

BOSTON PUBLIC LIBRARY



3 9999 06317 332 0

D785

U63

110.57

No. 11785.1163

No. 57



GIVEN BY

U. S. SUPT. OF DOCUMENTS

2715 1143
THE UNITED STATES
STRATEGIC BOMBING SURVEY

Reports. Pacific war. no 57

THE EFFECTS
OF
AIR ATTACK
ON THE
CITY OF NAGOYA

Urban Areas Division

June 1947

5496
/ 12

THE UNITED STATES
STRATEGIC BOMBING SURVEY

THE EFFECTS
OF
AIR ATTACK
ON THE
CITY OF NAGOYA

Urban Areas Division

June 1947

[Washington]



* * D 783
.463
no. 57

U. S. SUPERINTENDENT OF DOCUMENTS

JUL 25 1947

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 the 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.

TABLE OF CONTENTS

	Page
SECTION I. Summary and Conclusions.....	1
SECTION II. Effects of Air Attacks on the City of Nagoya.....	4
Chapter I. Nagoya Before the Attacks.....	4
Chapter II. Air Attacks—Direct Damage to People and Industry.....	8
Chapter III. Effects on People.....	12
Chapter IV. Effects on Transportation and Utilities.....	15
Chapter V. Effects on Industry.....	21
SECTION III. Importance of Large and Small Factories, and Size of Industrial Sample Covered by USSBS.....	48
Chapter I. Sources of Information.....	48
Chapter II. Trends in Size and Relative Importance of Factories.....	48
Chapter III. Percentage of Nagoya's Industry Covered by Survey.....	49
Chapter IV. Importance of Small Industry in Nagoya.....	50
SECTION IV. Effects of Area Attacks on Satellite Cities of Nagoya.....	52
Chapter I. History of the Attacks.....	52
Chapter II. Direct Damage to People.....	53
Chapter III. Industry—Production Trends and Effect of Air Attacks.....	53
Chapter IV. Conclusions.....	55

SECTION I

SUMMARY AND CONCLUSIONS

Introduction

In December 1945, the Urban Areas Division of USSBS completed an intensive investigation of Nagoya, Japan's third largest city. The purpose of that investigation was to determine the effects that Allied air attacks had on the economic life of the city, and especially to determine the extent to which air attacks reduced the ability of the city's industry to supply the Japanese war machine. The information that was collected in the investigation and the conclusions reached by the Urban Areas Division after an analysis of that information are set forth in this report. The report also provides some picture of the extent to which the air attacks affected Nagoya's people, their willingness to work, and their belief that Japan was fighting a winning battle.

NOTE.—Accompanying the detailed investigation of Nagoya, the Urban Areas Division also made a more general survey of five satellite cities near Nagoya—Gifu, Ogaki, Ichinomiya, Okazaki and Kuwana—all of which were hit by urban area attacks in July 1945. A résumé of the damage caused by those attacks is given in the final Section of this report.

During the last 9 months of the Pacific war, the AAF dropped 14,054 tons of bombs in air attacks on the factories and urban areas of Nagoya. Those factories and areas formed the third largest industrial center in Japan, and the main objective of the attacks was to choke off the substantial supply of war products, particularly aircraft and ordnance, that the city was feeding to the nation's war machine. A secondary objective was to destroy the morale and fighting spirit of Nagoya's people. The available evidence shows that the Allied air offensive achieved a high degree of success in accomplishing both objectives.

No other city in Japan, except Tokyo, received as many attacks as did Nagoya. The city was attacked 21 times in the period 13 December 1944–24 July 1945; of those attacks, 15 were precision and 6 were area. The large number and close succession of the attacks make it nearly impossible to isolate the effects of any single attack or to measure

precisely the relative effects of area and precision raids. This is especially so since other factors, nonraid in origin, were exercising varying degrees of influence upon the economic and industrial activity of the city during the raid period. However, by studying the activities and reactions of individual factories, by analyzing industrial and economic statistics for the city, and by comparing the industrial trends and their causes disclosed by that study and analysis with trends and causes reported by leading government and industrial officials in the city, the following general conclusions have been reached.

Precision attacks. It seems clear that precision attacks were the principal factor causing the rapid and accelerating economic decline that Nagoya experienced after the Allied air offensive began in December 1944. In terms of physical damage, precision attacks cut deeply into the productive capacity of leading factories in the aircraft and ordnance industries—industries that, respectively, accounted for about 49 and 13 percent of total city production. Spill-overs from precision attacks affected operations in plants adjoining target plants, and caused severe though temporary disruptions to the city's water supply. One of the more striking repercussions of the resulting water shortage was a large additional amount of incendiary area raid damage caused by a lack of water for fire fighting. The indirect effects of precision attacks were also of great importance. For example, those attacks, and fear of them, were the principal reason why Nagoya began to disperse her aircraft factories in December 1944 after the first precision attacks. (Nagoya's dispersal program was some months ahead of the national program; Nation-wide orders for the dispersal of the aircraft industry were not issued until 1 April 1945.) Her attempts to disperse, substantially all made within the raid period, were, however, so delayed by general reluctance to sacrifice existing production, and so hampered by air attacks, transportation tie-ups, material shortages, and administrative confusion, that no significant output was ever achieved at the new sites, and the huge pro-

duction losses directly due to dispersal were therefore never recovered. Another indirect effect was the contribution of precision attacks (prevalently carried out in daylight) to labor inefficiency and absenteeism, not only in the plants directly attacked, but also in factories that lay near the primary target areas.

Area attacks. From the standpoint of production declines caused, it is believed that the area attacks were considerably less important than the precision attacks, even though 71 percent of all bomb tonnage dropped on Nagoya was dropped in area attacks, and even though area attacks alone destroyed about 21 percent of the city's industrial structure as compared with a total destruction of 37 percent of that structure. It is further believed that the main reason for this was that in Nagoya the effects of area attacks duplicated, as much as complemented, the effects of precision attacks.

While the area raids caused large production losses at plants manufacturing components for large end-product or "customer" factories, and while it was contemplated that the chief effect that those raids would have on industry would be to interrupt end-product manufacture by creating component shortages, the component production declines caused by those raids actually had comparatively little effect on end-product output. The precision attacks had already cut deeply into end-product manufacture itself and thereby had greatly reduced component requirements. Even if end-product factories had been unaffected by precision raids, it is questionable, in view of limitations that would have been placed on end-product production by the rapid decline in receipts of essential raw materials, whether the component requirements of those factories would have been much greater during the raid period. In the absence of both precision attacks and raw materials shortages, however, the area attacks would have had a very substantial effect.

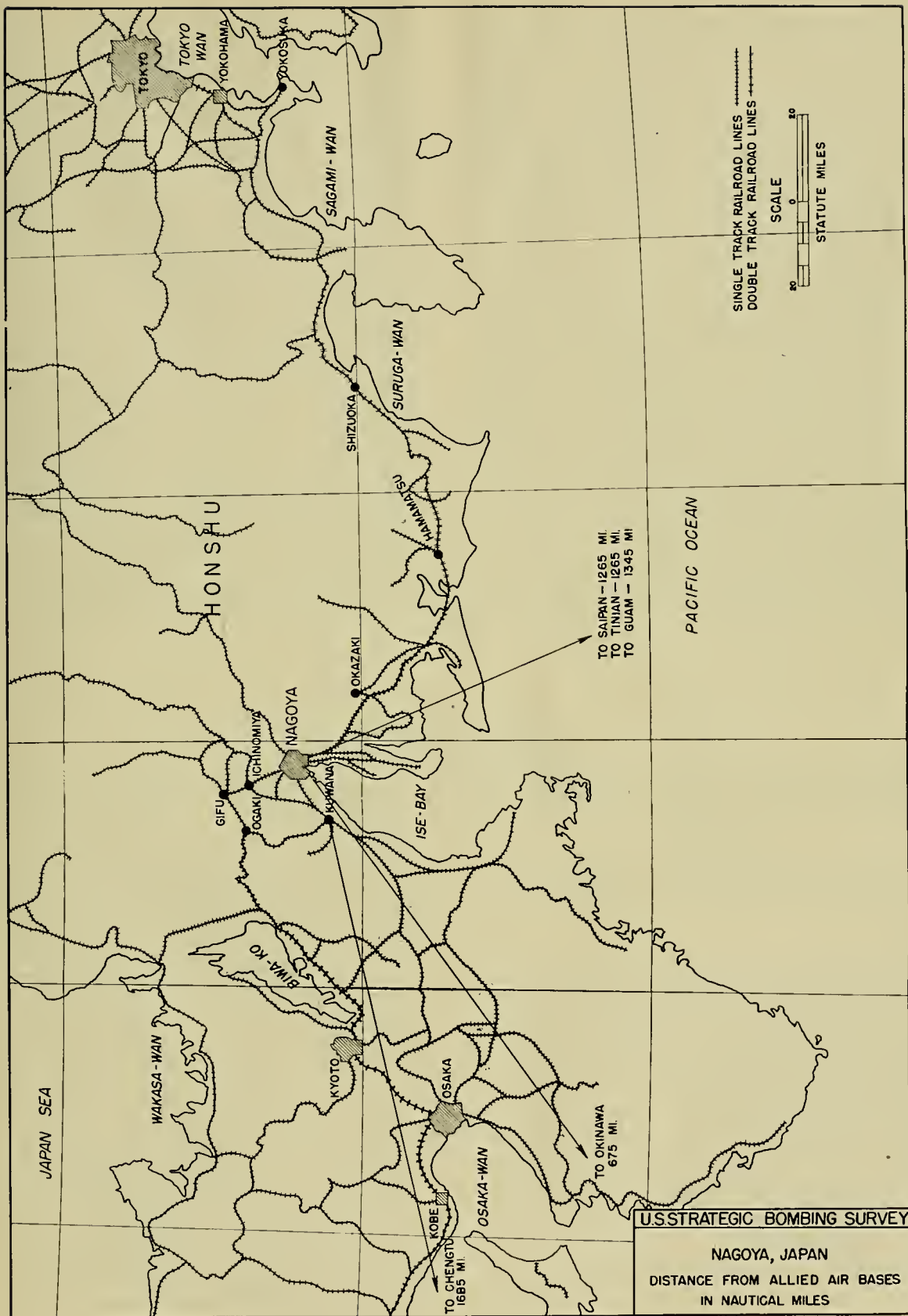
By March 1945, when the heavy area raids began, most of Nagoya's industries were operating below maximum levels, and had considerable excess capacity to cushion them against those raids. In the aircraft industry, much of the productive floor area had already been vacated as a result of dispersal, and the aggregate production of the other industries already had fallen more than 28 percent from the pre-raid level.

However, this does not mean that the effects of the area raids were not extremely important. They

were—especially the cumulative "shock effect." They contributed to a serious decline in worker incentive and morale, and fostered the conviction that Allied air power would ultimately wipe out all important industrial areas in Japan; they caused widespread damage to factories in every industry group; they rendered homeless more than 400,000 people; they resulted in severe (though temporary) disruptions to an already badly strained transportation system; and generally they insured inevitable paralysis of economic life in the city.

Raw materials. Nagoya's receipts of essential industrial materials fell off rapidly during the raid period; that falling-off ranked second to the combined effects of the precision and area attacks, and was probably no more than one-half as important as those attacks, in causing the actual production drop in Nagoya's industry. However, while the decline in raw material receipts was in part caused by the air attacks, nonraid factors would have caused those receipts to fall rapidly even without attacks, and the resulting pinching-off of new supplies of raw materials would have placed a steadily falling ceiling on productive activity. Unless national allocations policies were revised to increase Nagoya's share of Japan's total materials supply, that pinching-off of raw materials alone would have forced the city's output to levels not much higher, at best, than those to which it was in fact driven by all factors combined, but it would have taken some months longer to do so. In light of the raw materials situation, it is believed that the net effect of air attacks on Nagoya was to accelerate by a few months the decline in Nagoya's industrial activity that would inevitably have resulted from the growing national raw material shortage alone.

Labor difficulties. Frequently cited by Nagoya's governmental and industrial authorities as a major cause of production declines, labor difficulties were caused partly by air attacks and partly by other factors resulting in part from air attacks and in part from nonraid conditions. Thus, air alerts caused worker fatigue and loss of productive hours, and the destruction of workers' homes led to absenteeism and loss of morale; mass evacuations caused by that destruction aggravated an already bad food situation by disrupting the distribution system; the food situation in turn led to greater worker fatigue and to further absenteeism as workers foraged for food; the basic difficulty



in the food situation was simply a shortage in supply, largely caused by the submarine and mining blockade that limited food imports. Although similar interaction of raid and nonraid factors complicated almost every phase of the labor problem, it is still clear that the raids both created and intensified labor difficulties, and that those difficulties contributed to the decline of Nagoya's economy.

As Nagoya's expanding industries siphoned off surplus labor in the city and the surrounding countryside, shortages developed in the number of available workers, particularly skilled workers. Those shortages were not cured by the large number of women, students, and conscripts that were taken into the factories, since such workers were from 20 to 40 percent less efficient than regular workers, and almost all of them were unskilled. After the raids began, the shortage of skilled workers was displaced as the chief labor difficulty by sharply increased absenteeism and by growing inefficiency on the part of workers on the job.

Final comment. The air attacks against Nagoya, which directly and indirectly were largely responsible for causing the final collapse of the

city's industry, were launched to gain two broad objectives: (1) mainly by precision attacks, to wipe out Nagoya's aircraft production and, later on, its ordnance production, and (2) mainly by area attacks, to knock out the city's remaining industries and to destroy the people's will to resist. Since so much of Nagoya's production was concentrated in a small number of important factories, it is believed that the same objectives could have been gained at least as quickly, and with less expenditure of effort, by a continuation and expansion of the precision attack program followed in the first part of the raid period, without recourse to area attacks.

On the other hand, there is no doubt that area attacks alone caused widespread damage to Nagoya's industry and people, and the destructive potential of that type of attack was strikingly illustrated by the raid history of Nagoya. Given an enemy city a large part of whose production comes from small factories—a city such as Nagoya was in 1942, and as several other Japanese cities were as late as 1945—it is believed that area attacks would bring about that city's destruction more rapidly and cheaply than precision attacks.

SECTION II

EFFECTS OF AIR ATTACKS ON THE CITY OF NAGOYA

CHAPTER I

NAGOYA BEFORE THE ATTACKS

General

The city of Nagoya, 35°08' N.—136°54' E., is located at the head of Ise Bay on the South coast of the main Japanese island of Hanshu, about 165 miles west southeast of Tokyo. During the war it was the third largest city in Japan, with an end of 1944 population of 1,200,000 as compared with 5,100,000 for Tokyo and 2,200,000 for Osaka. It was the administrative center of the Tokai region—1 of the 9 regional blocs into which Japan was divided—and was the third largest industrial center in Japan, exceeded only by Tokyo-Kawasaki and Osaka-Kobe.

The region surrounding Nagoya added to the industrial strength of the city, and provided

means of cushioning it from the effects of an Allied air offensive against Japan. North of the city extended the fertile Nobi Plain, one of the nation's principal agricultural areas, and the proximity of that area made the city relatively independent of long-haul food imports and consequently made it less vulnerable than many Japanese cities to attacks on Japan's over-all transportation system. Satellite cities surrounding Nagoya were important sources of components for use by Nagoya's factories; those cities also contained several important end-product plants—for example, Gifu was the site of a great assembly complex operated by the Kawasaki Aircraft Co. and Okazaki boasted the Greater Japan Arms Works, which was a first-line producer of aircraft machine guns. The satellite cities, furthermore, offered numerous ready-made industrial sites to which Nagoya plants could disperse in the event of air attacks.

Four trunk rail lines and a local rail net served the city and gave easy access to its satellite cities and to the rest of Japan. In addition, Nagoya had an excellent harbor, capable of accommodating about forty 10,000-ton vessels, but by the time the Allied air offensive began, the antishipping campaign had virtually closed the port to large vessels.

