have been useful to the Survey, but also will furnish data valuable for other studies. Arrangements have been made to turn over the Survey's files to the Central Intelligence Group, through which they will be available for further examination and distribution.

PREFACE

Seventy percent of the B–29 bomb tonnage dropped on the Japanese home islands was dropped on 66 cities. The Urban Areas Division endeavored to measure the effects of those raids on the urban economy and determine the extent to which that bombing program contributed to Japan's surrender. The effect of mass bombing on the community was an additional aspect of the Division's investigation because of the importance of those effects on economic life.

Limitations of personnel and time made it impossible to conduct a thorough investigation of all the 66 cities which were subjected to planned area attacks. The results of such a complete survey, however, would scarcely have justified the effort, since in most of the bombed cities, the period after or between attacks was too brief to measure more than temporary effects. This consideration was important since the Germans demonstrated that they were able, after an attack which appeared to have completely crushed the economy of a city, to bring about industrial recovery in a matter of a few months. In Japan, of the 66 cities attacked, only six were attacked before the last 3 months of the war. Even in those six cities (Tokyo, Yokohama, Kawasaki, Nagoya, Osaka, and Kobe), subsequent area and precision attacks followed closely upon the initial attacks and complicated the problem of analysis. In the 60 other cities, there was little possibility of measuring more than the direct impact upon the people and services of the city and the initial industrial depression caused by the raids.

The six largest cities were chosen as subjects for detailed study because (a) they provided the only cases where recuperation, if it occurred, would be measurable and (b) the bulk of urban industry was concentrated in those cities. Detailed studies were also made of Kyoto, the fourth largest and only unbombed city of importance in Japan. Hiroshima and Nagasaki, targets of the atom bomb, were also studied in detail, although limitations were imposed upon the analysis of economic factors in those two cities, since they were attacked only a few days before the end of the war.

Altogether, the Division's investigation included the study of 39 cities, 33 on Honshu and Kyushu, and 6 on Hokkaido.[1]

Pertinent data relating to Japan's economic and social life were collected from national prefectural and municipal officials. Industrial statistics were gathered from 4500 detailed responses to factory questionnaires. Approximately 2400 of these, containing a complete series for all production factors were tabulated to assess the effect of bombing on the production of hit and unhit plants. Five field teams were engaged in key urban regions for 8 weeks supervising the collection of industrial and collateral material.

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[1] Urban Area Reports are available for:

(*a*) Tokyo-Kawasaki-Yokohama,

(*b*) Osaka-Kobe-Kyoto,

(*c*) Nagoya,

(*d*) Hiroshima,

(*e*) Nagasaki,

The report of the Area Studies Division of the United States Strategic Bombing Survey on the air offensive against German cities is prefaced by the following statement:

"The major cities of Germany present a spectacle of destruction so appalling as to suggest a complete breakdown of all aspects of urban activity. On the first impression, it would appear that the area attacks which laid waste to these cities must have substantially eliminated the industrial capacity of Germany. Yet this was not the case. The attacks did not so reduce the German war production as to have a decisive effect on the outcome of the war."

The cities of Japan, like those in Germany, presented a spectacle of enormous destruction. Although the over-all total damage was somewhat greater in Germany than in Japan the extent of destruction was comparable. Only 160,800 tons of bombs were dropped on Japan's home islands as compared with 1,360,000 tons dropped within Germany's own borders. One hundred and four thousand tons of bombs were dropped on 66 Japanese cities as compared with 542,554 tons of bombs that were dropped on 61 German cities.

As in Germany, the air attacks against Japanese cities were not the cause of the enemy's defeat. The defeat of Japan was assured before the urban attacks were launched. But this defeat, before it could be translated into the terms of surrender, might have required a costly invasion of the home islands had not the effect of the air attacks, both precision and urban, on Japan's industries and people exerted sufficient pressure to bring about unconditional surrender on 15 August. The city raids contributed substantially to that pressure by their impact on the social and economic structure of Japan.

The insufficiency of Japan's war economy was the underlying cause of her defeat. Before the air attacks against the cities began, war production had been steadily declining because of the ever-increasing shortages of raw materials, skilled labor, and an ill conceived dispersal program which was initiated too late. The Survey estimated that, even without air attacks, over-all production, by August 1945, would not have exceeded 60 percent and might have been as low as 50 percent of the 1944 peak. By the end of 1944, production in most critical industries had started to decline because of the curtailment of raw materials. This resulted in a growing margin of unused plant capacity. Thus, even substantial bomb damage to plant structures and equipment frequently had little, if any effect on actual production. The effectiveness of the blockade caused some duplication of effort in our air attacks against the aircraft and heavy ordnance industries; considerably more in our attacks on aluminum, steel, and oil plants. Such duplication resulted more from precision attacks against major units of those industries. The measure of waste, however, was small in terms of the substantial over-all production loss that did result from the air attacks.

As mentioned previously, national production without air attacks, as of August, probably would have been between 50 percent and 60 percent of the 1944 peak, had the shortage of raw materials been the only limiting factor. In July 1945, the actual level of production in 33 of the bombed

Japanese urban areas which included a major proportion of all industry, was 33 percent of the 1944 peak. Despite the fact that part of the air effort against the urban areas proved to be duplicative, the position of the urban economy in July 1945 points to the effectiveness of the attacks.

It cannot be stated, however, that the loss of 67 percent of her major urban production was the major factor in motivating Japan's decision to surrender. The Survey determined that, from July 1944 to August 1945, many different pressures were being exerted upon the leaders who were responsible for that decision. If the state of the economy was, as may reasonably be assumed, a question of concern to the leaders, the magnitude of this loss must have had a substantial effect upon their considerations.

Apart from the effects of the air attacks on production, the impact of the raids on the social structure of Japan's cities was calamitous. The attacks spread destruction and privation throughout the islands. Few inhabitants escaped the terror of the raids. Those who were not directly attacked shared the experience of millions of refugees who fled into the country seeking food and shelter. The raids brought home to the people the realization that there was no defense against the Allied aircraft; that nothing could prevent the wholesale destruction of every inhabited area in Japan and that further resistance was futile. Popular awareness of these facts, which had been known by the political leaders as early as March 1945, exerted further pressure on those leaders to end the war.

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CHAPTER I

The Target

Geographically, the pattern of Japan's industrial economy resembled an elongated S, stretching from Niigata at one extremity to Nagasaki at the other, to include the important centers of Tokyo, Yokohama, Nagoya, Kobe, Hiroshima-Kure, and Yawata, and their satellite towns. Along this route, Japanese industry was heavily concentrated. In the period preceeding the war, certain tentative moves had been made toward the decentralization of urban industry but rapid wartime expansion, dependent upon established channels of supply, resulted in an even greater concentration of industry in the cities.

Table 2 shows the concentration of representative industries in urban areas. Slightly less than one-half the total production of those industries was concentrated in the 6 largest cities. Sixty-four percent of the national production was concentrated in 24 cities. These percentages, except for the inclusion of aircraft parts manufacture, are in terms of final products which do not fully reflect the volume of general component manufacture concentrated in the areas. Although there is no accurate way of measuring the importance of such manufacture by city areas, it is estimated that approximately 75 percent was located in the 6 largest cities; the remainder being scattered throughout other cities, most of which were bombed. During the war, several of the more important end-product manufacturers established subassembly plants in smaller urban communities. The Nakajima Aircraft Co., for example, had plants in Omiya, Isezaki, Takasaki, Kumagaya, Maebashi, and other small towns north of Tokyo. The Kawasaki Aircraft Co. had major units at Gifu and Akashi; the Kawanishi Aircraft Co., at Himeji and Takatsuki, while Mitsubishi Aircraft spread to the smaller cities around Nagoya including Gifu, Ogaki, and Hakone. These plants formed an integrated network of parts production which funneled into centrally located assembly plants. Similarly, but to a lesser extent, the ordnance, machine parts, and electrical equipment industries established plants in the satellite cities around the major urban centers.

A number of large assembly plants, particularly in the aircraft industry, had been built in relatively isolated areas, lessening somewhat the concentration of that industry in the urban areas, but the bulk of other war industry, both end-product and supporting, was concentrated in densely built-up zones in the larger cities. The importance of urban as against outlying or isolated industry may be gauged by the fact that the metropolitan districts of Tokyo, Nagoya, and Kobe-Osaka, alone, embraced about 35 percent of the total industrial labor force, and more than 40 percent of the electric power substations. Thirty of the forty-six urban industrial concentrations selected as the most important by the Joint Target Group were located in those cities.

In Germany, the 15 cities which were the principal RAF targets were credited with approximately 12 percent of the total labor force of Greater Germany. In 1940, German cities with populations of over 800,000 accounted for barely 12 percent of the entire population, while in Japan, cities of that size contained 23 percent of the total population. The 6 largest cities of Japan, Tokyo, Yokohama, Osaka, Kobe, Nagoya, and Kyoto accounted for almost 20 percent of the total population. The 66 cities attacked in urban raids accounted for over 75 percent of the urban population, and 28 percent of the total population. In addition, these cities included almost all of the political, military, and economic administration of the Empire.

TABLE 1.—*Population in urban areas*

	Total	Urban	Percent of Urban to Total	Rural
1925	59,739,822	16,606,809	28	43,133,013
1930	64,405,005	19,439,405	30	44,965,600
1935	69,254,148	22,655,920	33	46,598,228
1940	73,114,308	27,577,730	38	45,536,578

TABLE 2.—*Percentage concentration of Japanese industry in selected urban areas*

	Combat A/C			Electrical equipment			Armament		Machinery and parts			Merchant		Navy	
	Final assembly	Engine manufacturing and assembly	All A/C Parts	Light	Heavy	Electron tubes	General and ordnance	Trucks and vehicles	Machine tools	Anti-friction bearings	Marine Engines	Shipbuilding	Ship repair	Shipbuilding	Ship repair
Tokyo			22	39	24	15	10		25	8	8	5.1	3.3		.5
Kawasaki			7	30	14	70	.5	8	5	9	9	1.9		2.9	.6
Yokohama			1	4	8		1	35	5			8.7	7.6	3.5	5.5
Nagoya	25	40	15	5	4		7	5	7			1.8	2.5		
Osaka			12	8	5	2	10		20	6	22	5.3	20	9.3	2.2
Amagasaki		1	3	1	1		.5		1	1	.5	1.9	.2		
Kobe		1	4	2	8	5	1.5	5	1.5		13	7.7	11.4	10.0	2.3
Subtotal 6 largest cities	25	42	64	89	64	92	30.5	53	64.5	24	52.5	32.4	45	25.7	11.1
Yawata-Tobata-Kokura				1	4		7	5	1			4.9	1.5		
Kure							5				3			16.8	11.0
Hiroshima							1		2			2.0			
Nagasaki			.5		2		4				13	12.6	2.2	15.2	5.3
Shimizu												1.2	.9		
Hamamatsu			3						1						
Eight others[1]	12		8	10	30	8	6		5	4	8	4.0	3.0	15.0	10.0
Total	37	42	75.5	100	100	100	53.5	58	73.5	28	76.5	57.1	52.6	72.7	37.4

[1] Includes Sakai, Niigata, Kyoto, Yokosuka, Kagamigahara, Hitachi, Hiratsuka, and Himeji.

NOTE.—Percentage concentration of all industry in 6 largest cities is approximately 48 percent. The percentage concentration of all industry in listed cities is 64 percent.

CHAPTER II

Economic Situation Before the Urban Attacks

Even before the beginning of the Pacific war, Japan's supply of many vital raw materials was inadequate. By 1944, the blockade and antishipping campaigns had caused serious and growing shortages in the supply of almost every basic raw material. By June 1944, iron ore stockpiles in Honshu had shrunk to 800,000 tons, from 2.6 million tons in December 1941. The monthly average of finished steel production for the second half of fiscal 1944 had dropped to 64 percent of the monthly average of the first half. In the same year oil imports for the October-December quarter had dropped to 67 percent of those for the same period of the preceeding year. Imports of coking coal from China had virtually ceased by the end of 1944, and Manchuria coal imports began seriously to decline. Domestic coal movements from Kyushu and Hokkaido were sharply curtailed by the Allied mining of harbors. By the end of 1944, imports of bauxite, upon which Japan was almost totally dependent, had ceased entirely. In terms of these items, which are the backbone of any industrial nation, the eventual collapse of the Japanese war economy was assured.

In spite of this situation, however, the overall output of end-products reached a peak in the last half of 1944. After the fall of Saipan, a national drive to increase production of war goods had met with considerable success, with urban industry production rising over 20 percent from April to October. It is obvious, in view of the diminishing imports, that this spurt in production was made possible only by the consumption of critically low stockpiles. In the urban economy, the aircraft and ordnance industries achieved particularly impressive gains in the last quarter of 1944; aircraft reaching its highest peak in October, ordnance in November. This was supported by peak output of metals in September and October. By November, metals production was starting to drop, falling further in December. By January, all three industries were down substantially, indicating (a) that stockpiles were reaching bottom, (b) that the effects of air raids were being felt (primarily by the aircraft industry), and (c) that preparations for dispersal were beginning to interfere with production.

TABLE 3.—*Metals production and end-product output April 1944–January 1945*[1]

Month	Percent Electric Power Consumption			Percent yen output		
	Metals	A/C	Ordnance	Metals	A/C	Ordnance
April 1944	100	100	100	100	100	100
May	92	105	106	106	94	112
June	93	98	103	101	118	106
July	91	97	99	92	121	111
August	93	97	100	109	126	123
September	89	97	100	121	107	126
October	89	104	102	121	134	132
November	91	113	109	116	131	147
December	88	105	107	110	131	132
January 1945	83	88	103	96	89	109
February	72	82	101	92	102	106

[1] Peak month first half 1944 = 100 percent.

Summary

The heavy area raids struck at a short economy. By sacrificing materials for the limited spurt of production in late 1944, the Japanese sacrificed the wherewithal to repair and replace damaged plants and equipment. The dearth of raw materials caused by the 1944 production drive, furthermore, was largely responsible for the failure of the dispersal program when it was finally embarked upon. Manpower was also affected by this production drive. After 10 years of war, the working population was exhausted. Added to this, the curtailment of food imports by late 1944 had resulted in a reduction of rations below the level needed to maintain working efficiency. An increase in lost hours from 20 percent in early 1944 to 25 percent by December was the beginning of the rapid decline in the effectiveness of industrial manpower.

The urban air attacks, when they reached significant weight in early 1945, fell upon an ideal target—an economic structure with neither the means nor the spirit to offer strong resistance.

CHAPTER III

The Air Attacks

Table 4 lists the cities which were attacked, the dates of attack and the tonnages dropped. This review of the bombing program shows that the main area bombing effort was not launched until very near the end of the war. Only eight cities had been targets up to the end of April, and two of these, Hamamatsu and Kagoshima, received only moderate tonnages. Nine cities had been hit by the end of May, 18 by the end of June, 57 by the end of July and 66 by 14 August. Until 15 June, the bulk of urban bombing tonnage was dropped on the four large urban complexes, Tokyo, Nagoya, Osaka, and Kobe.

In all, 16-112 urban sorties were flown in 95 missions against the 66 cities. The planned target areas in those cities comprised 192.16 square miles out of a total built-up area of 411 square miles.[1]

Allied aircraft dropped 160,800 tons of bombs on the home islands of Japan. This was just over 10 percent of the tonnage dropped within Germany's borders. Navy aircraft accounted for 6,800 tons, Army aircraft other than B–29s for 7,000 tons and the B–29s for 147,000 tons. Of the total, 104,000[2] tons of bombs were directed at 66 urban areas, 14,150 tons at aircraft factories, 10,600 tons at oil refineries, 4,708 at arsenals, 3,500 tons at miscellaneous targets, and 8,115 tons at airfields and seaplane bases in support of the Okinawa operation.

A brief review of the operational problems connected with the bombing of Japanese cities is appended to the report as Appendix A.

[1] Twentieth AAF Operations Summary.

[2] Discrepancy with total given on table 4 due to tonnage dropped in attacks of under 100 tons, which are included in the 104,000 figure.

CHAPTER IV

Effects of Air Attack on the Population

The vulnerability of the Japanese people to air attacks was never a primary consideration in basic Allied strategy. The Theater Air Command, however, while selecting urban targets primarily on the basis of their economic value, anticipated that, apart from the economic results of those raids, the impact of mass bombing on the people would seriously undermine the enemy's ability to continue the war. These effects are dealt with, in detail, in the reports of the Morale Division of the Survey. They are of interest here insofar as they are important to the discussion of the economic effects of bombing.

Generally speaking, the urban attacks resulted in a serious and widespread collapse in public morale which was reflected in all phases of the Japanese war economy.

Perhaps the most significant result of the raids on the general population was the spreading of the conviction that continued resistance to the Allied strength was futile. Particularly, the extension of the bombing program to the smaller cities convinced the people that the Allied aircraft could, and would, destroy every city in Japan. Furthermore, they were made painfully aware of the impotence of their government which could do nothing to prevent the wholesale destruction, or minimize its effects.

The mass flight of people from the bombed cities was virtually uncontrolled. The population of Tokyo city dropped 63 percent during the raid period. Official estimates of the number of evacuees from the huge Tokyo-Kawasaki-Yokohama complex, accounting for 11 percent of the total population, were placed at around 4.6 million or 58 percent of the preraid population. After the two devastating air raids on Nagoya in mid-March, 317,000 people, or 29 percent of the preraid population fled from the city. When the war ended, less than 50 percent of Nagoya's population remained. Although no official figures on the total number of evacuees was obtainable, the Morale Division of the Survey, on the basis of its investigation, estimated the number to have been in excess of the official figure of 8½ million.

Table 5 summarizes the physical effects of the raids on the people in 66 cities:

TABLE 4.—*Total tonnage dropped in urban area attacks of 100 tons or over (includes HE, IB and fragmentation)*

	1944 November	1944 December	1945 January	1945 February	1945 March	1945 April	1945 May	1945 June	1945 July	1945 August
1. Akasbi									975	
2. Amagasaki								1,773		
3. Aomori									547	
4. Chiba									889	
5. Choshi									629	
6. Fukui									954	
7. Fukuoka								1,526		
8. Fukuyama										556
9. Gifu									898	
10. Hachioji										1,594
11. Hamamatsu							1,486			
Hamamatsu						348				
Hamamatsu								918		
12. Himeji									768	
13. Hiratsuka									1,163	
14. Hiroshima										1
15. Hitachi									964	
16. Ichinomiya									1,640	
17. Imabari										510
18. Isesaki										614
19. Kagoshima						166				
Kagoshima							810			
20. Kawasaki						1,504				

TABLE 4 (*Continued*)

	1944 November	1944 December	1945 January	1945 February	1945 March	1945 April	1945 May	1945 June	1945 July	1945 August
21. Kobe				174						
Kobe					2,331					
Kobe								3,081		
22. Kochi									1,061	
23. Kofu									971	
24. Kumagaya										593
25. Kumamoto									1,114	
26. Kure									1,082	
27. Kuwana									1,511	
28. Maebashi										724
29. Matsuyama									896	
30. Mito										1,145
31. Moji								626		
32. Nagaoka										925
33. Nagasaki										1
34. Nagoya			152							
Nagoya					3,655					
Nagoya							2,516			
Nagoya							3,609			
35. Nobeoka								829		
36. Numazu									1,036	
37. Ogaki									659	
38. Oita									790	
39. Okayama								982		
40. Okazaki									851	
41. Omuta								770		
Omuta									965	
42. Osaka					1,733					
Osaka							2,789			
Osaka								3,980		
43. Sakai									779	
44. Saga										458
45. Sasebo								1,060		
46. Sendai									912	
47. Shimizu									1,030	
48. Shimonoseki									833	
49. Shizuoka								869		
50. Takamatsu									833	
51. Tokushima									1,051	
52. Tokuyama									751	
53. Tokyo				457						
Tokyo					1,667					
Tokyo						129				
Tokyo							6,900			
Tokyo						769				
54. Toyama										1,465
55. Toyohashi								946		
56. Tsu								102		
Tsu									1,308	
57. Tsuruga									679	
58. Ube									715	
59. Uiyamada									735	
60. Utsunomiya									803	
61. Uwajima									1,077	
62. Wakayama									801	
63. Yawata										1,302
64. Yokkaichi								567		
65. Yokohama							2,570			
Total Tons			152	631	9,386	2,916	20,680	18,029	32,670	9,886
Percent of Total			.2	.7	9.9	3.1	21.9	19.1	34.6	10.5

[1] Atomic bomb.

Tons dropped on sample cities—65,030 or 69 percent.

NOTE. Miyakonojo 158 tons of H. E. on urban area raid in May 1945.

Total January 1945 - August 1945 94,350 dropped only in urban raids.

SOURCE. The Air Attacks in the Pacific U. S. Strategic Bombing Survey Report No. 5-B.

TABLE 5.—*Damage to urban areas*

Total built-up area	square miles	[1]411
Target area	do	[1]192
Area destroyed	do	[1][2]178
Total population		21,928,000
Bombs dropped (74 percent incendiary)	tons	121,458
Buildings destroyed		2,094,374
Persons killed		252,769
Persons injured		298,650
Persons rendered homeless		8,324,000
Planned evacuations		2,100,000

[1] Operational summary, Twentieth Airforce. Refers only to 66 cities which were targets of planned urban area missions.

[2] 43 percent total built-up area for 66 cities.

A table of measurable damage cannot fully reflect the impact of the raids on the people. The number of people rendered homeless presented an almost insurmountable problem. National and local organizations which had been set up to care for the victims were largely ineffectual because of the magnitude of the disaster. The vast majority of bombed-out residents were, as a result, thrust upon their own resources either to improvise shelter on or near the site of their former homes or to move elsewhere. The preraid evacuation program succeeded in moving a small part of the population out of the cities but postraid evacuation was curtailed by reduced transportation facilities. Most people left the city on foot, carrying with them the remnants of their possessions. The destruction of food stocks and distribution centers in the cities, complicated by the uncharted movements of evacuees, seriously aggravated an already critical food situation. The breakdown of the official rationing system and the curtailment of factory food rations caused by the destruction of plants forced refugees and remaining residents more and more to the black markets, not only for food but for all goods. War risk insurance payments for destroyed homes, and end-of-employment bonuses, which were paid to workers when their factories were destroyed, stimulated the inflation.

When it is considered that not only were the residents in 66 cities directly affected by bombing but that the residents of an additional 100 communities also suffered from the effects of precision bombing raids, accidental bombings, recce-aircraft unloadings, and other unplanned attacks, it is understandable that, according to the findings of the Morale Division, over 40 percent of a large sample of the Japanese people in both urban and rural communities expressed themselves as most satisfied at the end of the war because of the cessation of air raids.

The Morale Division's survey further indicated that of all the gainfully employed people who evacuated their homes, 37 percent had been engaged in war industry. Only 26 percent of the workers among the urban non-evacuees were in war production. Of the war workers who evacuated the cities, only 4 percent left because their factories were moved; the rest either abandoned their jobs or left because of

TABLE 6.—*Comparative table of pre-raid importance and effects of bombing on the six largest cities*

	Tokyo, Kawasaki, Yokohama	Kobe, Osaka	Nagoya	Total 6 cities	Total 66 cities	Total all Japan	Percent 6 cities to 66 cities	Percent 6 cities all Japan	Percent 66 cities all Japan
Importance									
Area (square miles)	429	125	56	610		147,707		0.4	
Population: 1940	8,048,000	4,221,614	1,260,000	13,529,614		73,114,000		18.5	
February 1944	7,994,000	3,762,000	1,349,000	13,105,000	21,928,000	72,664,000	59.8	18.0	30.2
Total labor force February 1944	3,559,321	1,227,200	[4]540,000	5,335,521		31,534,858		16.9	
Industrial labor force February 1945	1,485,240	613,600	[4]362,000	2,460,840		9,404,424		26.5	
B U area (square miles)[2]	142	75.50	40	257.5	411		62.6		
Effects of Bombing									
Total bomb tonnage[1]	20,316	17,358	14,670	52,344	121,458	159,744	43.1	32.8	76.0
Percent B U area destroyed	49	32.6	31	42	43		60.1		
Area of destruction (square miles)	70	24.68	12.4	107.0	178				
Number buildings destroyed	861,600	490,000	123,100	1,474,700	2,094,374	2,250,000	70.4	65.5	93.1
People dehoused	3,446,000	1,542,000	495,000	5,483,000	8,324,000	8,740,000	65.9	62.7	95.2
People killed	99,408	16,802	8,152	124,362	252,769	299,360	49.2	41.5	84.4
People injured	99,567	47,255	10,095	156,917	298,650	432,872	52.5	36.2	69.0
Total casualties	198,975	64,057	18,247	281,279	551,419	[5]732,232	51.0	38.4	75.3
November 1945 population	3,582,000	1,482,000	[3]598,000	5,662,000	11,279,000	71,996,000	50.2	7.9	15.7

[1] *Planned* urban attacks.

[2] Twentieth Air Force estimates.

[3] May 1945.

[4] November 1944.

[5] Cf. Civilian Defense Report.

the destruction of their plants. The latter group seldom sought or heeded official pleas for reemployment. The evacuations resulted in a substantial loss of workers and a sharp increase in absenteeism among those who continued to work. A more detailed discussion of the problems affecting the industrial labor force in the urban economy is presented in a later chapter.

A report on the general impact of the urban attacks was written at the direction of this division by the combined faculties of the Tokyo Imperial University. Of several reports on this topic written for the division by Japanese sources, the University's report reflects the most careful and objective preparation. It is included in its entirety as Appendix B.

CHAPTER V

Physical Damage to Industry

Photo interpretation indicated that the air attacks destroyed about 43 percent of the built-up area of the 66 cities. In the 6 largest cities, the area attacks destroyed or seriously damaged from 25 to 40 percent of the storage and manufacturing floor space. In the 60 smaller cities, an average of 20 percent of such floor space was destroyed or damaged.

As indicated in the Summary of this report, much of the floor area affected by urban area raids represented idle or excess capacity. For example, in Nagoya, although area raids destroyed 25 percent of the productive floor area of the aircraft industry, the effort was largely wasted since earlier precision attacks had already compelled that industry to disperse, and much of the floor area destroyed in the heavy urban attacks was at the time non-productive.

Dispersal, although not as widespread in other industries as in aircraft, had similarly reduced the target value of a number of plants. In addition, the increasing shortages of raw material were steadily creating further excess capacity. However, physical damage to plant and equipment affected the production of every industry to some extent; and certain industries substantially. In Tokyo, by August 1945, the total number of plants in operation had been reduced to 13,193, or 32 percent of the October 1944 figure. In all, over 25,000 plants were destroyed or badly damaged. Most of these were plants employing under 100 workers. In 1940, such plants accounted for 52 percent of the total industrial output of the city and, in 1942, for 53 percent. In the same years, their labor force amounted to 65 percent and 58 percent, respectively, of the city's total and in October 1944, to 60 percent. Although production figures for October 1944 are not available, it is a reasonable assumption that this production would have represented between 50 percent and 55 percent of the total city output. In this same category, 28,256 of a total of 40,641 plants had ceased operations by July 1945, and the number of workers in this group had dropped from 662,561 to 178,986, a loss of 73 percent. Bomb damage resulted in a production loss of approximately 75 percent in this category; and as the category itself accounted for about half the production of the entire city, the decline actually represented an industrial loss of approximately 40 percent for the whole city. This loss, which resulted primarily from the destruction of a widespread network of component suppliers, bore heavily upon the city's overall production. It is impossible to measure exactly the results of this loss on industries. The radio and communications equipment industry was virtually paralysed but the aircraft industry was not affected to any appreciable extent, mainly because destruction to the large assembly plants and the dispersal program had sharply curtailed the need for components. The ordnance industry, one quarter of which was concentrated in Osaka, was affected seriously by the loss in the Tokyo raids of a major supplier of firing mechanism for AA guns.

TABLE 7.—*Decrease in number of plants and workers in Tokyo during raid period*

Number of Workers		October 1944	August 1945	Percent of Decrease
Category 1	Plants	25,963	8,970	65
1 to 9	Workers	81,518	35,751	56
Category 2	Plants	15,759	3,309	79
10 to 49	Workers	510,624	83,082	84
Category 3	Plants	919	668	27
50 to 99	Workers	70,419	58,125	17
Category 4	Plants	907	808	11
100 and over	Workers	438,946	419,376	4
Total	Plants	41,548	13,193	68
	Workers	1,101,507	596,364	46

Effects of Precision and Area Raids

The city of Nagoya provides comparison of the relative effects of precision and area bombing. In that city, physical damage statistics were obtained from 247 factories within or just outside the city limits. The statistics represent all but one of the factories employing 500 or more workers; a coverage of approximately 90 percent on Nagoya's industrial structure. The factories supplied figures for:

(1) The floor area directly employed in production (warehouses, offices, dormitories, and other nonproductive area excluded.)

(2) Structural damage[1] caused by each attack, in terms of a percentage of the productive floor area that existed just prior to that attack.

(3) The yen value of all productive plant and equipment just before each attack.

(4) The percentage of that plant and equipment destroyed by each attack.

Factories that were not hit by air attacks provided figures for items "(1)" and "(3)," as of the end of 1944, the beginning of the raid period. Thus, preraid production floor area and plant and equipment were computed for the 90 percent sample of Nagoya's industry, including both hit and unhit plants.

It was found that, of a preraid productive floor area of 39,334,000 square feet, air attacks destroyed 14,649,000 square feet, or 37.3 percent. More damage was caused by area attacks, particularly by the two that occurred in mid-May, than by precision attacks.[2] As might be expected, ton for ton precision attacks caused nearly twice as much industrial damage as area attacks: 4,053 tons of bombs in precision attacks destroyed 6,270,000 square feet of productive area, while 10,001 tons of bombs dropped in area attacks destroyed 8,379,000 square feet. Precision attacks destroyed 1,547 square feet per ton of bombs, and area attacks 838 square feet. There were 15 precision as against 6 area attacks on the city.

Because of the dominant position of the aircraft industry in the city, which industry had dispersed a large proportion of its equipment to locations outside of the city, as a result of the early precision missions, the percentage of preraid plant and equipment destroyed was considerably smaller than the percentage of productive floor area. Twenty-nine point seven percent of the plant and equipment was demolished, as compared with 34.8 percent destruction of floor area.

The air attacks against Nagoya had two broad purposes: (1) mainly by precision attacks to wipe out Nagoya's aircraft and (later) ordnance production and (2), mainly by area attacks, to eliminate the city's remaining industrial contribution and destroy the people's will to resist. The precision attacks cut deeply into the productive capacity of the leading factories in the aircraft and ordnance industries, which, respectively, accounted for about 49 percent and 16 percent of the total city production. These attacks, and the fear of them, were the principal reason why dispersal was so frantically initiated. Loss of production caused by dispersal was one of the largest single factors contributing to the over-all decline in Nagoya's industrial output during the last 8 months of the war. The precision attacks naturally contributed significantly to labor inefficiency and absenteeism, not only in the plants directly attacked but also in many factories that lay near the primary target area.

The area attacks in Nagoya were of considerably less importance, in terms of the actual production decline, than the precision attacks, even though 71 percent of all the bomb tonnage employed against the city was dropped in area attacks, and even though the area attacks, alone, destroyed 21 percent of the city's industrial structure. The area attacks here duplicated as much as complemented the effects of precision attacks. The effect of the area raids was felt most by plants manufacturing components for large end-product customers. The chief value of those raids would have been to interrupt end-product manufacture by creating component shortages. However, the effect of reduced component supply was substantially lessened by the precision raids, which cut deeply into end-product manufacture itself, thereby greatly reducing component requirements. Even if the end-product plants had been unaffected by precision damage, it is questionable, in view of the rapid decline in raw material recipts, whether the component requirements of those plants would have been much greater during the raid period. In the absence of both precision attacks and raw material shortages, however, the area raids would have had a very substantial effect on production. As it was, the cumulative shock of the March and May raids can not be over emphasized: they contributed to a serious decline in worker incentive and morale, caused widespread damage in every industry; rendered homeless more than 400,000 people; and caused severe (though temporary) disruption to an already badly strained transportation system. The general impact of the area raids was to make inevitable the paralysis of economic life in the city.

[1] Structural damage was defined as damage to structural and loadbearing members of buildings only. Roof and outer-wall damage was to be disregarded.

[2] More fully figures of raid destruction appear in this division's report on the city of Nagoya.