War Mobilization

By 1944, the people and industry of Nagoya had been molded into an efficient and productive war economy as the result of the National Government's program to mobilize the entire nation for all-out war production. Industrial production in Nagoya reached its peak in the fall of that year, after the loss of Saipan had goaded the Japanese into stepping up the flow of military supplies to the fighting forces.

People. By the end of 1944, most eligible persons in Nagoya were engaged in essential war work. Early in the war years, expanding industry had absorbed all surplus labor in the city, and as industry continued to expand, the increased needs of war factories were met by drawing upon new labor strength that flowed into the city from the surrounding region, by raiding civilian industry and agriculture, and by using more and more women. By 1944 those new sources had been largely exhausted, and to meet the still growing needs of the war plants, school children were compelled to "volunteer" for work in those plants. In April 1944, all students over 16 were called for such work, and in August of that year the age limit was dropped to 13. Exception was made only for agricultural school students and for those physically disqualified for factory work.

On the eve of the raids, therefore, Nagoya's population was fully mobilized for war work. Their morale was high; they believed in ultimate Japanese victory; they were confident of their ability to fight off any attacks that the Allies might mount; and their resolve to do so was quickened by proud recognition of the importance to Japan's war effort of the factories of the city.

Industry. The city contained the largest concentration of primary aircraft manufacturing capacity to be found in Japan. Six of the most important aircraft targets in the Empire were located within the city limits, or immediately outside of them. In addition, several large ordnance factories, including five forming the great Nagoya arsenal, made the city one of Japan's important ordnance centers. Those great end-product plants

of the aircraft and ordnance industries were backed up by important electrical equipment factories and by a large metals and metal products industry.

Nagoya as a Target

Most of Nagoya's industry was concentrated in two general areas:

1. A 15 square mile area around and north of Nagoya Harbor in the southern half of the city;
2. A smaller, crescent-shaped area about two miles wide in the extreme northeast sector of the city.

The 2 industrial areas, and a central commercial zone, were sandwiched between 2 crowded residential zones. At the end of 1944, the average density of population in the residential areas was 37,000 people per square mile, and ranged up to 75,000 per square mile in the most dense parts. Almost all residences were made of wood, and were highly inflammable.

The 45 large plants appearing on the map employed about 66 percent of the December 1944 labor force of the city and produced about 80 percent of the city's total 1944 industrial output. Thirteen of those plants alone produced more than 63 percent of the city's total output. This concentration of production into a few large factories made the city a likely target for a series of precision attacks. However, 36 factories employing between 500 and 1,000 workers each, 200 smaller plants employing between 50 and 500 workers each, and several thousand plants and workshops employing less than 50 workers each, were scattered throughout the city, and those plants and workshops, and the overcrowded and flimsily-constructed residential zones, made the city a promising target for incendiary area attacks.

The city's vulnerability to area attack was reduced by (1) fire breaks in the form of rail lines, canals, and a number of wide streets bordered by commercial buildings of solid fire-resistant construction (Photographs 1 and 2), and (2) the successful completion by December 1944 (before the raids began) of an "anti-fire-raid" program that included the razing of wooden buildings in and around factory areas and in the most congested residential areas to provide additional firebreaks. However, while those fire breaks were fairly effective in confining fire to the compartment in which it started, they were little real protection against the great mid-March and mid-May 1945 area attacks that sowed incendiaries widely over the city.

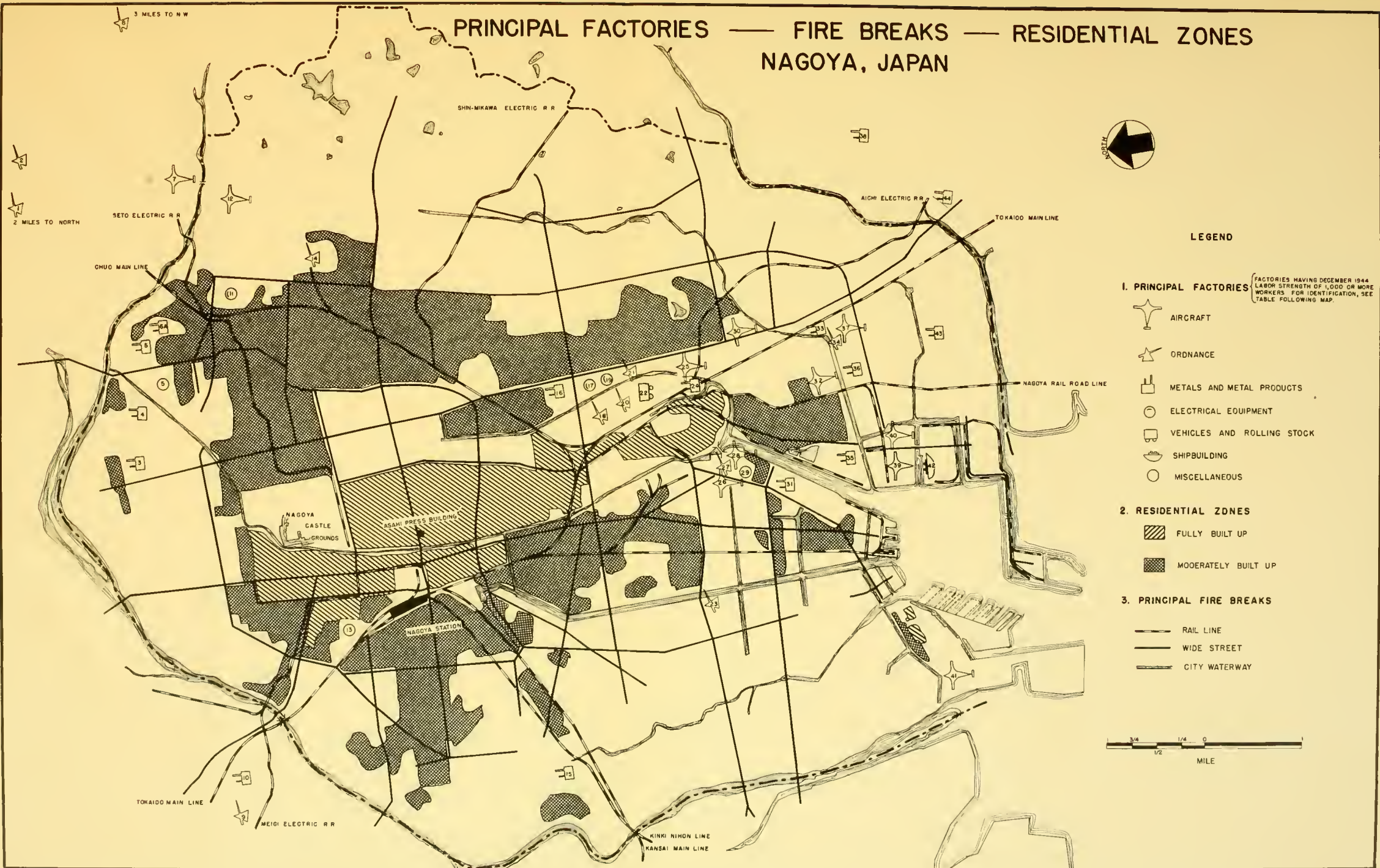
NAGOYA—IDENTIFICATION OF PRINCIPAL FACTORIES SHOWN ON MAP

[With indication of size in terms of productive worker strength]

Number on map	Target No. 90.20	Name	Worker strength Dec. 1944	Number on map	Target No. 90.20	Name	Worker strength Dec. 1944
		Aircraft industry (11 factories):				Metals and metal products industry (15 factories):	
12	193	Mitsubishi Aircraft Engine No. 4 factory	21, 639	31	2040	Sumitomo Light Metals Co.	11, 357
41	1729	Aichi Aircraft Assembly, Eitoku factory	20, 630	15	2129	Mitsubishi Aircraft Engine, No. 10 factory (small part also adjoins No. 12 on map)	9, 580
39	194	Mitsubishi Navy Aircraft, Oe-machi factory (parent plant of No. 3 Complex)	15, 000	43	247-D	Daido Steel Co., Hoshizaki factory	8, 770
40	194	Mitsubishi Army Aircraft, Oe-machi factory (parent plant of No. 5 Complex)	13, 500	3	1753	Kobe Steel Works	6, 828
26	2010	Aichi Aircraft Engine, Atsuta factory	5, 828	10	2140	Mitsubishi Heavy Ind., No. 12 factory	6, 170
37	1129	Okamoto Ind'l Co., Kasadera factory	5, 690	35	247-C	Daido Steel Co., Tsukiji factory	4, 555
32	-----	Mitsubishi Army Aircraft, No. 11 Dotoku factory (controlled by No. 5 Complex)	4, 620	6a	-----	Mitsubishi Aircraft Engine, No. 22 (Ozone) factory	4, 000
28	198	Aichi Aircraft Assembly, Funakata factory	3, 535	4	1146	Okuma Iron, Hagino factory	2, 272
7	-----	Yajima Manufacturing Co.	1, 669	24	247-B	Daido Steel Co., Atsuta factory	2, 125
30	-----	Mitsubishi Army Aircraft, Mizuho factory (part of No. 5 Complex)	1, 200	38	-----	Sumitomo Metals Co., Narumi factory	1, 863
25	-----	Nakajima Aircraft, Atsuta factory	1, 065	33	-----	Nagoya Screw Co.	1, 700
		Ordnance industry (11 factories):		36	1799	Hokoku Engineer'g Co., No. 2 factory	1, 400
27	198	Aichi-Clock Electric Co., Funakata factory	15, 200	44	-----	Chuo Spring Co., Narumi factory	1, 268
2	200	Nagoya Arsenal, Toriimatsu factory	7, 900	16	242	Okamoto Ind'l Co., Showa factory	1, 200
14	196	Nagoya Arsenal, Chikusa factory	6, 180	6	1797	Okuma Iron, Kamiida factory	1, 193
1	1691	Nagoya Arsenal, Takagi factory	5, 700			Electrical equipment industry (3 factories):	
9	1141	Howa Heavy Industry Co.	5, 252	11	254	Mitsubishi Electrical Equipment Co.	9, 020
20	197	Nagoya Arsenal, Atsuta factory	5, 066	19	1171	Japan Insulator Co.	1, 990
34	-----	Takano Precision Instrument Co.	3, 892	17	-----	Japan Special Ceramics Co.	1, 881
18	197	Nagoya Arsenal, Takakura factory	3, 255			Vehicles and rolling stock industry (1 factory):	
21	199	Aichi Clock-Electric Co., Mizuho factory	2, 101	22	241	Japan Vehicle Co.	4, 247
8	-----	Asahi Ordnance Co.	1, 368	42	2163	Shipbuilding industry (1 factory): Nagoya Shipbuilding Co.	3, 000
23	-----	Aichi Clock-Electric Co., Meitoku factory	1, 200			Miscellaneous industries (3 factories):	
				29	-----	Aichi Chemical Industrial Co.	2, 799
				13	1153	Japan Porcelain Co.	2, 228
				5	-----	Daito Industrial Co.	1, 551

NOTE.—Workers in the above 45 factories (employing 1,000 or more workers each) total 242,487, and represent about 66 percent of the entire industrial labor force serving the area shown.

PRINCIPAL FACTORIES — FIRE BREAKS — RESIDENTIAL ZONES NAGOYA, JAPAN



EXAMPLES OF FIRE BREAKS



Photo 1. View of a canal looking west from the Asahi Press Building.



Photo 2. A wide street east of the Asahi Press Building. Note the commercial buildings of solid construction bordering on the street. Effectiveness is not illustrated since IB fell on both sides of street.

CHAPTER II

AIR ATTACKS—DIRECT DAMAGE TO PEOPLE AND INDUSTRY

History of the Attacks

General. The air offensive against Nagoya began on 13 December 1944 with a precision raid on the Mitsubishi A/C Engine factory, and ended on 24 July 1945 with a precision raid on the Aichi A/C Assembly, Eitoku factory. A total of 21 air attacks made up the offensive, and a total of 14,054 tons of bombs was dropped; of that tonnage, about 71 percent was dropped in urban area attacks, practically all in the 4 fire raids of mid-March and mid-May 1945. For the most part, the precision attack targets were the important aircraft and aircraft engine factories, but in June and July, they included 3 large ordnance factories, and the Sumitomo Light Metals main plant (which manufactured aluminum components for major aircraft factories in the Nagoya region).

Attack data. Details on the location, size, and targets of the Nagoya attacks are shown on the map and in the table on Page 11. The attacks fell into three phases: the first made up mainly of small precision attacks; the second featuring the heavy area attacks of mid-March and mid-May and one large precision raid; the third consisting entirely of small and medium precision attacks. The weight of attack in each of those three phases is indicated by the following summary.

TABLE 1

NAGOYA—SUMMARY OF ATTACK DATA

First phase—13 Dec. to 15 Feb.
Second phase—12 Mar. to 17 May
Third phase—9 June to 24 July

Month	Number of attacks		Tons of bombs dropped	
	Precision	Area	Precision	Area
1944—Dec.....	3		470	
1945—Jan.....	2	2	183	232
Feb.....	1		105	
Mar.....	2	2	1,597	3,746
Apr.....	1		153	
May.....		2		6,023
June.....	5		1,094	
July.....	1		451	
Total.....	15	6	4,053	10,001

Operational aspects. During the first phase, the small number of aircraft participating (averaging only 46 planes per raid), their low bomb load, and weather difficulties at high altitude, generally limited the success of the attacks on Nagoya. However, the first 2 raids—precision attacks of 13 and 18 December on the Mitsubishi aircraft targets—caused considerable damage. With the beginning of the second and heaviest phase, a new system of bombing the city was inaugurated; the Twentieth AF opened a series of 4 urban area incendiary raids, with the B29s carrying a much greater bomb load per plane and approaching at low altitude. Three of the area raids took place at night; the other, on 14 May, occurred in the early morning, and represented the first fire raid on Japan in which bombing was done visually. The precision attacks of the second and third phases, mainly taking place in daylight, were also at low altitudes, and accuracy was much improved over the earlier precision attacks.

General Extent of Damage

Allied estimates. From photographic interpretation, the Twentieth AF estimated that air attacks destroyed or heavily damaged about 12.4 square miles of the city's built-up area, or 31 percent of the preraid total of 40 square miles. The Joint Target Group estimated that residential damage, in terms of roof area, amounted to about 40 percent of the pre-raid structure. Industrial damage, in terms of roof area, was placed at 39.8 percent.

Survey findings. The USSBS found that the above estimates were too low for residential damage, but approximately correct for industrial damage. The Survey obtained from the Japanese (1) the direct damage to residences and the number of people killed, injured, and dehousing (figures were supplied by Nagoya City Administration); and (2) the direct damage to productive facilities of industry in Nagoya and its environs (figures were compiled from questionnaires returned by most of the factories employing 50 or more workers each). The Survey's findings are set forth below.

Direct Damage to People

General description. The precision and area attacks together destroyed or badly damaged 67,311 residences, or about 47 percent of Nagoya's 143,600 pre-raid homes. The number of people killed, injured, and dehousing totaled 537,452, or about 44

percent of the city's pre-raid population of 1,230,000, but most of the people directly affected were deoused only. Greater destruction of homes and more dehousing of people resulted from the area attacks, both in terms of total figures and on a ton-for-ton comparison with precision attacks. However, the popular belief that fire raids would cause greater injury and loss of life than would precision attacks was not borne out by the experience in Nagoya. The precision attacks killed and injured 10,055 persons; the area attacks, employing about 2½ times as much bomb tonnage, killed and injured 8,192.