CHAPTER VI

Impact of the Raids on Industry

Introduction.—The air offensive against the urban areas of Japan was expected to affect war production substantially. It was to achieve this result through:

(1) Direct physical damage to major productive facilities and to the numerous small feeder plants concentrated in such areas.

(2) Destruction of finished items, raw materials, components, and goods in process at plant sites and in warehouses.

(3) Disruption of internal transportation and public services, thus creating obstacles to the normal movement of labor and goods and, to repair, reallocation, and dispersal efforts.

(4) Reduction of labor efficiency through increased absenteeism caused by the disruption of living conditions.

In terms of the broad objectives of the urban attack program, it was expected that the effects of (1), (2), and (4) would be more substantial in the larger urban complexes. And by attacks on the smaller cities the effects of (3) and (4), particularly, were expected to have a widespread and serious effect on the economy and result in general economic disorganization.

Before analyzing the effects of the raids on the production of urban industry, a brief recapitulation is given of the economic framework in which those effects were operative. The Survey estimated that by August 1945, without air attacks and without invasion, the shrinking supply of basic materials would have imposed a production ceiling upon the economy of from 50 percent to 60 percent of the 1944 peak. This estimated level of production appears somewhat low for urban industry. In July, production in unbombed Hiroshima was at 83 percent of its October 1944 peak; in June, production in 6 cities in the Hokkaido was at 93 percent of the October peak. An over-all sample of industries in 8 unbombed cities showed a level of production in June 1945 at 94 percent of the October 1944 peak. According to the data collected by the division, reallocations of materials to the unbombed cities was not substantial enough to affect these values. What benefit the unbombed cities received as a result of the destruction of industry in other urban areas was more than compensated for by the indirect effects of the air attacks which were felt in varying degrees in all urban areas. Therefore it is considered likely that urban industry at the end of the war, without air attacks, would have been at least at a 60 percent level of its 1944 peak, possibly somewhat higher. With this in mind, the following summary of production levels, as they were after the air attacks in July 1945, becomes more meaningful.

Summary of the Effects of Air Attacks on Urban Industry

In July 1945 the levels of urban industry production in relation to the October 1944 peak[1] were:

	Percent
In plants which were hit by bombing	27
In plants which were not hit by bombing but were located in bombed cities	51
In both hit and unhit plants in bombed cities	33
In unhit plants which were located in unbombed cities (in June)[2]	94

In order to measure the effects of air attacks, both direct and indirect, it was necessary to assume that the level of urban production achieved in October 1944 might have been maintained if three factors had not caused its decline. The three factors were broadly delineated as: (a) direct effects of bombing to productive plant and equipment, (b) the indirect effects of bombing (absenteeism, dispersal, disruption of supply lines, etc.) and (c) general economic conditions (raw material shortages, deterioration of equipment, food shortages, etc.). Had the October 1944 production level been maintained through June 1945, the aggregate production loss to urban industry caused by all three factors would have been approximately 3,200 million yen. The total loss of 3,200 million yen was broken down by analysis and

[1] October 1944 production equals 100 percent.

[2] July level was 75 percent but this reflects the effects of bombing in the Hokkaido in July.

apportioned between the three causes of production decline. The method used resulted in the following rough apportionment:

Twenty-nine percent of the total aggregate loss was due to (a) the direct effects of bombing

Thirty-nine percent of the total aggregate loss was due to (b) the indirect effects of bombing

Thirty-two percent of the total aggregate loss was due to (c) general economic conditions

The Nature of the Industrial Data Used for the Analysis of Urban Bombing—The Plant Sample

To provide basic data for an analysis of the effects of bombing on industry in urban communities, 9,000 industrial questionnaires were distributed to Japanese manufacturers in 39 cities on Kyushu, Honshu, and Hokkaido (not including those distributed to factories in Nagasaki and Hiroshima). Of these, 4,500 were returned and approximately 2,400 contained sufficient data on yen sales, electric power consumption, and labor to form complete production series for the period from October 1943 to August 1945, the period which was chosen for the analysis. Many of the incomplete questionnaires, although unsuitable for inclusion in the over-all industry series, proved useful in the analysis of industries in cities which were subjects of special reports. The following table lists the industrial classifications and the number of plants which were used to tabulate the data:

TABLE 8.

Category	Industry	Number of Plants
1	Aircraft assembly, subassembly, and A/C engines	86
2	Ordnance	141
3	Shipbuilding	109
4	Motor vehicles	49
5	Electrical products	218
6	Machinery and tools	328
7	Metal products	389
8	Metals production	333
9	Chemicals	212
10	Petroleum	11
11	Miscellaneous industries (textiles, leather, food, etc.)	505
12	Public utilities[1]	12
	Total	2393

[1] This classification was missing in some cities, and is not included in the calculation series. The proportionate share of each of the other industry groups is calculated on the sum of eleven industrial categories.

TABLE 9.

Geographically the sample is distributed as follows:

	Number of plants
Akashi	17
Amagasaki	119
Chiba	6
Fukuoka	36
Gifu	37
Hachioji	10
Hamamatsu	35
Himeji	30
Hokkaido (6 cities)	70
Ichinomiya	23
Kawasaki [1]	55
Kobe [1]	95
Kunidamatsu	3
Kumamoto	14
Kure	16
Kuwana	15
Kyoto [1]	185
Moji	17
Nagoya [1]	231
Ogaki	22
Oita	5
Okayama	41
Okazaki	19
Omiya	7
Omuta	6
Osaka [2]	618
Sakai	66
Shimizu	26
Shimonoseki	18
Shizuoka	25
Tokyo [1]	416
Tsuruga	2
Wakayama	24
Yokohama [1]	84
Total, 39 cities	2,393

The questionnaires were delivered to plants employing 50 or more people, except in the Tokyo-Kawasaki-Yokohama area where the plants sampled employed 100 or more workers. This was done because it had previously been determined that, in Tokyo, industry employing less than 100 workers was over 70 percent destroyed by the air attack. In that city, however, the returns from the 100 workers and more sample represented 37 percent of the total industrial electric power consumption and 31 percent of the total productive labor hours of the three cities, prior to the period of air attacks. In Nagoya, the returns approximate 70 percent of the total industry of the city. The sample in Kobe was almost 100 percent of

[1] Special reports were prepared for these cities.

TABLE 10.—*Industrial sample by industry*

[All values in 1,000's]

Industrial group[1]	PRODUCTION							LABOR							ELECTRIC POWER CONSUMPTION						
	Base production yen[2]	Percent Industrial group to total	1944 peak yen	July 1945 production yen	Percent Industrial group to total	Percent loss July to Base Period	Percent loss July to peak	Base[1] productive hours	Percent Industrial group to total	1944 peak	1945 July	Percent Industrial group to total	Percent loss July to base	Percent loss July to peak	Base[1] kw.-hr. Consumption	Percent Industrial group to total	1944 peak	1945 July	Percent Industrial group to total	Percent loss July to base	Percent loss July to peak
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	214,140	17.8	279,699	100,118	18.1	53	64	66,895	19.1	79,973	39,875	18.7	40	50	19,341	5.9	21,432	7,571	6.1	61	65
2	67,104	5.5	96,532	44,528	8.1	34	54	26,017	7.4	30,115	18,515	8.7	39	39	8,935	2.7	9,784	5,430	3.8	39	45
3	87,245	7.2	115,161	53,254	9.6	39	54	32,700	9.4	37,770	21,020	9.9	36	44	14,083	4.3	18,382	8,327	6.1	41	55
4	47,580	4.0	59,953	10,340	1.9	79	83	15,126	4.3	16,315	7,143	3.3	53	56	19,329	5.9	20,672	5,195	3.8	73	75
5	126,400	10.5	186,766	58,100	10.5	54	69	43,200	12.3	30,129	27,586	12.9	36	45	26,734	8.1	28,371	9,268	6.8	65	67
6	108,430	9.0	140,423	46,841	8.5	57	67	39,380	11.2	42,332	21,222	9.9	46	50	14,043	4.2	14,735	6,760	5.3	52	54
7	75,110	6.2	90,721	30,037	5.4	60	67	24,991	7.1	29,413	14,406	6.8	42	51	11,577	3.5	13,108	4,617	3.8	60	64
8	226,451	18.8	285,653	89,151	16.1	61	69	51,782	14.9	55,596	32,509	15.3	37	42	104,652	31.8	112,166	42,084	31.8	60	62
9	69,120	5.7	77,635	28,591	5.2	58	63	19,405	5.5	20,084	10,678	5	45	47	74,343	22.5	79,304	25,173	18.9	66	68
10	4,868	.4	6,384	1,765	.3	64	72	721	.2	871	622	.3	14	29	1,281	.4	1,944	717	.8	44	63
11	177,900	14.8	257,178	89,609	16.3	50	65	30,236	8.6	33,313	19,518	9.2	35	41	35,433	10.7	36,039	17,220	12.9	51	52
Total	1,204,348	100		552,334	100	54		350,453	100		213,094	100	39		329,751	100		132,362	100.1	60	

[1] See Table 8 for decription of industrial groups.

[2] Monthly average of period October 1934—September 1944

the city's industry. Kyoto's industry was about 90 percent represented in the sample. In Osaka, a distribution of questionnaires was made to plants with less than 50 workers as well as to those with more than 50 workers representing a coverage of almost 75 percent of the city's industries. The over-all industrial data covered plants which employed 18 percent of the total Japanese industrial labor force. Production factors of hit and unhit plants were tabulated separately. Of the total sample, the hit plants are in a ratio of about 3:1 to the unhit plants; and the unhit plants in the bombed cities are in about the same ratio to the unhit plants in the 8 unbombed cities.

Graphs (3-29) show yen sales, productive hours, and kw.-hr. consumption values month by month for 23 months (October 1943 through August 1945).

Table 10 gives the base period values for yen sales, productive hours, and kw.-hr. consumption by industry (1), the 1944 peak period values (3), the July 1945 values (4), the percentage of the base values for each industry compared to all industry (2), and the same percentage for each industrial group in July 1945 (5). Also given are the percentage declines in industry from the base to July 1945 (6) and from the peak to July 1945 (7).

Table 10 shows that during the raid period,

TABLE 11.

	Labor force (January 1945)	Percent of total	Electric power consumed (1,000 kw-hr.)	Percent of total	Percent of labor force in hit plants	Percent of labor force in unhit plants
Aircraft	360,924	21	16,773	5.8	89	11
Ordnance	107,817	6	9,214	3.2	62	38
Shipbuilding and Repair	187,697	11	21,164	7.4	78	22
Motor vehicles	72,083	4	18,196	6.3	90	10
Electrical equipment	215,541	13	25,941	9.0	61	39
Finished machinery	164,983	10	12,259	4.3	70	30
Machined and fabricated metal parts	142,457	8	12,121	4.2	74	26
Metals	227,127	13	93,526	32.5	74	26
Chemicals	74,681	4	40,528	14.2	73	27
Petroleum	3,668	2	1,314	0.5	76	24
Miscellaneous	146,178	9	29,235	10.1	66	34
Public utilities	5,656	.4	7,090	2.5	83	17
Total	1,708,742	96.6	287,161	100.0	275	225

[1] Equal 18 percent of total national manufacturing labor force.
[2] Average.

the aircraft, ordnance, and shipbuilding industries maintained their relative positions in the declining economy and even increased their relative importance somewhat (4 percent increase by yen, and 3 percent by kw.-hr. consumption). Of interest is the maintenance of the relative importance of the metals products and metals production industries, which were up 3.5 percent in terms of yen sales, even though kw.-hr. consumption was down 0.2 percent.

Table 11 shows the size of the labor force for each industrial group as of January 1945, and the percentage of that labor force in the hit and unhit plants in each group. The January values of electric power consumption are given here as an indication of the extent of dependence of each industry on electric power.

Over-all Production Trends.—Prior to the period of air attacks, yen sales in the sample, which represents 18 percent of Japan's industrial labor force, rose from 959 millions in October 1943 to 1,114 millions in October 1944, the peak production month for all industry. From October 1944, the trend was steadily downward; sales reached a low in July 1945, the last full month of the war, being at that time 531 millions of yen. Production in the hit plants and unhit plants was 511 millions of yen apart in October 1943, but only 78 million yen apart in July 1945. Although both groups had declined (Graphs 3, 4, 5,), the great preponderance of the drop was in the hit plants. The over-all decline in production amounted to 55 percent from the base period, and 65 percent from the peak period (Table 12). During the base period of the sample kw.-hr. consumption averaged 323 million per month, peak consumption being in May 1944 when 340 million KWH were consumed. In July 1945, kw.-hr. consumption had declined to 59 percent of the base and 61 percent of the peak. Thus two separate series of production factors indicate that by July 1945 Japanese production had declined to a level of 35 to 39 percent of the 1944 peak.

Productive hours declined from a base of 349 million and a 1944 peak of 385 million to a July 1945 figure of 213 million or percentagewise to 39 percent from the base, and 44 percent from the peak. The decline in total productive hours was not as sharp as the declines in sales and kw.-hr. indicating that more man-

TABLE 12.—*Production Declines Industrial Sample by Hit and Unhit Plants*

[In millions]

Category	Yen						Productive hours						Kw.-hr. consumption				
	Base	1944 peak	July 1945	Percent July base loss	Percent July peak loss	Percent July peak	Base	1944 peak	July 1945	Percent July base loss	Percent July peak loss	Percent July peak	Base	Peak	July 1945	Percent July base loss	Percent July peak loss	Percent July peak
Damaged	893	1,114	304	66	73	27	244	270	123	50	56	44	248	265	87	65	67	33
Undamaged	289	419	226	22	46	54	105	118	90	14	24	76	75	81	45	40	44	56
Total	1,182	1,533	530	55	65	35	349	385	213	39	45	55	323	340	132	59	61	39

NOTE—Totals in this table differ somewhat from the totals shown in Table 10, since separation of factories into damaged and undamaged categories presented problems of classification in the case of certain factory questionnaires that could not be resolved within a reasonable length of time. The difference in the table totals, however, in no case exceeds 2 percent. The totals also differ somewhat from the totals in Table 14. The latter table does not include the unhit plants in the unbombed city of Kyoto.

hours were required to do similar jobs at the end of the sampling period than at the beginning (further analysis in the chapter on labor).

The data indicate that the decline in production was most precipitous in the April-May-June period. Production in the unhit plants was maintained at high levels through April and May when it was still at 106 percent and 118 percent, respectively, of the base period. Thereafter, production in the unhit plants dropped to 95 percent in June 1945, the lowest level since February 1944. The hit plants, including three times as many workers, had production levels of 70 percent, 66 percent, and 47 percent of the base in April, May, and June.

The Decline in Production by Industry.—Table 13 expresses the values in table 10 as absolutes (columns 1 and 3) and percentages of the total losses (columns 2 and 4). The sum at the bottom of column 3 is a fictitious value since it is the sum of the 1944 peaks which occurred in different months. Percentages in columns 2 and 4 show for each industry the relative weight of the decline in production as of July 1945 measured from the base and the peak.

In terms of yen sales, metals production, aircraft, miscellaneous industries, electrical products, and machinery and tools, together, account for 72 percent of the aggregate decline from the base, and 74 percent of the aggregate decline from the peak. Metals production accounts for 21 percent of the aggregate decline from the base, and 19 percent from the peak. The all-industry decline in productive hours was due primarily to declines in aircraft, electrical products, metals production, machinery and tools, and shipbuilding; these amounted to 67 percent (base) and 68 percent (peak) of the declines in productive hours. In kw.-hr. consumption, two industries, metals production and chemicals, both high users of electricity per productive hour, accounted for 57 percent and 55 percent of the total declines from the base and from the 1944 peak respectively.

Production Losses Due to Bomb Damage.—During the period of raids, the factors affecting industrial production may be considered as falling into three broad categories:

(a) The direct effects of air attacks (bomb damage to plant, equipment, and inventories).

(b) The indirect effects (absenteeism, dispersal, repair and replacement activities, and disruption of supplies).

(c) General economic conditions (shortages of raw materials, deterioration of machinery, etc.).

In order to isolate factor (a) from factors (b) and (c), it is necessary to compare the decline in production factors in the damaged plants with that in the undamaged plants. These data are shown in Table 14.

It is asumed that all plants, both damaged and undamaged, would have been affected equally by general economic conditions. Thus factors (b) and (c) may be included as similarly weighted factors in both hit and unhit plant categories. Production in all plants would decline from these causes to the same extent as production in undamaged plants. Production in undamaged plants reflects only factors (b)

TABLE 13.—*Production declines*

[All in 1,000's]

Industrial group	Yen				Productive hours				Kw.-hr. consumption			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	July base loss	Percent	July peak loss	Percent	July base loss	Percent	July peak loss	Percent	July base loss	Percent	July peak loss	Percent
1	114,022	17.5	179,581	17.2	27,020	19.6	40,098	21.9	11,770	6.0	13,861	6.3
2	22,576	3.5	52,004	5.0	7,502	5.7	11,600	6.6	3,505	1.9	4,354	1.8
3	33,991	5.2	61,907	5.9	11,680	8.7	16,750	9.3	5,756	3.0	10,055	4.5
4	37,240	5.7	49,613	4.8	7,983	5.7	9,172	4.9	14,134	7.1	15,477	6.8
5	68,300	10.5	128,666	12.4	15,614	11.6	22,543	12.6	17,466	8.6	19,103	8.5
6	61,589	9.4	93,582	9.0	18,158	13.0	21,110	11.5	7,283	3.6	7,975	3.6
7	45,073	6.9	60,684	5.8	10,585	8.0	15,007	8.2	6,960	3.5	8,491	3.7
8	137,300	21.1	196,502	18.9	19,273	13.8	23,087	12.6	62,568	31.9	70,082	31.3
9	40,529	6.2	49,044	4.7	8,727	6.5	9,406	4.9	49,170	24.9	54,131	24.1
10	3,103	.5	4,619	.5	99	-	249	-	564	.3	1,227	.4
11	88,291	13.5	167,569	16.1	10,718	8.0	13,795	7.7	18,213	9.1	18,819	8.5
Total	652,014	100	1,043,771	100.3	137,359	100.4	182,817	100.0	197,389	100.9	223,575	99.5

TABLE 14.—*Production (yen sales) in hit and unhit plants in bombed cities (to provide a rough measure of production loss due to direct effects of air attacks)*

	Hit plants		Unhit plants		Hit plants		Hit plants		All plants	
	Millions of yen	Percent of peak	Millions of yen	Percent of peak	Percent of decline from peak	Portion of decline below peak attributed to direct effects of air attacks	Monthly deficit below peak (millions of yen)	Portion of deficit attributed to direct effects of attacks (millions of yen)	Monthly deficit below peak (millions of yen)	Monthly production as percent of peak
1944										
October (peak)	1,114	100	388	100			(1,114)		(1,502)	
November	1,087	98	378	97	2		27		37	98
December	1,033	93	372	96	7	3/7 or 0.43	81	35	97	94
1945										
January	931	84	319	82	16		183		252	83
February	868	78	317	82	22	4 22 or 0.18	246	44	317	79
March	752	67	303	79	33	12 33 or 0.36	362	130	447	70
April	626	56	266	69	44	13/44 or 0.30	488	148	610	59
May	589	53	308	79	47	26/47 or 0.55	525	289	605	60
June	423	38	244	63	62	25 62 or 0.40	691	276	835	44
July	304	27	198	51	73	24 73 or 0.33	810	267	1,000	33
Aggregate monthly deficits through June							2,603	922	3,200	
Aggregate monthly deficits through July							3,413	1,189	4,200	

Portion of deficit due to direct bomb damage: June = 29 percent; July = 28 percent.

[1] For each month, the difference between the percent decline from respective peaks in the hit and unhit plants is taken as numerator, and the total percent decline from peak in the hit plants alone is taken as denominator. For example, of the total 33 points decline in hit plants for March, it is considered that 21 of those points occurred as the result of indirect effects of air attacks and of general economic conditions (21 being the percent decline in unhit plants) and 12 points represented loss due to direct effects of air attacks.

and (c), since it was not subject to direct effects of bombing, (a).

Hit plants include some in which damage caused no production loss, and some in which loss due to direct damage was serious. The sample, therefore, represents an average level of production loss in hit plants. This level is not entirely accurate, however, since production data from numerous completely destroyed plants were unobtainable. If such data had been included they would tend to increase the production loss due directly to bombing. On the other hand, hit plants, because they include most of the large plants, represent a greater decline in production due to dispersal than do the unhit plants. This would tend to compensate for the lack of data from completely destroyed plants. Because of these compensating factors it is believed that the decline in production in hit plants as represented by the sample represents fairly well the actual decline.

Production in hit plants suffered a loss equal to that of the unhit plants in addition to that caused by direct bomb damage (a). Table 14 shows that in July 1945 production in undamaged plants had declined 49 percent from the October 1944 peak. Production in damaged plants, containing the only group in which all three factors (a), (b), and (c) were operative, by July 1945 had declined 73 percent from the October peak. Table 12 which includes plants in unbombed Kyoto in the unhit sample shows that production in unhit plants declined 46 percent from the October peak.

Of a total aggregate loss of 4,200 million yen in urban production in bombed cities during the period from October 1944 to July 1945, 3,413 million yen or 81 percent was accounted for by plants which suffered direct physical damage. The portion of the production deficit in the hit plants due directly to bombing was 1,189 million yen, or 28 percent of the total deficit for all plants. Thus factor (a), or the direct effects of damage, accounted for 28 percent of the total aggregate production loss.

In order to isolate factor (b), the indirect effects of bombing, from factor (c), the effects of general economic conditions, Table 15 was prepared, showing production data for unhit plants in bombed areas and for unhit plants in unbombed areas. The latter group included plants of more than 50 workers in Hiroshima (which was not bombed until August), Kyoto, and for *six* cities in Hokkaido (which were not bombed until July). The production for each group of plants is in the ratio of slightly more than 3 to 1. This ratio is approximately the same as that between hit and unhit plants in the bombed areas. The analysis could not be continued beyond June because of the July bombing of the cities of Hokkaido. However, the ratio of decline, even had these figures been entered, would not have been affected materially. This is evidenced by the ratios of decline for June and July as shown on table 14 for all plants and hit plants. The data from table 15 indicate first that production in unhit plants in bombed areas fell to a level of 63 per-

TABLE 15.— *Production in unhit plants in bombed areas and in unhit plants in unbombed areas (to provide a rough measure of production loss due to indirect effects of air attacks)*

	Unhit plants in bombed areas		Unhit plant in unbombed areas		Unhit plants in bombed areas		Unhit plants in bombed areas	
	1,000,000 of yen	Percent of peak	1,000,000 of yen	Percent of peak	Percent decline from peak	Portion of decline due to indirect effects of bombing	Monthly deficit below peak 1,000,000 of yen	Portion of deficit due to indirect effects of bombing
1944								
October peak	388	100	117	100				
November	378	97	111	95	3		10	
December	372	96	109	93	4		16	
1945								
January	319	82	93	79	18		69	
February	317	82	95	81	18		71	
March	303	78	105	90	22	12/22 or 0.55	85	47
April	266	69	101	86	31	17/31 or 0.55	122	67
May	308	79	120	103	21	24/21 or 1.00	80	80
June	244	63	110	94	37	31/37 or 0.84	144	121
July	198	51	88[1]	75[1]	49[1]			
June total							597	315

[1] These figures reflect some effect of bombing in July.

cent in June 1945 from the October 1944 peak. Production in the unhit plants in unbombed areas fell to only 94 percent of the October peak in June 1945. These data tend to support a previous opinion that urban industry, if it had not been bombed, would have maintained a higher level than the general economy, which the Survey had estimated would have been at 50-60 percent of peak by August in the absence of air attacks.

Table 15 indicates further that the portion of the decline in production in unhit plants in bombed areas, due to the indirect effects of bombing, was 315 million yen out of a total of 597 million yen. Since this part of the analysis deals only with that part of the production decline due to (b), the indirect effects of bombing and (c), the effects of general economic conditions, the decline of 315 million yen may be considered as caused by (b), and the total decline of 597 million yen as the sum of (b) and (c). The ratio of (b) plus (c) to (b) is therefore 597 : 315, or roughly 2 to 1.

If the ratio of 597 : 315 is applied to the total production deficit for all plants shown on table 14, from which the deficit attributable to factor (a), or the direct effects of bombing, had been subtracted, it is found that, for all plants in the sample, a deficit of 1,260 million yen, or 39 percent of the total, was caused by (b), the indirect effects of bombing. The balance of the deficit, 1,018 million yen, or 32 percent of the total, is found to be caused by factor (c), or general economic conditions.

To summarize the preceding analysis, the data indicate that, had urban production levels continued at the level of October 1944 through June, the aggregate loss of production caused by all factors, would have been 3,200 million yen, or slightly more than two full production months at peak. This loss is apportioned roughly as follows:

	Percent
To direct bomb damage	29
To the indirect effects of bombing	39
To general economic conditions	32

TABLE 16.—*Yen Output Ratios Hit and Unhit Plants*

	Yen output in July 1945 as percent of 1944 peak			Percent yen output—		
	All	Hit	Unhit	Hit	Unhit	Ratio
Aircraft	36	28	85	90	10	0.0:1
Ordnance	46	44	47	55	45	1.2:1
Electrical equipment	31	22	47	65	35	1.9:1
Finished machinery	33	23	56	70	30	2.3:1
Machined and fabricated metal parts	36	25	58	69	31	2.2:1
Metals	32	27	34	64	36	1.8:1
Miscellaneous	34	24	56	71	29	2.4:1
All industry	35	27	54	.	.	.

CHAPTER VII

Effects of the Air Attacks on Public Utilities and Services

The urban raids aggravated the difficulties under which public services and utilities had been laboring for some time. Physical damage, except as it disrupted local transportation and communication facilities and prohibited the general use of public services, had little effect on the operation of those services to meet essential needs. Shipping and rail movements were maintained during the raid period with only slight interruptions, and the supply of water, gas and electric power to the remaining essential consumers was always adequate.

The drastic curtailment of public services for the civilian population, however, tended to lessen the efficiency of the public services and indirectly affected essential activities. Damage to local transportation facilities hindered evacuations and dispersal measures and interfered seriously with the efficiency of industrial labor.

Transportation

The network of highways, railroads and shipping lines that made up the transportation system of Japan was extremely vulnerable to enemy action. It was so closely tied-in with the island economy that any disruption in its operation, in any part of the empire, was felt in the manufacturing centers.

Shipping

At the time of the raids, shipping activity in the major ports of Japan had already declined to only a small fraction of capacity. The ports of Tokyo and Yokohama had virtually ceased to operate; Osaka's shipping had declined in March 1945 to 38 percent of the May 1944 figure; Nagoya in 1944 was handling but 6 percent of its 1941 shipping; Kobe was approaching a standstill, handling less than 100,000 tons in February 1945. This drastic decline in activity was principally due to the blockade and anti-shipping campaigns. Toward the close of the war, Allied mining further restricted the already limited use of the major ports.

The area raids did not materially affect the reduced operations of the ports, although loadings and unloadings were at times delayed several days due to damage to lighters, warehouses, wharves, and to the flight of harbor labor. Osaka and Kobe were most seriously affected by destruction of lighters and by labor troubles which prevented the efficient handling of the few ships which managed to reach port. In Osaka, the air attack destroyed or seriously damaged 200,000 tons out of a June 1944 total of 512,000 tons of lighters and 162 of the port's 307 towboats. One third of Osaka's cranes and 13 of the 22 mechanical loaders were put out of commission. The heaviest blow to the port of Osaka, however, during the raid period, was the destruction by area attack of the harbor pumping system which caused the inundation of a large part of the unloading area. This created greater dislocation than the destruction of 60 percent of the harbor warehousing. In Kobe harbor, facilities suffered less from physical damage, since the port was well equipped with fire-resistant concrete warehouses and 50 percent of all freight was normally handled at wharves, lessening the port's dependence on lighters. In Kobe, and also in Nagoya, absenteeism among harbor workers proved to be the only limitation to the already crippled harbor operations during the period of urban attacks.

Railroads

The area raids had little effect on mainline rail operations. At Hiroshima, target of the atom bomb, rail traffic was delayed only 48 hours. Worn-out and inadequate equipment, shortage of coal and overwork were the principal reasons for the declining efficiency of the rail network. The air attacks were felt chiefly in terms of disruption to local transportation facilities and delays in moving freight from rail heads to receivers, caused largely by worker absenteeism. Railroad labor was the principal limiting factor to efficient service throughout the raid period. This was directly caused by the air attacks which complicated the problems of distributing food, brought about increased fatigue from loss of sleep due to air alerts and

from destroyed local passenger facilities. During the early days of the attacks, factories sent their own labor to help with freight handling, but by March 1945, labor troubles had become critical in the factories themselves and it became unprofitable to continue this arrangement.

For the one major city where such figures were avilable, Nagoya, railroad labor statistics indicate that (a) the total number of freight handlers fell off about 38 percent between November 1944 and July 1945, mainly due to permanent evacuations, while (b) the total productive hours worked monthly by handlers on the job fell about 50 percent, due to increased absenteeism caused by the raids. Local rail officials in Nagoya considered the latter the chief handicap to rail activity in the area during the raid period.

TABLE 17.—*Nagoya—Railroad labor and freight movements*

Month	Rail freight handlers		Hours worked monthly		Freight movements	
	Total Number	Percent of November 1944	Total number (1,000)	Percent of November 1944	Tons (1,000)	Percent of November 1944
1944						
November	19,716	100.0	4,515	100.0	630	100.0
December	18,017	91.4	4,040	89.5	517	82.1
1945						
January	18,436	93.5	3,960	87.7	479	76.0
February	16,682	84.6	3,700	81.9	505	80.2
March	14,723	74.7	3,060	67.8	443	70.3
April	14,013	71.1	2,750	60.9	342	54.3
May	13,398	67.9	2,665	59.0	279	44.3
June	12,335	62.5	2,410	53.4	277	44.0
July	12,197	61.8	2,260	50.1	268	42.5

Although physical damage to railroad trackage and rolling stock was generally not significant, bomb damage to the Takatori and Suita repair shops in Kobe and Osaka respectively, reduced locomotive repairs in the Kinki Region in June to 38 percent of what they had been in May. Repairs in July and August were about 50 percent of May.

Internal Transportation (Streetcars, Buses, Trucks, Automobiles)

Before the raids, facilities for the transportation of materials and passengers in the cities had been badly depleted because of a lack of replacements, poor maintenance and over use. Fuel shortage was an increasing limitation to the use of motor driven transport. These facilities were particularly deficient in the larger urban areas where considerable distances and a greater volume of traffic were involved. In Tokyo-Kawasaki-Yokohama, where 15 percent of the trolleys, and 60 percent of the buses had been immobilized prior to the raid period, principally because of the lack of repair parts, approximately 45 percent of the remaining streetcars and 10 percent of the buses were destroyed by area attacks. Passenger traffic decreased about 50 percent during the raid period, but this was in a large part compensated for by the extremely heavy evacuations from the cities. In Tokyo, the number of trucks during 1944 had shrunk from 15,000 to about 7,500, and even before the air attacks, only 30 percent of the legitimate demands could be filled. The air raids destroyed 2,200 of the 7,500 remaining vehicles, limiting still further the use of this means of transportation.

In Osaka, the area raids of March and June cut deeply into an already inadequate supply of trucks and buses, and also destroyed repair facilities which were vital to maintain even the small number of vehicles remaining. Prior to the raids, only 25 percent of the trucks were operating. The raids destroyed 20 percent of these. An additional 50 percent of the trucks remaining were rendered inoperative for the rest of the war because of failure to repair.

In Kobe, although 700 trucks were destroyed by bombing during the raid period, the important limiting factor to continued operation was the shortage of operating and repair labor.

In Nagoya, the shortage of trucks was acute during the last two years of the war. The area raids of March and May seriously aggravated this shortage by destroying 140 (more than 10 percent) of Nagoya's usable trucks as well as most of the repair facilities. By August, there were only 2,400 trucks left in all Aichi Prefecture (including Nagoya), and of those only 700 were in operation.

The breakdown of local transportation interfered seriously with the dispersal program and the normal movement of goods and supplies. It hindered the evacuations, made it difficult, and often impossible, for workers to get to and from their jobs, and complicated the distribution of food. The dislocation of local transportation increased worker absenteeism and contributed importantly to the general collapse of public

morale. Had the disruption of local transportation been complemented by the early disruption of mainline rail movements, a program which was barely underway at the end of the war, the virtual paralysis of the economic and social life of the urban areas might have resulted.

Electric Power

Japanese records cover three principal categories of electric power consumption: (1) lighting, both private and public, (2) industrial installations having a capacity of more than 50 kw., which consumed normally about 83 percent of the total output, and (3) industrial installations having a capacity of less than 50 kw., which represented some 7 percent of the total output. Investigations indicated that plants of less than 50 kw. capacity generally employed fewer than 50 workers, while those of over 50 kw. employed more than 50 workers. Power in Japan was divided between hydro-electric and thermal plants on approximately a 60-40 percent basis. Thermal stations, while often employed as base load plants in certain areas, particularly in west and central Honshu, were normally utilized to offset the drop in hydro-electric production during the dry seasons in the fall and winter.

At the outset of the war, because of the coal shortage, electric power was strictly rationed with a view to cutting out nonessential consumers. No modifications in these restrictions were made, even after the attacks had reduced the demand, as it was considered better for public morale to keep them in effect. Although the attacks caused considerable damage to many of the municipal thermal plants, sub stations and lines—amounting in the aggregate to some 10 percent of all such installations in Japan—the electric power supply was always adequate, and after March 1945, far in excess of all essential demands. Industrial consumption in the major urban areas declined, on an average, to 50 percent of 1944 use. The decline was less precipitous than that of production. In almost all cities, in 1945, it was unnecessary to operate the stand-by thermal plants, since hydro power sufficed.

Gas

The supply of gas in the urban areas was short during the entire period of the war, being limited primarily by the shortage of coal. Both domestic consumers and certain low-priority industries were strictly rationed. In general, the supply of gas for essential industrial use remained adequate throughout the war. In Osaka, after June, extensive leakage caused a curtailment of supply to some essential industrial users, but even there, effects on production were not apparent. In the bombed urban areas, gas plants sustained some, and mains and pipes considerable damage. But the simultaneous destruction of both industrial and domestic consumers was proportionately so much more extensive that no shortage was experienced by the remaining essential users. As in the case of electric power, the supply of gas was never a limiting factor to industrial activity during the war.

Water

City water systems were hit badly during the attacks, but that damage had only a slight effect upon the economy. Only in Nagoya, where the destruction of conduits and service mains was particularly heavy, is there evidence that industry was affected. Priorities for industrial use were established there after the heaviest area raids, mostly at the expense of the shipbuilding and chemical industries. Civilian supplies fell to less than 65 percent of needs, adding greatly to personal discomfort, although it was claimed that public health was never endangerd. In Nagoya, as in other large cities which were subjected to repeated attacks, the lack of water proved a serious handicap to any efficient defense against incendiary bombs. In most attacked cities, after the raids, water service was suspended for a period of 5 to 10 days. Although limited supplies were usually restored, lack of replacement parts and skilled repair workers prevented any considerable recuperation.

Communications

Bomb damage and disruption to mail, telephone and telegraph services in the urban areas hampered air raid defense measures and the ability of the government and industry to make necessary adjustments after the raids.

All communication services had been declining in efficiency before the raid period due to shortage of maintenance supplies and to inefficient personnel. In the larger cities, dam-

age to lines and equipment was so heavy that, during the raid period, only highest priority messages were allowed. Normal business matters necessitated transmission either by very slow mail or by personal travel, both of which were rendered extremely difficult by disrupted transportation. Almost any action on the part of industry to obtain materials, labor, and other essentials required innumerable contacts with various government agencies, and when communication facilities were impaired, the effect on business activity, especially in the immediate post-raid period, was substantial. Local telephone service virtually disappeared. In Osaka, long distance telephone calls in July fell to less than 10 percent of what they were in February; in Kobe, to less than 1 percent. To alleviate the shortage of telephone cables in Kobe and Osaka, 30 percent of Kyoto's cables were taken down and sent to those cities as replacements. Wireless communication was also affected, since most sending and receiving stations were located at some distance from the cities, and messages had to be relayed by mail, telephone or telegraph. Mail service was disorganized by the mass evacuation of people from the cities, the destruction of mail trucks, slowdowns of railroads, and absenteeism of personnel. In the entire Kinki Region, embracing the cities of Kobe, Osaka, and Kyoto, attendance of communications workers after the June raids was only 30 percent of the preraid figure.

It is impossible to measure exactly the influence of communications failure on the economy and on the well being of the people. At the time these facilities were most needed, after the raids, when industry had to make adjustments, when dispersal operations required constant communications, and when the plight of the people required communication with relatives and friends, the facilities were not available.

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CHAPTER VIII

Industrial Labor

Summary.—By July 1945, the last full month of the war, the effective supply and quality of labor had become a critical factor in Japanese production. Drafting and shifting of workers even before the raids had brought about a steady decline in the skill of workers. Air raids had created a general disruption to city life, which had already lost much of its stability because of food shortages, evacuations and inflation. Because of the general disruption, and also because of a short-sighted labor policy, management was unable to utilize, with efficiency, the labor at hand. In certain industries more labor was available than materials, but most Japanese sources claimed that, even had raw materials and components been available in larger quantities during 1945, the increased absenteeism among the workers—caused by evacuation, air alerts, dehousing, transportation difficulties, malnutrition and fatigue—would have prevented increased production.

Pre-raid Period.—The Japanese economy had been confronted with the problem of manpower deficiencies even before the war. The rapid industrialization of the country in the 1930's created a shortage of engineering skill and trained labor which remained a constant limitation to a flexible economy.

From 1939 on, however, the government made a strenuous attempt to consolidate the labor force for a major war. Workers in commerce, export manufacturing, domestic service, and other non-essential activities were gradually diverted into war production. By curtailment of materials, electric power, and the conscription of workers, nonessential industry, including the traditional 1 to 10 worker "home-industry" shop, was largely eliminated by 1944.

The conscription of workers for war production, which began in 1939, did not reach a peak until 1943, by which time over 1,300,000 workers had been drafted for war industries. Conscription thereafter, in 1944 and 1945, having exhausted most of the supply, accounted for less than 300,000 additional workers. To supplement this group of conscript workers, women and students were also drafted for industrial work.

Control.—The insufficiency of Japanese administration and management was most conspicuous in the control of labor. The Welfare Ministry, which exercised broad control over a complicated network of regional and prefectural labor offices, was never able or willing to take the strong measures demanded by the situation. Army and Navy consultants, who exerted powerful influence in local labor offices, were largely responsible for the maladministration of the labor force. Military conscription depleted the ranks of skilled workers by as much as 30 percent in some industries. Allocations of new workers were made on the basis of Army-Navy preferences instead of actual need. No attempt was ever made to check on the utilization of labor by industry, with the result that the quality of the labor force deteriorated. Large industries were favored, both by labor allocations and by extra worker rations of food and clothing, which enabled them to abide by wage controls and still maintain their labor force. Small industries received only neglible allocations of labor and no extra rations, and were consequently forced to patronize labor black markets.

By early 1945, the control of labor was disorganized to such an extent that centralized administration was relinquished by the Welfare Ministry. However, by that time, perfectural and regional controls, to whom final authority was delegated, were themselves so disrupted by the air attacks that control of any kind practically ceased.

Industrial Labor Force.—The total labor force in the industrial sample which has been used as the basis for the analysis of production in a preceding chapter amounted to 1,708,402 workers in January 1945. This figure represents 18 percent of the national manufacturing labor force. During the sampling period from October 1943 through July 1945, the labor force sample rose from 1.6 million workers in the

early months of 1944 to 1.8 million in October 1944, the peak month, and declined by July to 1.6 million, or to about the same point as it was in early 1944. Considering the radical decline in production during 1945 and the maintenance of the relatively high level of workers, it is immediately clear that there was no scarcity of labor. A labor force, however, cannot be judged in terms of numbers. In terms of productive labor hours worked, the only real index of an effective labor force, the sample data indicated that, in July 1945, the effective labor force was at a level of 61 percent of the base year (October 1943-September 1944) and 55 percent of the October 1944 peak.

Absenteeism.—Productive labor hours, during the pre-raid base year, represented 80 percent[1] of the total labor hours. The absenteeism rate at that time was therefore 20 percent. By July 1945, the absenteeism rate (lost hours) had risen to 49 percent with productive labor hours representing only 51 percent of the total.

Output Per Hour.—During the base year, a productive work hour yielded 3.4 yen. In the peak month of October 1944 output per hour had increased to 4.1 yen. In July 1945 output per productive hour had declined to 2.5 yen representing a decline of 26 percent from the base year output and a 36 percent decline from the 1944 peak. Thus, in July 1945, approximately one-third more hours were required to produce a similar volume of work than in the base year.

The declines in labor productivity are shown in the following table.

TABLE 18.—*Declines in labor and production factors*

Factors	July 1945/ base year	July 1945/ October 1944 peak
	Percent	*Percent*
Yen sales	55	65
Kw.-hr. consumption	59	61
Productive hours	39	45
Labor force	0	11
Yen sales productive hours	26	36
Kw.-hr. productive hours	33	30

Considering only productive labor hours, the effective labor force in July 1945 was at 61 percent of the base year average and 55 percent of the 1944 peak. It is clear from the declines in various production and labor factors, as shown on the preceding table, that there would have been sufficient labor, in terms of the number of workers and even in terms of productive hours, for the volume of production which was possible by July. However, there was a sharp decline in the efficieney of the labor force and in the managerial ability to utilize labor.

Hit and Unhit Declines, Lost Hours.—In Japanese data, lost hours are ascribed to general absence, enforced idleness, air alerts, and bomb damage. The total figures cannot be broken down acurately by causes, because of the loose interpretation of those causes by Japanese plant managers. However, examination of the labor forces in plants which were damaged by the raids and in plants which received no damage, reveals that lost hours increased from 20 percent to 56 percent in the case of the former, and from 20 percent to 34 percent in the case of the latter, and from 20 percent to 49 percent over-all for both hit and unhit plants (see table 19).

The difference between 34 percent lost hours in unhit plants and 49 percent, which represents lost hours for the entire sample, is fifteen percentage points. However, the 34 percent increase in lost hours in the unhit plants is lower than the 40 percent increase for the unhit plants in the heavily bombed Tokyo complex and for unbombed plants in unhit areas. This indicates that, in most of the bombed cities, there was some effort to reallocate labor into the unhit plants. Although this succeeded to a certain extent in other bombed cities, in Tokyo, the magnitude of the destruction and the volume of evacuations from the city appear to have prevented such reallocation. It is difficult to ascribe an exact portion of the total increase in lost hours to any one factor because of the overlapping influence of indirect bombing effects and general economic conditions in both bombed and unbombed areas. Only a rough approximation can be given. Of the total increase in lost hours from the base year to July 1945, from 20 percent to 49 percent, the direct effects of bombing appear to have caused about one half of the increase, while general economic conditions and the indirect effects of bombing together caused the other half.

[1] In German cities 87 percent. U. S. S. B. S. Area Studies Division Report.

TABLE 19.—*Increase in lost hours, bombed and unbombed cities*

Area	Lost total hours	
	Base year	July 1945
	Percent	*Percent*
All Japan: Hit plants	20	56
All Japan: Unhit plants	20	54
All Japan: Hit and unhit	20	49
Tokyo complex: Unhit plants	17	40
Kyoto	24	40
Hokkaido[1]	28	44
Hiroshima[2]	25	40

[1] Bombed in July; percentage figure for June.

[2] Not bombed until August.

The table presents the increase in lost hours in the unhit plants in the heavily bombed Tokyo complex, and in unhit plants in unbombed cities. Although the lost hours rates in the base year differ somewhat for different areas, the rates in July 1945 for all the areas are markedly similar. This suggests that the general breakdown of the economic and social structure had a comparable impact on industrial labor in all the urban areas. The indirect effects of the air attacks played their part in this general breakdown. Even in Hiroshima and the cities of Hokkaido, which were relatively isolated from heavily bombed areas, and were closer to sources of materials, the rate of increase in lost hours by July was comparable to that in the unhit plants in the heavily bombed areas.

TABLE 20.—*Decline in individual ratios*

Industrial group[1]	Yen sales per productive hour					Yen sales per kw.-hr.					Kw.-hr. per productive hour				
	Base	Peak 1944	July 1945	Percent loss July base	Percent loss July peak	Base	Peak 1944	July 1945	Percent loss July base	Percent loss July peak	Base	Peak 1944	July 1945	Percent loss July base	Percent loss July peak
1	3.4	3.8	2.5	22	34	11.7	14.2	13.2	13	7	.28	.30	.19	32	37
2	2.6	3.6	2.4	8	33	7.6	9.9	8.2	8	17	.35	.37	.29	17	22
3	2.7	3.1	2.3	15	26	6.3	7.7	6.4	2	17	.43	.50	.39	9	22
4	3.2	3.5	1.1	66	69	2.5	2.9	2.0	20	31	1.29	1.4	.73	43	48
5	2.9	4.1	2.1	28	39	4.9	7.2	6.3	29	12	.62	.63	.34	45	46
6	2.7	3.5	2.2	9	37	7.8	10.2	6.9	12	32	.36	.39	.31	14	21
7	3.0	3.2	2.3	23	28	6.5	7.7	7.1	9	8	.46	.52	.32	30	38
8	4.4	5.4	2.7	39	50	2.2	2.9	2.7	23	7	2.0	2.1	1.2	40	43
9	3.5	3.9	1.3	63	67	1.0	1.6	1.1	10	31	3.55	4.0	2.35	34	41
10	6.8	8.7	2.8	59	68	4.0	5.5	2.5	37	55	1.67	2.3	1.15	31	50
11	5.9	8.1	4.6	22	43	5.0	7.1	5.2	4	27	1.17	1.2	.88	25	27
Total	3.4	4.1	2.5	26[2]	36[2]	3.6	4.6[2]	3.9	8[2]	15[2]	.96	1.0	.64	33[2]	36[2]

[1] Table 8 for description of industrial groups.

[2] Average for summary total of all industries.

TABLE 21.—*Table of lost labor hours as percent of total hours*

	January 1945 labor force	Lost Hours Monthly average, 1944 Percent	Lost Hours July 1945 Percent	Lost Hours Increase Percent	July 1945 Lost Hours Hit plants Percent Total Hours	July 1945 percent of labor force	July 1945 Lost Hours Unhit plants Percent Total Hours	July 1945 Percent of labor force
By industry:								
Aircraft	360,924	20	51	31	56	89	43	11
Ordnance	107,817	17	41	24	39	62	44	38
Shipbuilding	187,697	24	52	28	57	78	33	22
Motor vehicles	72,083	24	57	33	60	90	49	10
Electric equipment	215,541	17	42	25	60	61	26	39
Finished machinery	164,983	18	49	31	60	70	32	30
Machine parts	142,457	25	59	34	67	74	41	26
Metals	227,127	20	46	26	51	74	38	26
Chemicals	74,631	15	51	36	59	73	32	27
Miscellaneous	146,178	18	44	26	29	66	34	34
Total, all industries[1]	1,708,742	20	49	29	56	75	34	25
By region or city:								
Hokkaido	- -	28	[2]44	16	....	...	.	.....
Hiroshima	(50,590)	25	40	15	.....	....	..	.....
Tokyo complex		21	56	35	.....	....	.....	.....

[1] Includes two categories not listed, Petroleum (3608) and Public Utilities (5636). This figure also includes the labor force of Hokkaido. The labor force for Hiroshima is not included in the industrial breakdown.

[2] June value before bombing, 44 percent. July value 59 percent.

TABLE 22.—*Manpower—Classifications of gainfully employed in Japan proper, 1930, 1940, 1944*

	1930	1940	1944
Agriculture	14,131,025	13,841,576	13,668,681
Marine products	568,436	542,958	457,037
Mining	315,476	597,755	790,537
Manufacturing	5,875,991	8,132,314	9,303,195
Commerce	4,905,655	4,881,538	2,323,560
Transportation	945,116	1,364,396	1,531,589
Government and professional	2,005,192	2,144,893	3,099,700
Domestic service	802,167	708,945	453,825
Others	70,582	218,140	124,336
Totals	29,619,640	32,432,515	31,752,410
MALES GAINFULLY EMPLOYED			
Agriculture	7,734,858	6,618,378	5,831,854
Marine products	515,727	467,384	374,462
Mining	270,719	528,526	666,625
Manufacturing	4,438,365	6,178,584	7,046,224
Commerce	3,406,465	3,005,651	1,102,983
Transportation	906,665	1,213,929	1,274,469
Government and professional	1,611,648	1,515,281	2,030,150
Domestic services	92,259	38,738	49,312
Others	63,531	154,157	74,404
Totals	19,040,237	19,720,628	18,450,483
FEMALES GAINFULLY EMPLOYED			
Agriculture	6,396,167	7,223,198	7,836,777
Marine products	52,709	66,574	82,575
Mining	44,759	69,229	123,912
Manufacturing	1,447,626	1,953,730	2,256,971
Commerce	1,499,190	1,875,887	1,220,577
Transportation	38,451	150,467	257,120
Government and professional	393,544	629,612	1,069,550
Domestic service	709,908	670,207	404,513
Others	7,051	63,984	54,932
Totals	10,589,405	12,752,888	13,306,927

Source: Manpower Division, U. S. S. B. S.

TABLE 23.—*Manpower—Labor conscription*[1]

Year	1939 - 1945	
	Conscription for year	Cumulative total
1939	850	850
1940	52,692	53,542
1941	258,182	311,724
1942	311,649	623,383
1943	699,728	1,323,111
1944	229,448	1,552,559
1945	47,771	1,600,330

[1] Source: Welfare Ministry and Manpower Division, U. S. S. B. S.

CHAPTER IX

Subcontracting and Component Parts Supply

Part of the objective of the urban raids was the destruction of smaller "feeder" plants in the industrial areas. It was believed that the effect of such destruction would be immediately and seriously felt in the war economy. The extent of destruction to such plants in certain major cities was substantial, as evidenced by the discussion on physical damage in a preceding chapter.

Two approaches were made to the problem of estimating the importance of subcontracting industry; one by breaking down, by size of plant, electrical power consumption, production sales, and labor force in the major industrial cities; the other by studying the subcontracting system of large firms in typical major industries. Labor statistics from Tokyo, Osaka and Kobe made it possible, in those cities, to sample small plants in different industries and to weigh the results on the basis of the relative importance of each size-category.

Analysis of national electric power data indicated that plants employing 1-50 workers consumed approximately 10 percent of the total industrial output. Further studies of this size of plant, conducted in the six largest cities of Japan, corroborated this analysis with one exception, the city of Tokyo. Here it was found that such plants accounted for considerably more than 10 percent of the city's industrial power consumption and almost half of all industrial workers. Attacking the problem from a different angle, it was found that, in all the principal urban areas, with the exception of Tokyo, industry in the under-50 kw.-consumer group accounted for less than 10 percent of the total industrial production. Further investigation showed that plants in this category were almost entirely in the 40–50 worker group, and conversely that factories employing more than 50 workers usually fell in the over-50 kw. group. The data, therefore, pointed to the general conclusion that plants employing less than 50 workers, did not, together, contribute more than 10 percent to total industrial activity in Japan.

The conclusion that plants up to 50 workers accounted for not over 10 percent of Japan's war time industrial activity was supported by further studies made of subcontracting in the principal cities.[1]

"Home" Industry

Before the urban attacks began, "home" industry, in the strict sense of household industry (which by Japanese definition included plants with up to 10 workers), had almost disappeared. Table 24, showing the pre- and post-raid distribution of workers in Tokyo, illustrates this. The disappearance of "home" industry in a war economy was expected, since it was, at all times, primarily concerned with the production of civilian goods.

[1] A detailed study in Osaka showed that a major part of that city's pre-war small factories in metal-working and related fields were still in operation when the urban attacks began and that many of those factories were contributing to end-product production in the aircraft (propeller), ordnance, shipbuilding and machine-building industries. Osaka's principal wartime industries. Before the first attack on Osaka, 29 percent of all industrial labor in the aircraft and related industries was in workshops employing less than 50 persons. In ordnance, the figure was 25 percent; in shipbuilding, 11 percent, and in machine-tool and other machinery and metal fabrication, 27 percent. Electric power consumption data, however, indicated that in Osaka, as in the country as a whole, factories employing less than 50 workers used less than 10 percent of all power consumed by industry. Because of the close correlation between electric power consumption and industrial output, it was concluded that those factories also produced less than 10 percent of the total industrial output of the city.

TABLE 24.—*Tokyo: number of workers and plants arranged by size of firm*

Workers	1–10	10–49	50–99	100–499	500–999	1,000	Total
1940	239,469	177,351	63,862		247,410		728,092
October 1944	31,500	510,624	70,419	137,862	90,354	210,750	1,051,489
August 1945	[1]35,800	83,082	58,125	137,927	97,199	184,250	596,383
Plants							
1940	81,048	8,609	930		774		774
October 1944	23,963	15,759	919	706	103	98	907
August 1945	[1]8,408	3,309	608	622	93	93	808

[1] May 1945.

Investigation of Subcontracting in Tokyo

An analysis of the importance of subcontracting obviously cannot be restricted to plants of the "home" industry type or to plants of under 50 workers. These were given special attention only because of the prevalent belief in Allied quarters during the war that such plants represented an important segment of the economy. It was discovered, however, that subcontracting in wartime Japan followed more or less the same pattern as it did in the Western countries, being widely distributed in plants of from 50 to 10,000 or more workers. The effect of the urban raids on the great number of plants within that range was extensive. The utimate effect of such destruction or damage varied considerably as among cities and industries.

Because of the singular importance of smaller plants, other than "home" industries, in the Tokyo complex this area was chosen for a special investigation of subcontracting. The results of this investigation are not applicable to all urban areas since only in the Tokyo complex was there such a large concentration of component plants, as evidenced by electric power and labor statistics. Nagoya, although almost as significant in over-all production as Tokyo, was dominated by large end-product aircraft plants which were dependent only to a limited extent on smaller component suppliers in that immediate area. The cities of Osaka and Kobe were dependent upon feeder plants to a somewhat greater extent than Nagoya, but not to the extent that Tokyo was.

Questionnaires were submitted to 100 of the largest end-product plants in all industrial categories in Tokyo, Kawasaki and Yokohama. Thirty-three of the leading end-product plants returned responses which were complete enough to warrant certain conclusions.

Distribution by Size of Component Suppliers

The size of component plants supplying the 33 assembly plants ranged from small shops employing a handful of workers to large factories with labor forces of 10,000 or more, the latter often, themselves, producing important end-products in volume. The distribution, by size, of component plants for the 33 end-product manufacturers is shown in Table 25.

TABLE 25

Industry	Number of component plants		Total Workers	
	Under 100 Workers	Over 100 Workers	Under 100	Over 100
1. Aircraft	89	61	2,205	36,984
2. Ordnance	8		202	
4. Motor vehicles	51	32	1,520	65,185
5. Electrical equipment	303	61	11,607	15,970
6. Machinery and tools	157	17	3,521	10,235
8. Metals production	20	6	558	12,673
11. Miscellaneous	3	8	100	1,120
	631	185	19,713	142,167

Plants employing 100 or more workers accounted for 88 percent of the total labor force represented in the subcontracting sample. Of the remaining 12 percent, 7 percent were employed in plants having a labor force of 1–50 workers and 5 percent were in plants of 50–100 workers.

Value of Component Parts Received.—Although only 12 percent of the workers were employed in plants employing under 100, they supplied, in terms of yen output, 56 percent of the components used by the end-product companies. Only 44 percent was supplied by the plants of the 100 worker and over group, containing 88 percent of the workers. This unbalance is due to the fact that the smaller plants were wholly, or almost wholly, controlled by the end-product plants, whereas the large component suppliers supplied not only the 33 customers in the Tokyo region but also other plants throughout Japan. It is significant however that the 33 companies were dependent, to such a considerable extent, on small subcontractors. The table below shows the average monthly value of components supplied to the 33 end-product plants:

TABLE 26

Industry	Monthly value of components supplied by subcontracting plants	
	Under 100 workers	Over 100 workers
	(1,000 yen)	(1,000 yen)
1. Aircraft	301	1,015
2. Ordnance		158
3. Motor vehicle	532	3,598
5. Electrical equipment	5,676	2,148
6. Machinery and tools	2,862	498
8. Metals production	362	292
11. Miscellaneous	39	187
Total	9,772	7,896
Grand Total		17,668

A considerable dependence on small subcontractors was shown by the Electrical Equipment industry (75 percent of which was concentrated in this region) and the Machinery and Tools industry. The former received 73 percent of its components from 303 plants in the under 100 worker category; the latter, 85 percent of its components from 157 plants in the same category. Industries manufacturing larger end-product units appear to have been less dependent upon small contractors.[1]

Production Loss Due to Component Shortages.—Of the 33 plants, 6 reported no loss of production, while 27 reported shortages of component parts with a resultant loss of production during the period of air attacks. Of the reported declines, two set the loss at 65 percent and 60 percent respectively, two set the loss at 50 percent, one set the loss at 40 percent, one at 30 percent, two at 24 percent and 20 percent respectively, two at 15 percent, three at 10 percent, one at 6 percent, seven stated loss as "major" and six stated the loss as "minor." To recapitulate, 13 responses, or 39 percent of the total 33, set the loss at over 30 percent or major, 14 responses, or 43 percent of the total set the loss at under 30 percent or "minor", and 6 responses, or 18 percent of the total set the loss at zero. Of the six largest reported losses, half were in the aircraft industry and half in the electrical equipment industry. Of the seven stated "major" losses, three were in the electrical products industry, three in the basic metals industry and 1 in machinery and tools.

Causes of Decline in Component Parts Production.—The end-product manufacturers were asked to cite the causes which affected the output of their component suppliers. Twenty-three responses were recorded. The primary causes of decline cited were, in order of importance: (1) direct damage to component factory by air raid (10 responses), (2) inability to obtain sufficient materials (8 responses), (3) change in number of man hours devoted to actual production (2 responses), (4) shortage of fuel, change in number of workers, and shortage of technicians, skilled workers and equipment (1 response each). As secondary causes, 8 listed "the change in number of man hours devoted to actual production," 3 listed "the inability to obtain sufficient materials," 2 listed "direct damage to component factory by air raid," 2 listed "dispersal of component factories to another location," 1 each listed "shortage of electric power," "change in number of workers," "poor material distribution," and "change in components manufactured."

The Electrical Equipment industry was significantly affected by shortage of components. Nine large factories gave the following reasons for the failure of their suppliers to deliver. As primary cause, 5 listed "direct damage to factory by air raid," while 4 listed "inability to obtain sufficient materials." As secondary cause, 5 listed "the change in number of man hours devoted to actual production" and 1 each listed "dispersal of factory to another location," "inability to obtain sufficient materials," and "poor material distribution."

In the aircraft industry, of three important plants responding, two listed as the primary cause "the inability to obtain sufficient materials" and one listed "direct damage to factory by air raid."

Bomb damage to component suppliers was cited as the primary cause of component failure among the 33 customer plants. Next in order of importance was the shortage of raw materials as it affected these suppliers, and last was labor trouble. The latter two causes were in part induced, in part aggravated, by bomb damage. The impact of bomb damage on smaller component plants is illustrated by the damage statistics for the Tokyo-Kawasaki-Yokohama complex, which revealed that plants of 100 workers and under were 73 percent destroyed. In Tokyo, the electrical equipment industry, particularly radio and communications equipment, was drastically affected by damage to its smaller component suppliers.

Although the 33 customer plants could supply full information concerning the value of receipts for only 816 of their component plants, representing their primary source of supplies, a total of 3,066 subcontracting plants were listed by 87 large end-product plants which responded to another section of the questionnaire. Geographical distribution and damage information were supplied by these customer plants for 3,066 subcontractors.

[1] This was supported by the study of Nagoya's industry, predominantly aircraft end-products, which was dependent upon subcontractors to only a negligible extent.

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TABLE 27.—*Percentage distribution of component plants in Tokyo complex and outside*

Industry	Tokyo complex	Outside Tokyo complex
	Percent	*Percent*
1. Aircraft	74	26
2. Ordnance	67	33
4. Motor vehicles	47	53
5. Electrical equipment	31	69
6. Machinery and tools	77	23
8. Metals production	92	8
11. Miscellaneous	74	26
Average for total	66	34

TABLE 28.—*Damage to component plants supplying Tokyo region*

Industry	Plants in Tokyo complex		Plants outside Tokyo complex	
	Number	Number destroyed and damaged	Number	Number destroyed and damaged
1. Aircraft	406	186 (46%)	141	29 (21%)
2. Ordnance	6	1 (17%)	3	1 (33%)
4. Motor vehicles	72	15 (21%)	80	29 (36%)
5. Electrical equipment	399	102 (26%)	869	189 (22%)
6. Machinery and tools	177	79 (45%)	54	30 (56%)
8. Metals production	108	43 (40%)	9	2 (22%)
11. Miscellaneous	20	5 (25%)	7	1 (14%)
Total	1188	431 (36%)	1163	281 (24%)

The group of component plants listed in Table 28 were about equally distributed between the Tokyo complex and other urban areas. Thirty percent were either damaged or destroyed; those within Tokyo sustaining the greater damage. The distribution of component plants in the electrical equipment industry, with the greater number of plants outside the Tokyo urban complex, illustrates an effect of the urban raids which is difficult to measure, namely, the cumulative effect on over-all industry of the destruction of smaller plants in different urban areas.

It is true that limitations to end-product capacity, caused primarily by the shortage of basic materials, by physical damage to assembly plants, and by dispersal, tended to neutralize the destruction of component plants during 1945. The production of the city of Nagoya, a one-industry town, was an extreme example of such duplication. In Tokyo, where industry was more generally distributed, the destruction of component suppliers had a serious effect on the city's output. But the extent to which any one city was or was not affected by component shortages during 1945 is not a true index of the effect of component shortages on the over-all economy. The state of industrial production during the last few months of the war was so chaotic and subject to so many different pressures that it is difficult to separate causes which are naturally related. Thus, manufacturers often included in "material shortages" all supplies, including components. It is as difficult to measure the cumulative effect of the destruction of thousands of component plants in the urban areas as it is to measure the true impact of damage to people, since, in both cases, a table of casualties or a listing of examples does not present the full situation. Component plants did not limit their supplies to customers in the immediate area where they were established; they served a wide area of activity all over Japan. For instance, the Division's studies on Hiroshima and Nagasaki indicated that both those cities were relatively independent of the component plants in the immediate area, receiving most of their parts from Tokyo, Osaka, and many other far-distant cities. The Osaka Arsenal suffered a precipitous decline in production because of the destruction of the Nippon Kogaku plant in Tokyo, which supplied firing mechanisms for AA guns, the Arsenal's chief item of output. The electric steel production of the Mitsubishi Steel Works at Nagasaki, was virtually stopped because of the destruction, in an urban attack of its supplier of carbon electrodes in Kumamoto.

It is indisputable that the general state of the economy in 1945, limited the effect of component shortages, but the cumulative effect of such shortages had a substantial impact on certain industries. Had the economy been operating at full capacity during the raid period, a similar scale of destruction to component suppliers would have had a serious impact on the total economy.

CHAPTER X

Repair and Reconstruction

Japan's ability to repair and replace damaged plants and equipment was seriously limited by supply shortages. Where supplies were available—primarily in the hands of Army-Navy plants or the big Zaibatsu companies—they were used rather for dispersal than repair. In most cities there was not enough material, or labor, to construct even the simplest covering to protect damaged equipment from exposure. While shortages were the underlying reason for the negligible reconstruction which was undertaken, the Japanese appear to have been reluctant to repair, even where available supplies might have allowed such activity. Whereas the German reaction was characterized by enterprise and ingenuity, the Japanese in general, reacted with inertia. This may have arisen from their realization that remaining capacity was sufficient to process the available materials and, later, may have been supported by the general feeling that repair was wasted effort since the Allied aircraft would ultimately destroy everything.

Even prior to the air attacks, industry had been faced with the mounting problems of maintenance. Normal but unchecked deterioration of equipment, plus mishandling by incompetent and unskilled personnel, had accelerated the breakdown rate. The air attacks greatly intensified these problems, for industry, thereafter, was confronted both by severe damage to much of its own equipment and shops and by the loss of important sources of spare parts, skilled labor, and machine replacements.

The recuperability of a given factory varied with the factory's own resources, its priority standing with the Munitions Ministry and the Armed Forces and, to a degree, its own ingenuity. The larger high-priority firms maintained their own repair teams and pools of machines, from which parts and replacements were drawn.

Branch plants of large companies, such as Mitsubishi, Sumitomo and the like, were favored by assistance from the parent organizations.