TABLE 2
NAGOYA—DAMAGE TO HOMES AND PEOPLE

I. Total figures

Type of attack	Number of Homes		People killed	People injured	People deoused
	Totally destroyed	Badly damaged			
Precision-----	5, 918	4, 270	5, 669	4, 386	85, 173
Area-----	54, 959	2, 164	2, 483	5, 709	434, 032
Total---	60, 877	6, 434	8, 152	10, 095	519, 205

II. Per ton of bombs

Precision-----	1. 5	1. 1	1. 4	1. 1	21. 0
Area-----	5. 5	. 2	. 2	. 6	43. 4
All attacks----	4. 3	. 5	. 6	. 7	36. 9

Approximately 85 percent of the people deoused were forced to evacuate the city. Evacuation, and other indirect effects on people of the raids, are discussed in Chapter III of this section.

Direct Damage to Industry

Discussion of source. The tables below were compiled from physical damage statistics obtained from 247 factories within Nagoya or just outside the city limits, including all but 1 of the factories employing 500 or more workers each; the tables represent a coverage of approximately 90 percent of Nagoya's entire industrial structure. (Further discussion of coverage, in terms of production and labor force, is given in Section III of this report.) The factories supplied figures for:

1. The floor area directly employed in their production process just before each attack. The factories also gave figures for nonproductive floor area, such as warehouses, offices, and dormitories;

these were disregarded in compiling the physical damage tables.

2. Structural damage caused by each attack, in terms of a percentage of the productive floor area that existed just before that attack. "Structural damage" was so defined that, considering the small extent of industrial repair in Nagoya, the figures represent the minimum of productive floor area made useless by the attacks. The Japanese were told to consider as "structural damage" only the damage to structural and load-bearing members of buildings. Roof and outer-wall destruction was to be disregarded.

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.

Those factories that were not hit by air attacks were told to provide figures for items "(1)" and "(3)" as of the end of 1944, the beginning of the raid period. Thus for the 90 percent sample of Nagoya's industry, the "pre-raid" productive floor area (that is, the floor area as it existed at the time the raid period began) could be computed from the items "(1)" reported by the factories, both hit and unhit, making up that sample. Similarly, "pre-raid" plant and equipment could be computed from the items "(3)".

Damage to productive floor area. It was found that, of the 39,334,000 square feet of "pre-raid" productive floor area thus computed, air attacks wiped out 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.

As might be expected, ton for ton, the bombs dropped in precision attacks (in a more limited type of mission and on a more concentrated type of target) caused nearly twice as much industrial damage as the bombs dropped in area attacks.

Table 4 needs qualification. The precision attacks of January through April 1945 were directed toward targets already hit in December 1944, and the July 1945 attack was against a target that had been hit in the previous month; the overall damage caused by precision attacks would probably have been increased if all precision attacks had been directed toward targets not previously hit. On the other hand, the two area attacks of mid-March 1945 were concentrated upon zones that were primarily residential and commercial, rather than industrial. Had those attacks been made

TABLE 3

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, ALL INDUSTRIES

Preraid total productive floor area, 39,334,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec-----	1, 654, 000	4. 2		
1945—Jan-----	78, 000	. 2	105, 000	0. 3
Feb-----	214, 000	. 5		
Mar-----	650, 000	1. 7	1, 696, 000	4. 3
Apr-----	737, 000	1. 9		
May-----			6, 578, 000	16. 7
June-----	2, 450, 000	6. 2		
July-----	345, 000	. 9		
Aug-----	142, 000	. 4		
Total-----	6, 270, 000	15. 9	8, 379, 000	21. 3

Total destruction by all attacks, 14,649,000—37.2 percent.

against more industrialized areas, as were the mid-May attacks, the extent of industrial damage caused by all area attacks combined would have been increased. The foregoing conditions would tend to increase the damage caused by both precision and area attacks, however, and it is estimated that, had those conditions prevailed, the ratio of 2 to 1 in favor of precision attack tonnage would still be approximately correct.

Damage to industrial plant and equipment. Statistics for plant and equipment destruction that are comparable to those for destruction of productive floor area were obtained from all Nagoya's factories that were studied, except for the two large Mitsubishi aircraft assembly complexes and a smaller Mitsubishi A/C engine parts factory. It is known, however, that in the two large complexes, the percentage of total preraid plant and equipment destroyed by air attacks was considerably smaller than the percentage of productive floor area destroyed; those complexes were among the first to vacate productive floor area and to transfer plant and equipment out of Nagoya in dispersal operations. For the remainder of Nagoya's industry, Table 5 indicates that about 29.7 percent of total pre-raid plant and equipment was demolished by air attacks, as compared with 34.8 percent destruction of pre-raid productive floor area.

Bomb damage to specific industries. In terms of the percentage of preraid productive facilities destroyed, the greatest damage was inflicted upon Nagoya's aircraft and ordnance industries, which included most of the precision attack targets. An industry-by-industry description of bomb damage, and an analysis of the direct and indirect effects on industry of air attacks, are given in Chapter V of this section.

TABLE 4

NAGOYA—PHYSICAL DAMAGE IN TERMS OF BOMB TONNAGE

Month	Precision attacks			Area attacks		
	Total production floor area destroyed	Bombs dropped	Destruction per ton of bombs	Total production floor area destroyed	Bombs dropped	Destruction per ton of bombs
	<i>Square feet</i>	<i>Tons</i>	<i>Square feet</i>	<i>Square feet</i>	<i>Tons</i>	<i>Square feet</i>
1944—Dec-----	1, 654, 000	470	3, 519			
1945—Jan-----	78, 000	183	426	105, 000	232	453
Feb-----	214, 000	105	2, 038			
Mar-----	650, 000	1, 597	407	1, 696, 000	3, 746	453
Apr-----	737, 000	153	4, 817			
May-----				6, 578, 000	6, 023	1, 092
June-----	2, 450, 000	1, 094	2, 239			
July-----	345, 000	451	765			
Aug-----	142, 000	Negligible				
Total-----	6, 270, 000	4, 053	1, 547	8, 379, 000	10, 001	838

AIR ATTACKS ON NAGOYA, JAPAN

DECEMBER 1944-- AUGUST 1945

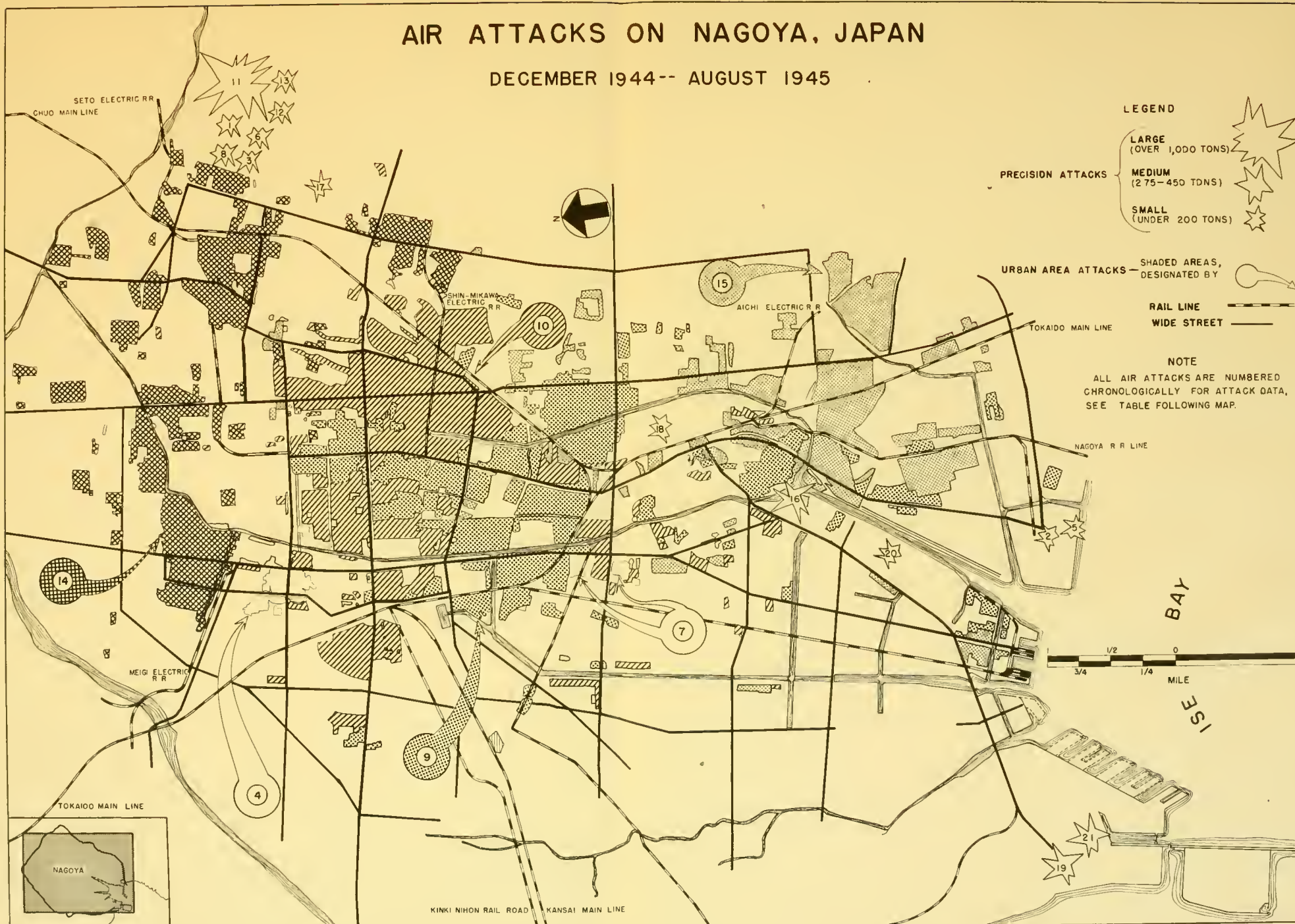


TABLE 5

NAGOYA—PLANT AND EQUIPMENT DESTROYED, ALL INDUSTRIES ¹

[Showing comparison with productive floor area destruction]

Month	Value of plant and equipment destroyed, in thousands of yen (percentage of pre-raid total in parentheses)			Percentage of pre-raid productive floor area destroyed. All attacks
	Precision attacks	Area attacks	All attacks	
Preraid total.....			880, 899	
1944—Dec.....	4, 648 (0. 5)		4, 648 (0. 5)	(2. 8)
1945—Jan.....	150 (—)	4, 974 (0. 6)	5, 124 (0. 6)	(. 4)
Feb.....	2, 477 (. 3)		2, 477 (. 3)	(. 6)
Mar.....	6, 558 (. 7)	34, 259 (3. 9)	40, 817 (4. 6)	(6. 6)
Apr.....	17, 619 (2. 0)		17, 619 (2. 0)	(2. 2)
May.....		121, 096 (13. 7)	121, 096 (13. 7)	(13. 4)
June.....	65, 946 (7. 5)		65, 946 (7. 5)	(7. 4)
July.....	2, 059 (. 2)		2, 059 (. 2)	(1. 0)
Aug.....	2, 553 (. 3)		2, 553 (. 3)	(. 4)
Totals.....	102, 010 (11. 6)	160, 329 (18. 2)	262, 339 (29. 8)	(34. 8)

¹ Figures in this table do not include damage to the 2 Mitsubishi Aircraft assembly complexes, and to a smaller Mitsubishi Aircraft Engine parts factory.

NAGOYA—DATA FOR AIR ATTACKS SHOWN ON PRECEDING MAP

[Listed chronologically, with numbers corresponding to numbers on map.]

Number	Date	Type of attack	Target	Tons of bombs dropped
1	13 Dec	Precision	Mitsubishi Aircraft Engine, No. 4 factory	186
2	18 Dec	do	Mitsubishi Army-Navy Aircraft, Oe-machi	161
3	22 Dec	do	Mitsubishi Aircraft Engine, No. 4 factory	123
4	3 Jan	Urban Area	N. Central Nagoya	150
5	14 Jan	Precision	Mitsubishi Army-Navy Aircraft, Oe-machi	99
6	23 Jan	do	Mitsubishi Aircraft Engine, No. 4 factory	84
7	do	Urban Area	N. Central Nagoya	82
8	15 Feb	Precision	Mitsubishi Aircraft Engine, No. 4 factory	105
9	12 Mar	Urban Area	Central Nagoya	1, 886
10	19 Mar	Urban Area	N. Central Nagoya	1, 860
11	24 Mar	Precision	Mitsubishi Aircraft Engine, No. 4 factory	1, 545
12	30 Mar	do	Mitsubishi Aircraft Engine, No. 4 factory	52
13	7 Apr	do	Mitsubishi Aircraft Engine, No. 4 factory	153
14	14 May	Urban Area	N. Nagoya	2, 679
15	17 May	Urban Area	S. Nagoya	3, 344
16	9 June	Precision	Aichi Clock-Electric, Aircraft Engine and Aircraft Assembly—Atsuta, Funakata.	278
17	26 June	do	Nagoya Arsenal, Chikusa factory	199
18	do	do	Nagoya Arsenal, Atsuta factory and Japan Vehicle Co.	97
19	do	do	Aichi Aircraft Assembly, Eitoku factory	363
20	do	do	Sumitomo Light Metals Co.	157
21	24 July	do	Aichi Aircraft Assembly, Eitoku factory	451

Total tonnage—Precision..... 4, 053

Total tonnage—Urban Area..... 10, 001

14, 054

NOTE.—In addition to the attacks shown, there were several others of low tonnage on targets of opportunity. Most tonnage in precision attacks was HE, and most tonnage in area attacks was IB.

CHAPTER III

EFFECTS ON PEOPLE

Introduction

The Urban Areas Division, in studying the effects of air attacks on Nagoya, concentrated upon investigating the effects of those attacks on the city's industrial and economic life. As a natural byproduct of its investigation, however, the Division collected much general information about the impact of the war on Nagoya's people before and during the raids. Meanwhile, the Morale Division of USSBS made an intensive survey, in Nagoya and in over 60 other Japanese cities and towns, of the people's wartime sentiments and of their reactions to the raids. In this chapter, data collected by the Urban Areas Division and some of the findings of the Morale Division are consolidated.

General Description

Long before the raids began, the authorities in Nagoya took steps to prepare the city for defense against air attack, and they increased their efforts after the fall of Saipan in mid-1944. Throughout the pre-raid period, however, the people of Nagoya remained generally unconvinced of the danger of large-scale fire raids, and apathetic toward the local government's defense precautions, which they regarded as extreme and as the result of undue apprehension on the part of the authorities.

The air attacks that took place in the first phase of the raid period (six precision attacks and two minor area raids) caused very little damage to houses and very few casualties; the fact that damage was so small strengthened the people's confidence, and was taken as proof that they could cope with future raids with the existing defense system. The people's attitude during this first phase of air attacks was summed up by Nagoya city officials as follows:

"Because of the smallness of the damage, the people in general during this period believed that the flames could be extinguished to some extent if they fought against them courageously, and never dreamed that the greater part of the city would be reduced to ashes by one air raid, and also thought the damage could not be very great. Thus, they had the ease of mind, which was the cause of neglecting the protection measures against bombing."

The two devastating fire raids of mid-March 1945 all but wiped out the people's illusions about the effectiveness of Nagoya's air defenses. Evacuation, which for many months had been little more than a government-sponsored program in which cooperation could be obtained only by offers of special privileges, suddenly turned into the panicky mass flight of nearly 317,000 people, many made homeless overnight, and many struggling to escape the horrors of another unquenchable rain of incendiaries. Of those who remained in Nagoya after the March area raids, another 170,000 fled the city after the second pair of heavy fire raids took place in mid-May.

In brief, before the first heavy fire raid, Nagoya still had a population of more than 1,100,000 people, most of them confident that the existing air defenses were fully adequate. When the war ended, there were only 544,000 people left in the city, and in November 1945, the Morale Division found that only 7 percent of those still in the city expressed satisfaction with Nagoya's air raid precautions, and that only 3 percent were satisfied with the adequacy of Nagoya's post-raid relief activities.