In some cases replacements were secured by buying out smaller firms which had been damaged and were unable to continue production. Similarly, large firms were at times able to prevail upon machine tool producers to send repair teams and spare parts to their damaged plants and occasionally even to supply replacements. Smaller low-priority firms were entirely dependent upon their own labor force and resources for repair, as replacements were virtually impossible to obtain unless inducements were offered to the repair companies.

The Osaka region contained 20 percent of Japan's machine tool and 34 percent of her production machinery capacity. Assistance from the machine tool industry in Osaka, however, was confined to a few large firms and was not effective in terms of the over-all damage which industrial equipment had sustained. This was principally due to an ill-timed decision of the government to convert the entire machine tool industry to direct production of war materials rather than to continue production of machine tools. This affected the industry not only in Osaka, but in all large cities. By 1944, over 20 percent of the entire machine tool industry was in direct production of war materials, no allocations of materials having been made for machine tool production in 1945.

In May 1944, at the instigation of the Munitions Ministry, the Precision Machinery Control Association established the Kosaku Kikai, K.K. This organization was charged with the repair of damaged machinery for companies in war production. Under the national plan, companies which were damaged were to inform the local office of the Munitions Ministry. The Ministry would then direct member companies to send repair teams to the damaged plant. The teams made recommendations to the Munitions Ministry which, if approved, authorized the repair company to start operations. In practice, the system was inefficient and time-consuming and many firms frankly stated that they preferred to obtain repairs from private sources or make them themselves, rather than become involved in official negotiations. The aircraft industry alone had a high enough

priority to obtain effective aid through this channel. The Munitions Ministry at Osaka furnished the following data which shows the percent of machines repaired as against requests received.

	Percent
June–December 1944	50
January 1945	40
February 1945	52
March 1945	40
April 1945	5
May 1945	11
June 1945	20
July 1945	1

Numerically, the Ministry received requests for the repair of 2,776 machines of which, through its facilities, it was able to repair only 897.

An indication of the amount of repair accomplished is shown by information received from a special study conducted in Osaka. In that city, repair data for 5,259 damaged shops in 10 industrial categories indicated that approximately 2,579 of the number were abandoned and no repairs attempted, while 1,642 shops continued production in the undamaged part of the shop. Of the 1,038 shops remaining, 320 succeeded only in replacing roof covering, 309 erected a new building on the cleared site, and 116 were dispersed to new sites and new buildings constructed.

Only 83 shops undertook repair using their own special labor and construction staffs and 279 shops were forced to use their productive labor for repair purposes. Another 308 shops were repaired by private contractors. Thus a total of 670 shops were repaired entirely through efforts of the plants themselves; 310 shops were repaired through government facilities and only 20 received aid from the Army or Navy. Of the 322 shops repaired with all types of government aid, 136 were in the high-priority aircraft industry. Machine-tool makers and shipbuilders were the only others receiving significant government aid. (Table 29.)

It is apparent that industry demonstrated little ability to recuperate from the mounting air attacks which began in March 1945. The government sponsored repair system was poorly organized and wholly inadequate to carry out an efficient, thorough repair program. The program was in fact so badly administered that most companies avoided its dubious assistance. Only the large producers, particularly of aircraft, received substantial help from either the Ministry or the Armed Forces. The smaller companies were able to accomplish very little, and that only with difficulty and by resorting to various illegal methods. It should be noted, however, that the extent of post-attack repair or replacement of plant and equipment was not a wholly accurate criterion of productive recuperability. Many companies did not attempt repairs on machinery because material and labor shortages from June through August 1945 were so acute that there would have been insufficient materials to work with and insufficient personnel to man the repaired machines had the damaged equipment been restored. Further, dispersal frequently took priority over repair and many firms simply abandoned damaged equipment to concentrate on removing undamaged and slightly damaged machinery to dispersal sites. To summarize, the recuperability of industry was slight in the period from March to August 1945 due to dispersal, shortages of repair parts and skilled labor, local transportation difficulties, a generally inefficient administration of facilities, the inertia of the industrialists, and, finally, to lessened demands for productive area and equipment.

TABLE 29. *Repair history—Osaka city*

	Aircraft	Ordnance	Shipbuilding	Motor vehicles	Electrical equipment	Machine tools, finished machine, precision instruments	Chemicals	Petroleum machinery	Miscellaneous	Utilities	Total
Disposition											
Shops abandoned	803	51	217	33	153	445	340	12	498	27	2,579
Undamaged part continued in production	556	39	131	28	106	219	220	8	320	18	1,645
Roof covering only replaced	122	4	32	1	14	94	8	1	44	0	320
Structural damage repaired, shops restored	85	0	43	0	1	63	43	3	54	1	293
Site cleared, new building erected	94	10	13	4	17	41	64	.	58	8	309
New building on new site	34	0	18	0	5	7	12	..	40	0	116
Total shops damaged											5,262
Repair Group											
Firms own general labor and construction staff	5	3	3	0	7	8	51	3	3	0	83
Firms own productive labor	88	8	35	1	1	36	103	3	36	7	318
Private construction contractors	54	9	10	4	15	51	84	.	81	0	308
Facilities provided by Government departments	128	0	56	0	5	52	..	..	67	2	310
Facilities provided by armed forces	8	0	0	0	5	4	..	.	3	..	20
Total shops where repair was attempted											1,000

CHAPTER XI

Dispersal of Industry

Dispersal of industry, as a countermeasure to air attacks, was accomplished with certain success by the British, Russians and Germans. Since Japanese war industry was largely concentrated in urban areas and therefore highly vulnerable to air attacks, it was expected that the Japanese would profit by the experience of other nations and early utilize dispersal as a protective measure. But the Japanese did not profit by the experience of others. They failed to disperse on a scale necessary for protection until their vital centers of war production were under heavy air attack. After the raids on the aircraft industry in December, only certain aircraft factories, acting upon their own initiative or upon the prompting of local Army and Navy officials, began to disperse.

The first national decree, which applied to large assembly plants in the aircraft industry, was not issued until 1 April 1945. This was followed on 1 May 1945 by a second national decree that directed the dispersal of all plants essential to the aircraft and ordnance industries. The second decree was partially the result of the heavy March area raids against major industrial concentrations. But even the first decree in April was too late. The most probable reason for the Japanese failure to disperse before the air attacks developed was the unwillingness of both government and industry to sacrifice, for dispersal, any part of the peak production achieved in the last half of 1944. By April most stocks and inventories of raw materials had been exhausted by the post-Saipan drive for production. Over-all output had long since passed the peak, and was on the decline because of current short supplies of raw materials and components. With some excess capacity available in April, and with much more forseeable in the immediate future, most industries were reluctant to sacrifice their by-then dwindling production for dispersal. The excess cushion of plant capacity offered a certain degree of insurance against disastrous production loss due to bomb damage. Dispersal operations, which ultimately were forced upon industry, were begun only half heartedly. The inertia which characterized the repair and replacement of damaged plants and equipment also characterized the dispersal program. Even had the initiative been present, shortages of building materials, equipment, construction labor and the insufficient transportation system still presented strong limitations to a successful completion of the program.

The area raids, in large part, insured the failure of the dispersal program. They disrupted transportation and supply lines, increased worker absenteeism, and dissipated essential construction materials by forcing their use in emergency repairs. By causing the extension of the dispersal program in May to include all elements of the aircraft and ordnance industries, they committed Japanese industry to an impossible program which, even under non-raid conditions, could not have been completed.

Dispersal of Component Plants

Although there was general reluctance on the part of end-product plants to disperse, some pressure was brought to bear upon component suppliers. The dispersal of subcontracting plants was most noticeable in Tokyo, where some of the component producers began dispersal as early as February, although the movement did not gather momentum until after the heavy March raids. Efforts were also made to disperse 400 subcontracting plants from Osaka to locations outside the city.

A questionnaire submitted to 100 of the largest end-production industries in the Tokyo region revealed that most end-product plants assisted some of their component suppliers to disperse as early as February. The parent plants helped in selecting dispersal sites, arranging transportation, supplying equipment and underwriting expenses. The results of the dispersal of the smaller plants were uniformly disappointing. The main cause for the failure was alleged to be transportation difficulties. Also cited was the difficulty in maintaining contact with the parent companies who, themselves, were struggling against the cumulative effects

of shortages and air attacks. The few component plants which did manage to regain operating capacity in dispersed locations were prevented from exploiting it by lack of materials, labor troubles and changes in the demand for their products. For those reasons, the end-product producers considered the dispersal of their component suppliers unsuccessful.

Although the failure of the Japanese to consider, in time, the necessity for dispersal is only one chapter in the long history of political and economic mismanagement, a review of the steps which led to the "sitting-duck" vulnerability of Japanese war industry presents an object lesson which has significant implications for our own future planning.

The following paragraphs outline the progress of the Japanese dispersal program with special emphasis on the cities of Osaka and Kobe. Results of the special investigation of dispersal in those areas represent fairly well the general results of the national program.

Dispersal From 1942 to Late 1944

Prior to the fall of Saipan there were few advocates of dispersal among Japan's military and industrial leaders. Neither group realized the magnitude of the air attacks that were to come, and the military, especially, were unwilling to make the necessary sacrifices in production and in the expenditure of materials, effort, and labor which a thorough and effective dispersal program would have required. Nor did the experience of German industry under air attack modify thinking on this subject. As a result, from 1942 to late 1944, there was no official, planned dispersal program for Japanese industry. Such dispersal as did occur during this period was nearly always incidental to the rapid expansion of various war industries and was designed to utilize existing plant facilities as a matter of convenience and economy. Air raid protection was a secondary consideration.

In the Osaka area, where a careful study of dispersal was made, leading companies, including Mitsubishi Electric and the Sumitomo Metal Industry, took over the plants or less essential enterprises such as textile mills, breweries, and pottery works. Concurrently, the larger industries moved some shops into schools. In Osaka City alone, 22 schools were utilized as factories. As the war progressed and industry became dependent upon student labor, work-shops were actually set up in the schools, to profit more efficiently from the time and energies of the student workers. Of 282 primary and middle schools in Osaka City, 221 were utilized in this manner. In addition to removals to nonessential plants and to schools, a few large producers dispersed, in effect, by increasing the importance of plants which formerly had functioned as subassembly and parts suppliers. For example, the Kawasaki Aircraft Company which produced 17.4 percent of all combat aircraft in Japan in 1944 established aircraft engine and airframe plants at Akashi, west of Kobe. The Akashi engine plant, a final assembly installation, received parts from plants at nearby Futami and at Takatsuki. In the summer of 1944 the company started to convert both the Futami and Takatsuki plants to final assembly by moving some of Akashi's machine tools and other equipment to them. When the Akashi plant was hit in January 1945, 94 percent of its machine tools and other machinery was still serviceable and the company was able to move much of it to the other two plants, enabling engine production to continue. The Futami plant, as a result of this foresight, was able to produce 1,300 aircraft engines between January and August 1945. The Takatsuki plant barely started production and produced a total of only 13 engines.

It is not possible to make a wholly accurate analysis of the over-all dispersal which took place during this period. There was no general policy in effect, nor was there any government agency charged with supervising and maintaining records concerning that dispersal which did occur. Nevertheless, the records of individual companies during this period suggest the nature and magnitude of the dispersal and make possible certain valid conclusions.

Dispersal in Osaka City and region, in this period, was confined entirely to large producers, principally aircraft, electrical equipment, and machine tool concerns. Inasmuch as dispersal was undertaken on the initiative and responsibility of the individual companies, only the largest companies had the necessary materials, transportation, capital and labor to undertake plant movements. The Army and Navy were far more interested in maintaining production levels to the exclusion of all other considerations.

Movements were generally over relatively short distances. Transportation was largely confined to trucks and ox-carts, the latter being by far the more reliable. It took from two to four months before production was underway at the new sites.

The large companies which dispersed at this time, reported success. Mitsubishi Electric and Shimazu Engineering both stated that their programs were 100 percent completed. Kawasaki Aircraft, Kawanishi Aircraft, and Sumitomo Propeller, whose dispersal consisted of transferring final assemblies to existing subassembly and parts plants, were able to accomplish their plans with equal facility. Moreover, these rapid, short distance, expansion-dispersals in 1944 did not interfere with production. At this time all companies were producing at their highest yearly rates and losses from dispersal were readily absorbed.

The success of early dispersal suggests that had a general dispersal program been undertaken during this period, a great deal more could have been accomplished than in the period beginning in 1945 when shortages were more acute and air raids were in progress. The failure to disperse during this period, from 1942 to late 1944, represents a serious and basic error on the part of both Government and industry.

The 1945 Program

In late November and December of 1944, a few large companies in the Tokyo area were directed to disperse but it was not until 23 February 1945 that a definite decision was made by the government in Tokyo to disperse on a national basis.

On 12 March 1945 (3 days after the catastrophic 9 March area raid on Tokyo), the Central Counter Planning Headquarters of Production and Defense was organized in the Munitions Ministry to supervise and enforce dispersal of all war industry in Japan. It functioned through the regional offices of the Munitions Ministry.

Nationally, the organization planned to move certain major war industries to 1,575 dispersed plants, 1,191 of these to be located above ground, 132 semi-underground, and 252 underground. In addition, it planned to disperse thousands of small producers, on a local basis, through its regional offices. First priority was given the aircraft industry, including producers of engines, airframes, propellers, and aircraft ordnance. Second priority was given to producers of communications equipment, special steel, bearings, machine tools, chemicals, antiaircraft ordnance, special attack equipment such as torpedoes, and aviation gasoline.

The Home Islands were divided into six autonomous regions so that production could continue in the areas not immediately attacked in the event of Allied landings elsewhere in Japan. Within each region the local Munitions Ministry officials assigned a general area into which each company was to move, the choice of the exact site being left to the company. The Industrial Equipment Board of the Munitions Ministry was to purchase or lease the sites and provide subsidies for dispersal expenses. Although a few producers, such as the Osaka Arsenal, did actually receive their funds, this was the exception rather than the rule and most companies received only promises of future repayment. This added to the reluctance of many companies to move.

The dispersed plants were to be located on sites suitable for underground and semi-underground installations where necessary and, if possible, where some buildings were already in existence. The companies were to start production on a temporary basis in such buildings as were available until the permanent underground, or other installations were completed. They then were to move to the completed plants and convert the abandoned buildings into administrative and research offices and workers' quarters.

With respect to production, the Government estimated that losses of 20 percent would be average during the 6 months the program was underway. This estimate proved highly unrealistic. Estimates of individual companies were considerably higher and turned out to be far more accurate. For example, the Sumitomo Propeller Co., which produced 66 percent of all aircraft propellers in Japan, estimated dispersal of its four major plants would cut production as follows: Sakurajima plant 90 percent, Kanzaki plant 30 percent, Shizuoka plant 40 percent, Tsu plant 60 percent.

On 1 April 1945, the first national order was issued for the dispersal of first-priority factories. This was followed by a second order,

on 16 May 1945, for the dispersal of second-priority factories. In July 1945 a final national order was issued directing the dispersal of all war factories not previously included. Actually many of the important aircraft, ordnance, communications and electrical equipment producers were unofficially informed before the directives were issued, which explains why some companies were already in the process of moving when the orders were announced.

It is difficult to estimate how much of the 1945 dispersal plan was realized. The branch offices of the Munitions Ministry maintained few records and the accuracy of these is open to serious question. Companies were reluctant to report their own noncompliance and other failures and uniformly over-estimated how much they had accomplished. If machinery was moved to a new site but not installed or was simply enroute, it was reported as "dispersed." Similarly, if employees were no longer at the parent plant, or simply had left their homes because of the air raids, they were reported as "dispersed."

Of 400 small companies in Osaka City which were ordered to disperse, 183 reported dispersal in progress and varying degrees of completion, ranging from 10 percent to a few who reported 100 percent. These smaller firms claimed to have dispersed a total of 13,043 machines and about 18,000 employees. The remaining 217 companies reported no dispersal accomplished at the war's end. No over-all data are available as to the number of dispersed plants that actually began production at the dispersed sites, but, from individual cases, an estimate of 15 percent to 20 percent would be generous. Those few plants that were able to start production at dispersed sites were unable to regain anything approaching their old rates of production. In effect, dispersal of small plants from Osaka City was a failure. Fifty-four point two percent of the plants accomplished no dispersal at all despite orders to do so, and of the 45.8 percent which did report some activity, only a fraction were able to start production at their new sites. Always rates of production were substantially lower than at the old sites. Small plant dispersal from Osaka City was typical of that from other major cities. The net results were to increase the difficulties of plants for which they were subcontracting; to decrease the total number of machines in production, thus decreasing over-all production.

The failure of dispersal of large plants in the Osaka region was less marked, but had the same net effects upon production. The Kawasaki Aircraft Co., which earlier had enjoyed fair success by converting its subassembly plants and parts producers to final assembly plants, began a further dispersal early in 1945. This time it planned to disperse its Kagamigahara airframe assembly plant to three production lines running through a series of old mills and forest huts. It also planned to disperse its Futami and Takatsuki engine plants, utilizing tunnels and old mines for shops. At the time the war ended, 1,200,000 square feet out of a planned 1,900,000 square feet of new construction had been completed and the company considered its dispersal 60 percent complete. However, at the war's end, it had not yet started production at the new sites.

The significant effects of air attacks on dispersal are illustrated by the case of the Naruo plant of Kawanishi Aircraft, which produced 3.1 percent of all combat airframes. In the first months of 1945, the company began to disperse its Naruo plant. In April 1945, the company built 72 planes, but in May 1945 production fell to 61; the company attributing the drop entirely to dispersal. On 9 June 1945 the Naruo plant was hit for the first time, and the company immediately accelerated its dispersal. The combined effects of dispersal and the air attacks from June 1945 to August 1945 held production down to 23 planes for the period, against a planned 320.

The records of other representative large firms indicate similar results. Mitsubishi Electric was able to accomplish 35.9 percent of its planned dispersal. The Osaka Arsenal planned to disperse only 4 to 5 percent of its total capacity because of the nature of its heavy equipment but had completed only 25 percent of this by the end of the war. Ten antiaircraft ordnance companies under the control of the Osaka Arsenal were able to effect an average of 56.5 percent of planned dispersal but production averaged only 17.5 percent of that planned at the new installations. Thirty other companies engaged in making fuses, shells, and various aircraft and ordnance parts under the direction of the Osaka Arsenal accomplished

an average of 42.4 percent of planned dispersal and production averaged 30.3 percent of that planned.

Dispersal undertaken prior to late 1944 was successful in the main because it was on a small scale, little new construction was necessary, the distances involved were relatively short, and the scarcity of materials was not as great as in the closing months of the war. In 1945 the picture had changed. First, there were extreme shortages of transportation, labor and materials, all of which were intensified by air attacks; second, there were basic errors in dispersal policy, planning, and administration. Practically all the dispersing companies in Osaka City and region listed transportation as their single greatest bottleneck. Motor transport was already overtaxed when dispersal began. Trucks, generally, were in disrepair and poorly maintained. Ox and horse carts were more reliable but not suitable for long hauls; a trip of 16 km requiring from 12 to 24 hours. Transportation of equipment and materials from factories to railroad facilities and again from the railroads to the new sites presented one of the most difficult problems. Moreover, roads at the new sites often proved unsatisfactory for heavy transportation.

The railroads were overburdened. Breakdowns were frequent and repairs became increasingly difficult and time consuming due to a shortage of skilled labor. Machinery and materials frequently were exposed for days or weeks to the weather while awaiting rail transportation, often resulting in extensive damage to valuable equipment. The important Sumitomo Propeller Co. estimated that it could have completed its dispersal by August 1945 instead of by December 1945 (which it anticipated) if proper transportation had been available.

Labor, under the increasing pressure of wartime conditions, presented a critical problem to dispersal movements. The workers had little desire to move from their homes and families to new areas where quarters and food were even more difficult to procure than in the cities. Increased absenteeism, resulting from fear of raids, evacuations, and fatigue, made it difficult to maintain the sagging production levels at the home plants, let alone to allow for the diversion of part of this labor force for dispersal. Some additional labor was available from the conscription pools, but of the type which hindered rather than helped the operations. The Armed Forces, Munitions Ministry and an association of leading contractors, who were supposed to provide labor, provided only negligible assistance.

The third drawback to dispersal was the scarcity of materials—principally construction materials. Cement was very scarce and while timber was plentiful there was a shortage of personnel to process it into lumber. The shortage of electrical equipment, such as wiring and transformers for installation in new plants, also impeded dispersal. Destruction of a large part of this industry in the Tokyo raids was the primary cause of this shortage. A few companies such as the Sumitomo Communications Equipment Co., which had delicate equipment to move, were unable to procure an adequate supply of packing and crating materials.

In terms of policy and planning, it is indisputable that dispersal was undertaken too late. The reluctance of the Armed Forces and the major producers to sacrifice production for dispersal operations continued until the time when the air attacks forced action. Despite the air attacks, there were still many companies who did not support the government's policy. Such companies, when directed to disperse a certain percentage of their production equipment, moved their unessential equipment, continuing production with their most important equipment and thereby defeating the purpose of dispersal.

The administration of the program was bad. Basically, there was no coordinated priorities system. As a result, the entire aircraft industry attempted to disperse at once with innumerable plants competing for transportation, materials, and government aid. While the aircraft industry was trying to move, the second national directive was sent out and other priority companies began their dispersal. This succeeded only in adding to the confusion. Supervision and enforcement of orders were ineffectual. While the Munitions Ministry and its regional offices had nominal authority, in the case of the large companies it meant little as they were inclined to follow the directions of the branch of the service from which they received such aid as was available. Each of the

armed forces, in turn, embarked on a program of favoring its own most important producers and protecting its own production. This rivalry seriously damaged the authority of the Munitions Ministry and made a shambles of the priority system. Finally, planning was unrealistic and few leaders seemed to understand the magnitude of dislocation which dispersal would cause, particularly in view of the increasing urban area raids. Estimates of production losses due to dispersal were always highly optimistic, and few companies took the government's figures seriously.

The end of the war found the dispersal program in the major cities still under way but falling further and further behind in its schedule, increasingly hampered by air attacks on the urban areas. The net result of undertaking dispersal in 1945 was to further reduce the productive capacity of industry. In view of the magnitude of the urban area raids and the direct and indirect damage resulting from them, dispersal could not have been successfully concluded, even if the war had continued another year. The basic error was one of timing, and once the program was undertaken this error was compounded by the effect of the air raids and the maladministration of the few resources still remaining.

TABLE 30.—*Pre-raid and Post-raid Data—Japanese Urban Areas*

	Prerad Data						Bomb tonnage					Post raid data						
	Population 1944 (in 1,000's)	Percent 66 cities	Percent all cities	Percent national population	Built-up area	Percent 66 cities	High explosive	Incendiary bombs	Fragmentation	Total	Percent dropped in urban attacks	Population after raids (in 1,000's 1 Nov. 1945)	Number Killed	Number Injured	Number Dehoused (in 1,000's)	Area destroyed	Percent pre raid	Buildings destroyed
					Square miles											*square miles*		
Tokyo	6,578	31.5	23.8	9.0	110.80	27.0	1,586	12,393	24	14,003	68	2,777	93,056	72,840	2,891	56.30	50.8	727,655
Osaka	2,843	13.6	10.5	3.8	59.80	14.5	3,431	7,654	131	11,216	68	1,103	9,915	31,088	1,099	15.54	26.0	334,201
Nagoya	1,349	6.5	4.8	1.8	39.70	9.7	4,049	10,603	18	14,670	68	508	8,152	10,005	495	12.37	31.2	123,179
Yokohama	1,035	5.0	3.6	1.4	20.20	5.4	20	2,580	1	2,601	100	625	4,832	17,968	400	8.90	44.0	98,970
Kobe	919	4.4	3.3	1.3	15.70	3.8	516	5,491	135	6,142	89	379	6,887	16,167	443	8.75	56.0	115,895
Kawasaki	381	1.8	1.4	.5	11.80	2.7	2,594	1,098	20	3,712	30	180	1,520	8,759	155	3.70	32.8	35,114
Hiroshima	343	1.6	1.3	.5	6.90	1.7	7	0	0	7	(1)	137	71,379	68,023	200	4.70	68.5	61,825
Kure	339	1.6	1.2	.5	3.26	.8	885	1,082	19	1,986	55	152	1,967	702	12	1.30	40.0	22,306
Fukuoka	326	1.5	1.2	.4	6.56	1.6	0	1,526	0	1,526	100	252	953	1,079	57	1.37	21.5	14,104
Nagasaki	272	1.3	1.0	.4	3.30	.8	309	53	20	382	(1)	143	13,294	29,739	121	1.45	43.9	12,881
Amagasaki	270	1.3	1.0	.4	6.90	1.7	1,856	1,773	0	3,629	49	153	411	976	44	.76	11.0	11,155
Sakai	221	1.1	.8	.3	2.32	.6	0	779	0	779	100	168	1,411	1,501	57	1.02	44.0	14,751
Kumamoto	212	1.0	.8	.3	4.80	1.2	110	1,491	22	1,623	69	181	583	1,310	47	1.00	21.0	11,486
Shizuoka	212	1.0	.8	.3	3.46	.8	349	924	4	1,277	77	162	1,952	6,770	127	2.28	66.0	31,355
Shimonoseki	207	1.0	.8	.3	1.42	.3	2	837	0	839	100	156	241	505	41	.51	36.0	9,224
Wakayama	206	1.0	.7	.3	4.00	1.0	36	854	0	890	88	148	1,625	4,675	125	2.10	52.5	25,353
Omuta	180	.9	.7	.2	5.37	1.3	68	1,735	0	1,803	95	128	780	1,571	55	2.27	42.5	11,083
Gifu	176	.8	.6	.2	2.60	.6	0	898	0	898	100	143	818	1,059	0	1.93	74.0	20,303
Hamamatsu	163	.8	.6	.2	4.24	1.0	2,032	1,056	3	3,091	29	81	2,947	1,702	124	2.97	70.0	23,810
Okayama	162	.8	.6	.2	3.38	.8	4	982	0	986	100	92	1,745	975	105	2.13	63.0	25,203
Moji	135	.6	.5	.2	1.12	.3	1	626	0	627	100	94	161	260	20	.33	26.9	3,891
Nishinomiya	127	.6	.5	.2	9.46	2.3	34	1,923	47	2,004	100	91	749	442	56	3.50	37.0	0
Chiba	111	.5	.4	.2	1.98	.5	147	860	33	1,040	85	97	856	1,205	41	.86	43.4	8,102
Himeji	104	.5	.4	.1	1.92	.5	351	768	0	1,119	69	83	514	510	55	1.47	71.7	11,513
Oita	82	.4	.3	.1	2.20	.5	21	824	0	845	94	66	177	270	13	.55	25.2	2,916
Okazaki	80	.4	.3	.1	.95	.2	0	851	0	851	100	76	151	129	32	.65	68.0	8,257
Akashi	79	.4	.3	.1	1.42	.3	642	975	0	1,617	60	46	1,421	171	58	.90	63.5	10,966
Hachioji	78	.4	.3	.1	1.40	.3	0	1,594	0	1,594	100	63	290	70	74	1.12	80.0	12,895
Shimizu	78	.4	.3	.1	1.41	.3	59	1,042	0	1,101	91	60	351	403	33	.74	52.0	8,454
Ichinomiya	66	.3	.2	.09	1.28	.3	0	1,640	0	1,640	100	58	648	682	41	.97	76.0	10,468
Ogaki	57	.3	.2	.08	1.20	.3	5	659	0	664	100	51	61	124	0	.48	40.0	4,762
Hiratsuka	50	.2	.2	.07	2.35	.6	46	1,163	2	1,211	96	30	228	292	31	1.04	44.2	7,217
Kuwana	43	.2	.2	.06	.82	.2	818	693	0	1,511	100	29	421	372	0	.63	77.0	6,223
Tsuruga	31	.1	.1	.04	1.13	.3	11	683	0	694	99	23	161	340	21	.77	68.0	4,098

TABLE 30 (2)

	Preraid Data						Bomb tonnage					Post raid data						
	Population 1944 (in 1,000's)	Percent 66 cities	Percent all cities	Percent national population	Built-up area	Percent 66 cities	High explosive	Incendiary bombs	Fragmentation	Total	Percent dropped in urban attacks	Population after raids (in 1,000's 1 Nov. 1945)	Number Killed	Number injured	Number Dehoused (in 1,000's)	Area destroyed	Percent pre raid	Buildings destroyed
					square miles											*square miles*		
Saseho	265	1.2	.9	.4	2.34	.6	16	1,064	1	1,081	98	148	1,000	497	65	.97	42.0	12,825
Sendai	264	1.2	.9	.4	4.53	1.1	27	1,018	0	1,045	87	238	602	1,687	87	1.22	27.0	11,642
Yawata	253	1.1	.9	.3	5.78	1.3	205	1,302	0	1,507	86	151	1,996	956	71	1.22	21.0	NA
Kagoshima	190	.9	.7	.2	4.87	1.2	524	964	0	1,488	54	190	NA	NA	NA	2.15	44.1	NA
Toyama	161	.8	.6	.2	1.88	.5	20	1,472	0	1,492	98	101	2,149	3,787	11	1.87	99.5	22,766
Toyohashi	141	.7	.5	.2	3.30	.8	73	958	0	1,031	93	106	576	796	75	1.70	52.0	19,787
Kochi	137	.7	.5	.2	1.90	.5	29	1,079	4	1,112	95	112	447	429	43	.92	48.0	12,064
Ube	124	.6	.5	.2	1.80	.4	1,595	722	0	2,317	31	83	336	591	23	.42	23.0	5,168
Matsuyama	121	.6	.4	.2	1.67	.4	0	896	0	896	100	117	380	761	67	1.22	73.0	13,285
Tokushima	117	.6	.4	.2	2.30	.6	43	1,092	0	1,135	93	81	1,070	832	73	1.70	74.0	18,153
Yokkaichi	116	.6	.4	.2	3.51	.9	763	572	0	1,335	42	95	834	1,641	13	1.23	35.0	12,491
Takamatsu	107	.5	.4	.1	1.80	.4	24	809	0	833	100	73	1,273	880	73	1.40	78.0	15,956
Kofu	106	.5	.4	.1	2.00	.5	5	971	0	976	100	83	832	1,262	86	1.30	65.0	18,099
Aomori	100	.5	.4	.1	2.08	.5	149	547	0	696	69	57	1,018	255	72	.73	35.0	15,310
Fukui	100	.5	.4	.1	1.90	.5	0	961	0	961	100	46	1,584	1,556	92	1.61	84.8	21,584
Utsunomiya	91	.4	.3	.1	2.75	.7	2	803	0	805	100	81	570	1,189	48	.94	34.2	10,985
Hitachi	85	.4	.3	.1	1.38	.3	5	971	0	976	100	39	1,019	424		1.08	78.2	16,093
Maebashi	85	.4	.3	.1	2.34	.6	15	691	18	724	96	80	471	168	54	1.00	42.0	11,434
Tsu	76	.4	.3	.1	1.47	.4	780	730	0	1,510	86	59	1,498	919	17	1.18	81.0	11,657
Noheoka	73	.3	.3	.1	1.43	.3	171	853	0	1024	81	73	284	293	15	.52	36.0	3,769
Nagaoka	67	.3	.2	.09	2.03	.5	4	925	0	929	100	38	881	1,908	50	1.33	65.5	10,302
Mito	66	.3	.2	.09	2.60	.6	2	1,145	0	1,147	100	49	205	662	43	1.70	65.0	9,781
Ujiyamada	65	.3	.2	.09	.93	.2	59	773	0	832	88	61	102	228	5	.36	39.0	4,943
Chosi	63	.3	.2	.09	1.12	.3	6	662	31	699	90	60	394	248	25	.48	43.0	5,017
Numazu	58	.3	.2	.08	1.40	.3	22	1,044	1	1,067	97	77	268	530	45	1.25	89.5	9,903
Fukuyama	57	.3	.2	.08	1.20	.3	0	556	0	556	100	49	275	393	12	.88	73.3	10,154
Imabari	54	.3	.2	.07	.97	.2	85	490	12	587	84	39	242	407	35	.73	76.0	8,099
Kumagaya	52	.3	.2	.07	.60	.2	12	581	0	593	98	57	242	614	3	.27	45.0	5,797
Uwajima	51	.3	.2	.07	1.00	.2	21	1,079	0	1,110	96	40	248	279	21	.52	52.0	6,315
Saga	49	.2	.2	.07	1.20	.3	18	439	12	469	94	(49)	25	26	1	.00	00.0	173
Tokuyama	43	.2	.2	.06	1.27	.3	556	718	34	1308	57	71	942	668	17	.68	53.5	4,327
Isezaki	40	.2	.2	.05	1.00	.2	0	614		614	100	42	9	0	8	.17	17.0	1,746
Total for 66 cities bombed	20,892	100	75.9	28.55	412.0	100.3	25,220	95,621	592	121,433		11,279	252,769	307,660	8,323	177.79	46	2,157,83

[1] Atomic bomb.