Defense Precautions—Effectiveness

Fire control. In addition to the city's regular fire-fighting personnel and equipment, Nagoya had three types of volunteer fire organizations before the raids began: a civil fire brigade (Keibodan), which supported the regulars; several neighborhood associations (Chonakai), which were assigned to concentrate upon fires in their respective districts of the city; and many smaller neighborhood groups (Tonarigumi). Although, in the words of Nagoya city officials, "the citizens were well-trained * * * in extinguishing 6-pound incendiary bombs," it is evident that their training fell far short of preparing them for the overwhelming number of large incendiaries that fell in the March and May raids. Civilian fire-fighting forces, moreover, were greatly depleted by the mass evacuations that followed those raids. The fire trucks operated by the Prefectural Fire Department were too few in number, in poor condition, and without sufficient fuel. Finally, continual interruptions in the city's water supply, caused by repeated damage to the water works from precision attack spillovers and by damage to the water mains from both precision and area attacks, led to critical shortages of water for fire

control. The breakdown of Nagoya's fire defense system after the heavy area raids began, and the failure of a plan then adopted to check the fires, were described by city officials as follows:

"With the increasing violence, however, a large amount of incendiary bombs thrown down, especially large incendiary bombs, could not be extinguished by the apparatus and personnel of the neighborhood groups and associations, and a new plan was devised to check the spreading of fires. In order to check the spreading of the flames, ceilings and wooden fences were removed, sand boxes and bags were made, and firehooks and other implements were obtained. But in the latter part of the war, the fighting spirit of the citizens was depressed by the continuous extensive bombing; many citizens evacuated the city to escape from bombing and thought only of taking out their household goods, resulting in the neglect of putting out of fires and many vacant houses."

Air-raid shelters. An elaborate network of shelters had been constructed throughout the city during the early war years. Those shelters were not far below ground surface, and were often fragilely built, but it is believed that they provided adequate protection during the raids. Training in shelter discipline, however, apparently was neglected before the attacks. Describing people's reaction to the first air attack (occurring on 13 December 1944), Nagoya authorities remarked that "as the hostile planes were so bright and beautiful, the citizens unconsciously put their heads out from their shelters and watched them."

Post-raid relief. Through a patriotic relief association, Nagoya set up 4 city depots and 30 sub-depots to distribute emergency food, bedding, fuel, and medical supplies, to raid victims. However, it is believed that the available emergency supplies were far from sufficient to meet the needs of the great numbers injured or deboused by the March and May area raids.

Evacuation

Total evacuations. It is estimated that about 819,300 people left Nagoya between July 1944 and the end of the war, either due to the fear of air attacks, or as the result of actually being injured or deboused in those attacks. (Another 30,000 are estimated to have evacuated the city accompanying the dispersal of factories.)

TABLE 6

NAGOYA—EVACUATION BY MONTHS ¹

Before the heavy area raids began		After the heavy area raids began	
1944—July	64, 600	1945—Mar	316, 900
Aug	17, 000	Apr	33, 700
Sept	Negligible.	May	169, 900
Oct	24, 800	June	24, 600
Nov	72, 900	July	16, 600
Dec	68, 800	Aug	Negligible.
1945—Jan	22, 900		
Feb	16, 600		
Totals	287, 600		561, 700

Total evacuations, 849,300.

¹ Estimated from net monthly population changes, with allowances for births, deaths, and people drafted into military service. Nagoya officials indicated that the movement of people into Nagoya was negligible after June 1944. The above figures include workers who left the city after November 1944 accompanying the dispersal of factories; the officials estimated that those workers totaled about 30,000.

Evacuation before the heavy area raids. A program to evacuate some of Nagoya's people was first announced by the local government in March 1944 in accordance with Japanese Cabinet orders. The plan was to remove all people who could not be industrially employed and who could not participate in air raid defense—in other words, the aged, the very young, the infirm, and the pregnant women. As already mentioned, Nagoya authorities had difficulty in convincing the people that evacuation was necessary, and movement from the city did not begin until July 1944. The program lagged until November 1944, when the local government decided to offer cash bounties, transportation facilities, and housing accommodations outside the city, as special inducements to those who agreed to evacuate. By the end of February 1945, the prefectural and city administrations had succeeded in evacuating approximately 287,600 people, or about 20 percent of the mid-1944 population.

Evacuation after the area raids. Most of the evacuation in the last 6 months of the war took place in March and May, directly after the heavy fire raids. In those 2 months, there was a mass departure of nearly 487,000 people, 70 percent more than had been evacuated in the entire 8 months prior to the March raids. An estimated 275,000 of that total had been made homeless (based on officials' statements that 85 percent of those deboused were forced to evacuate); most of the others fled in fear of a recurrence of large-

scale area attacks. According to the officials questioned, the great fire raids threw the city into utter confusion, all transportation facilities and highways temporarily were jammed, and the defense of the city was all but forgotten. The local government was virtually powerless to control the evacuation, and workers, whose departure hitherto had been restricted, left along with the non-workers.

NOTE.—It appears, however, that the larger part of the workers who left the city continued to work in Nagoya's factories, commuting from their new quarters outside the city. According to statistics supplied by the city administration, the number of industrial workers residing in Nagoya fell 60 percent between December 1944 and June 1945, or from 334,000 to 134,000. In the same period, the number of industrial workers actually working in an 80 percent sample of industry in Nagoya and its environs fell from 264,379 to 207,595, a decline of only 22 percent. While the total industrial labor force was not seriously cut, the mass evacuations contributed substantially to the decline in productivity per worker by enormously increasing workers' travel time to and from the factory (over an already badly strained local transportation system), and by greatly aggravating worker fatigue.

Health

General. By direction of the Urban Areas Division, the Director of Nagoya's Health and Welfare Department submitted a detailed report on the people's health. That report indicates that health conditions were poor even before the air attacks began, and that the great fire raids of March and May made the city's health problem much more acute. The information contained in the report is summarized below.

Working conditions. "The prolongation of working hours (10 to 12 hours a day), the practice of all-night labor, and lack of food and nutrition caused a striking downfall in the physical status of general workers and employed students." In an examination of 836 student workers after the war ended, it was found that 476, or nearly 57 percent, had "weak physiques" or needed special care.

Housing conditions. "Although a great many dwellings were lost in the air raids, there was no remarkable increase in the number of inhabitants per house, thanks to the evacuation of old and young people, women, and sick invalids. But the common fact that two or three families shared one house resulted in an unsanitary condition." While the air raids did not materially increase over-

crowding, the report showed that the threat of sickness and epidemics became much more real because of such unsanitary conditions created by the attacks as the following:

1. "Frequent air raids damaged some parts of the sewage system of the city, and its function was suspended towards the end of the War."

2. "People were obliged to live in an unsanitary way for the last several months for want of laundries and public baths, which unfortunately were destroyed in the air raids, and because of fuel, soap, and labor shortages."

Malnutrition. "Food calories of the allowance per capita were 1,348 in 1943, 1,364 in 1944, and 1,232 in 1945. Limited rationing of staple foods (mostly substitutes), and a very small allowance of vegetables, without any fish and meat, were causes of the lack of albumin, fat, and vitamins on the part of the citizen's life * * * air raid damage to the storehouses and markets for foodstuffs crippled the ration system, with the most unhappy results to the city life."

Medical facilities. "On account of the frequent incendiary bombing, most of the hospitals, practitioner's office, and clinics, were reduced to ashes. Doctors and physicians evacuated into the country. The remaining people were thrown into a deplorable plight without any means of medical treatment. The city authorities started some emergency clinics in the city, but could not get the desired effects for the want of medical facilities and supplies." The destruction of hospital facilities and the scarcity of doctors were shown statistically as follows:

	End of 1940	End of War
Number of hospitals.....	63	36
Number of patient beds.....	4, 172	1, 413
Number of doctors and physicians..	2, 134	1, 090

Vaccinations and inoculations against typhoid and dysentery were systematically made during the earlier war years, but "the city's Sanitary Station was burnt out, so that its proper function was suspended for some time."

Final comment. "Frequent bombing much affected the mental condition of the people. They could not sleep well at night. This was a major cause to the unhealthy situation of the civilians' life."

Conclusion

The city of Nagoya was highly vulnerable to the great fire raids of March and May 1945. The people were unprepared mentally for those at-

tacks—their apathy toward local government defense measures confirms that fact, and so does the Morale Division's finding that only 30 percent of Nagoya's people expressed disbelief in the usually optimistic Japanese newspaper accounts and radio broadcasts.¹ Physically, too, they were unprepared; the city's air defenses were far from adequate, and poor health conditions had greatly reduced the people's resistance to hardship.

The heavy fire raids came as a distinct shock to the people, and disrupted the lives of nearly all of them. The Morale Division found that, out of every three people still in Nagoya after the war ended, two had been directly involved in aerial bombardment (mainly as the result of the area attacks); that ratio was exceeded only by the atom-bombed cities of Hiroshima and Nagasaki, and by the heavily burned city of Nagaoka.

The effect of the air attacks, and particularly of the urban area attacks, was to lower people's morale, and to destroy their will to resist and their faith that Japan was fighting a winning battle. The Morale Division found that toward the end of the war half of the population of Nagoya were low in confidence of victory—a marked change from the pre-raid attitude. Only Tokyo, Osaka, Yokohama and Nagasaki, surpassed Nagoya in the percentage of population that expressed dissatisfaction with the national leaders' conduct of the war. Finally, 25 percent of the people still in Nagoya at the war's end said that the air raids had made them unwilling to continue the war; in that respect, Nagoya was surpassed by no other large city in Japan, except Kyoto.

CHAPTER IV

EFFECTS ON TRANSPORTATION AND UTILITIES

Freight Transportation

General. Nagoya was served by all three main forms of transportation: ships, trucks, and railroads, but the ships and trucks played relatively small roles in over-all freight transportation in the last 2 years of the war (exhibit B). Their relative importance, and the effects on them of the air attacks, are discussed below.

Shipping. At the time the raids began, shipping activity in Nagoya harbor had been declining

steadily for several years, and the port had been virtually abandoned so far as ocean-going steel ships were concerned. In 1939 entrances totaled 12,361,075 gross registered tons; in 1941, they were 6,238,565 gross registered tons; in 1944, they had dropped to 399,372 gross registered tons, and in the last quarter of that year, they were at an annual rate of only 200,000 gross registered tons. The sharp drop in port activity during the war was principally due to the activities of allied submarines that operated along the routes leading to the harbor. Toward the close of the war, Allied mine fields made the danger of using the port even more forbidding. In addition, the rapid depletion of the Japanese fleet made it imperative to adopt measures to reduce vessel turnaround time so as to increase the efficiency of the remaining tonnage; accordingly, it was decided that ships carrying cargo from the Continent or the South to Nagoya and to other east coast ports should be unloaded at Moji, or in the Kobe-Osaka area, and the cargo forwarded by rail.

Because of this pinching-off of activity in Nagoya harbor, shipping there was not a target of the air attacks, and those attacks had little effect on the trickle of water-borne commerce still using the port when they began. The effect that the attacks did have on Nagoya's shipping was almost entirely indirect, reaching it through their effect on stevedore labor at the port. Throughout the last year of the war, a shortage of such labor and a lack of freight cars hampered the handling of cargo arriving at the port, even though the volume of that cargo had greatly shrunk. As a result, the backlog of goods awaiting movement away from the wharves at times reached 40,000 tons, as compared with an average monthly inbound tonnage of 36,000 tons from June through December 1944, and 15,000 tons from January through August 1945. The attacks, especially the large-scale urban area raids that began in mid-March 1945, aggravated this shortage of stevedores; bombed-out workers left the city, and the rate of absenteeism among those remaining rose sharply as they sought means of evacuating their families to places of safety.

Trucking. The local trucking companies and the City Administration furnished the Survey with detailed information on the movement of freight to and from Nagoya by nonmilitary trucks. Data for freight movements by military trucks were not available. However, both the trucking

¹ In no other city surveyed by the Morale Division did so small a percentage of the population express disbelief.

companies and the Administration maintained that military trucking did not play a large part in the over-all trucking picture in Nagoya, and that conclusions as to the importance of trucking in Nagoya, and as to trends in trucking activity, could safely be drawn from the data available.

These data make it clear that while trucking activities declined less precipitously than did activity in the other forms of transportation serving Nagoya, it contributed in only a very limited degree to supplying the city with food, raw materials, and components, to carrying its finished products to customers, or to connecting it with its satellite cities.

Nor did trucks supply quick and efficient internal transportation within the city. Most of the few trucks available were employed by local industries for intra- and inter-plant hauls. How far the number of trucks fell short of satisfying the needs of those industries is illustrated by the fact that truck shortages made it necessary for the great Mitsubishi No. 5 Army Aircraft assembly complex and the Mitsubishi Aircraft engine plants, whose activities were of paramount importance to Japan's crumbling defenses, to carry some subassemblies and parts from their dispersed shops to their final assembly plants by oxcart. The inability of the authorities to allocate trucks to move cargo away from Nagoya's wharves, where it had accumulated owing, in part at least, to freight car shortages, also indicates the woeful inadequacy of local trucking facilities to meet war needs and to take up the slack caused by damage to, or interference with, other means of transportation.

In general, it may be said that truck transportation in Nagoya was never adequate in the last 2 years of the war. One chief cause of that inadequacy was shortages in physical equipment. There were not enough trucks to begin with, and the useful life of those available was cut by shortages of spare parts and repair materials. In addition, trucking activities were hampered throughout the period by a growing gasoline shortage for which no adequate solution was found, although alcohol and charcoal gas were resorted to extensively as substitute fuels. The area raids of mid-March and mid-May 1945 seriously increased the shortage of trucking equipment by destroying 140 (or more than 10 percent) of Nagoya's useable trucks, and, even more important, by destroying most of the repair facilities of the local truck companies. By 15 August 1945 there were only 2,400 trucks left

in all Aichi Prefecture (which includes Nagoya), and of those, only 700 could be kept in operation.

The deficiencies in the equipment of this industry were matched by the limitations of the highway system. That system's shortcomings alone would have provided an almost insuperable barrier to extensive use of motor transportation to give flexibility to the industrial complex of the region or to insure a steady flow, in volume, of vital goods to and from its factories.

Rail. Nagoya was an important rail center. It was a key station on the Tokaido main line, Japan's principal double-tracked rail carrier, that ran from Tokyo to Nagoya and thence to Kobe. It also was a terminus of the Kansai (Nagoya to Osaka via Yokkaichi) and Chuo (Nagoya to Tokyo via Tajimi) lines. Those lines gave it access (1) to the great manufacturing centers of Tokyo-Kawasaki-Yokohama, Osaka-Kobe, Kokuru-Tobata-Yawata, Omuta, Nobeoka, and Nagasaki, and (2) to the Shimonoseki Straits port of Moji, through which funnelled vital raw materials from Japan's conquered territories on the Continent and in the South. In addition, it was connected by rail to the Japanese Seaports of Tsuruga, Toyama (Fushiki), and Niigata, all of which assumed ever increasing importance as ports of entry toward the end of the war, when the allied submarine and mining campaigns forced shipping from the Continent to abandon the routes leading to Shimonoseki. Besides the major lines, there were also a number of privately owned lines leading from Nagoya to the satellite industrial cities surrounding it.

In Nagoya itself, there were 9 stations able to load or unload 1,898 freight cars² daily, and capable of holding 4,783 freight cars on classification or detention lines. The storage facilities of the stations and their appurtenant warehouses had a total floor area of over 1,230,000 square feet. In addition to the 9 stations within the city, Nagoya was served by several small stations on its outskirts, and by a large classification yard at Inasawa Coaling Station, 5 miles northwest of the city. That yard had a capacity of 11,893 freight cars.

Rail-borne imports declined gradually after mid-1944, with the rate of decline accelerated after the mid-March area raids. Exports also declined gradually during the same period, except for a temporary rise in the first quarter of 1945 which

² Average freight car capacity: 15 tons.

probably reflected efforts to disperse Nagoya's industry.

On the national level, a general decline in production all over Japan, and decreases in national imports and supplies of bulk raw materials, resulted in a gradual reduction in the amount of goods offered for transportation during the last year of the war. However, despite this gradual lightening of the burden that Japan's railroads were required to assume, and despite the advantageous position of the city as a rail center, the rail transportation situation at Nagoya became increasingly congested. As a result, the movement of even priority goods was often delayed, and many factories in Nagoya stated that interruptions in the flow of raw materials and components were important causes of declines in their production, and ascribed those interruptions directly to transportation bottlenecks.

For the most part, Nagoya's rail transportation difficulties were not of local origin but resulted from conditions that affected the whole Japanese rail system, conditions that placed ever increasing handicaps upon rail activities in the period when Japan was being compelled to shift from shipping to rails for national transportation.

Informed Japanese railroad officials have stated that until the beginning of the area raids, the chief of those handicaps were shortages of freight cars and shortages of trackage, and that, in addition, shortages of coal began to threaten operation as the war continued. (The roads at times operated on as little as a 1-day coal reserve.)

All the factors mentioned above were national rather than local, both in origin and in effect. However, the air attacks introduced new limiting factors of purely local origin; the attacks aggravated shortages of unskilled labor for the loading and unloading of freight cars, tied up traffic, and damaged rail installations in the city.

Rail labor. Local rail officials stated that rail activity in Nagoya was greatly handicapped during the period of the raids, and that the chief cause of that handicap was raid-induced shortages of labor for the loading and unloading of freight cars. Local railroad labor statistics and accompanying statements show that (1) the total number of freight handlers fell off about 38 percent between November 1944 and July 1945, mainly due to permanent evacuations, while (2) the total productive hours worked monthly by handlers on

the job fell about 50 percent, due to increased absenteeism caused by the raids.

TABLE 7
NAGOYA—RAIL LABOR AND FREIGHT MOVEMENTS

	Rail freight handlers		Hours worked monthly		Freight movements	
	Total number	Percent of Nov. 1944	Total number (thousands)	Percent of Nov. 1944	Tons (thousands)	Percent of Nov. 1944
1944—Nov----	19,716	100.0	4,515	100.0	630	100.0
Dec-----	18,017	91.4	4,040	89.5	517	82.1
1945—Jan----	18,436	93.5	3,960	87.7	479	76.0
Feb-----	16,682	84.6	3,700	81.9	505	80.2
Mar-----	14,723	74.7	3,060	67.8	443	70.3
Apr-----	14,013	71.1	2,750	60.9	342	54.3
May-----	13,398	68.0	2,665	59.0	279	44.3
June-----	12,335	62.6	2,410	53.4	277	44.0
July-----	12,197	61.9	2,260	50.1	268	42.5

It may be noted that during the period, total rail imports and exports fell off over 57 percent, or more rapidly than did either the number of freight handlers or the total hours worked by them. In light of the insistence of responsible officials that labor shortages became increasingly acute during that period, this decline in the work performed per worker-hour indicates a growing inefficiency and a weakening in the physical stamina of the labor that was available. That inefficiency and weakening in large part grew out of the raids, which disrupted the lives of the laborers, complicated the problems of distributing food, and caused increased fatigue by interfering with sleep, and by destroying local transportation facilities—thus greatly increasing the difficulties of traveling to and from work.

During the earlier months of the raid period, the large factories to which rail spurs ran assigned their own workers to unload cars delivered to their plants and thus prevent rail labor shortages from delaying receipts of vital raw materials and components. Other factories accomplished the same result by sending loading and unloading gangs to the freight terminals to help out, but by March 1945, labor troubles had become critical in most of the large factories themselves, and it became hardly a profitable solution of the problem to divert labor from other jobs to handle freight cars.

Rail tie-ups. Each area raid and each precision attack that affected the rail system was

followed by a sharp drop in total rail traffic at Nagoya. That drop was succeeded by an equally sharp recovery in a day or two, and by a second sharp drop five to seven days after the raid, with a new recovery then beginning almost at once. All in all, the reaction to the attacks was very temporary, though fairly violent, and the gross loss was not large.

After each raid, loading and unloading operations at Nagoya's stations and freight yards also dropped sharply, with recovery to pre-raid levels beginning promptly and usually taking about a week to achieve, and with most of the recovery concentrated in the first 2 or 3 days.

The drop in loading and unloading activity immediately after each raid resulted in a sharp rise in the number of freight cars tied up in marshalling and freight assembly yards, even though the over-all drop in rail traffic cut the number of newly arrived cars requiring handling. In general, this tie-up was at its peak the night after the raid, and the backlog was gradually liquidated during the succeeding week. This suggests that when the raids began, freight handling facilities were operating so near capacity that little flexibility in meeting the impact of the raids was possible. Statements of the local rail officials indicate that the cause of this saturation of capacity and this lack of flexibility was probably the shortages of freight-handling labor already discussed.

Rail damage. The air attacks damaged 512,000 square feet, or 13.2 percent of a total area of 3,882,000 square feet in Nagoya's 9 stations, and destroyed 761,000 square feet, or 61.7 percent, of the total 1,232,000 square feet of storage area appurtenant to those stations. About 92,000 metric tons of freight were destroyed in the stations, in cars on classification and holding lines, or in rail warehouses. This tonnage was equivalent to about 11 days average rail imports during the raid period. The raids damaged little rolling stock—250 freight cars, 69 trucks, 96 carts, and 100 drays. However, they caused damage to a substantial number of cranes, switches, etc., that led to short-term decreases in the ability of the lines to handle traffic. Very little trackage was destroyed; the total for 14 attacks that hit 7 stations was only 1,380 meters, with the time required to repair the damage on each occasion varying from 1 hour to 5 days. Some of the trackage was in sidings, and in addition it was often possible to switch trains around damaged sections in main lines, so that

there was little or no real interruption to normal operations.

In general, physical damage did not greatly reduce the ability of the local rail facilities to handle the freight offered to them for movement; what interference there was resulted chiefly from damage to trucks and cranes, which hampered the loading and unloading of freight cars.

Freight Movements

Total imports and exports. The transportation difficulties described earlier in this chapter helped to reduce the volume of Nagoya's imports and exports of freight. Total imports declined gradually between June and November 1944, and then fell off at an accelerating pace through April 1945, with the sharpest drop occurring in the last month, following the mid-March area attacks; the import rate in April (and May) was only 30 percent of the level prevailing in the first half of 1944. After May, total imports fell off slowly until the end of the war (Exhibit C). Total exports also dropped during the last 12 months of the war, but the rate of decline was not so rapid, and the trend was broken by a strong recovery in February–April 1945. That recovery probably was due to the removal of productive facilities from Nagoya accompanying the dispersal of the city's large factories; much of the recovery was made up of increases in exports of machinery and miscellaneous items (Exhibit D). All in all, exports dropped considerably less than did imports:

	Tons		Percent decline
	Oct. 1943	Aug. 1945	
Total imports.....	639, 488	108, 587	83
Total exports.....	341, 257	115, 840	66

Imports of industrial materials. A general downward trend in imports of the principal bulk industrial materials—coal, iron and steel—began as early as the spring of 1944, while over-all industrial production in Nagoya held up well until November of that year (but dropped rapidly thereafter). This suggests that over-all production levels were maintained during the second half of 1944 at the cost of cutting deeply into stockpiles of raw materials, so that at the time the air attacks began, the portion of Nagoya's industry that was mainly dependent upon coal, iron and steel, probably would be sensitive to any substantial decreases in raw materials receipts. As reported in greater

detail in Chapter V of this section, several factories in the city, especially in the large metals and metal products industry, were in fact forced to cut production after December 1944 because coal and other raw material and fuel receipts fell considerably below their needs. On the other hand, the greater part of Nagoya's industry suffered heavy production losses after December due to air attacks and other factors besides raw materials shortages, so that their materials requirements were reduced.

Many of those factories that did ascribe part of their production drops to scarcity of raw materials also stated that the insufficiency of receipts was due directly to transportation difficulties. Available evidence confirms that opinion, and further indicates that the transportation difficulties in 1945 were primarily of local origin and partly raid-induced.

Coal (Exhibit E). A comparison of Nagoya's coal imports (almost all of which came by rail) with Japan's national coal production and national carloadings of coal discloses (1) that the trend in local imports was about the same as the trends in national figures through February 1945, and (2) that in March, the first month of heavy area raids on Nagoya, local imports broke suddenly downwards, dropping 65 percent in March and April, while national carloadings and production remained at late 1944 levels at least until June.

NOTE.—The Ship and Rail Transportation Division of USSBS also found that Japan's railroads generally were able to transport all cargo offered to them in 1945; this further confirms that Nagoya's coal import drop was due mainly to local conditions.

Iron and steel (Exhibit F.). Local iron and steel imports generally held up better than national production during the second half of 1944, perhaps reflecting the high priority position of Nagoya's chief industries. In the first 6 months of 1945, however, the local imports fell over 63 percent, while national production dropped only about 51 percent; this supports the theory that the acceleration of the decline in imports of iron and steel was due largely to local conditions.

Other materials. Nagoya's other imports fell off in about the same way as her coal imports. Demand for those products, like the demand for coal, was in excess of receipts, and there is no evidence that the transportation priorities of the other materials changed relative to the priority of coal. It is believed, therefore, that local conditions acted

to reduce the imports of other materials in about the same way as those conditions influenced coal imports.

Importance of air attacks. Nagoya's imports in 1945 were mainly by rail, and it was reported earlier in this chapter that the air attacks introduced new factors, of purely local origin, that limited rail imports. Some idea of the influence that air attacks had is given by a comparison of imports before and during the raids. Of the total decline in Nagoya's imports between June 1944 and May 1945, about 23.6 percent occurred in the 6 months before the raids began, and about 76.4 percent occurred in the first 5 months of the raid period.

Summary. The rapid acceleration in the rate of decline in Nagoya's imports after November 1944 had a limiting effect on part of the city's production, but production at the majority of Nagoya's factories was not influenced to any great extent by growing materials shortages, since other factors forced production down and cut raw materials requirements to the point where reduced receipts were adequate. While the shrinkage in national supplies of industrial materials, which had begun to cut Nagoya's imports in 1944, would have continued to depress them in 1945, the decline would have been more gradual had it not been for transportation difficulties of local origin, largely the direct and indirect results of the air attacks.

The area attacks of mid-March and mid-May 1945 were particularly effective in creating local rail transportation problems, and the rails accounted for the bulk of Nagoya's imports.

Internal Passenger Transportation

Before the raids. Tram-car and bus facilities in Nagoya were heavily overloaded throughout the war years, despite strenuous government efforts to improve the situation by such devices as barring the rush-hour transport of nonworkers, eliminating all but the most important stops, limiting the hours of service in sections where traffic was light, and refusing free transfers to nonworkers.

Effects of air attacks. The raids caused minor damage to trackage and power transmission lines (which was quickly repaired), and destroyed or seriously damaged about 100, or about 14 percent, of the total serviceable tram-cars and busses available at the beginning of the raids. There was additional damage to, and interruption of, repair facilities, and this appreciably affected the serviceability of vehicles. As might be expected, tram-

car and bus transportation was violently disrupted after each heavy raid. For the most part, serious disruption lasted no longer than one week, although the destruction of Uchida bridge in May and Shiratori bridge in June (both in South Central Nagoya) blocked traffic on 2 important tram-car lines for 83 and 99 days respectively. However, the cumulative effects of the raids led to a severe and steady decline in the passenger transportation of the city.

TABLE 8
NAGOYA—TRAM-CAR AND BUS
FACILITIES

	Number serviceable		Number actually operated		Number destroyed or badly damaged	
	Tram-cars	Busse	Tram-cars	Busse	Tram-cars	Busse
1944—Oct.....	403	317	350	133	-----	-----
Nov.....	397	317	342	137	-----	-----
Dec.....	386	317	321	140	-----	-----
1945—Jan.....	373	305	287	129	-----	-----
Feb.....	372	302	316	116	-----	-----
Mar.....	329	274	220	110	39	28
Apr.....	276	270	204	87	-----	2
May.....	266	252	203	93	14	15
June.....	241	209	190	90	4	-----
July.....	235	203	175	71	-----	-----
Aug.....	229	203	182	71	-----	-----
Total destroyed or badly damaged.....	-----	-----	-----	-----	57	45

The greater part of the decline in the number of serviceable and operating vehicles was due to the area attacks of mid-March and mid-May 1945. As mentioned in Chapter III of this Section, those raids also forced many thousands of workers to evacuate and take up quarters outside the city. Far from relieving the strain on internal passenger transportation, that evacuation aggravated it; many of the evacuees continued to work in Nagoya factories and added many passenger-miles to the total commuting distance traveled by the city's labor force.

The strain caused by the severe temporary dislocation following the raids, and by the gradual decline in transportation capacity, fell unevenly upon Nagoya's industry, especially affecting the large aircraft and heavy industry plants on the periphery of the city.

In brief, air attacks caused serious tie-ups for short periods, and made the already tight passenger transportation situation much worse. The

overcrowding and delays that resulted contributed heavily to absenteeism, tardiness, and fatigue among industrial workers, and the worker inefficiency and the loss of productive man hours that followed were important factors leading to the collapse of industry in the city.

Utilities

Electric power (Exhibit G). Electricity for Nagoya, as for most of the Tokai district, was supplied mainly by the Chubu Electric Supply Co. That company was able to give the Survey detailed records of its operations and of the effect on it of the air attacks. In addition, the Survey obtained production records of Nagoya's two steam-generating plants. Those records show that the supply of power in Nagoya was, with minor exceptions, adequate throughout the war; indeed at the war's end, capacity was in excess of demand. These facts were confirmed by statements of the consuming factories in Nagoya.

As was usual in Japan, most of the power supplied was generated by hydroelectric plants, and steam-generating plants were used chiefly to meet the drop in output of the hydro plants in the winter and summer dry seasons. The drop in demand toward the end of the war enabled the Japanese to meet the requirements of Nagoya's factories almost entirely with hydrogenerated power, even though the summer dry spell intervened. This resulted in a considerable saving of coal at a time when local coal receipts had sunk very low.

The earthquake of 7 December 1944 caused power suspensions in Nagoya for up to 10 days, and from time to time, air attack damage (which equalled 9.5 percent of the company's assets), coal shortages, and the seasonal fluctuations mentioned above, caused some restriction of nonindustrial use, although they failed to offer any serious limitation on the supply of power for industrial use. In the words of the company "as soon as damage occurred, we repaired them for a practical use by the zealous efforts of the company's employees and other people concerned. On the other hand, the power load having decreased as the attacks increased, service to customers was maintained without much inconvenience under the circumstances."

In sum, the power system was not deficient; over-all demand decreased more rapidly than did the capacity of the system to deliver power; and power shortages at no time did much to cut production in Nagoya's factories.

Gas (Exhibit H). Nagoya's gas supply at all times exceeded demand during the war years, except only for a brief period following the 7 December 1944 earthquake, when a general shortage was felt. There were two producing plants in Nagoya—the Kanagawa and the Sakurada works of the Toho Gas Company. Those plants suffered minor damage in the air attacks (14.6 percent of the total pre-raid productive floor area and 11.5 percent of the pre-raid plant and equipment were destroyed), but this did not prevent the plants from meeting requirements. As production fell at the consuming factories and as Nagoya's homes were destroyed, the decline of demand cut gas requirements and the corresponding drop in coal needs came at the producing plants, as it had at the steam-generating plants in the electric power system, just at the time that Nagoya's total coal receipts were falling off rapidly.

Water. The city's water system, adequate until December 1944, was seriously disrupted by the air attacks. Spill-overs from precision attacks on the Mitsubishi Aircraft Engine No. 4 factory damaged the adjoining purification plant on 5 separate occasions, causing suspensions of water service of from 5 days to 2 weeks in duration. Other precision attacks elsewhere in Nagoya damaged conduit lines in 14 places, and area attacks often put service mains and branch pipes out of commission. In all, about 500,000 hydrants were destroyed, and service pipes below 20 inches in diameter were hit in about 800 places. A month after the war ended, maximum daily supply was still only 60 percent of the pre-raid quantity; less than 65 percent of water needs were being satisfied even in the undamaged portions of the city; and the Water Works estimated that even if its pumps were fully restored, leakage in the burned-out sections of the city would make it unable to fully supply water needs in the city's southern and extreme western districts.