NOTE. In compiling these tables, figures from the investigations conducted by the Urban Areas Division have been used wherever possible, as they were in most cases, collected and checked at source. It should be observed that certain of the entries, particularly for *killed, injured, buildings destroyed* and *persons dehoused* may be slightly at variance with those submitted by other divisions of the Survey. It was in these categories that the Japanese were themselves most at variance. The differences, however, are not serious, and in any case where a definite question arose, the limiting factors were duly considered and a plausible choice made. Attention is specifically called to the following. *Bomb tonnage* represents total weight of bombs incendiary explosive, high explosive, and fragmentation, dropped over urban areas. figures for *built-up areas* are taken from the Twentieth Air Force records. *post raid population* figures are taken from the national census of November 1945, and *buildings destroyed* are listed in a rough, comprehensive figure comprising residential, industrial and others, the only figure which was uniformly available

NA—Not available.

APPENDIX A

Operational Aspects of the Air Offensive Against Japanese Cities

The initial attacks against the Japanese homeland by land-based aircraft were executed by crews of the India-based Twentieth Bomber Command, staging on airfields in China. Because of the logistical problems involved, the long distances covered, the limited bomb loads carried, and the inadequate number of aircraft employed, the results of these operations were not significant.

During the summer months of 1944, the Marianas were wrested from the Japanese and airfields for the B–29 operations were made available approximately 1,500 miles from the large industrial center of Tokyo. On 24 November, the Twenty-first Bomber Command initiated its operations against the Japanese aircraft industry by sending 111 aircraft from Saipan, to attack the extensive Nakajima Aircraft Works at Musahino, near Tokyo.

The next $3\frac{1}{2}$ months were devoted to an attack on the aircraft industry. This period also served the purpose of tactical experimentation to determine the best methods of utilizing the operational capabilities of the B–29 in an air offensive against Japan. Between 24 November 1944 and 9 March 1945, apart from tactical missions against Iwo Jima, 20 major missions were flown by the Mariana-based B–29s, 16 of them against priority targets in the aircraft industry, and 4 against the urban areas of Tokyo, Nagoya, and Kobe. These attacks were made from altitudes of 27,000 to 30,000 feet by planes flying in squadron formations. High gas consumption, required to assemble and climb to bombing altitude, limited the bomb load to about 3 tons. In the 4 area attacks, which were largely of an experimental nature, a total of 609 tons of bombs, predominately high-explosive, were dropped on Tokyo on 2 separate missions; 251 tons, principally incendiary, were released over Kobe, while the city of Nagoya, as a secondary target, received 207 tons when a primary precision target was obscured by cloud cover.

These early operations afforded opportunity to discover and correct the problems that were encountered by the flying crews in this theatre of war. Poor weather rendered flying hazardous and bombing inaccurate. Severe weather fronts interfered with air navigation and cloud formations often totally obscured the target. Of 16 attacks executed at high altitudes during the early days of operations, 4 completely failed to bomb the primary target, 7 bombed with three-quarters of the airborne force, and 5 with less than three-quarters of the mission force. Even during periods of good visibility, frequently strong winds at high altitudes interfered considerably with bombing accuracy.

Although high-altitude flying did afford some protection to B–29s from fighter planes and antiaircraft, the Japanese resistance to the air attack was, at the outset, both active and effective. A peak was reached in January when 5.7 percent of all B–29s airborne were lost to the enemy and to unknown causes. From January on, enemy fighter reaction declined and flak became the principal cause of losses.

When operations were initiated from the Marianas in November 1944, only 119 aircraft were available, and at the beginning of March 1945 the strength was still under 400. The limited number of aircraft and crews greatly hampered flexibility in tactics, and made it difficult to concentrate many airplanes on a single target or allow a dispersal of force over several targets. Poor airfield facilities, lack of maintenance equipment and supplies, and maintenance difficulties inducted by high altitude operations made possible only 3.3 sorties per month per aircraft assigned in November 1944, compared to 7.1 achieved in July 1945.

By the end of March, many of the operational problems had been solved. The crews and ground personnel had gained in experience; Loran and other new navigational aids had been introduced; the logistical support required to sustain B–29 efforts was improved; airplanes were arriving in the Marianas in increasing numbers; and, certain changes in bombing tactics and strategy had been adopted.

The goal of the Command during the early months of operations, that is, late November 1944 to early March 1945, had been to destroy the principal installations of the Japanese aircraft industry by high-level, daylight precision bombing. The results of the early precision attacks fell short of expectations. Similarly, three experimental high-altitude daylight incendiary attacks executed against urban industrial areas met with limited success.

On the night of March 9-10, a new type of low-altitude incendiary bombing attack was directed against the Tokyo urban area. The results of the experiment proved so gratifying that the bombing program was expanded to incorporate this new technique.

The Tokyo raid was carried out by individual aircraft bombing at an average altitude of 7,050 feet. The advantages of flying at such low altitude were numerous: (a) the high gas consumption required to assemble for formation and to climb to bombing altitude was reduced and the bomb load was correspondingly increased; (b) strain on engines and other parts of the aircraft was lessened, and greater effectiveness and better performance cut down the number of losses attributable to malfunction of equipment; (c) cloud conditions were fewer at low altitudes and winds not as strong as those prevailing at altitudes above 30,000 feet.

During the ten days following 9 March, and including the Tokyo raid of that date, 5 attacks were carried out against 4 major Japanese cities. A total of 1,595 B–29 sorties dispatched on these raids dropped 9,365 tons of incendiary bombs from altitudes averaging 7,000 feet, destroying 32 square miles of densely populated and highly industrialized areas. In these repeated attacks by the maximum force, losses from antiaircraft and enemy fighters were below expectations.

The quantity and types of incendiary bombs required for operations were often lacking, and for a time the number of incendiary missions was largely determined by stocks on hand. Availability rather than preference dictated the bomb loading. On several occasions incendiary bombs were unloaded from ships in the harbor and transported directly to the aircraft hardstands for loading into the airplanes. After June the total supplies of incendiaries sufficed, though the desired types were still not available in quantities needed. A lack of high explosives was felt principally in the 4,000 pound type. Other high explosives were available in the States, and had generally been ordered in sufficient quantities and types. Shortages of tail fins, fuses, adapters, and shackles also hindered operations.

The Command did not completely change its tactics in favor of low level urban attacks, but continued to send medium and high-level precision missions whenever the weather permitted. Daytime precision raids were thus executed from lower bombing altitudes, 12,000 to 20,000 feet, thereby lessening the adverse effects of wind and weather, increasing bombing accuracy and making possible greater bomb loads, and reducing the number of noneffective aircraft.

On May 14 the first medium-altitude day mission against a major urban industrial area was executed against northern Nagoya. Of 529 aircraft dispatched only 12 were lost and 3.2 square miles of the urban areas destroyed. Thereafter, daylight visual urban attacks were made on remaining undamaged sections of cities which, at night, had been difficult to isolate by radar.

The size of the force striking from the Marianas was continually increasing. During March the 314th Wing began operations in conjunction with the 73rd and 313th Wings. During March and April aircraft of the 58th Wing, formerly based in India, began to arrive on Tinian, and in late May the 315th Wing aircraft began to arrive on Guam. Air strength gradually increased from 119 on 24 November 1944 to 385 on March 1945, and to 1,020 on 14 August 1945. Greater strength made possible a distribution of force over several targets on the same day, lessening the danger from concentrated enemy aircraft attacks and increasing the effectiveness of the force.

With the capture of Iwo Jima in March 1945 and the completion of the long airstrip on that island, the B–29s not only had an emergency landing base but were also provided with a staging base for operations against targets in northern Japan and an operating airfield for escorting fighters. The fuel reserve could be

even further reduced and bomb tonnage increased, since, henceforth, in cases of emergency, a stop could be made at Iwo Jima.

By the middle of June, the target value of the principal urban areas had been reduced to such an extent that the command was confronted with the necessity of extending its program to smaller cities, or considering a new target system which could be attacked under similar operational conditions. The early success of the program appeared to warrant its extension. It was conceded that the direct loss of important industrial floor space in the smaller cities would be proportionately far less per ton of bombs than had resulted in the larger urban concentrations, but the widespread disruption of the economy caused by such attacks would complement substantially the effects of the precision program, since many small component plants would be destroyed, the dispersal efforts of larger industries curtailed, and the labor force demoralized. The Theater Command was of the opinion that the impact of this program on the economic and social structure would seriously affect the enemy's desire to continue the war.

From 17 June until the end of the war, a total of 57 urban areas were attacked in 60 raids. In July alone 36 urban targets were heavily bombed, and this accelerated scale of effort was maintained through the first fourteen days of August when 10 new urban areas were attacked, and 2 cities received repeat attacks. Throughout the June-August period of intensive area strikes, precision attacks continued against objectives which, except for a few in Nagoya, Tokyo, Osaka and Amagasaki, were located either in rural areas or in smaller towns.

APPENDIX B

THE REPORT ON THE EFFECTS OF THE URBAN AREA BOMBING ON JAPANESE WARTIME ECONOMY

By Prof. Dr. C. Maiide and Associates, Tokyo Imperial University, December 23, 1945

In the course of its investigation in Japan, the Survey interrogated many different sources in an effort to judge Japanese opinion on the effects of the urban area attacks. One report, by the combined faculties of Tokyo Imperial University, is reproduced in its entirety (with some grammatical corrections), as it was submitted to the Survey on 23 December 1945.

Preliminary Note to the Report

The following Report is a result of the Scientific Research of the members of the Committee on "The Effects of the Urban Area Bombing on Japanese Wartime Economy," which was conducted by our Faculty under the order of the President of the University.

Our report is rather abstract and not statistical enough, but this does not mean that it is merely the product of dogmatic judgment. On the contrary, it is a product of statistical survey and scientific research by the following committee. In this connection, we feel it may be necessary to explain the method by which the research was made and the course of the studies which we undertook.

At first, in order to study the important and extensive problems which were raised in your letter, we formed the above mentioned committee which consisted of the following persons: Chairman, Prof. C. Maiide (Dean of the Faculty,), Prof. T. Arisawa (Prof. of Statistics), Prof. Y. Wakimura (Commerce and Industry), Prof. M. Yamada (Agriculture), Prof. N. Yanagawa (Theory of Distribution), Prof. F. Kitayama (Credit and Finance), Prof. K. Okochi Labour and Social Problems), Prof. S. Takamiya (Business Management), Assistant Professor G. Konno (Transportation), Asst. Prof. T. Yasuhira (Industry), Asst. Prof. N. Yokeno (Economic Geography), Asst. Prof. H. Furuya (Economic Theory), Instructor Mr. Y. Ando; research members: Mr. H. Toyoda, Mr. Y. Oishi, Mr. S. Ujihara, Mr. S. Shioda, Mr. H. Sato, Mr. K. Ishihara.

The work of the committee was to gather necessary statistics and data to explain the "Effect of the Strategic Bombing of our Wartime Economy" in regard to the productive life of the nation.

Secondly, we conducted hearings to learn the opinions of well-informed officials and also those of the people who experienced the most terrible bombing. Such ministries as the Commerce and Industry Ministry, Agriculture and Forestry Ministry, Transportation Ministry and Communications Board, and manufacturing companies such as Mitsubishi Heavy Industrial Inc. (Mutsubishi Jyukogyo K.K.), Nippon Steel Pipe Producing Inc. (Nippon Kokan K.K.), Fuji Electrical Machinery Co., Ltd., Tokyo Shibaura Denki K.K., Ishikawajima Shipbuilding, Inc. (Ishikawajima Zosen K.K.), "Seikosha" Optical and Precise Machine Maker (Seikosha), supplied us with necessary statistics and suggestive opinion. Also in this connection we are obliged to the Tokyo Municipal Office and Chiba Municipal Office. This method was rather helpful to our study, for it was often difficult to obtain most recent materials due to the war ravage.

Thirdly, the Committee not only testified statistics and made a scientific research by an inductive method, using statistic and data papers, but also met in conference seven times to reach its conclusions.

I. Before the first heavy strategical air raid started, the munitions production of Japan had already been thrown into a desperate condition by the effective ocean blockade by the Allied forces, especially by the United States submarine activities. [1]

On account of the successful blockade and eventually the isolation of Japan proper, the transportation of war materials from the southern regions and the continent had to be stopped. It was indeed a death blow to the war economy of Japan which had been importing almost every item of material from abroad for the use of its home munitions industry, namely—iron, ore, petroleum, bauxite, industrial salt, rubber, etc. [2]

II. The strategical bombing by B-29s, along with attacks by medium and small sized planes of the United Sates task forces based on the Volcano Island and the Ryukyu Islands, destroyed many cities and factories, revealing the weakness of Japan's war economy, especially the munitions production, which had already suffered greatly since the latter half of 1944, and thus finally inflicted a death blow on the productive capacity.

Above all, owing to the offensive conducted by the U. S. Air Force aiming mainly at the destruction of munitions factories, which had regionally been concentrated in great cities not sufficiently equipped with antiaircraft arms, great losses were sustained. How fatal and extensive was the damage and devastation wrought by air attacks upon Japan's wartime productive activities is explained below.

(*a*) Destruction of factory equipment and plants, machines, generating plants, power transmission facilities and raw material reserves resulted in the stoppage or decrease of production.

(*b*) Wreckage of many homes, stoppage of communications and confusion of family life due to evacuation of raid victims, increased considerably the number of absentee employees. The physical and mental overwork owing to the frequent attacks and the shortage of foodstuffs, also decreased productive capacity of labor. Moreover, the deaths and quitting of engineers and skilled workers had much to do with the decrease of Japan's war production.

(*c*) The cutting off of means of communication, confusion of postal and telegraphic services, destruction of railways, disorder of express business, delay in delivery of manufactured weapons and war materials to the Government and the decrease of attendants, resulted in the deterioration of business efficiency and paralyzed the Government's administrative capacity for pushing on productive plans.

(*e*) Indirect effects of air raids were also great in the sense that the materials, manpower and transportation capacities, which should have been concentrated on the munitions production, were shifted to the repairing of damaged establishments, installation of air defense equipment and also for evacuation purposes. In other words, the main reasons that greatly lowered the productive efficiency were the removal of plants to safer places in anticipation of air raids, frequent interruption of working process with the issuance of air alerts, shifting of laborers to air defence services and the difficulty of continuing outdoor works and light-emitting operations, as in the case of melting furnaces, because of observance of air-raid warnings.

III. As mentioned above, the strategical bombing of the U. S. Air Force inflicted heavy damage on the munitions production in Japan. Particularly intensive was the damage to essential industries, including the aircraft industry (engine factory, parts and accessory producing factories, which greatly relied on

[1] According to the data of the economic mobilization plan which can be regarded as an index-number to the economic strength of our country, Japan was forced to the verge of collapse in the third quarter of 1944. This circumstance must be concomitant with the fall of the Marianas. As we lost those islands due to the successive defeats sustained on the Aleutians, the Gilbert Groups and the Solomon Islands, Japanese shipping tonnage decreased rapidly and, furthermore, Japan's efficiency of navigation greatly deteriorated because of the increase of sunken tonnage due to the intensive United States submarine activities and the diversion of Japan's ships to the strategical transportation.

[2] Although every material here mentioned is indispensable to the munitions production, the scarcity of oil was especially fatal to Japan's military strategy because the air activities and naval operations as well were conditioned by the quantity of oil.

subcontractor's factories, were massed in urban area), special steel, liquid fuel, nitrogen, rubber and weapons industries. Furthermore, it was impossible to repair the damage systematically and speedily because Japan's economic capacity had been almost exhausted. In view of the fact that Japan's productive activities were destroyed in large extent, the manufacturing industries of war material were confronted with many difficulties. For example, due to Japan's quantitatively and qualitatively inferior machine tool and automobile industries, the replacement of damaged machines and vehicles was extremely difficult. Thus, as a result of the widespread and severe wreckage of all fields of Japanese economy, the normal circular process of wartime production, centering around the munitions industries, was on the verge of collapse. Eventually, the last hope of the speedy and large-scale production of special attack arms and others in anticipation of the conversion of the mainland into a battlefield of decisive battles, became hopeless. Preparatory for decisive fighting on the mainland, plans for the establishment of a regional autarchy and self-defensive structure were underway, but the realization of such plans become impossible with the intensification of the bombing attacks.

IV. As to the effect of the strategic bombing on the daily economic life of the urban populace, the effects of incendiary attacks against the cities and towns were so severe that casualties amounted to a great number and many houses, much clothing, foodstuffs and other necessities were destroyed on a large scale. Impossibilities of recovery from damages, insufficiency of relief materials, and shortage or unfitness of the Government's policies to meet these demands made the sufferers' living extremely difficult. Moreover, traffic was thrown into disorder because streets and roads became too crowded with air-raid refugees, evacuees and their baggage. Of course the confusion of transportation was aggravated, owing to devastation by air raids. This delayed the flow of necessities into the cities, and inefficiency of the functioning of the rationing system aggravated the people's concern over the supply of foodstuffs. As air-raid alarms were issued so often, day and night, the people felt incessant unrest. The payment of war insurance and drawing of deposits accelerated inflation. Black market transactions became rampant. The people's morality and regard to their economic life, became more degraded. In this way, city life as a whole was paralyzed. Even the minimum standard of living could not maintain its ground.

V. The effect of the strategic bombing on the people's fighting morale cannot be underestimated. Before the severe air raids started, the public in general, who were hoodwinked by the secret policy of the Government, were not acquainted with the actual phases of the war and the real condition of the country's potenialities, especially with the deplorable condition of munitions industries. They believed in the propaganda stories concocted by the Government, and seemed to be resolved to fight to the last. However, there is no denying that with the aggravation of difficulties in the people's daily lives, following the progress of the war situation, particularly with the shifting of the attacks from cities to local districts, the people gradually became concerned over the future of the war. In consequence, their fighting morale was weakened. However, as a greater part of the people still indulged in wishful thinking as to the decisive battles in Japan proper, they were yet determined to carry on to the last. On the other hand, the war leaders, confronted with the complete destruction of the industrial centers of Japan by the strategical bombing, belatedly realized the great difference of production capacity between the United States and Japan and came to realize the impossibility of carrying on any longer. Though there were many different views, the majority of leaders entirely lost heart to continue hostilities. Particularly, the debut of atomic bombs in the Pacific war theater was decisive.

VI. The above-mentioned arguments can be summarized as follows: The Japanese economy, which had already numberless contradictory elements, due to the prolongation of hostilities, confronted a deadlock following the ocean blockade. In addition to that, the large-scale strategic bombing completely shattered the foundation of Japan's economy, particularly the munitions production, revealing its inconsistency and weakness, and finally brought about its inevitable collapse. Even though, at the last phase of the war, the deplorable degradation of Japan's productive capacity was not yet revealed in the production index num-

ber, there is no denying, when viewed objectively, that Japan's munitions production was in a desperate condition due to the constant bombing attacks.

Had the war continued longer and the strategic bombing, particularly the atomic bombing been repeated, Japan's munitions production would have been completely destroyed. Had the attacks by the U. S. Air Force begun earlier and been systematically conducted, first against the factories of critical raw materials, then against those of munitions production and had been repeated successively against the same cities without interval, the effect of attacks would have been greater and speedier.

The mines layed by planes in the last period of the war almost disrupted water transportation across the strait between Moji and Shimonoseki and in the Inland Sea of Seto, throwing the water transportation over the Sea of Japan into utter confusion. Thus, in fact, the communication between the Japanese mainland and the China Continent was disrupted, and thus the dreams of the Japan-Manchuria-China block were brought to naught. Furthermore, due to the attacks by deck-borne aircraft against the water traffic between Hakodate and Aomori, the transportation activities between Hokkaido and Japan proper fell into confusion, and fatal effects were brought upon the Japanese economy.

The assaults by small-sized aircraft side by side with the great earthquake in the Tokai District and ship bombardments, dealt considerable damage to the munitions production and at the same time caused confusion to transportation activities. It is generally thought that, had the air attacks on transportation facilities been more intense, Japan would have collapsed sooner.

NOTES FOR GRAPHS

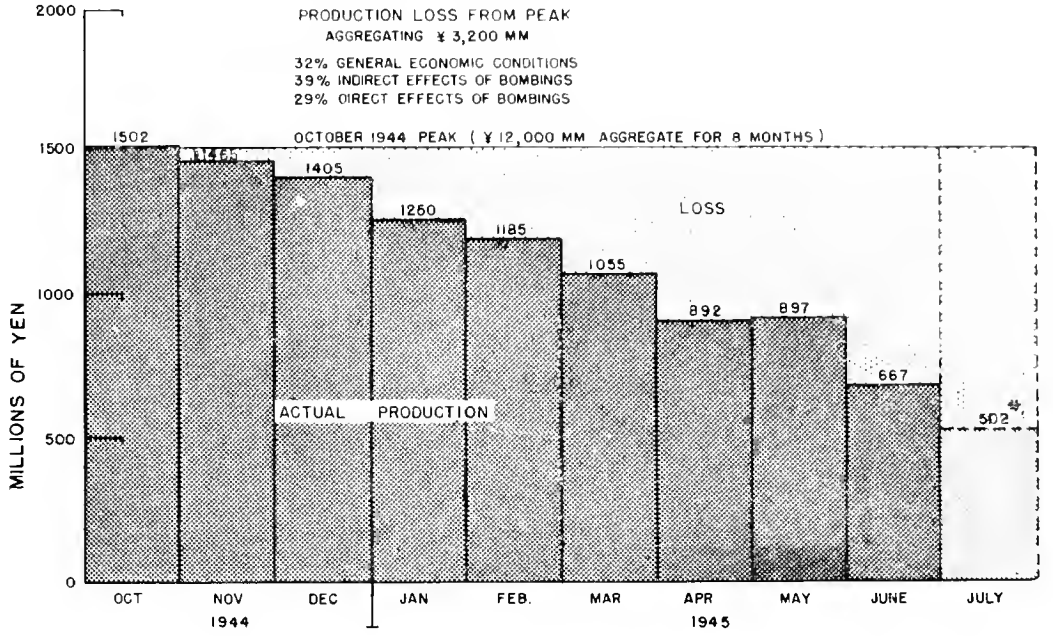
Note 1. Data for consolidated industries represent summary totals for all cities. Data for hit and unhit categories are restricted to cities which were attacked. Where there was a question concerning the classification plants into either hit or unhit groups such plants were excluded from the hit and unhit summaries but were included in the consolidated summaries. The summary totals of hit and unhit industries, therefore, do not equal the totals for the consolidated groups.

Note 2. Value given in box legend for graphs 3 through 29 are monthly averages for the period October 1943 to September 1944.

Note 3. In all graphs the monthly average for the period October 1943 to September 1944 equals 100%.