The water shortage resulting from the attacks was widespread. Civilians suffered from an acute lack of water despite numerous wells throughout the city. Some large factories had their own supplies; for the others, a priority system had to be established, largely at the expense of chemical and shipbuilding plants. Finally, as already mentioned in Chapter III, the water shortage proved a serious handicap to the defense against incendiary attacks.

CHAPTER V

EFFECTS ON INDUSTRY

Introduction

Sources. The chief sources of the data on which the succeeding sections of this chapter are based are the returns to questionnaires that the Urban Areas Division submitted to all factories in Nagoya whose labor force equalled or exceeded 50 workers at any time during the war, and whose records or management survived the attacks and could be located. Those questionnaires required the following information for the period October 1943–August 1945:

1. Yen sales, month by month, subdivided by product type and by consignee, with a statement of the causes of all significant increases or decreases in monthly sales totals.

2. Labor force, month by month, subdivided by type of worker (skilled, unskilled, clerical, etc.), and showing number of female and student workers.

3. Total productive hours worked each month, and total hours lost, with the latter broken down by cause of the loss (absenteeism, air alerts, etc.).

4. Monthly receipts and inventories of principal raw materials and components, with receipts broken down by source.

5. Monthly electric power, gas, and fuel consumption, and monthly fuel inventories.

6. Factory lay-out; bomb damage, raid by raid, to structures, plant and equipment, inventories, and work in process; steps taken after damage to repair, abandon or replace damaged facilities.

Returns to those questionnaires were received from 306 factories, including 78 that employed 500 or more workers each. Of those 306 returns, 238 (including 67 from factories in the 500-or-over worker class) were completely filled out, and 68 were in some respect incomplete—usually because the records of the reporting factory had been destroyed in the air raids. As is shown in greater detail in Section III, the factories making returns included all but 2 of the large (i. e., over 500 workers) plants in Nagoya and its suburbs, and much detailed information on those 2 factories was collected in a different form by the Survey. As Section III further shows, the factories making returns, together with the 2 large factories on which information was available in other forms, accounted for about 83 percent of the city's labor force and about 90 percent of its yen output, with

the figures for factories making complete returns being about 70 percent and 71 percent respectively. In addition, all the important factories located just outside the Nagoya city limits and forming part of the city's industrial structure filed returns, and all but one of those returns were complete.

Except where otherwise stated, the statistics hereafter given in this report were compiled by tabulating the data from the complete returns only. Data from the incomplete returns and from the nonquestionnaire sources could not be included if the various factors were to be presented on a comparable basis. However, those data are referred to in the text whenever appropriate, and were given due weight in reaching the conclusions reported.

The information contained in the returns was supplemented in interviews with selected industrialists, and by narrative written reports prepared by representative key factories. Additional information was contained in written reports submitted by departments of the government of the Nagoya Administrative Region, and officials of those departments added to those reports orally.

Method of analysis. It was soon apparent that no statistical computation could be made that would give quantitatively the effect of the raids and of the other factors that influenced production during the raid period:

1. Single factors could not be isolated, since their impact fell so unevenly from industry to industry, and within industries, that satisfactory samples of factories affected and of factories not affected could not be obtained, even after weighting.

2. Even if such samples could have been obtained, the relative effect on each sample of many of the factors common to both would not have been known and could not validly have been estimated or assumed on the basis of the information available, and, as a result, those factors could not have been weighted out. On some of those factors, no reliable information could be obtained; on others, available information was too general to permit their effect to be estimated with the accuracy necessary for statistical calculation. In general, the factors were numerous; the period in which their effects were crowded was short; and while they were clearly interrelated, the extent to which one caused another, or multiplied or duplicated its effects, was not known and could not be estimated or calculated with the necessary accuracy.

For example, the direct effect of bomb damage could not be determined by comparing statistics for hit plants with those for unhit plants since:

1. The samples would be unsatisfactory. In terms of output in the last pre-raid month, the factories in the hit sample would comprise 93.3 percent of Nagoya's total industry, while those in the unhit sample would total only 6.7 percent, including only about 0.1 percent of the aircraft industry, none of the shipbuilding or vehicles industries, 0.2 percent of the chemical industry, and 8.0 percent of the metals and metal products industry. Factories in the unhit category were not representative of Nagoya's industry, and trends of that category, therefore, could not be taken as a reliable indication of the effects of nonraid factors and the indirect effects of air attacks on the city's industry as a whole.

2. Even if the samples were satisfactory, there would be no basis in the available information for determining the relative effect on the hit and unhit samples of the nonraid factors, or of the indirect effects of the raids, with sufficient accuracy for those factors and effects to be weighted out. (It is known, of course, that certain of those factors had greater or less influence than certain others and it is known that they affected different industries within each sample differently; but approximations of relative weight sufficiently exact to permit an analysis on the basis of comparative statistics could not be made.)

While the effects of the various factors in causing production declines in Nagoya's industries could not be computed quantitatively, it was possible to determine the approximate relative importance of those factors in other ways. Each of those industries was dominated by a few large factories, sometimes only one, and the questionnaires submitted by those factories, and the testimony and narrative reports made by their management, and by government officials charged with supervising industry, made it practicable to appraise, factory by factory, and, cumulatively, industry by industry, (1) the relative rank of the principal factors as causes of the declines, and (2) even to give broadly expressed approximations of the degree to which one factor outranked another. In all cases, of course, the testimony of the management in smaller factories was checked to see if developments reported by them were consistent with the conclusions indicated by the reports of the large factories. In addition, available data on yen

sales, labor force, productive hours worked, electric power consumption, and material and component receipts were tabulated and the trends and fluctuations disclosed were checked for support of, or variance with, those conclusions.

Definitions and qualifications. The following definitions and qualifications should be noted:

1. In this chapter, factories just outside Nagoya's city limits, since they form part of Nagoya's economic structure, are included in all data for the city and in all references to the city or its industries.

2. As stated above, the Survey obtained data on 308 factories whose production aggregated about 90 percent of Nagoya's entire 1944 output. Almost all the remaining 10 percent of that output was produced by factories employing less than 50 workers each, perhaps one-fourth of it in workshops employing less than 10 workers each. Section III shows in greater detail that this 10 percent was relatively unimportant to Nagoya's industrial life. Except where otherwise indicated, the remainder of this section confines itself to reporting developments in the 90 percent sample that submitted information.

3. A check of representative factories showed that there was no substantial difference between monthly yen sales and monthly output of finished products expressed in terms of the yen value of those products. Accordingly, the factories were asked to report yen sales, since that would permit a breakdown by consignee, and the sales reported by the factories making returns are considered as their "production" and are so referred to in this report. Where the "production" was not of the usual finished product of the factory but represented an unloading of work in process, parts, etc., resulting from such causes as a decision to disperse or to abandon normal operations, or where sales differed substantially from output for some other reason, that fact is pointed out in the text.

4. Spill-overs from precision attacks damaged many factories in addition to those at which these attacks were directed. Since this spill-over damage may be considered a normal bonus earned by precision attacks, it has been counted as precision attack damage in this report. Accordingly, statements in this chapter that specific factories were damaged by precision attacks do not necessarily mean that those factories were the actual targets of those attacks; the damage may have been spill-overs from bombs aimed at adjoining plants.

5. Figures on the labor force of Nagoya and of her factories include only plant workers, that is, workers occupied in the actual productive process; clerical and administrative workers are not included.

6. As used in this report, the terms "labor shortages" and "labor difficulties" are synonymous, and include the effects of all phenomena resulting in insufficiencies in the number of productive hours worked or decreases in labor productivity per hour worked, viz, insufficiencies in the actual number of workers, lack of skilled workers, absenteeism, fatigue, tardiness in reporting for work and loss of time owing to air defense measures.

Relative importance of industries in Nagoya. The following table shows the relative importance, in terms of annual production and of worker strength, of the various industrial groups found in Nagoya.

TABLE 9
NAGOYA—RELATIVE IMPORTANCE OF INDUSTRIES

[Compiled from questionnaires from factories employing 50 or more workers]

Industry category	Annual production—1944		Labor force—Dec. 1944	
	Thousands of yen	Percent of total	Number of plant workers	Percent of total
Aircraft.....	1,440,277	47. 7	82, 596	31. 2
Ordnance.....	463, 115	15. 3	60, 802	23. 0
Metals and metal products.....	722, 503	24. 0	78, 697	29. 8
Electrical equipment.....	161, 896	5. 4	18, 706	7. 1
Vehicles and rolling stock.....	50, 813	1. 7	4, 380	1. 7
Chemical.....	29, 743	1. 0	2, 386	. 9
Shipbuilding.....	26, 808	. 9	4, 250	1. 6
Miscellaneous.....	120, 739	4. 0	12, 562	4. 7
Total—All industry.....	3,015,894	100. 0	264, 379	100. 0

NOTE.—The figures in this table are compiled from complete returns only. In addition incomplete returns were made by 11 large and 57 small factories. All important factories in Nagoya and its environs made returns, complete or incomplete, except the Mitsubishi Navy Aircraft Works and the Mitsubishi Aircraft Engine Ozone Factory. Detailed information on both was obtained from Aircraft Division of USSBS. Inclusion of plants filing incomplete returns and of the 2 Mitsubishi plants named above would change the relative importance of the chief industries as follows:

	Annual production, 1944 (percent of total)	Labor force, Dec. 1944, (percent of total)
Aircraft.....	49. 0	31. 7
Ordnance.....	12. 6	20. 0
Metals and metal products.....	26. 8	32. 4
Electrical equipment.....	4. 3	6. 3

As is shown in Table 9, Nagoya's aircraft industry was by far the largest of her end-product industries, accounting for 49 percent of the city's total output, while the metals and metal products industry, whose 1944 output was 27 percent of the total for the city, was the largest of the basic and component industries. The ordnance industry, second largest of the end-product groups, accounted for half of the remaining 24 percent of the city's 1944 production, and the rest was divided among several small groups, none of which produced over 5 percent of the city's output.

Aircraft Industry

General. Nagoya's aircraft industry, accounting for about half of the city's entire industrial production, was dominated by three giant factory complexes operated by the Mitsubishi Company—one making aircraft engines and the other two assembling Army and Navy aircraft respectively—by the Okamoto Industries' Kusadera plant, which made brakes and landing gear, and by the Aichi Aircraft Company's Eitoku assembly plant. The industry also included a smaller engine plant controlled by the Aichi Aircraft Company.

The Mitsubishi No. 4 aircraft Engine factory in northeast Nagoya was the largest in Japan, and one of the largest in the world. In its peak month, August 1944, it turned out over 40 percent of all the aircraft engines made in Japan in that month.

The Mitsubishi assembly complex that manufactured Army aircraft was known as the No. 5 complex after February 1945, and will be so referred to throughout this section. It consisted of a parent plant in Oe-machi (southeast Nagoya), two smaller factories in Nagoya (the Dotoku³ and Mizubo plants), and several plants outside Nagoya. The outside plants achieved significant production only in 1945, after the plants inside Nagoya had begun to disperse. Peak production in the No. 5 complex, in terms of number of aircraft produced, was reached in December 1943, and represented over 6 percent of the national total for that month. Throughout this report, except where otherwise stated, production tables and graphs present the combined output of all the plants in the No. 5 complex. As a result, they do not show variations in production at the individual plants, such as a decline in production at

the Oe-machi plant that took place during 1944 and 1945 when machinery and labor were transferred from that plant to other plants within the complex. However, all important developments involving changes in production at the individual plants, such as the shift in production from plants inside Nagoya to others outside the city, are brought out in the text.

The naval aircraft assembly complex operated by Mitsubishi (known as the No. 3 complex after February 1945, and hereafter so referred to) had its parent plant in Oe-machi, adjoining that of the No. 5 complex. This parent plant accounted for practically all the output of the No. 3 complex until the fall of 1944, when large portions of the plant's productive facilities were transferred to locations outside the city, particularly to Suzuka, 22 miles southwest of Nagoya. In terms of the number of aircraft produced, this complex was of even greater importance than No. 5. In December 1943, when No. 5 reached its peak and turned out 6 percent of that month's total for all Japan, No. 3 also was at near-peak levels, with its output representing nearly 11 percent of that total. For the No. 3 complex, production data suitable for inclusion in the tables and graphs set out in this report could not be obtained. However, other information collected by the Survey about this complex was sufficient to show in some detail all instances where the production history of the complex changed the picture of Nagoya's aircraft industry that is presented by those tables and graphs. Those changes are pointed out in the text of this report, and they were given due consideration in arriving at the conclusions expressed.

The contribution of the Okamoto Industries' Kasadera plant (in southeast Nagoya) to national production of brakes and landing gear cannot be measured accurately, but it is known that the plant was the largest of its type in the Empire. In addition to supplying the aircraft industry in Nagoya and the great aircraft complexes around Tokyo, it made large direct deliveries to the Army and Navy Air Forces.

Peak production at the Aichi Eitoku assembly factory (in southwest Nagoya) was reached in December 1944, and represented 6 percent of the national total. Although the Aichi Atsuta engine plant (in south Nagoya) was a large factory—employing in its peak production month about 8,000 workers, or approximately one-fourth as many as the Mitsubishi engine plant—its produc-

³ Dotoku was the main plant of a No. 11 works which in turn was controlled by the No. 5 complex.

tion never was high. Its peak engine production, reached in May 1944, was only 3 percent of the national total.

Aircraft industry production trends (exhibit I). Activity in this industry during the last 2 years of the war falls into three well-defined phases: (1) a rise to maximum wartime levels in the summer of 1944, with those levels maintained through October of that year, (2) a moderate relapse in November 1944, followed by a precipitous decline in December 1944 and January 1945, with production dropping in January to about 27 percent of peak levels, and (3) a leveling-off from February through April and a subsequent decline in the last 4 months of war to a production rate of less than 6 percent of peak levels.

Examination of the factory questionnaires returned by the aircraft industry in Nagoya, and interviews by the Survey with leading industrialists in that city, disclose that changes in the industry's total production were almost entirely ascribable to increases and decreases in output at the large factories dominating the industry. The three major phases of activity may therefore be analyzed in terms of production changes at the dominant factories (Exhibit J) and in terms of the causes underlying those production changes.

First phase—rise to peak production levels. Broadly, over-all production rose steadily from October 1943 (initial month in the period studied) through August 1944. The general trend was broken only by a violent fluctuation in May and June 1944, caused almost entirely by temporary interruptions in the supply of nuts and bolts to the Mitsubishi No. 4 Engine factory; as a result of those interruptions, engines that otherwise would have been completed in May were actually finished in June, sharply cutting the May production figures, and inordinately swelling those for June.⁴

From August through October 1944, the over-all output leveled off, with continued rises in the Mitsubishi No. 5 assembly complex and at the Okamoto Kasadera brake and landing gear plant being offset by a September drop in output at the Aichi Atsuta Engine factory and an October drop at the Mitsubishi No. 4 Engine factory.

The trends reported above would have been changed only slightly had production figures for

the Mitsubishi No. 3 complex been included in the over-all statistics. The No. 3 complex output rose to a peak in December 1943, but fell off by 23 percent in the following quarter, owing to preparations for a change in aircraft design; plans for that change were subsequently abandoned and output then rose to a new but only slightly higher peak in August 1944. A moderate decline then followed in September and October, reflecting the transfer of production of one type of plane to plants outside Nagoya.

Second phase—period of precipitous decline. In the 3 months November 1944 through January 1945, over-all production in the industry in Nagoya fell 73 percent, from ¥141,122,312 to ¥37,679,116.⁵ Over seven-eighths of the decline was concentrated in December and January.