AGGREGATE LOSS OF PRODUCTION IN JAPANESE URBAN INDUSTRY AND CAUSES OF PRODUCTION LOSS

OCT 1944 TO JUNE 1945

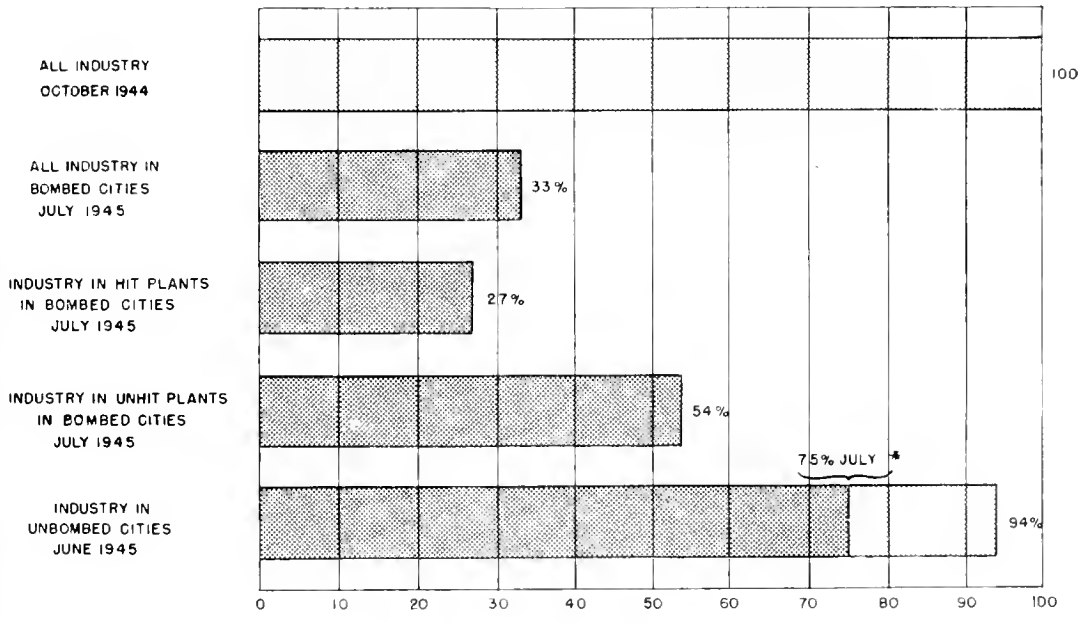


* AGGREGATE LOSS = ¥ 4200 MILLION THROUGH JULY

GRAPH 1

JAPANESE URBAN INDUSTRY

LEVELS OF INDUSTRIAL PRODUCTION



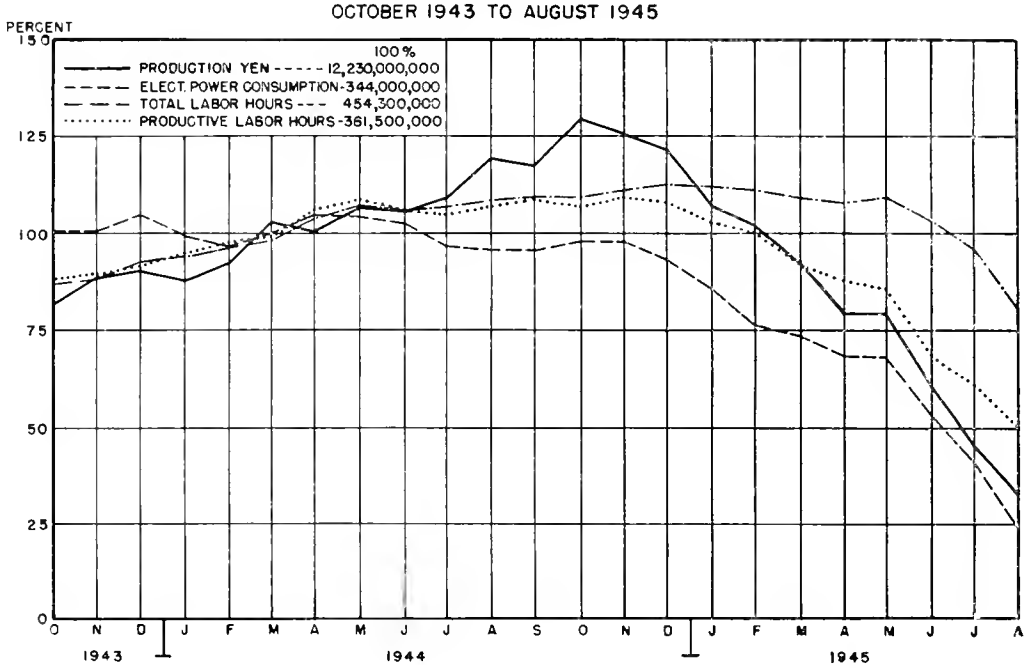
* EFFECTS OF BOMBING – HOKKAIDO

GRAPH 2

ALL JAPANESE URBAN INDUSTRY

CONSOLIDATED

OCTOBER 1943 TO AUGUST 1945

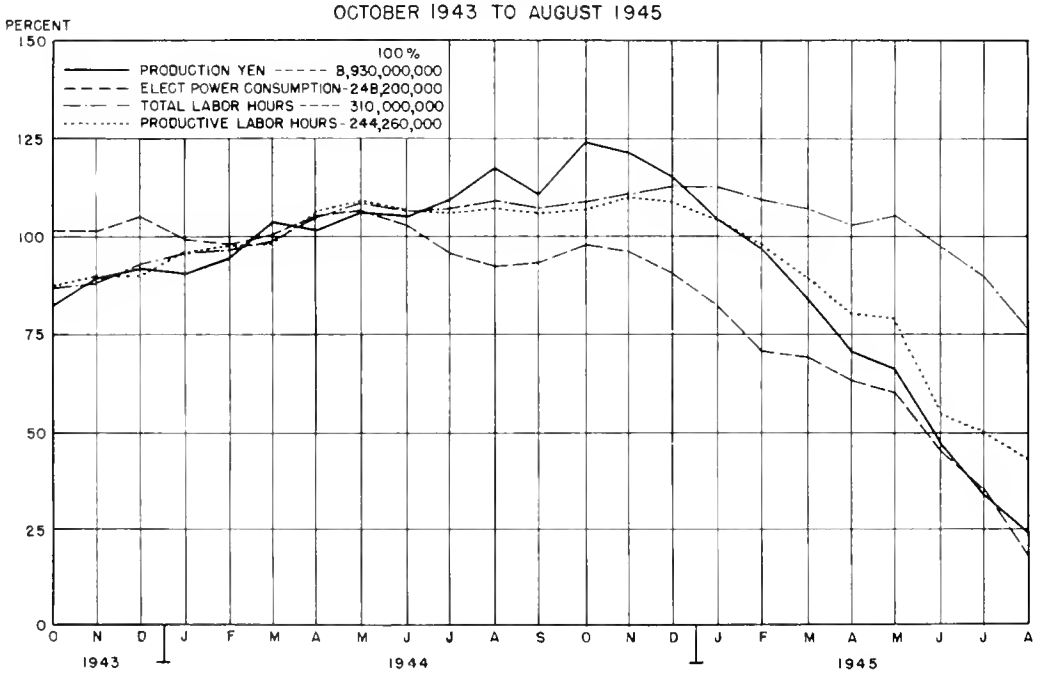


GRAPH 3

ALL JAPANESE URBAN INDUSTRY

HIT

OCTOBER 1943 TO AUGUST 1945

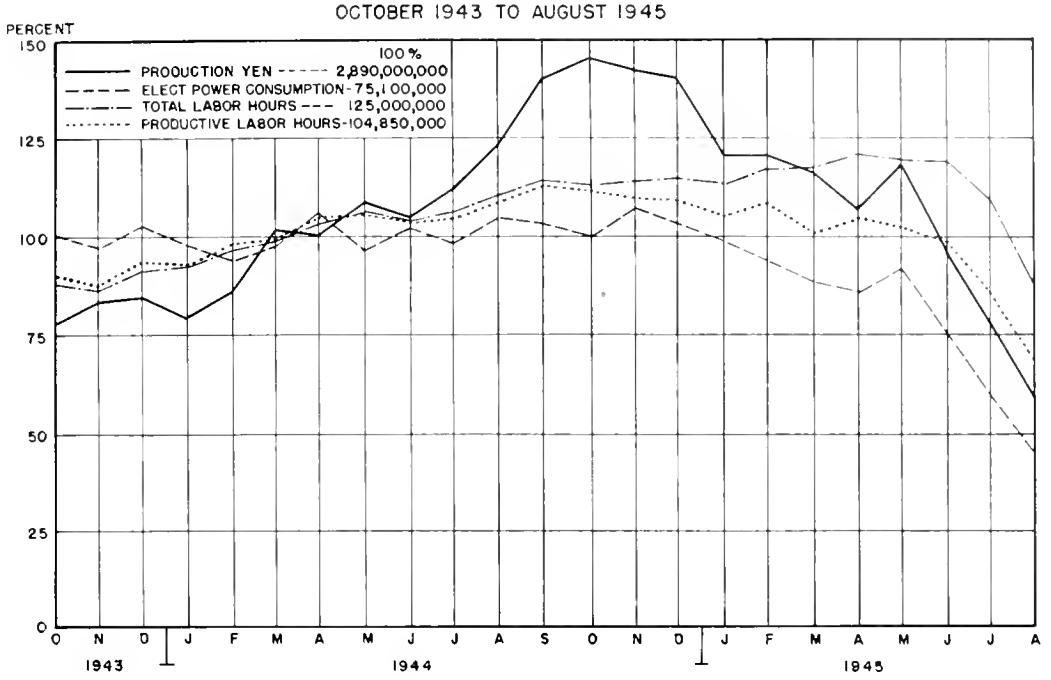


GRAPH 4

ALL JAPANESE URBAN INDUSTRY

UNHIT

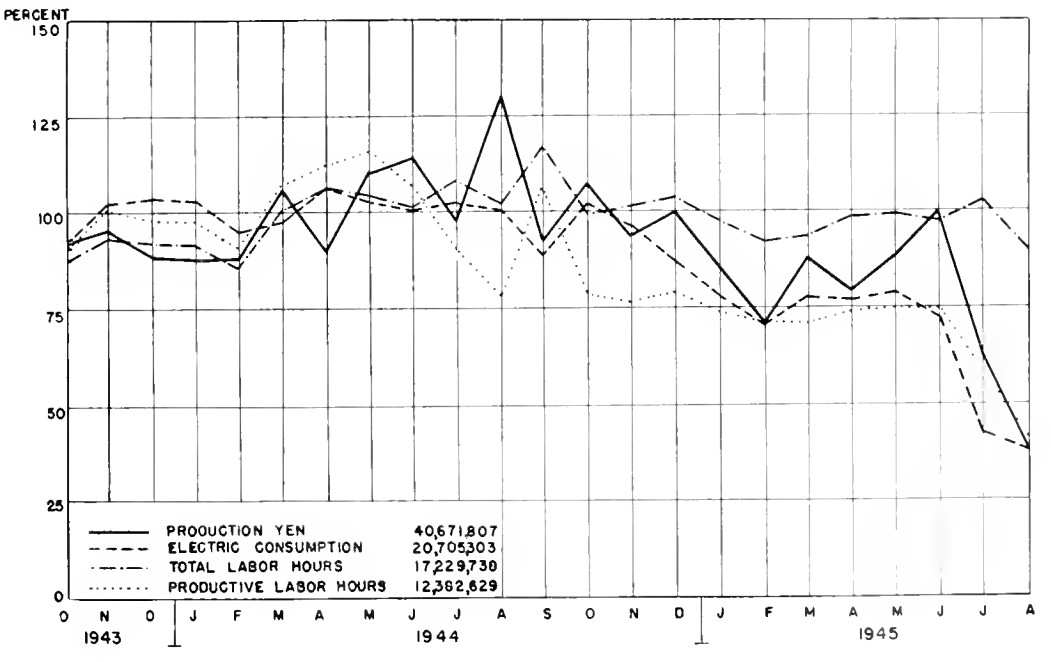
OCTOBER 1943 TO AUGUST 1945



GRAPH 5

HOKKAIDO INDUSTRY

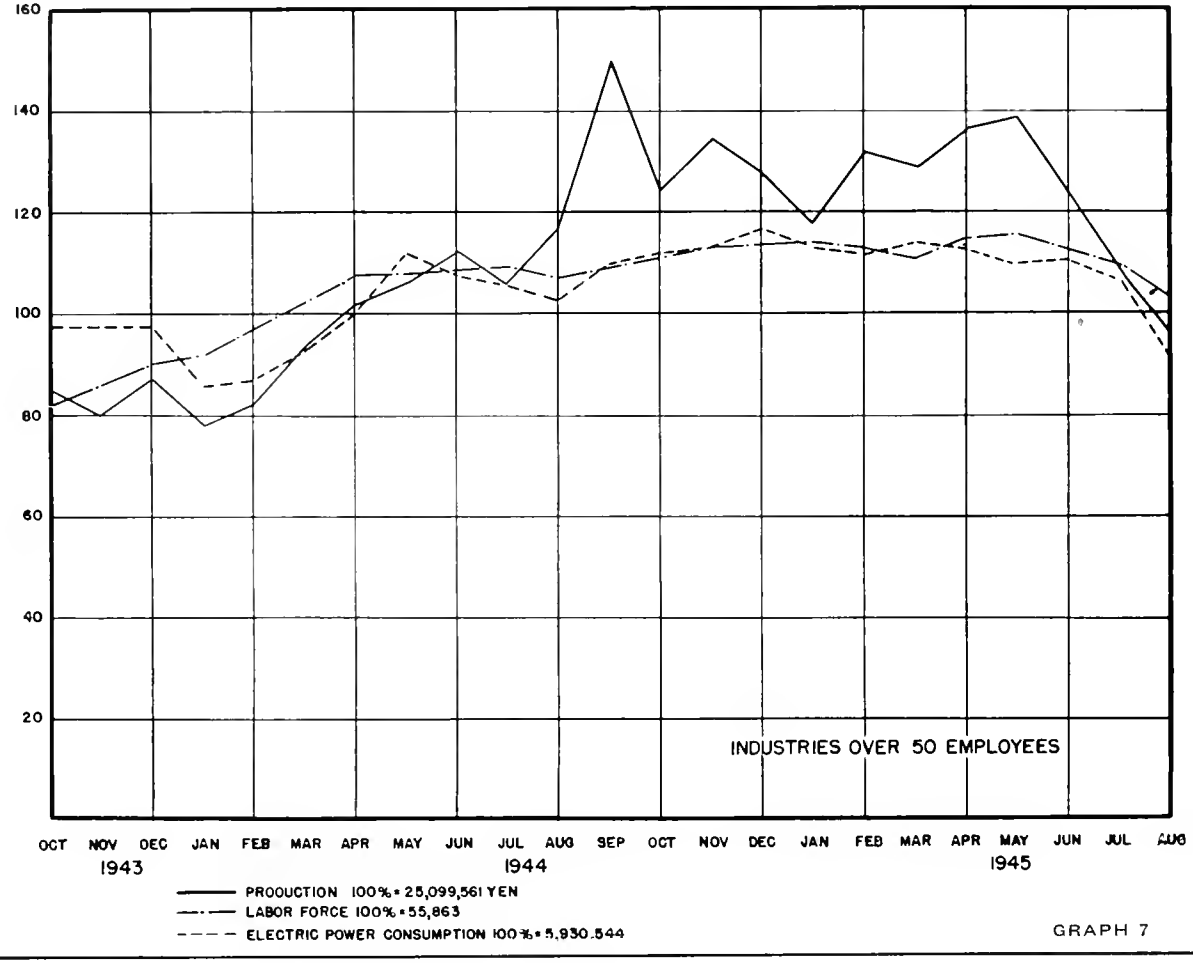
OCTOBER 1943 TO AUGUST 1945



GRAPH 6

JAPANESE URBAN INDUSTRY

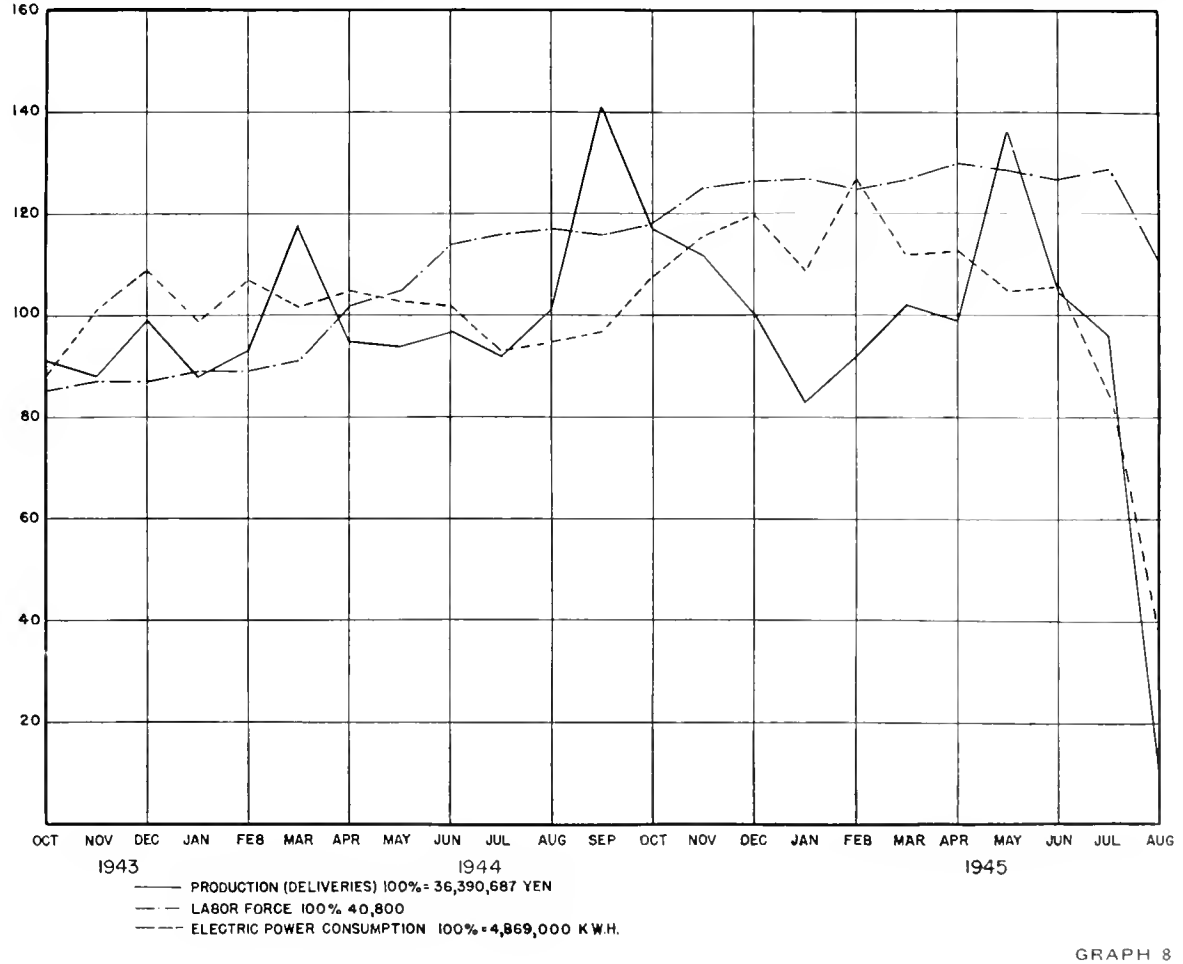
TOTAL KYOTO INDUSTRIAL PRODUCTION, LABOR FORCE & ELECTRIC POWER CONSUMPTION



GRAPH 7

JAPANESE URBAN INDUSTRY

TOTAL HIROSHIMA INDUSTRIAL PRODUCTION, LABOR FORCE, & ELECTRIC POWER CONSUMPTION

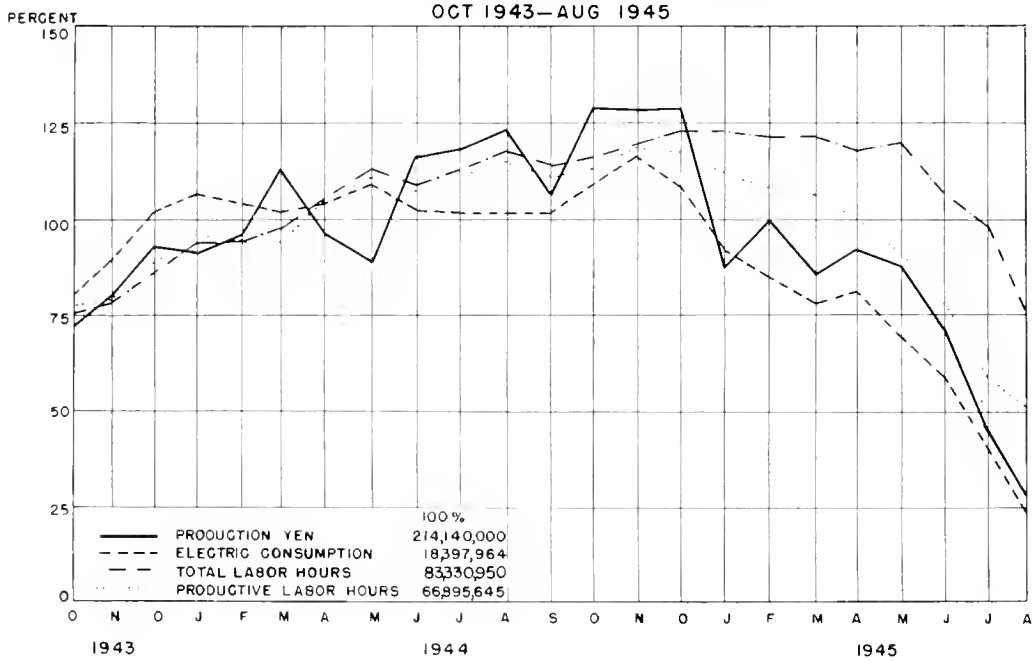


GRAPH 8

JAPANESE URBAN INDUSTRY

AIRCRAFT INDUSTRY (01)—CONSOLIDATED

OCT 1943—AUG 1945

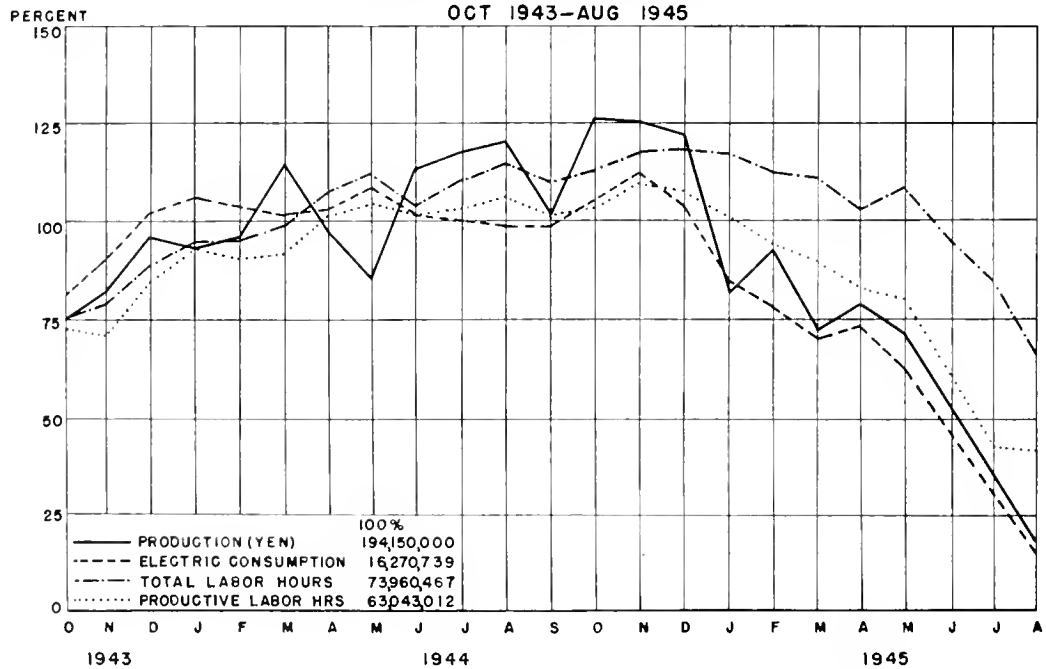


GRAPH 9

JAPANESE URBAN INDUSTRY

AIRCRAFT INDUSTRY (01)—HIT

OCT 1943—AUG 1945

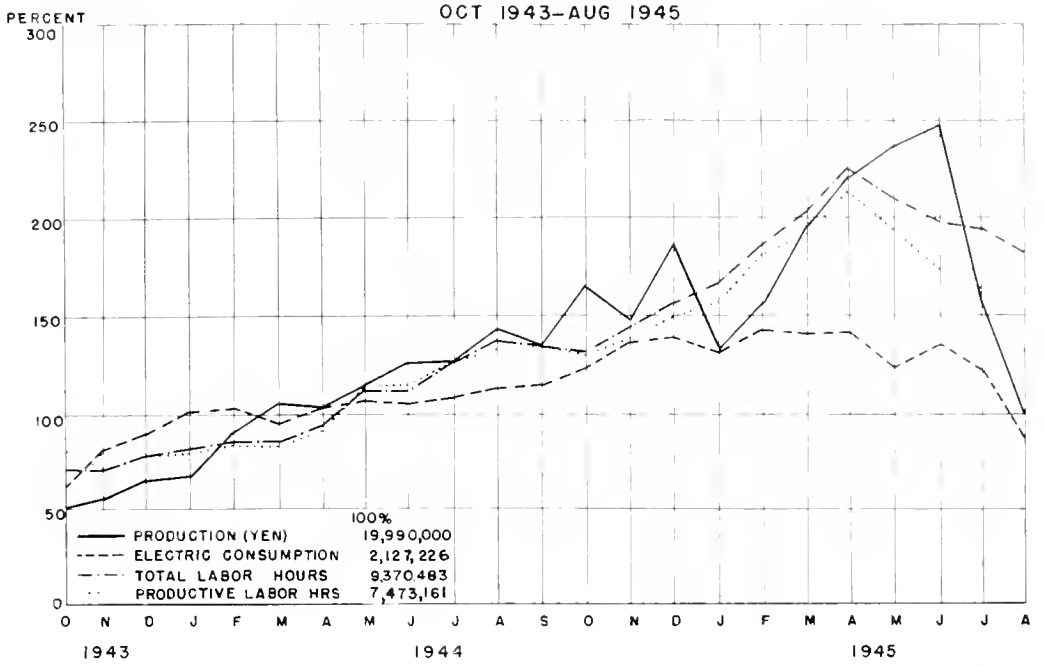


GRAPH 10

JAPANESE URBAN INDUSTRY

AIRCRAFT INDUSTRY (01)—UNHIT

OCT 1943–AUG 1945

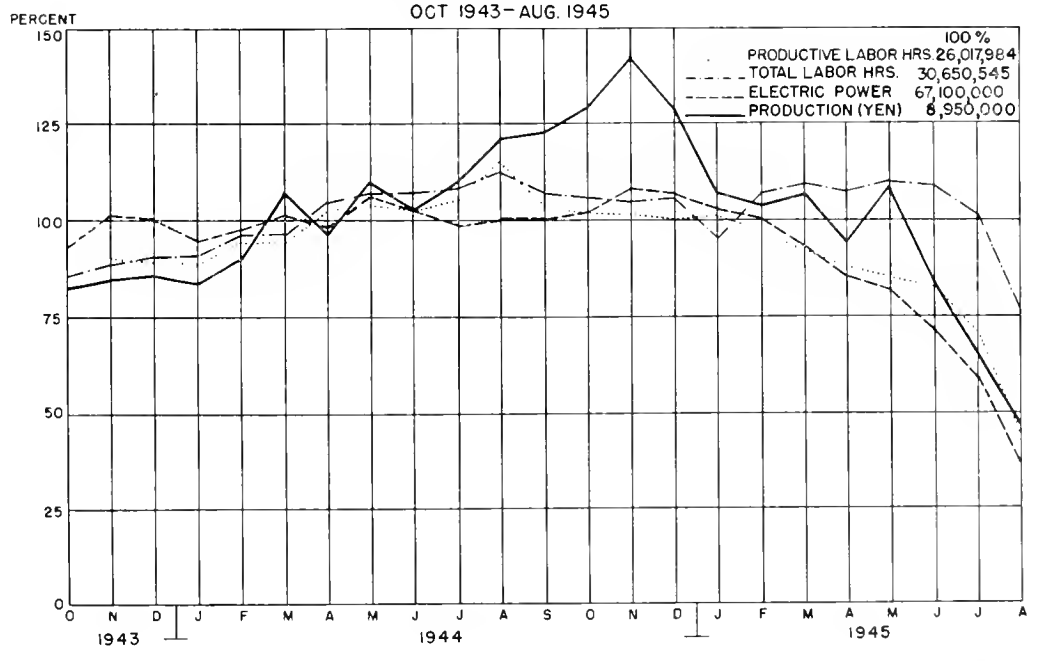


GRAPH 11

JAPANESE URBAN INDUSTRY

ORDNANCE (02) — CONSOLIDATED

OCT 1943–AUG. 1945

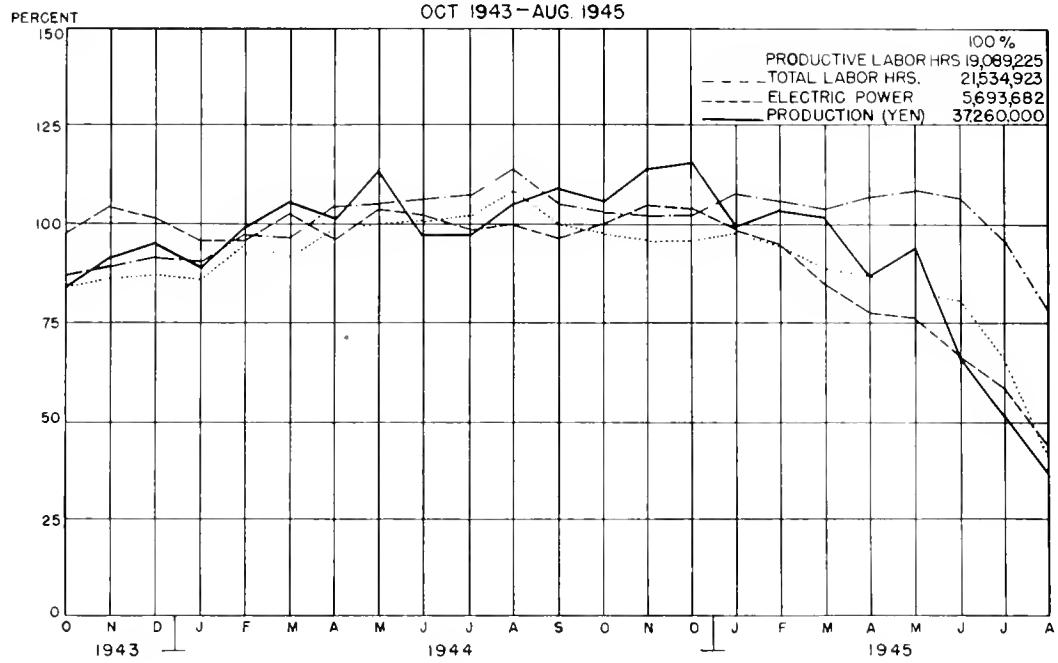


GRAPH 12

JAPANESE URBAN INDUSTRY

ORDNANCE (02) HIT

OCT 1943 – AUG. 1945

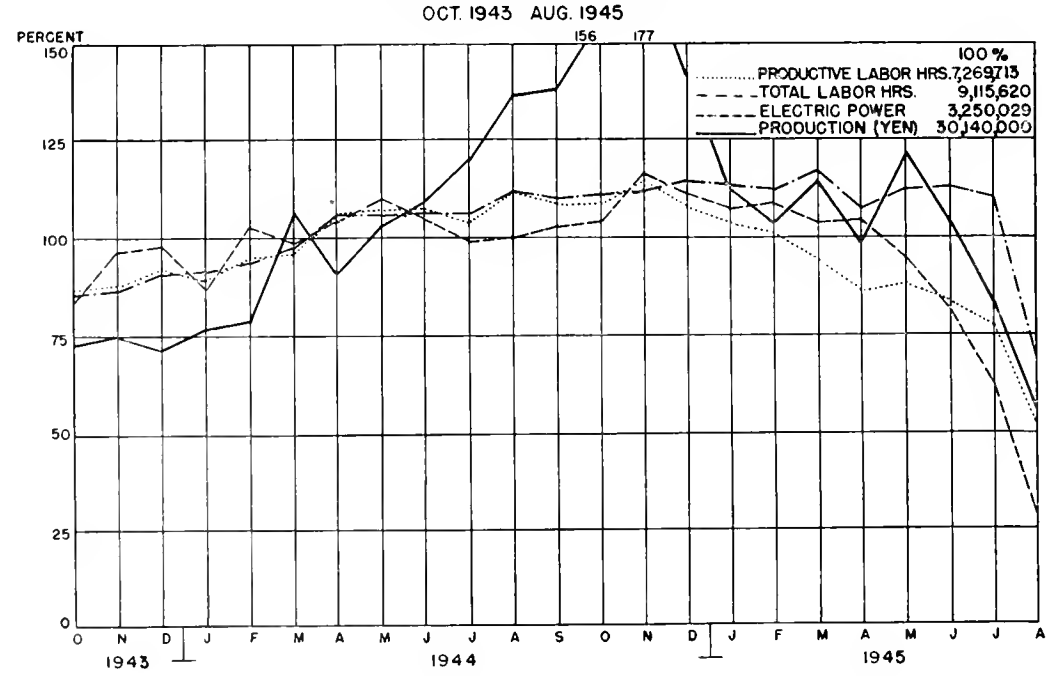


GRAPH 13

JAPANESE URBAN INDUSTRY

ORDNANCE (02) UNHIT

OCT. 1943 AUG. 1945

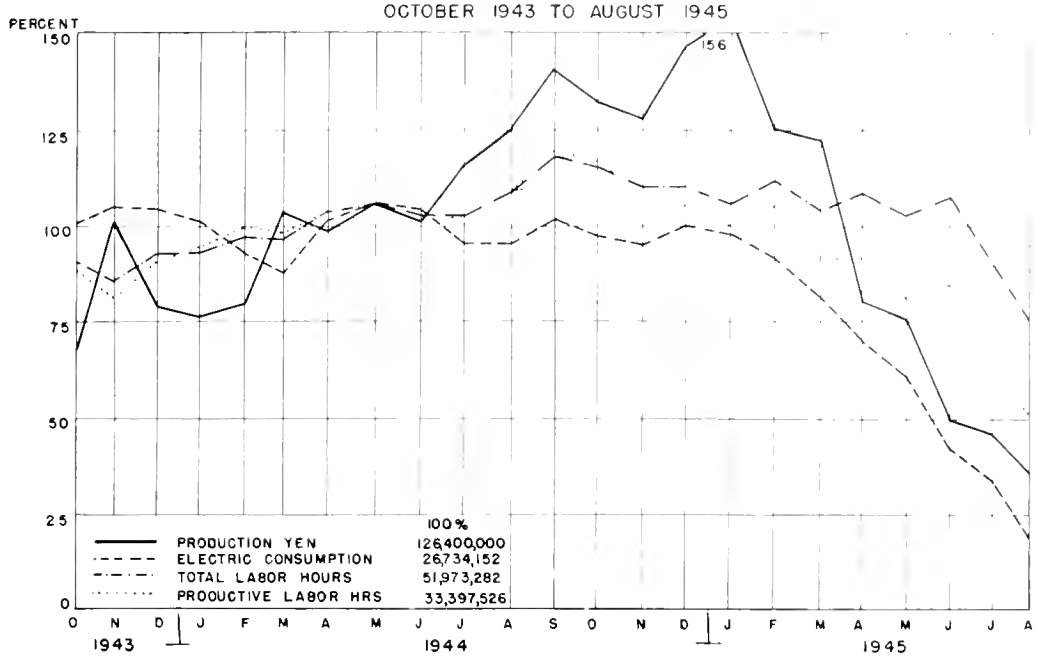


GRAPH 14

JAPANESE URBAN INDUSTRY

ELECTRICAL EQUIPMENT (05)— CONSOLIDATED

OCTOBER 1943 TO AUGUST 1945

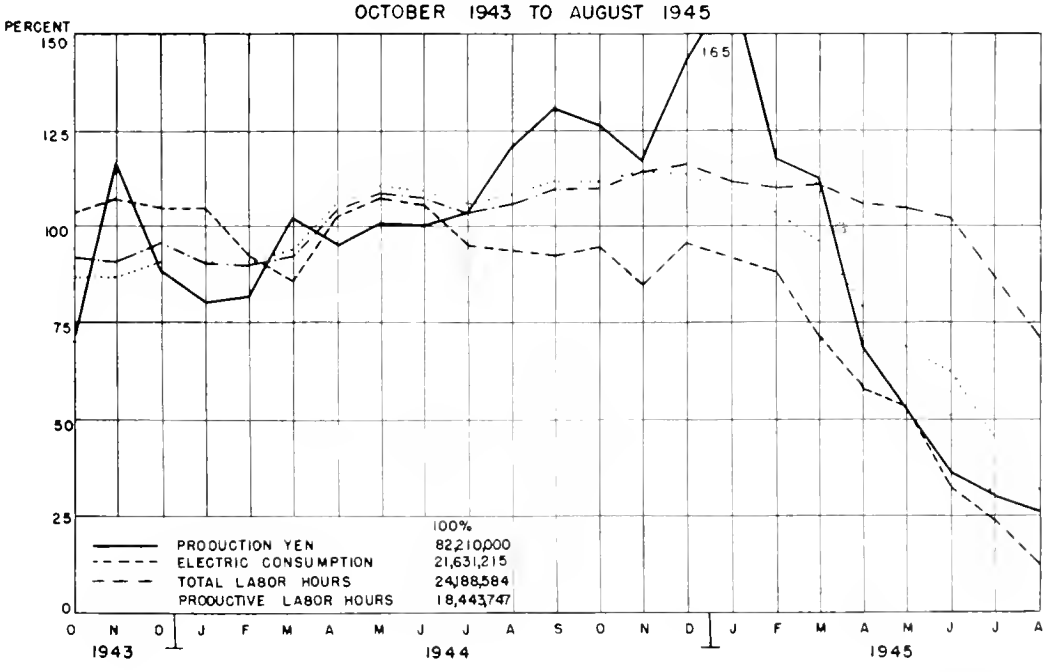


GRAPH 15

JAPANESE URBAN INDUSTRY

ELECTRICAL EQUIPMENT (05)—HIT

OCTOBER 1943 TO AUGUST 1945

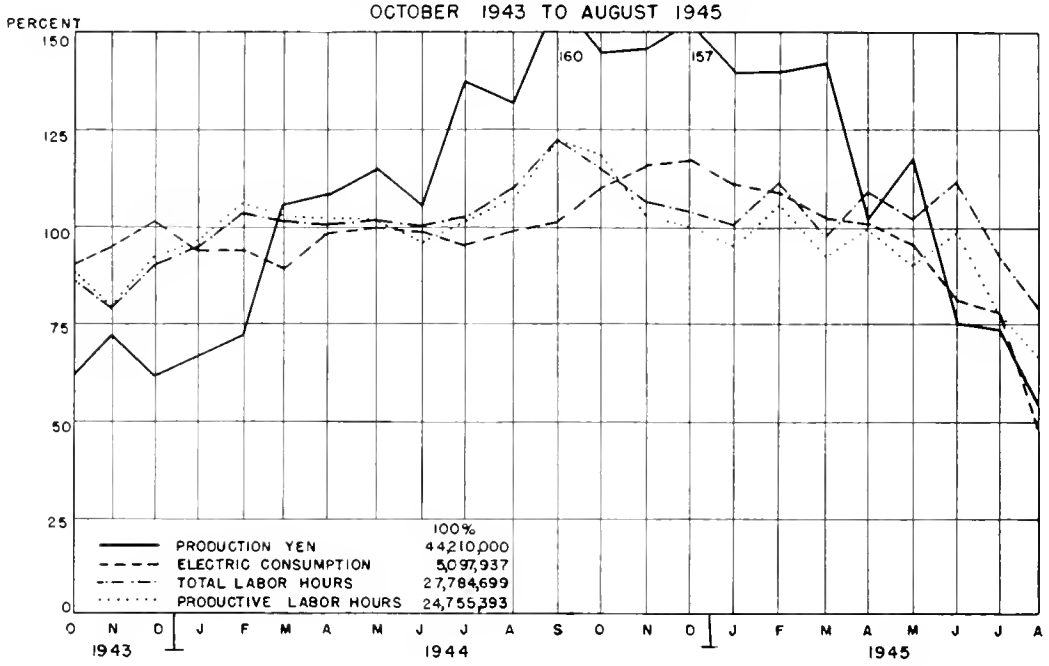


GRAPH 16

JAPANESE URBAN INDUSTRY

ELECTRICAL EQUIPMENT (05)– UNHIT

OCTOBER 1943 TO AUGUST 1945

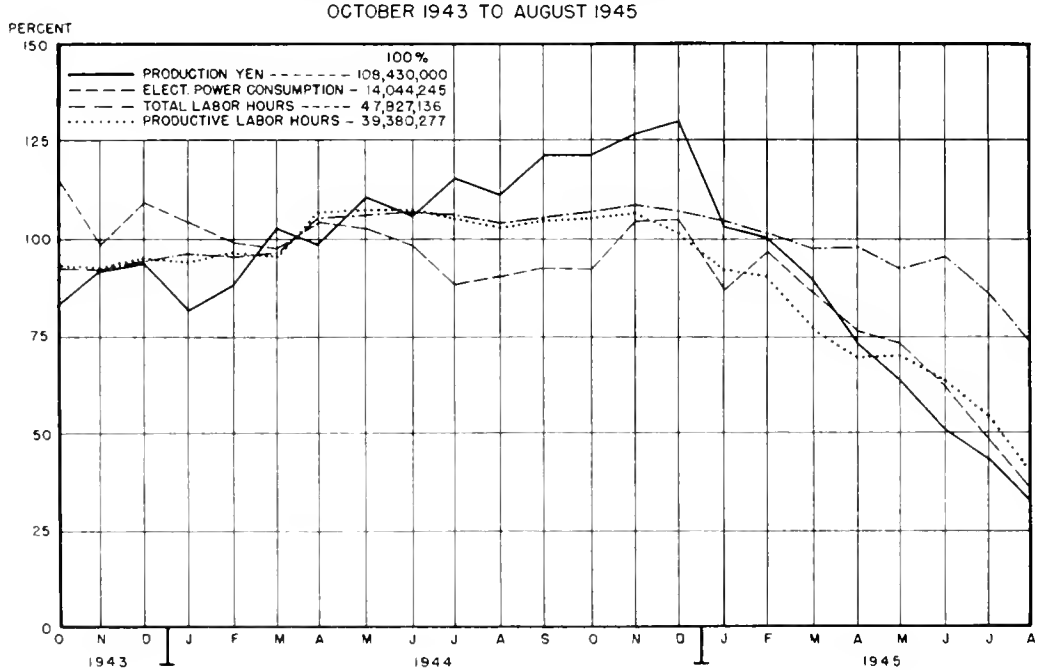


GRAPH 17

JAPANESE URBAN INDUSTRY

FINISHED MACHINERY (06) CONSOLIDATED

OCTOBER 1943 TO AUGUST 1945

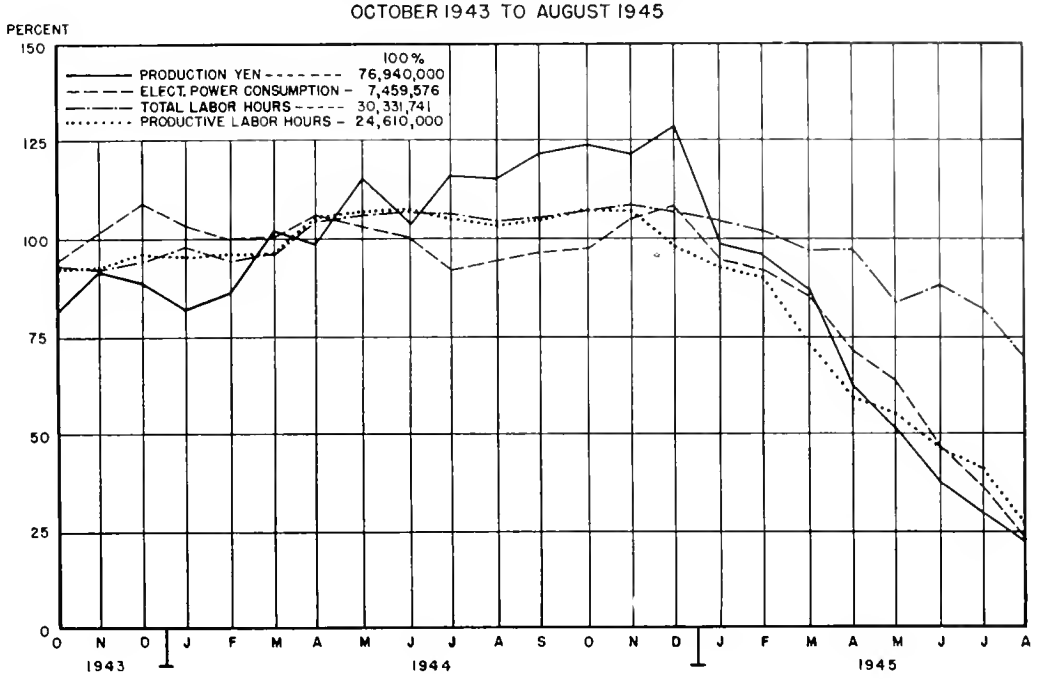


GRAPH 18

JAPANESE URBAN INDUSTRY

FINISHED MACHINERY (06) HIT

OCTOBER 1943 TO AUGUST 1945

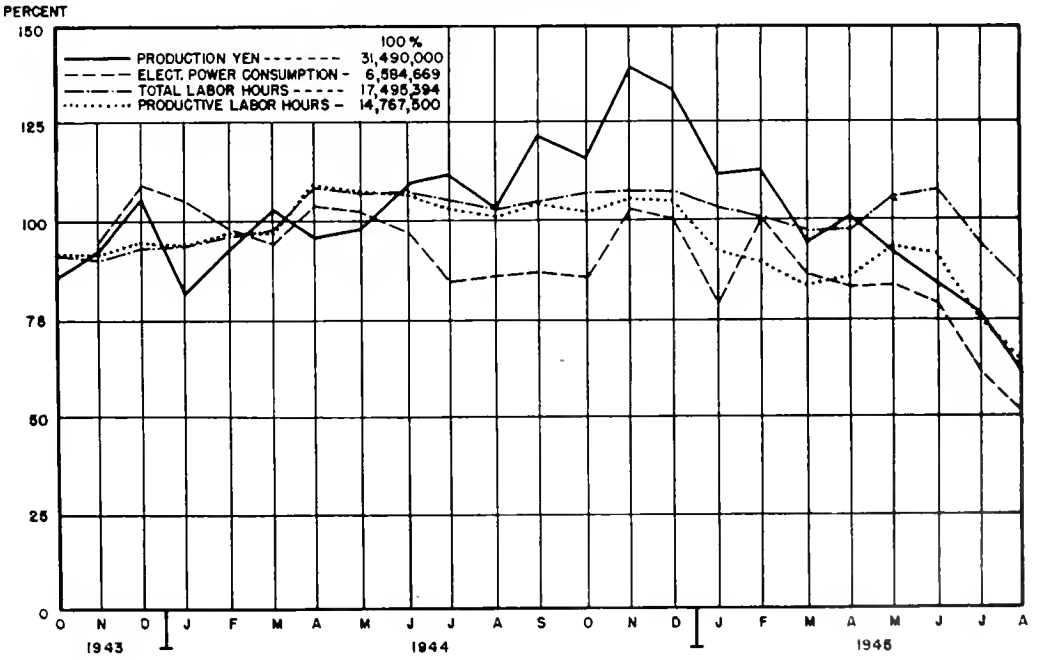


GRAPH 19

JAPANESE URBAN INDUSTRY

FINISHED MACHINERY (06) UNHIT

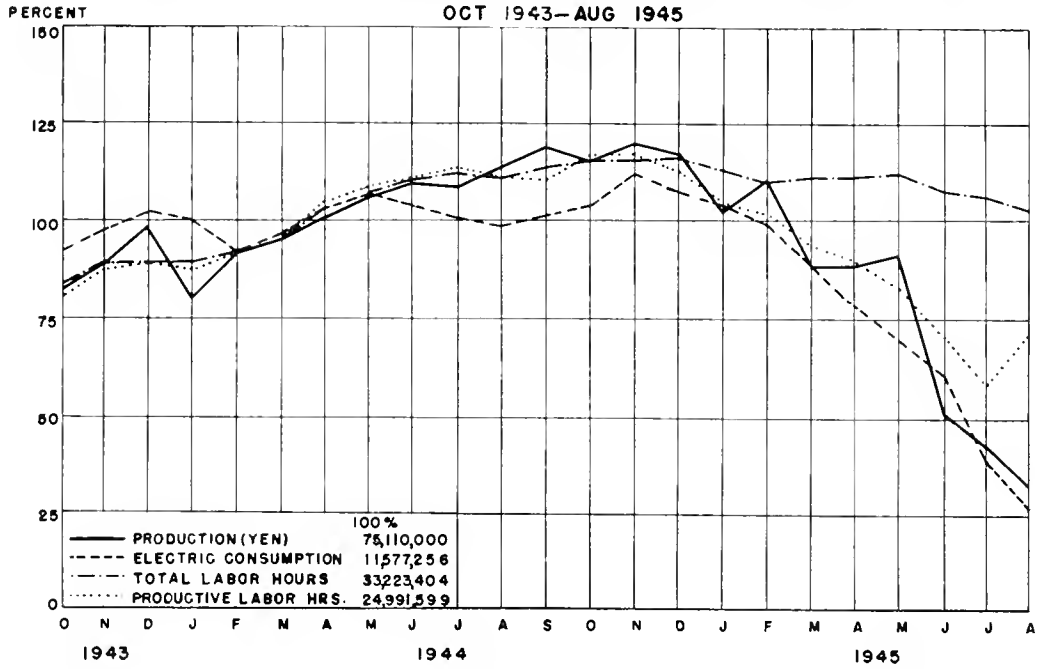
OCTOBER 1943 TO AUGUST 1945



GRAPH 20

JAPANESE URBAN INDUSTRY

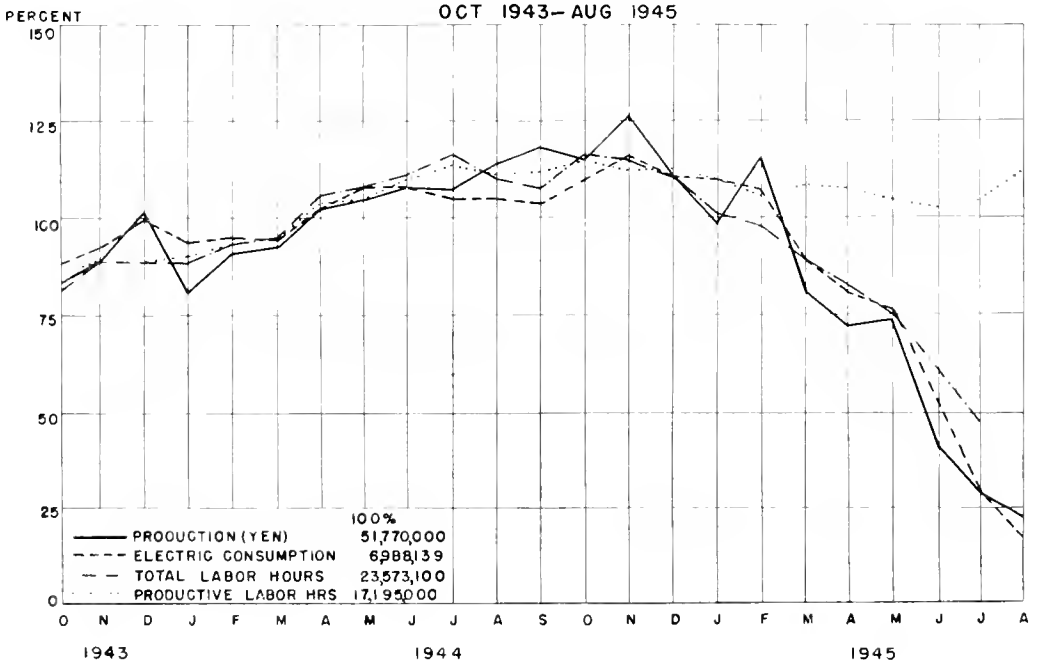
MACHINED & FABRICATED METAL PARTS (07) CONSOLIDATED



GRAPH 21

JAPANESE URBAN INDUSTRY

MACHINED & FABRICATED METAL PARTS (07) HIT

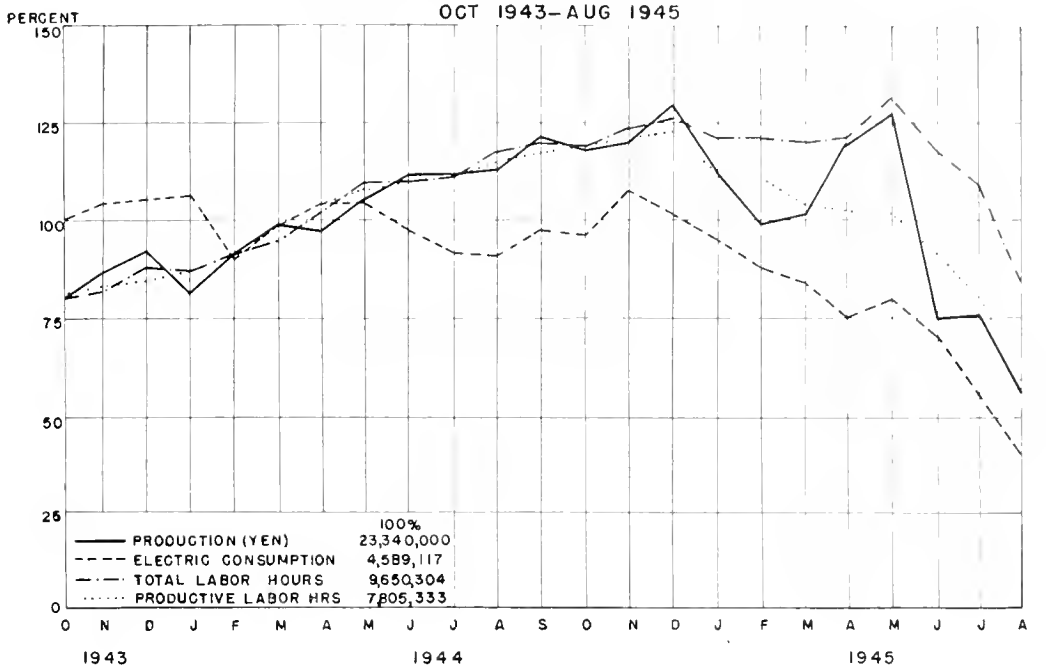


GRAPH 22

JAPANESE URBAN INDUSTRY

MACHINED & FABRICATED METAL PARTS (07) UNHIT

OCT 1943–AUG 1945

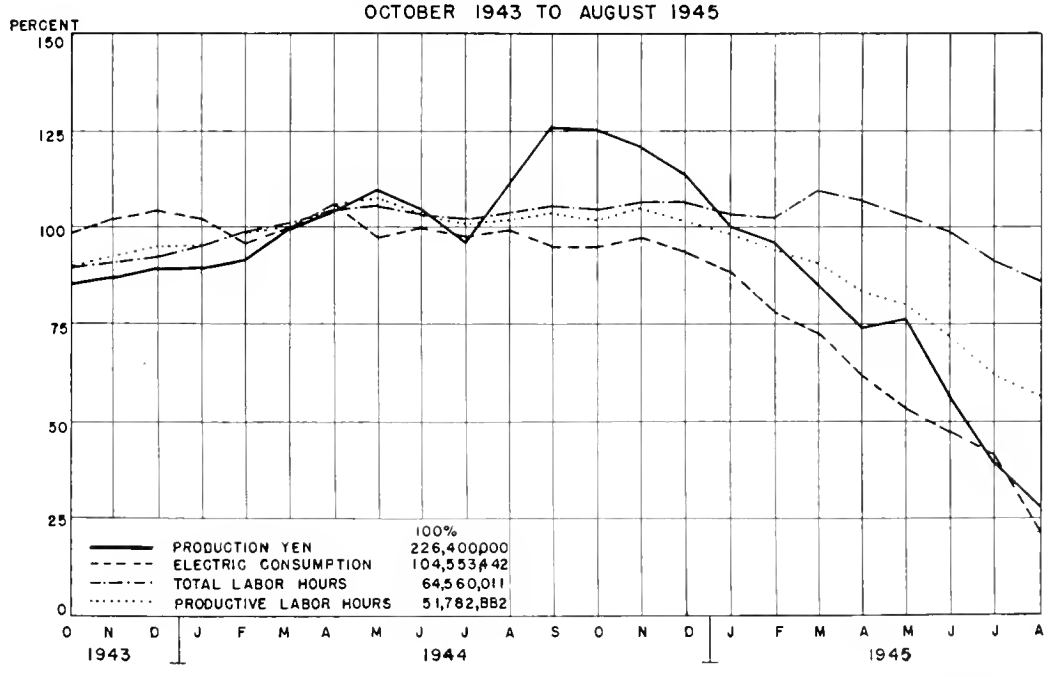


GRAPH 23

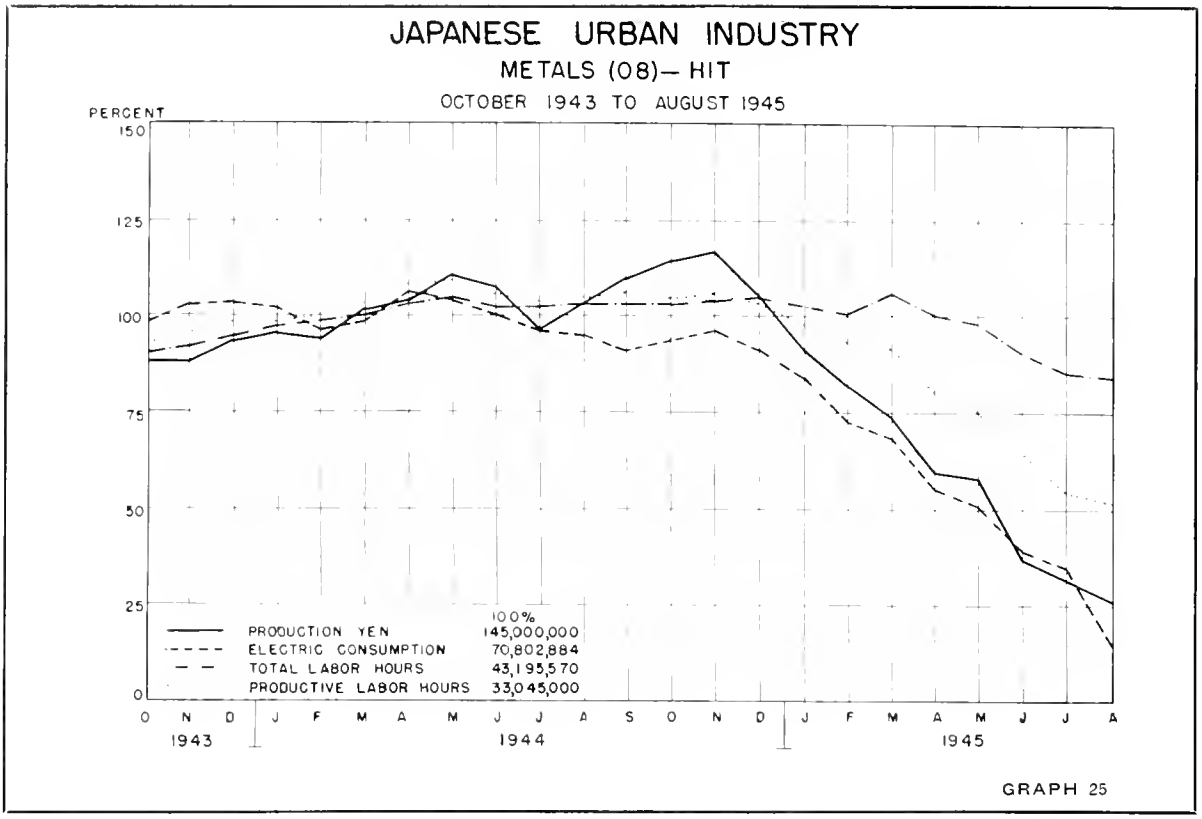
JAPANESE URBAN INDUSTRY

METALS (08)–CONSOLIDATED

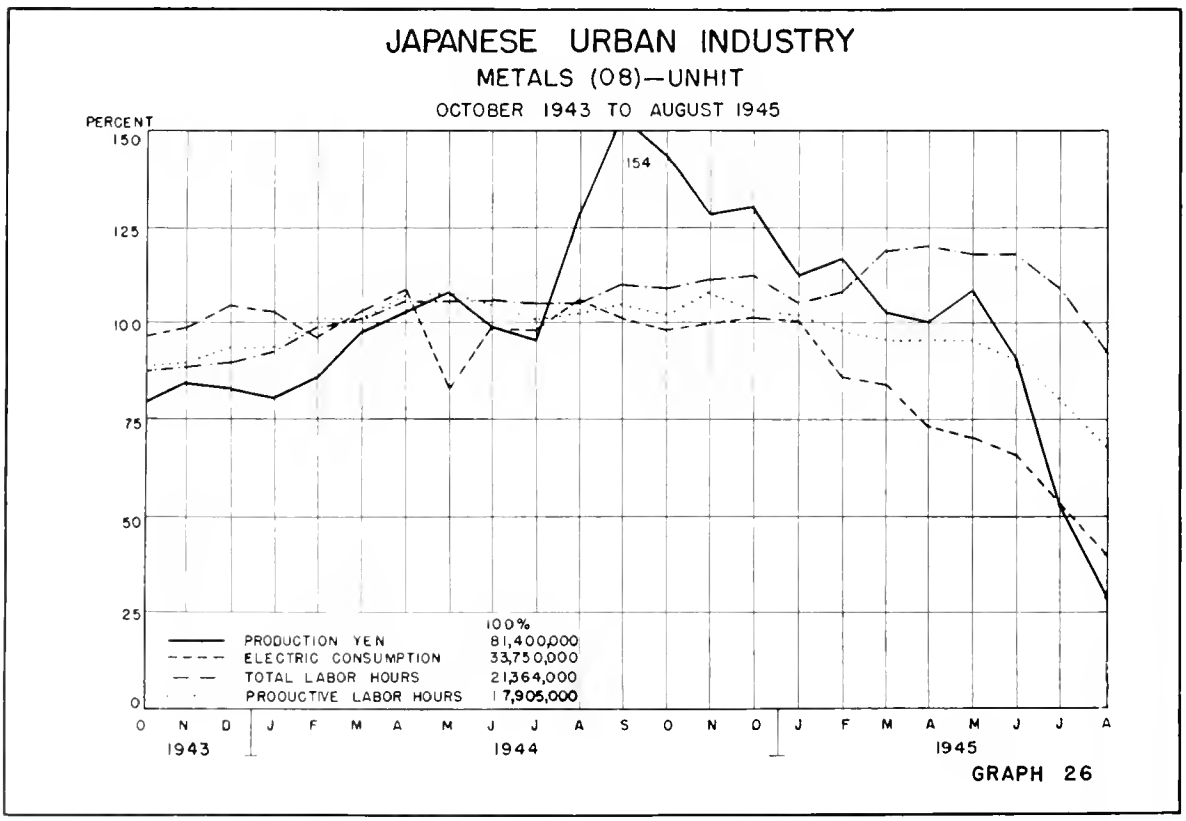
OCTOBER 1943 TO AUGUST 1945



GRAPH 24



GRAPH 25

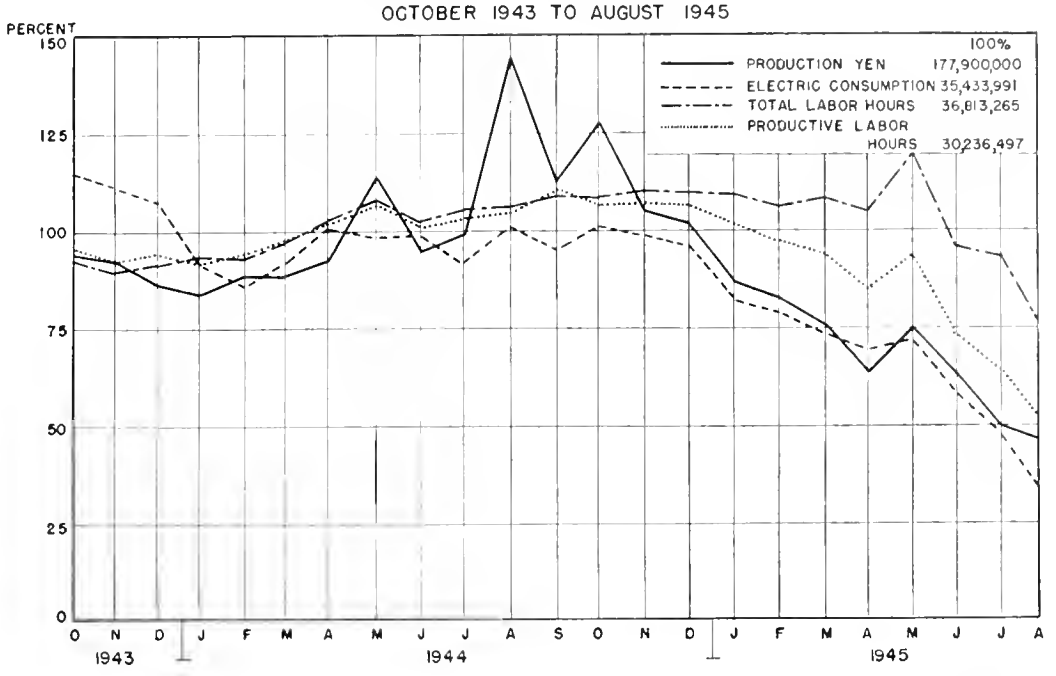


GRAPH 26

JAPANESE URBAN INDUSTRY

MISCELLANEOUS (II)—CONSOLIDATED

OCTOBER 1943 TO AUGUST 1945

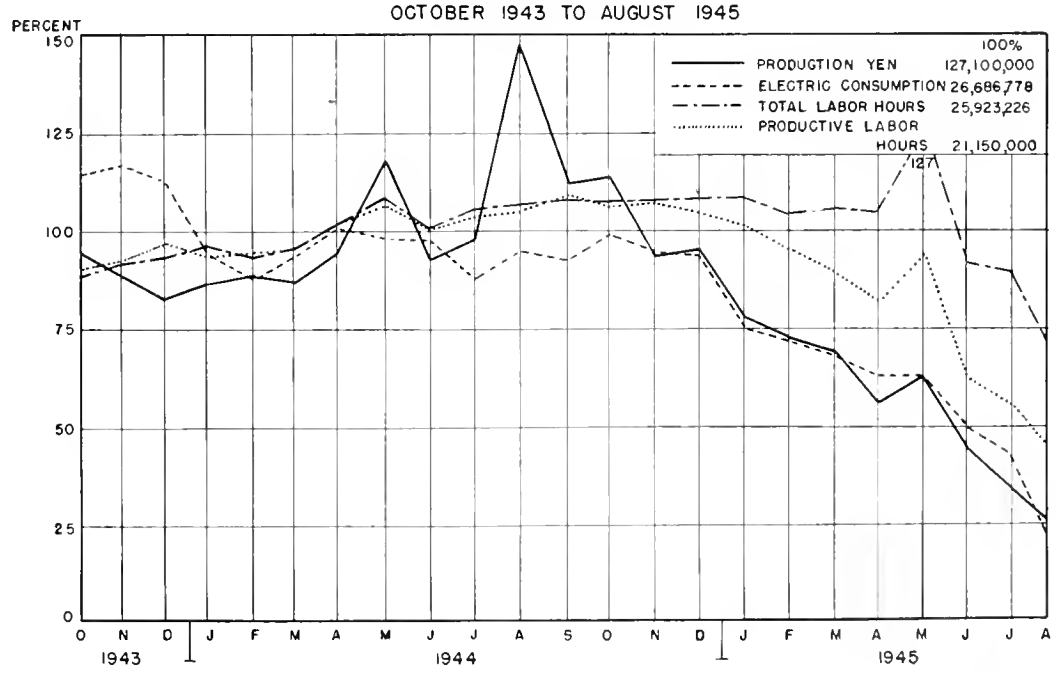


GRAPH 27

JAPANESE URBAN INDUSTRY

MISCELLANEOUS (II)—HIT

OCTOBER 1943 TO AUGUST 1945

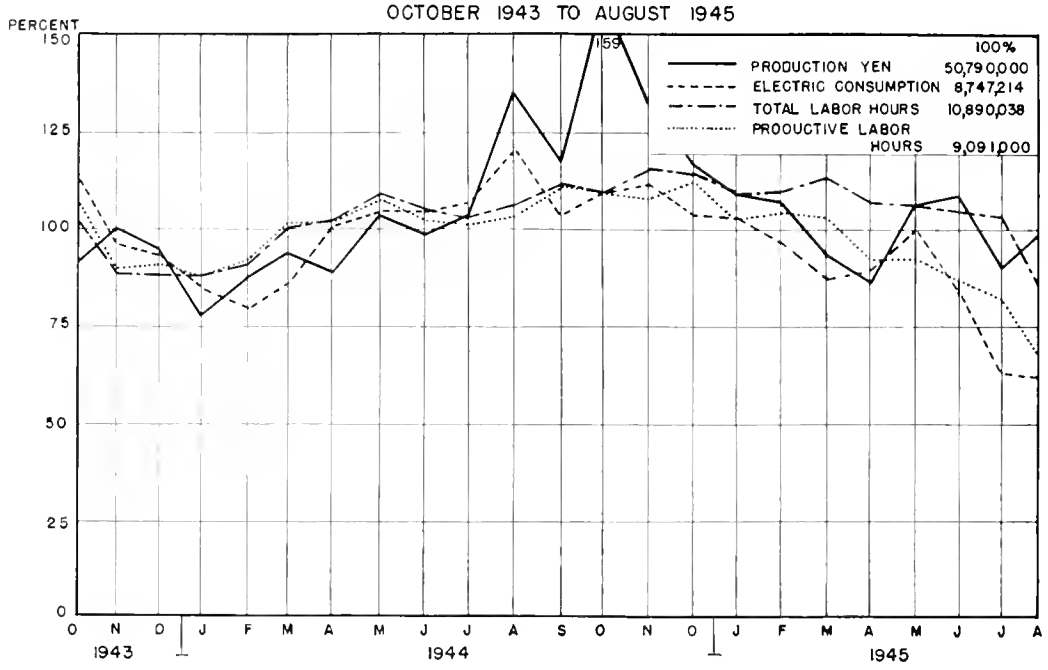


GRAPH 28

JAPANESE URBAN INDUSTRY

MISCELLANEOUS (II) — UNHIT

OCTOBER 1943 TO AUGUST 1945

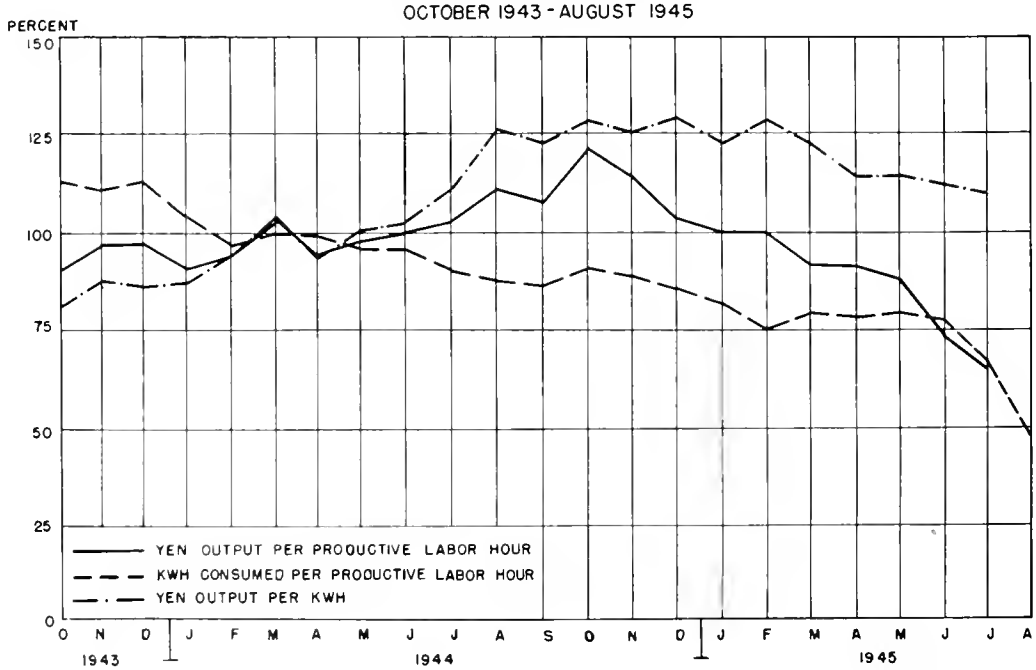


GRAPH 29

PRODUCTION RATIOS

COMBINED URBAN INDUSTRY

OCTOBER 1943 - AUGUST 1945

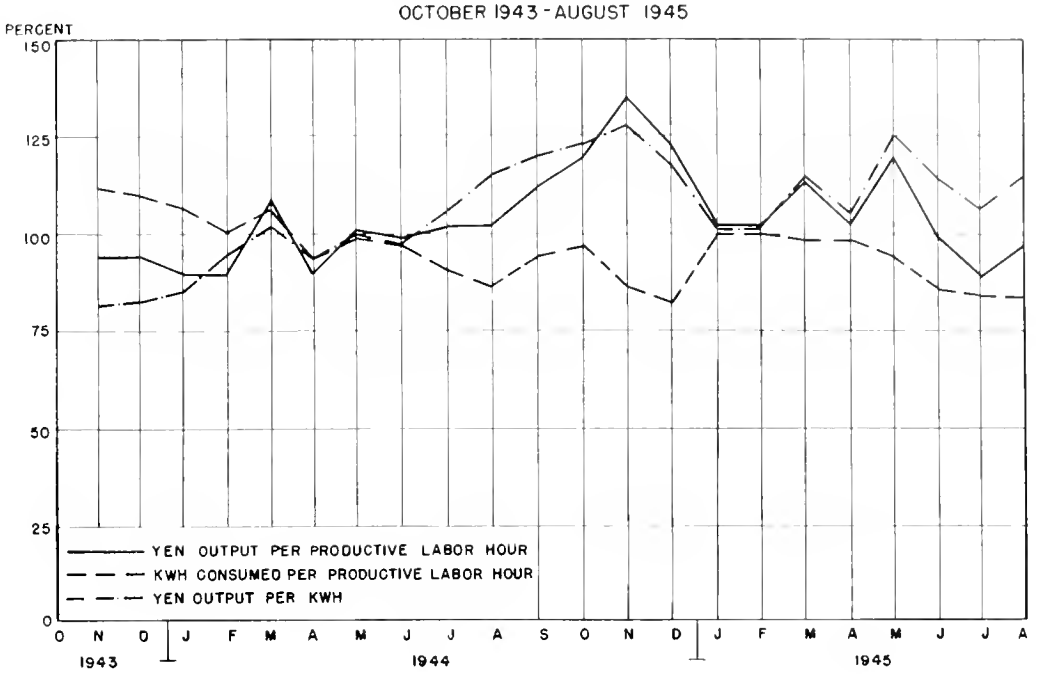


GRAPH 30

PRODUCTION RATIOS

ORDNANCE INDUSTRY (02)