Most of the production drop in this period took place at the Mitsubishi No. 4 plant and at the Okamoto Kasadera plant, where output fell ¥40,248,000 and ¥36,200,000 respectively.

The decline at the Mitsubishi No. 4 plant actually had begun in October 1944; through November it was caused almost entirely (1) by the necessity of replacing raw materials formerly available with substitutes requiring greater skills in handling, and (2) by the loss of skilled labor to the armed forces. Difficulties were encountered in fabricating and heat treating the substitute materials and a higher percentage of failures resulted. In December 1944 the rate of decline at this plant was abruptly accelerated, and the reasons for the decline changed; in that month, and in January 1945, the chief causes of the drop were the December precision attacks and hurried dispersal efforts touched off by those attacks, although a lack of parts from subcontractors also exercised some influence. As the result of the attacks and of the decision to disperse, no more machining or finishing of parts was performed, and thereafter production consisted only of assembling engines from parts on hand or subsequently received from other factories.

At the Okamoto Kasadera plant, almost the whole decline occurred in November and December 1944, and resulted from preparation for dispersal and from the reallocation of raw materials and components to other factories.

⁴ Production at the No. 4 factory: April—¥46,287,000; May—¥23,704,000; June—¥68,889,000; July—¥40,130,000.

⁵ As given in supporting tables, the January figure was ¥47,665,116, but approximately ¥10,000,000 of this represented production at Mitsubishi No. 5 plants located outside the city of Nagoya.

Production statistics for the Mitsubishi No. 5 assembly complex appearing in the graphs and tables of this report show an extraordinary rise from ¥28,500,000 in November to ¥50,300,000 in December, followed by a decline to about ¥12,800,000 in January (exhibit J). Actually, the December rise should be ignored as illusory. It did not reflect a rise in actual productive activity; rather it represented a large-scale unloading of miscellaneous items, not aircraft or completed fuselages. That unloading apparently reflected a decision, made after the precision attack on 18 December, to transfer all assembly to sites outside Nagoya and thereafter to limit activity at the parent plant at Oe-machi to the production of Army aircraft parts. Production had already virtually stopped at the other large No. 5 assembly plant in Nagoya (the Dotoku factory) as a result of heavy damage by the earthquake of 7 December, and no attempt was made to resume large-scale operations at that factory. In January, only ¥2,800,000 of the ¥12,800,000 total for the complex represented production at plants in Nagoya, and the remaining ¥10,000,000 represented aircraft manufactured at the dispersed factories outside Nagoya in their first month of significant production. Thus despite the apparent rise in December shown in the graphs and tables in this report, productive activity at the No. 5 plants within the city actually declined steeply in both December and January.

A small December drop at the Aichi Atsuta engine plant was due to damage by the 7 December earthquake and to a shortage of fuel injection pumps. In January, the Aichi Eitoku assembly plant production also suffered a small drop as the result of delayed effects of the December earthquake.

In short, production statistics compiled from the questionnaires, after adjustment for the exceptions noted above, indicate that by January 1945 Nagoya's aircraft industry had been reduced to minor levels, with output only 27 percent of the late 1944 peak. The principal causes of the precipitous decline were (1) the direct and indirect effects of the December precision attacks—bomb damage and preparations for dispersal—and (2) the earthquake of 7 December.

NOTE.—Production at the Mitsubishi No. 3 plants fell about 15 percent in November because of a lack of components. In the next 2 months it dropped sharply to about 18 percent of the October 1944 level.

That drop resulted from the same factors—the effects of precision attacks, and the 7 December earthquake—that led to the rapid decline in output at the other major plants.

Third phase—leveling and gradual decline. After January 1945, production in the industry leveled off through April; in May it dropped about 50 percent, mainly as the result of heavy damage to the Okamoto Kasadera plant in the 17 May area attack; and after that it continued to decline steadily to the end of the war as the result of continued dispersal and precision attacks. In July, the last full month of the war, production within Nagoya was only 5.4 percent of peak levels.

In determining production in this third phase, deduction again was made from the figures for production in Mitsubishi No. 5 plants located outside the city. As for the Mitsubishi No. 3 assembly complex, except for a temporary rise in February, production followed the same general trend and reflected the same factors as did the remainder of the industry.

Relative importance of factors influencing production. The above discussion, explaining the changes in the production levels of the industry in terms of the production changes at the dominant factories, indicates that both the plunging decline in December–January and the more gradual decline in the last 7 months of the war were due chiefly to dispersal and bomb damage. Other factors now and again played parts, sometimes important parts; but the factors named were controlling. The succeeding paragraphs of this section appraise the relative importance of the contribution to the declines made by each significant factor.

Dispersal. Principal cause of the 1945 decline in the aircraft industry was the belated and almost panicky dispersal program begun after the December 1944 precision attacks. As early as 1943, local Army and Navy authorities had advised some plants in the industry to disperse. Those plants, however, were being subjected to unremitting government pressure to increase production, and were extremely reluctant to begin dispersal for fear that it would cut their output. As a result, dispersal plans did not get beyond the discussion stage before the December attacks. Those attacks gave sudden urgency to the need for removing the industry from the city, and active preparation for removal was begun immediately. For the most part, however, the physical transfer-

ring of machinery and workers to dispersal sites did not start until February and March 1945.

NOTE.—Although belated, Nagoya's dispersal program was nevertheless in advance of national plans. After the fall of Saipan in July 1944, many advocates of immediate dispersal of Japan's key industries arose in the central Munitions Ministry and in other governmental departments. However, no action at the national level was taken until 23 February 1945, when the Army and Navy high commands met and agreed upon the necessity of a Nation-wide dispersal program. The meeting was especially concerned about the precision attacks on Japan's aircraft factories, and it gave first priority to efforts to save that industry. Accordingly, the first national dispersal decree, issued 1 April 1945, was substantially limited to ordering large aircraft factories to move their plant and equipment away from the larger cities. This was followed on 1 May 1945 by a second Munitions Ministry decree, which ordered the dispersal of smaller plants connected with aircraft production, including those manufacturing electrical equipment. Finally in July 1945, the Tokyo, Nagoya, Osaka, and Kyushu districts issued regional dispersal orders that, in effect, called for removal of all plants not previously ordered to disperse.

The basic dispersal plan was first to move excess plant capacity while maintaining production at the original sites, and then, as production was begun at the new sites and as additional capacity was consequently made excess at the old sites, to move that additional capacity, repeating the process until the dispersal was completed. This plan would have permitted dispersal with very little interruption in over-all productive activity. In practice, however, the plan failed. Instead of being the orderly, economical move contemplated by the authorities, dispersal became almost panicky: the sense of urgency was so acute that the Japanese devoted practically all their energies and resources to the evacuation of productive facilities, and made little effort to repair bomb damage or to maintain production at the original factories in Nagoya.

Had the plants at the dispersal sites got into production as planned, the production drop within Nagoya might have been compensated for. However, even though an impressive portion of the aircraft industry's labor and machinery had been transferred from Nagoya to the dispersal sites by August 1945, production at the new sites never reached significant levels. A shortage of construction labor and materials, and the desire for haste, prevented the construction of completely new installations outside Nagoya, and the dispersing

industry therefore had to move chiefly into existing factory structures, largely spinning mills. Those structures were themselves highly vulnerable and a few, located in or around cities near Nagoya that were hit in the July area raids, received considerable bomb damage. Transportation bottlenecks not only delayed the transferring of equipment, but also hampered the flow of raw materials, components, and subassemblies, within the dispersed complexes.

The very breaking-up of large plants into scattered smaller plants, which was the industry's chief method of reducing vulnerability to attack, almost inevitably led to less efficient operation. The Japanese themselves expected that production at the dispersed sites would be 20 percent less than it would have been had the plants remained at the original sites and escaped bomb damage. Failure to coordinate the dispersal of component suppliers with the dispersal of the large end-product factories, and the effect on those suppliers of the raids, especially the area raids, resulted in failures and irregularities in component receipts. Labor, forced to commute longer distances from home, or to leave home, was less efficient. For all these reasons, production at the dispersed sites fell far below plans.

The contrast between (1) the success of the Japanese in dispersing large portions of the productive facilities of the industry to new locations outside Nagoya, and (2) their failure to achieve significant production at the dispersed sites, is clearly illustrated by a few important examples. By 15 August the large Aichi Eitoku assembly plant, which began to disperse in March 1945, had moved to the dispersed sites 54 percent of the 20,000 workers and 85 percent of the 1,870 machine tools it planned to move, and had virtually completed a 3-plant complex in 1 dispersal area in Gifu Prefecture. Yet no substantial production was achieved at any of the dispersal sites of this plant. Similarly, by August the Aichi Atsuta engine plant had moved to dispersal sites 578 machine tools of a planned 800, and 1,850 employees of a planned 2,500. Production at those sites was scheduled to reach 100 engines a month by August, yet just 3 engines were actually turned out in July and 5 in August. The parent plant of Mitsubishi No. 3 assembly complex moved 22,063 men and 1,861 machine tools to its new sites, but while production at those sites was planned to reach 400 planes a month, in July it was only 22, and in

August 79. The dispersal plan of the Mitsubishi No. 4 engine plant fell into 2 parts: (1) a transfer of part of its machinery and labor to a new 3-plant complex in Ogaki (Mitsubishi No. 16 Engine complex which, although considered as an independent complex rather than a dispersed element of the No. 4 plant, got all its labor, plant and equipment from the No. 4 plant), and (2) a dispersal of its remaining plant and equipment to neighboring cities and counties. By July the dispersal to No. 16 complex was completed, and about one-fourth of the planned total of machine tools had been moved to the other sites. Aggregate engine production at the No. 16 complex between the beginning of its operation and the end of the war was less than half the production at No. 4 in the single month of November 1944, the last month before the raids began; and no production was ever achieved at the other dispersed sites.

Bomb damage. In terms of both the amount of productive floor area destroyed and the percentage this area was of the pre-raid total, the aircraft industry received more direct damage from air attack than did any other industry in Nagoya. Detailed information on bomb damage, including damage to factories of the Mitsubishi No. 3 assembly complex, indicates that about half of the pre-raid productive floor area in the aircraft industry was made useless. As shown in the following table, precision and area attacks made about equal contributions to that result.

TABLE 10

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, AIRCRAFT INDUSTRY

Preraid total productive floor area, 11,545,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec-----	1, 593, 000	13. 9		
1945—Jan-----	40, 000	. 3		
Feb-----	205, 000	1. 8		
Mar-----	319, 000	2. 8	204, 000	1. 8
Apr-----	246, 000	2. 1		
May-----			2, 658, 000	23. 2
June-----	263, 000	2. 3		
July-----	329, 000	2. 9		
Aug-----				
Total-----	2, 995, 000	26. 1	2, 862, 000	25. 0

Total destruction by all attacks, 5,857,000—51.1 percent.

It should be emphasized that the amount of productive floor area destroyed cannot be taken as an index of the effect of air attacks on productive activity. For example, in this industry the greatest destruction in any 1 month was caused by the mid-May area raids, which destroyed about 23 percent of the pre-raid productive floor area. The May raids had, however, much less effect on production than did the lighter December precision attacks, which destroyed 14 percent of the pre-raid total. In the first place, a large part of the damage to plant and equipment caused by the May area raids was suffered by the Nakajima Atsuta factory, whose output was small, averaging less than ¥300,000 a month in 1944. The May raids caused a serious production loss only at the Okamoto Kasadera plant, where they destroyed 60 percent of both floor space and plant and equipment. In the second place, it was the December attacks that goaded the Japanese into their headlong rush to disperse, and it was that dispersal, more than any other factor, that caused the industry's December-January production drop to 27 percent of peak levels. In the third place, two-thirds of the damage to productive floor area in the May raids was concentrated in the Nagoya factories of the Mitsubishi No. 5 assembly complex, and most of the buildings hit had already been vacated owing to dispersal. (The effect on production of the precision raids after May was similarly limited by the fact that dispersal had already stripped the targets of much productive machinery.)

Altogether, air attacks destroyed or damaged 1,451 machine tools in the Mitsubishi No. 3 and No. 4 complexes, and in the Aichi Eitoku and Atsuta plants. The relative contribution of the direct effects of the raids and the indirect effects, particularly dispersal, is indicated by the fact that in those same complexes and plants (together representing about three-fourths of end-product manufacture in Nagoya's aircraft industry), dispersal caused a total of 5,371 machine tools to be moved from the city, or over 3½ times as many as were destroyed or damaged by air attacks. The machines moved were lost to the city's production as thoroughly as those destroyed or damaged, and indeed, were in large measure lost to the nation's industry, since the dispersed plants generally failed to get into production.

Earthquake. While the 7 December earthquake played a significant role in causing the precipitous

production decline of December and January, its contribution is difficult to assess with any exactness. It was closely followed by the December air attacks, and its effects tend to become intermingled and confused with theirs. Officials in the aircraft industry declared, however, that while the earthquake struck a sudden blow to the industry, its consequences were, for the most part, comparatively short-lived, and that the air attacks, and the dispersal they precipitated, did far more to cause the December-January slump in output at Nagoya's aircraft factories.

Labor. In general, labor difficulties in various forms harassed the industry throughout the last 2 years of the war.

In the pre-raid period, the chief difficulty was a shortage of skilled workers, as expanding industry exhausted skilled labor reserves. In the second half of 1944, that shortage was greatly intensified by (1) a rapid acceleration in the rate of industrial activity, (2) the growing use of substitute materials that required greater skill in handling and treating than did materials formerly available, and (3) the drafting of skilled workers by the armed forces immediately after the fall of Saipan.

This lack of skilled workers in the preraid period is not reflected by the over-all labor statistics for the industry, which show a steady rise through January 1945 in the size of the labor force, and a congruent rise, until the raids began in December 1944, in the number of productive hours worked (Exhibit I). Those rises are, however, due in large part to the employment of women, students, conscripts, and other untrained persons, who in the aggregate came to make up a large part of the labor force of the industry. At both the No. 5 and the No. 3 Mitsubishi assembly complexes, for example, conscripts accounted for 42 percent of the total labor force at the peak in March 1944. The top figure at the No. 4 engine plant, reached in April 1944, was 16 percent. At the Aichi Eitoku plant, the peak was not reached until February 1945, when conscripts equalled 50 percent of total employment, and at the end of the war the Aichi Atsuta engine plant labor force was almost 59 percent conscripts. Similarly at the five major factories (excluding the No. 3 assembly complex) students comprised 18.4 percent and women 18.0 percent, of the labor force in December 1944.

Informed officials in the industry in Nagoya estimated that the efficiency of conscript workers was 15 percent to 20 percent lower than that of

regular employees. Similarly, those officials agreed that although women and students tended to have a better attendance record than adult male workers, their efficiency was markedly lower. All three groups—women, students, and conscripts—were predominately unskilled and their addition to the labor force did not answer the need for skilled workers.

In general, the shortage of skilled labor hindered, although it did not prevent, the rise of production to peak levels by the summer of 1944. In the fall of that year, however, the shortage did make a major contribution to a moderate drop in output (concentrated mainly at the Mitsubishi No. 4 engine factory).

After the raids began in December 1944, absenteeism and decreased worker efficiency became the chief labor difficulties. As might be expected, absenteeism was highest by far among the workers deboused by the raids. In addition, food shortages, aggravated by disruption of the distribution system owing to mass evacuations, led many to forage in the country for food. Longer commuting distances to work for those evacuated to the country, and damage to the local transportation systems, increased tardiness. The effects of this increased absenteeism and tardiness after the raids began is reflected in the over-all labor statistics, which show a rapid drop between December and February in the average number of productive hours worked per man, with no recovery thereafter.

As shown in Exhibit I, while the index of productive hours worked fell off during the raid period it did not fall at so rapid a rate as did the index of production. Aircraft industry officials have stated that this was partly due to a decrease in worker efficiency. That decrease, resulting from food shortages, from loss of sleep due to raid alerts and air attacks, and from the workers' growing doubts as to the ability of the country to resist Allied pressure, meant that in order to achieve the same output more hours had to be worked than before the raids began.