OCTOBER 1943 - AUGUST 1945

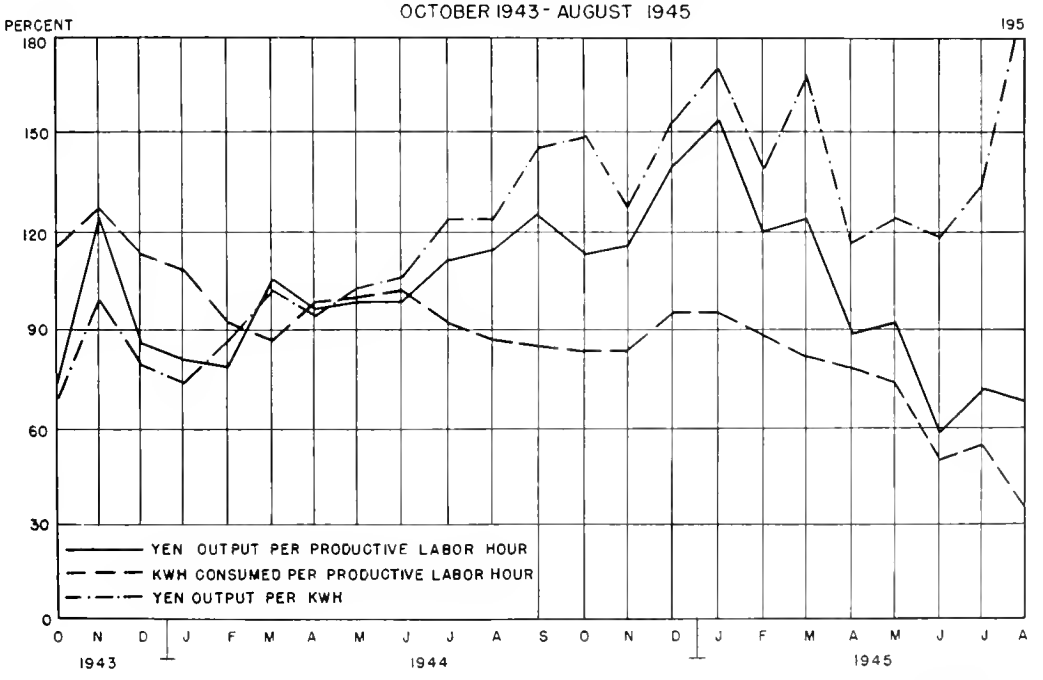


GRAPH 31

PRODUCTION RATIOS

ELECTRICAL EQUIPMENT INDUSTRY (05)

OCTOBER 1943 - AUGUST 1945

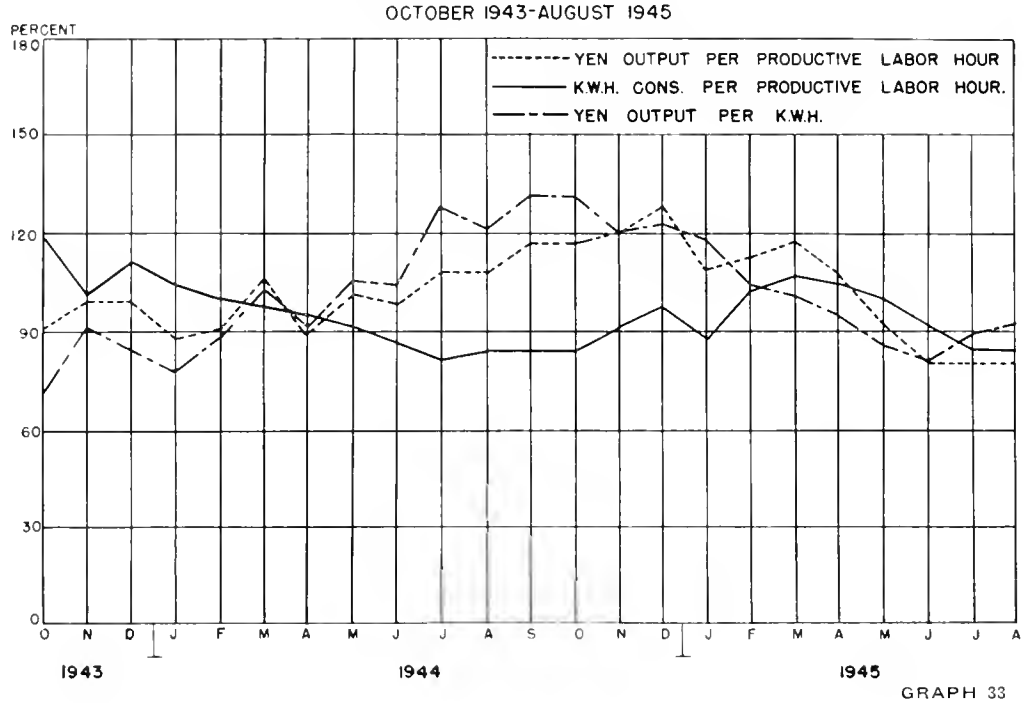


GRAPH 32

PRODUCTION RATIOS

FINISHED MACHINERY INDUSTRY (06)

OCTOBER 1943-AUGUST 1945

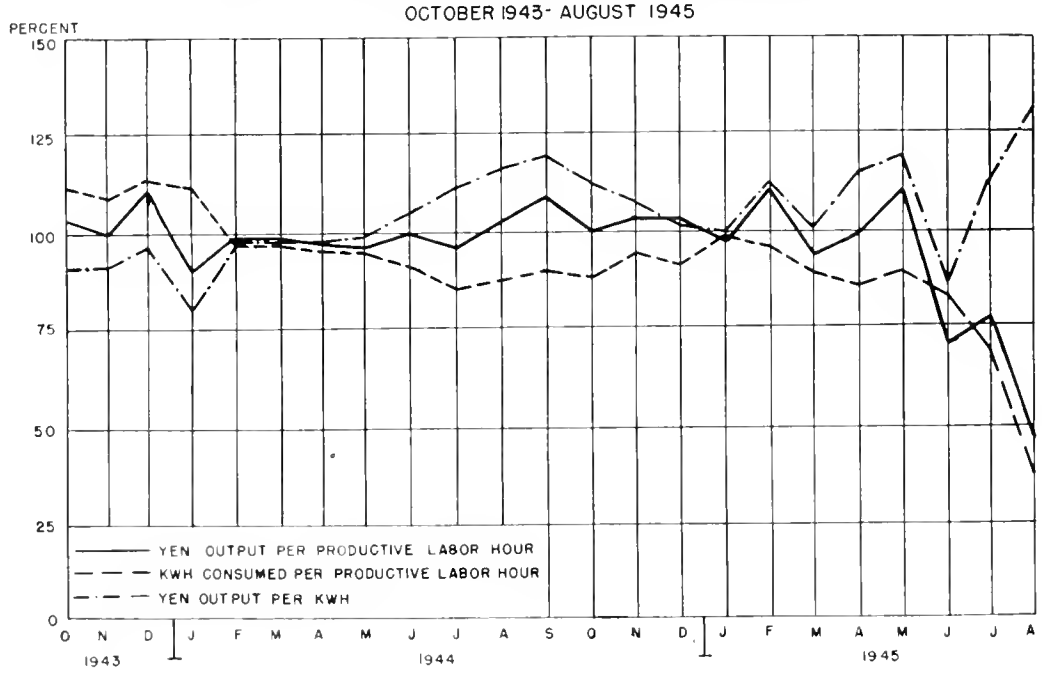


GRAPH 33

PRODUCTION RATIOS

MACHINED AND FABRICATED METAL PARTS INDUSTRY (07)

OCTOBER 1943- AUGUST 1945

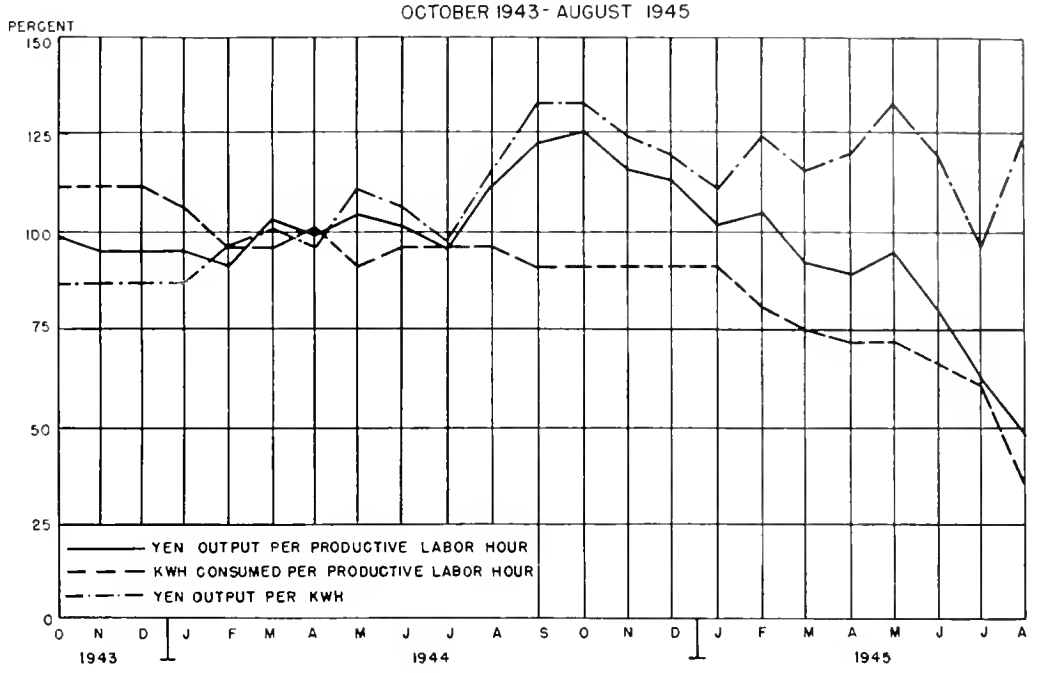


GRAPH 34

PRODUCTION RATIOS

METALS INDUSTRY (08)

OCTOBER 1943 - AUGUST 1945

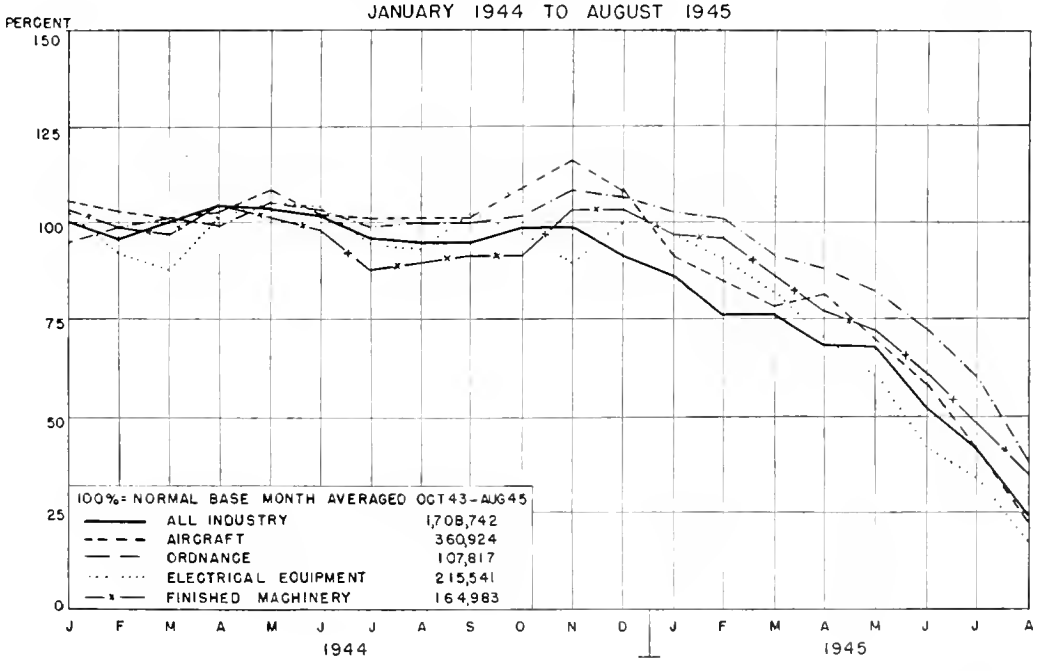


GRAPH 35

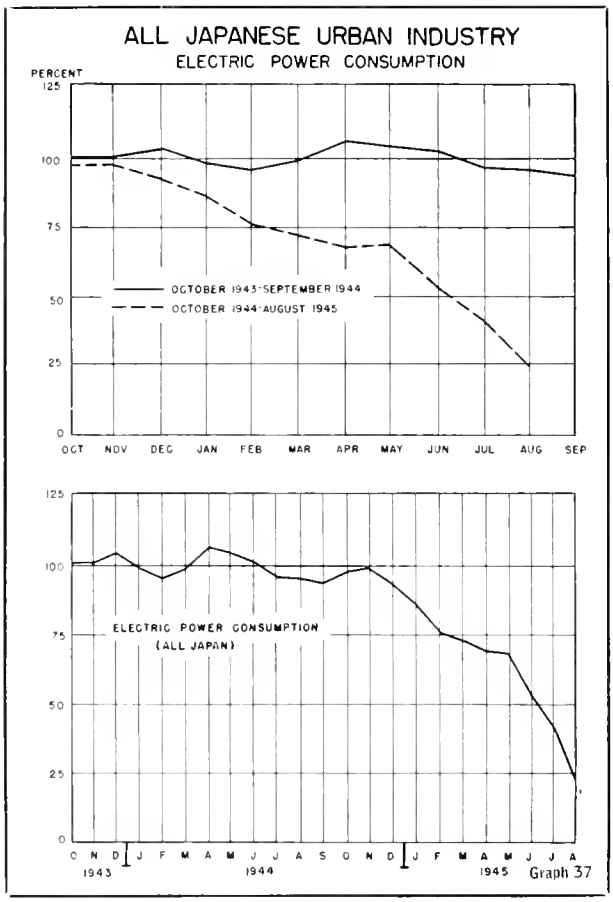
ALL JAPANESE URBAN INDUSTRY

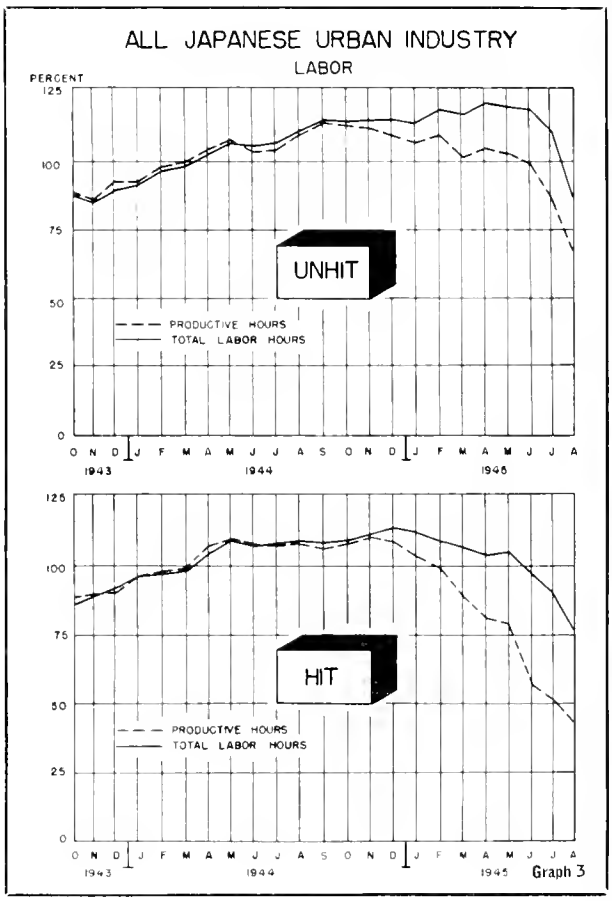
RATE OF ELECTRIC CONSUMPTION OF MAJOR END PRODUCT INDUSTRIES

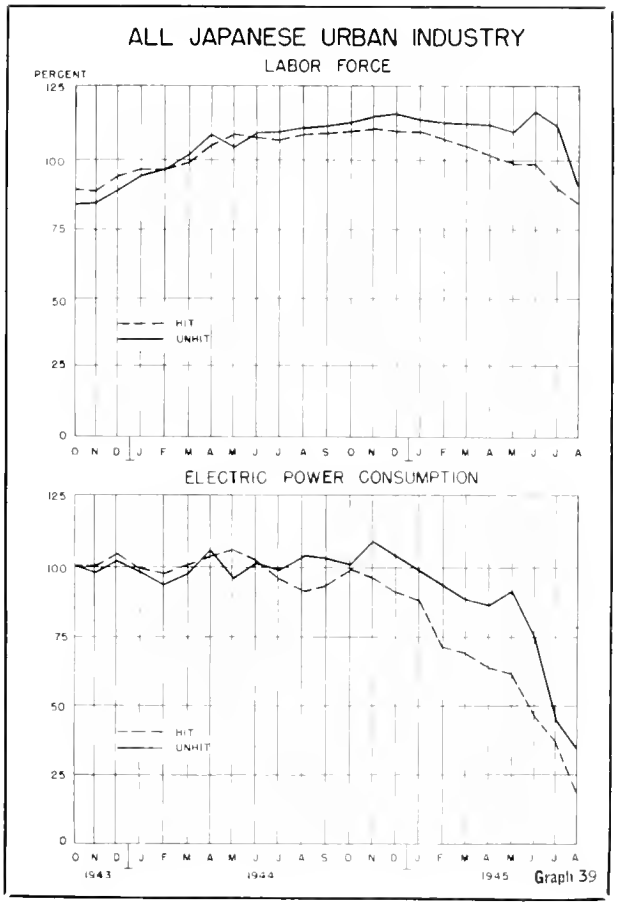
JANUARY 1944 TO AUGUST 1945



GRAPH 36


ALL JAPANESE URBAN INDUSTRY
ELECTRIC POWER CONSUMPTION
PERCENT
125
100
75
50
25
0
OCTOBER 1943-SEPTEMBER 1944
OCTOBER 1944-AUGUST 1945
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
ELECTRIC POWER CONSUMPTION
(ALL JAPAN)
O N D J F M A M J J A S O N D J F M A M J J A
1943
1944
1945
Graph 37


ALL JAPANESE URBAN INDUSTRY
LABOR
PERCENT
125
100
75
50
25
0
UNHIT
PRODUCTIVE HOURS
TOTAL LABOR HOURS
HIT
PRODUCTIVE HOURS
TOTAL LABOR HOURS
O N D J F M A M J J A S O N D J F M A M J J A
1943
1944
1945
Graph 3


ALL JAPANESE URBAN INDUSTRY
LABOR FORCE
PERCENT
125
100
75
50
25
0
HIT
UNHIT
O N D J F M A M J J A S O N D J F M A M J J A
ELECTRIC POWER CONSUMPTION
125
100
75
50
25
0
HIT
UNHIT
O N D J F M A M J J A S O N D J F M A M J J A
1943
1944
1945
Graph 39

UNITED STATES STRATEGIC BOMBING SURVEY

LIST OF REPORTS

The following is a bibliography of reports resulting from the Survey's studies of the European and Pacific wars. Those reports marked with an asterisk (*) may be purchased from the Superintendent of Documents at the Government Printing Office, Washington, D. C.

European War

OFFICE OF THE CHAIRMAN

*1 The United States Strategic Bombing Survey: summary Report (European War)
*2 The United States Strategic Bombing Survey: Over-all Report (European War)
*3 The Effects of Strategic Bombing on the German War Economy

AIRCRAFT DIVISION

(By Division and Branch)

*4 Aircraft Division Industry Report
5 Inspection Visits to Various Targets (Special Report)

Airframes Branch

6 Junkers Aircraft and Aero Engine Works, Dessau, Germany
7 Erla Maschinenwerke G m b H, Heiterblick, German
8 A T G Maschinenbau, G m b H, Leipzig (Mockau), Germany
9 Gothaer Waggonfabrik, A G, Gotha, Germany
10 Focke Wulf Aircraft Plant, Bremen, Germany
11 Messerschmitt A G, Augsburg, Germany — Over-all Report; Part A; Part B; Appendices I, II, III
12 Dornier Works, Friedrichshafen & Munich, Germany
13 Gerhard Fieseler Werke G m b H, Kassel, Germany
14 Wiener Neustedter Flugzeugwerke, Wiener Neustadt, Austria

Aero Engines Branch

15 Bussing N A G Flugmotorenwerke G m b h, Brunswick, Germany
16 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
17 Bavarian Motor Works Inc, Eisenach & Durrerhof, Germany
18 Baverische Motorenwerke A G (BMW) Munich, Germany
19 Henschel Flugmotorenwerke, Kassel, Germany

Light Metal Branch

20 Light Metals Industry of Germany — Part I, Aluminum; Part II, Magnesium
21 Vereinigte Deutsche Metallwerke, Hildesheim, Germany
22 Metallgussgesllschaft G m b H, Leipzig, Germany
23 Aluminumwerk G m b H, Plant No. 2, Bitterfeld, Germany
24 Gebrueder Giulini G m b H, Ludwigshafen, Germany
25 Luftschiffbau, Zeppelin G m b H, Friedrichshafen on Bodensee, Germany
26 Wieland Werke A G, Ulm, Germany
27 Rudolph Rautenbach Leichmetallgiessereien, Solingen, Germany
28 Lippewerke Vereinigte Aluminiumwerke A G, Lunen, Germany
29 Vereinigte Deutsche Metallwerke, Heddernheim, Germany
30 Duerener Metallwerke A G, Duren Wittenau-Berlin & Waren, Germany

AREA STUDIES DIVISION

*31 Area Studies Division Report
32 A Detailed Study of the Effects of Area Bombing on Hamburg
33 A Detailed Study of the Effects of Area Bombing on Wuppertal
34 A Detailed Study of the Effects of Area Bombing on Dusseldorf
35 A Detailed Study of the Effects of Area Bombing on Solingen
36 A Detailed Study of the Effects of Area Bombing on Remscheid
37 A Detailed Study of the Effects of Area Bombing on Darmstadt
38 A Detailed Study of the Effects of Area Bombing on Lubeck
39 A Brief Study of the Effects of Area Bombing on Berlin, Augsburg, Bochum, Leipzig, Hagen, Dortmund, Oberhausen, Schweinfurt, and Bremen

CIVILIAN DEFENSE DIVISION

40 Civilian Defense Division—Final Report
41 Cologne Field Report
42 Bonn Field Report
43 Hanover Field Report
44 Hamburg Field Report—Vol I, Text; Vol II, Exhibits
45 Bad Oldesloe Field Report
46 Augsburg Field Report
47 Reception Areas in Bavaria, Germany

EQUIPMENT DIVISION

Electrical Branch

48 German Electrical Equipment Industry Report
49 Brown Boveri et Cie, Mannheim Kafertal, Germany

Optical and Precision Instrument Branch

*50 Optical and Precision Instrument Industry Report

Abrasives Branch

*51 The German Abrasive Industry
52 Mayer and Schmidt, Offenbach on Main, Germany

Anti-Friction Branch

*53 The German Anti-Friction Bearings Industry

Machine Tools Branch

*54 Machine Tools & Machinery as Capital Equipment
55 Machine Tool Industry in Germany
56 Herman Kolb Co., Cologne, Germany
57 Collet and Engelhard, Offenbach, Germany
58 Naxos Union, Frankfort on Main, Germany

MILITARY ANALYSIS DIVISION

59 The Defeat of the German Air Force
60 V-Weapons (Crossbow) Campaign
61 Air Force Rate of Operation
62 Weather Factors in Combat Bombardment Operations in the European Theatre
63 Bombing Accuracy, USAAF Heavy and Medium Bombers in the ETO
64 Description of RAF Bombing
64a The impact of the Allied Air Effort on German Logistics

MORALE DIVISION

64b The Effects of Strategic Bombing on German Morale (Vol I & II)

Medical Branch

65 The Effect of Bombing on Health and Medical Care in Germany

MUNITIONS DIVISION

Heavy Industry Branch

*66 The Coking Industry Report on Germany
67 Coking Plant Report No. 1, Sections A, B, C, & D
68 Gutehoffnungshuette, Oberhausen, Germany
69 Friedrich-Alfred Huette, Rheinhausen, Germany
70 Neunkirchen Eisenwerke A G, Neunkirchen, Germany
71 Reichswerke Hermann Goering A G, Hallendorf, Germany
72 August Thyssen Huette A G, Hamborn, Germany
73 Friedrich Krupp A G, Borbeck Plant, Essen, Germany
74 Dortmund Hoerder Huettenverein A G, Dortmund, Germany
75 Hoesch A G, Dortmund, Germany
76 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany

Motor Vehicles and Tanks Branch

*77 German Motor Vehicles Industry Report
*78 Tank Industry Report
79 Daimler Benz A G, Unterturkheim, Germany
80 Renault Motor Vehicles Plant, Billancourt, Paris
81 Adam Open, Russelheim, Germany
82 Daimler Benz-Gaggenau Works, Gaggenau, Germany
83 Maschinenfabrik Augsburg-Nurnberg, Nurnberg, Germany
84 Auto Union A G, Chemnitz and Zwickau, Germany
85 Henschel & Sohn, Kassel, Germany
86 Maybach Motor Works, Friedrichshafen, Germany
87 Voigtlander, Maschinenfabrik A G, Plauen, Germany
88 Volkswagenwerke, Fallersleben, Germany
89 Bussing NAG, Brunswick, Germany
90 Muehlenbau Industrie A G (Miag) Brunswick, Germany
91 Friedrich Krupp Grusonwerke, Magdeburg, Germany

Submarine Branch

92 German Submarine Industry Report
93 Maschinenfabrik Augsburg-Nurnberg A G, Augsburg, Germany
94 Blohm and Voss Shipyards, Hamburg, Germany
95 Deutschewerke A G, Kiel, Germany
96 Deutsche Schiff und Maschinenbau, Bremen, Germany
97 Friedrich Krupp Germaniawerft, Kiel, Germany
98 Howaldtswerke A G, Hamburg, Germany
99 Submarine Assembly Shelter, Farge, Germany
100 Bremer Vurkan, Vegesack, Germany

Ordnance Branch

101 Ordnance Industry Report
102 Friedrich Krupp Grusonwerke A G, Magdeburg, Germany

103 Bochumer Verein fuer Gusstahlfabrikation A G, Bochum, Germany
104 Henschel & Sohn, Kassel, Germany
105 Rheinmetall-Borsig, Dusseldorf, Germany
106 Hermann Goering Werke, Braunschweig, Hallendorf, Germany
107 Hannoverische Maschinenbau, Hanover, Germany
108 Gusstahlfabrik Freidrich Krupp, Essen, Germany

OIL DIVISION

*109 Oil Division, Final Report
*110 Oil Division, Final Report, Appendix
*111 Powder, Explosives, Special Rockets and Jet Propellants, War Gases and Smoke Acid (Ministerial Report #1)
112 Underground and Dispersal Plants in Greater Germany
113 The German Oil Industry, Ministerial Report Team 78
114 Ministerial Report on Chemicals

Oil Branch

115 Ammoniakwerke Merseburg G m b H, Leuna, Germany—2 Appendices
116 Braunkohle Benzin A G, Zeitz and Boehlen, Germany Wintershall A G, Leutzkendorf, Germany
117 Ludwigshafen-Oppau Works of I G Farbenindustrie A G, Ludwigshafen, Germany
118 Ruhroel Hydrogenation Plant, Bottrop-Boy, Germany, Vol. I, Vol. II
119 Rhenania Ossag Mineraloelwerke A G, Harburg Refinery, Hamburg, Germany
120 Rhenania Ossag Mineraloelwerke A G, Grasbrook Refinery, Hamburg, Germany
121 Rhenania Ossag Mineraloelwerke A G, Wilhelmsburg Refinery, Hamburg, Germany
122 Gewerkschaft Victor, Castrop-Rauxel, Germany, Vol. I & Vol. II
123 Europaeische Tanklager und Transport A G, Hamburg, Germany
124 Ebano Asphalt Werke A G, Harburg Refinery, Hamburg, Germany
125 Meerbeck Rheinpreussen Synthetic Oil Plant—Vol. I & Vol. II

Rubber Branch

126 Deutsche Dunlop Gummi Co., Hanau on Main, Germany
127 Continental Gummiwerke, Hanover, Germany
128 Huels Synthetic Rubber Plant
129 Ministerial Report on German Rubber Industry

Propellants Branch

130 Elektrochemischewerke, Munich, Germany
131 Schoeneheck Explosive Plant, Lignose Sprengstoff Werke G m b H, Bad Salzemen, Germany
132 Plants of Dynamit A G, Vormal, Alfred Nobel & Co, Troisdorf, Clausthal, Drummel and Duneberg, Germany
133 Deutsche Sprengchemie G m b H, Kraiburg, Germany

OVERALL ECONOMIC EFFECTS DIVISION

134 Overall Economic Effects Division Report
Gross National Product
Kriegseilberichte
Hermann Goering Works
Food and Agriculture
} Special papers which together comprise the above report
134a Industrial Sales Output and Productivity

PHYSICAL DAMAGE DIVISION

134b Physical Damage Division Report (ETO)
135 Villacoublay Airdrome, Paris, France
136 Railroad Repair Yards, Malines, Belgium
137 Railroad Repair Yards, Louvain, Belgium
138 Railroad Repair Yards, Hasselt, Belgium
139 Railroad Repair Yards, Namur, Belgium
140 Submarine Pens, Brest, France
141 Powder Plant, Angouleme, France
142 Powder Plant, Bergerac, France
143 Coking Plants, Montigny & Liege, Belgium
144 Fort St. Blaise Verdun Group, Metz, France
145 Gnome et Rhone, Limoges, France
146 Michelin Tire Factory, Clermont-Ferrand, France
147 Gnome et Rhone Aero Engine Factory, Le Mans, France
148 Kugelfischer Bearing Ball Plant, Ebelsbach, Germany
149 Louis Breguet Aircraft Plant, Toulouse, France
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