The available evidence indicates that labor difficulties, although not a major cause of the precipitous decline in production that took place after the raids began, nevertheless aggravated the effects of the major causes of that decline—bomb damage, dispersal, and the earthquake.

Raw materials. At various times throughout the period studied (October 1943–August 1945) the aircraft industry in Nagoya was beset by short-

ages of basic raw materials and alloys that forced the use of substitutes requiring greater skill and care in handling. Only toward the end of 1944, however, did those shortages contribute materially to causing a decline in production in the industry. Even then their contribution was far outweighed by the contributions of bomb damage, dispersal, and the earthquake. After January 1945, production levels had fallen so low in this industry in Nagoya, and raw material needs had been so cut in consequence, that available supplies were in most cases adequate to meet requirements, and raw material shortages played little part thereafter in causing the production decline that continued to the end of the war.

In general, it appears that as events actually developed, Japan's general raw material shortage did not play a large part in causing the production decline in this, Nagoya's largest industry. It is also evident, however, that the aircraft industry as a whole did face an ever-increasing shortage of vital materials, particularly of aluminum and of certain alloys. That shortage, even if there had been no earthquake, or air attacks, or dispersal, would eventually have forced production down to levels as low as those actually reached during the raid months, but would have taken several months longer to do so. In Nagoya itself, of course, the extent to which raw material shortages alone would have forced down production would have depended upon the materials allocation policy decided upon by Japan's central government.

Components. Until the fall of 1944, component shortages had not seriously affected production in this industry, although from time to time the lack of certain items, and, more often, the irregularity of supply of items, had temporarily hindered production. In the last months of 1944, however, a drop in component receipts contributed substantially to production declines at the Mitsubishi No. 3 assembly complex, at the Aichi Eitoku assembly plant, and at the Aichi Atsuta Engine plant. In 1945, largely as the result of effects that the air attacks had on component suppliers, and of the tightening over-all raw material situation, all the major factories in this industry in Nagoya experienced failures of component supplies. There were differences in amount between orders and deliveries, and components were slow in arriving at the customer plants. Those failures and delays would have had a severe effect on production had not component needs, like raw material needs, already

been reduced by the decline of production at the consumer factories. Component shortages, therefore, were not major causes of the 1945 collapse of Nagoya's aircraft industry. As already pointed out, however, they did hinder the plants at the dispersed sites from getting into production, and thus from the national viewpoint actually contributed to a serious decline in plane and aircraft engine output.

Conclusions. Collapse of the aircraft industry in Nagoya may be ascribed almost wholly to the precision attacks on the industry. The chief direct cause of the production decline in the industry was panicky dispersal; but that dispersal was itself an immediate result of the early precision attacks, and its effects should, in the last analysis, be credited to those attacks. By the end of January 1945, the back of the industry had been broken, with production cut to about one-fourth of peak levels. The area attacks contributed materially to the later more gradual decline that practically wiped out the remaining production by the end of the war; but this further decline was largely anticlimactic. Labor shortages, particularly in the skilled worker category, absenteeism, and declining worker efficiency, troubled the industry in the last year of the war, but were not themselves major causes of the industry's collapse. They did, however, aggravate the effects of dispersal and bomb damage. Raw materials and components shortages actually had little effect on production. However, unless the national allocations policy had been changed so as to favor Nagoya at the expense of other aircraft centers, growing tightness in the over-all materials situation, and declines during the raid period in the production of component suppliers, would have placed steadily lowering ceilings on the output at Nagoya's aircraft factories, even if those factories had not dispersed and had remained undamaged by air attacks.

Ordnance Industry

General. This was the third largest industry in Nagoya; in 1944 it accounted for about one-eighth of the city's production and employed almost one-fifth of the city's labor force as of the end of that year. Like the aircraft industry, the ordnance industry was dominated by a few large factories; excellent coverage by industrial questionnaires shows that approximately 90 percent of its 1944 production, and over 80 percent of its December 1944 labor force, was concentrated in

nine plants—one run by the Howa Heavy Industry Co., and the remaining eight forming two large complexes operated by the Nagoya Arsenal and the Aichi Clock & Electric Co. respectively.

The Nagoya Arsenal complex was made up of five of the large factories, three inside the city limits, one just over the northeast city boundary, and one about five miles northeast of the city. Together those five factories accounted for 47.1 percent of the ordnance industry's 1944 output and employed 45.3 percent of its December 1944 labor force. The head office of the Arsenal controlled all five plants, and interchanges of raw materials, components and labor, were not difficult to effect. The Aichi Clock three-plant complex was headed up by the Funakata plant—by far the largest ordnance factory in Nagoya—and turned out 33.0 percent of the industry's 1944 output and employed 29.8 percent of its December 1944 labor force. The Howa Heavy Industry factory, just over the northeast city boundary, was Nagoya's fourth largest ordnance plant, with 9.6 percent of total production and 8.5 percent of total labor force in the industry.

Ordnance industry production trends (Exhibit K). Although productive activity followed the general trend of other industries in Nagoya and began to decline at the end of 1944, it was nevertheless relatively steady until June 1945, at no time before that month diverging as much as 25 percent from the mean for the base period October 1943–September 1944. Production history of the ordnance industry during the last 2 years of war may be divided into four phases: (1) a pre-raid phase, consisting of a rise in the winter of 1943–44 and, after a spring slump, a continuous rise from July through November 1944 to a peak 24 percent higher than the mean for the base period; (2) an initial phase of the raid period consisting of an abrupt drop in December 1944–January 1945 to about 68 percent of peak levels; (3) a phase of adjustment covering a 4-month period during which the rate of decline was largely checked; and (4) a phase of final collapse—a precipitous decline from May 1945 to the end of the war, with production falling by July (the last full month of war) to 29 percent of peak levels.

Of the nine major factories dominating the industry, five showed pronounced variation in production during the period studied, and accounted for most of the increases and decreases in productive activity for the industry as a whole. In

1944, those factories manufactured 78 percent of the industry's entire output. Since variations in production levels at the remaining factories had no significant effect on the level of over-all output, trends for the industry as a whole are analyzed below in terms of developments at the five key factories (Exhibit L).

First phase—the pre-raid period. The period October 1943 through November 1944 was one of a general rise in production, broken only by a slump in the spring of 1944. The principal cause of both the general rise and the slump was government orders fixing production levels, causing changes in product or design, or requiring changes in the direction of productive effort.

Second phase—initial phase of the raid period. In the 2 months, December 1944 and January 1945, total production for the industry fell ¥14,479,028. Of this decline, the great Aichi Funakata plant contributed ¥8,780,000, and the Howa plant ¥3,053,233. Production also fell at most of the other factories, although in a narrow range, and only three (the Nagoya Arsenal's Chikusa and Toriimatsu plants, and a factory run by the Takano Mfg. Co.) continued to rise; the aggregate increase of those three was only ¥317,044. Chief causes of the sharp drop in the industry's output in these 2 months were the 7 December earthquake, raw material shortages that began to afflict the industry at this time despite its relatively high priority, and preparations for dispersal.

Third phase—period of adjustment. From February to May 1945, the rate of decline was slowed, with slight upswings in February and May reflecting efforts to increase output and irregular improvement in receipts of raw materials. Production was still relatively high, however; the average for this 4-month period was almost 83 percent of the mean for the October 1943–September 1944 period, and was 67 percent of the November 1944 peak.

Fourth phase—final collapse. In June and July, the headlong downswing was resumed, and total production dropped ¥16,887,287. July output was only 29 percent of the November 1944 peak. Leader in the new drop was the Aichi Funakata plant, which accounted for one-third of the total decline when its output fell from ¥5,350,000 to zero as the result of the extremely successful precision attack of 9 June. Mainly because of the mid-May area attacks, a 26 June precision attack, and dispersal, the next three largest plants—the Arsenal's

Chikusa and Toriimatsu factories and the Howa factory—added ¥7,786,535 to the decline. Only one large plant, the Arsenal's Atsuta factory, phases of sharp production decline were bomb that played the largest roles in causing the two showed a rise, but the rise was only ¥178,642.

Relative importance of factors. The factors damage and dispersal, the first a direct, and the second an indirect, effect of air attack. The 7 December earthquake, raw materials shortages, and labor difficulties, all contributed to forcing down production, but did so only for relatively brief periods or to a minor degree.

Bomb damage and dispersal. About three-eighths of the ordnance industry's pre-raid productive floor area was destroyed by air attack.

TABLE 11

NAGOYA — PRODUCTIVE FLOOR DESTROYED, ORDNANCE INDUSTRY

Pre-raid total productive floor area, 6,661,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec.....				
1945—Jan.....			25, 000	0. 4
Feb.....				
Mar.....	93, 000	1. 4	445, 000	6. 7
Apr.....	143, 000	2. 2		
May.....			550, 000	8. 3
June.....	1, 100, 000	16. 5		
July.....				
Aug.....	142, 000	2. 1		
Total.....	1, 478, 000	22. 2	1, 020, 000	15. 3

Total destruction by all attacks, 2,498,000—37.5 percent.

The first attacks that caused substantial damage were the area raids of mid-March and mid-May. The only important ordnance plant that was damaged by those attacks was the Arsenal's Chikusa factory, which was hit in both March and May. The March raids inflicted heavier damage on Chikusa but apparently had little effect on production there, while the May raids probably were responsible for much of the production decline that occurred at that factory in May and June.

Most of the heavy precision attack damage to this industry occurred on 9 June, when Nagoya's largest ordnance plant, the Aichi Fumakata factory, was almost completely destroyed and was forced to stop operations.

Dispersal operations for the most part took place late in the raid period, and the Japanese were unable to compensate for the attendant production loss by getting into action at sites outside Nagoya prior to the end of war. Dispersal itself was undertaken because of the air attacks, and the loss from dispersal, which should be considered as an indirect effect of those attacks, effectively complemented the loss that was directly caused by bomb damage.

Raw materials. From time to time, short-term interruptions to receipts of raw materials, and irregularities in those receipts, interfered with production in the industry. However, the materials situation was not a major cause of production decline; for the most part, raw materials receipts held up well in comparison with the production levels that industry was able to maintain. During the final months of the war, in fact, high priority allocation of raw materials to the industry was continued at the expense of industries deemed by the Japanese to be less important, such as the vehicle and rolling stock industry. Aggregate production during the first 6 months of 1945 was 71 percent of aggregate production in the last 6 months of 1944. Aluminum and Duralumin receipts during the first half of 1945 were 87 percent of receipts in the last half of 1944; for brass, the figure was 104 percent; for tin, 136 percent; for copper, 49 percent; and for steel, 56 percent. To bring steel up equal to the 71 percent production figure would have required use of only about two-fifths of the industry's aggregate steel inventories on 1 January 1945, and for copper the amount would have been only about one-sixth of 1 January copper inventories.

Components. None of the large factories complained of component shortages; in explanation of this, some officials pointed out that the production decline resulting from other factors had so cut component requirements that component receipts, though reduced, were adequate.

Labor. While the testimony of management in the industry was that labor difficulties contributed to the drop in production during 1945, it seems probable that those difficulties acted as multipliers aggravating the effect of the air raids, rather than as major independent causes of the decline. Even at the end of the war, monthly totals of productive hours had declined less rapidly than had production (Exhibit K). There was little increase in absenteeism; the drop in productive hours reflected

permanent loss of workers rather than either loss of discipline among remaining workers or unavoidable raid-caused absenteeism.

Metals and Metal Products Industry

General. This industry is really a combination of three closely related industries: (1) metals and primary fabrication, (2) machined and fabricated metal products, and (3) finished machinery, machine tools, and precision instruments. The three industries are combined in this report for two main reasons. First, it was found that many of the factories involved made several products, of which some were associated with one, and some with another of the three industries, and insuperable problems of factory classification arose. Secondly, the three industries were so closely related (each having many factories depending on raw materials and components similar to those used by factories in the others, or using and depending on the products of factories in the others) that the effect on them of the air attacks could best be studied if they were treated as a group.

The consolidated industry was easily the second largest in Nagoya; in 1944, it turned out almost one-fourth of the total industrial production in the city, and in December of that year it employed almost three-tenths of the city's total industrial labor force. It was dominated by six large plants; the Sumitomo Light Metals Co.'s Nagoya plant, the Hoshizaki and Tsukiji factories of Daido Steel Co., the No. 10 factory of Mitsubishi Aircraft Engine, the No. 12 factory of Mitsubishi Heavy Industries, and the Kobe Steel Works' Nagoya plant.

Industry production trends (Exhibit M). In this industry, productive activity during the last 2 years of the war falls into just two phases: the first, a strong and comparatively steady rise that continued until the end of November 1944; and the second, a steep decline that began abruptly in December 1944 and continued almost unbroken until the end of the war, with production in July, the last full month of the war, falling to about 30 percent of peak levels.

The production graphs and tables set out in this report do not include data for two factories: the Sumitomo Light Metals Co. and the Mitsubishi Aircraft Engine Ozone factory. Sumitomo was the largest plant in Nagoya's metals and metal products industry. In November 1944, the last preraid month, it produced about one-fifth of the industry's total output. Detailed information on Sumitomo is available only for the period after

1 October 1944; for the earlier months, "the data were lost by air raids," and its management could give only a generalized narrative account of developments. However, the detailed information that the plant did furnish shows that, had its production been included in the statistics for the industry, little or no change would have been made in the trends shown by those statistics for the last 11 months of the war.⁶ That information was fully considered in arriving at the conclusions given in this report, and it is set out in the text whenever appropriate. The Mitsubishi Aircraft Engine Ozone factory returned no questionnaire to the Survey, but its production was not over 20 percent of Sumitomo's output. Furthermore, general information collected by the USSBS Aircraft Division on the Ozone plant indicates that its production followed the general trends of the metals and metal products industry. It is believed that, had data for the Ozone factory been included in the statistics for the industry, no substantial changes would have resulted.

If the Sumitomo and Ozone production is excluded, 11 large factories represented about 73 percent of the industry's total 1944 production, and made up 72 percent of the over-all decline during the raid period. Seven of those 11 plants accounted for 66 percent of total production (still excluding Sumitomo and Ozone) and made up 63 percent of the over-all decline during the raids.

NOTE.—Inclusion of Sumitomo, the industry's largest plant, naturally would increase the concentration of production in the large factories. For the peak month of November 1944, for example, fully 76 percent of the entire industry's production (including Sumitomo) was accounted for by Sumitomo and the 11 large factories. The same 12 plants were responsible for nearly 78 percent of the over-all decline during the raid period.

As in the aircraft and ordnance industries, trends in the metals and metal products industry may safely be analyzed in terms of trends at its dominant factories (Exhibit N).

⁶ If December 1944 production is taken as a base, the production indices for the period October 1944–August 1945 for all plants in the industry, including the Sumitomo plant, show close agreement with the production indices for all plants except Sumitomo:

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
With Sumitomo . . .	114	122	100	98	87	79	72	58	39	41	32
Without Sumitomo.	109	118	100	89	87	73	70	61	42	38	36

First phase—period of rising production. Over-all production in the industry rose steadily from October 1943 until November 1944, when it reached a peak 28 percent higher than the mean for the first 12 months of the period. There were no noteworthy features of this rise; for the most part it reflected increased demand for the products of the industry and governmental pressure to increase output, accompanied by governmental assistance in obtaining enough labor. From time to time, however, production levels dropped temporarily at individual plants; usually those drops resulted from labor shortages of one form or another. For example, at the Hoshizaki plant of the Daido Steel Co., a January 1944 drop was "due to dullness of workers following the New Year ceremony, which was noticeable every year"; a July and August slump resulted from "worker fatigue due to high temperature in the summer season"; and a sharp October relapse was due to "worker fatigue owing to a production drive in August and September, which was planned to recover the loss of the preceding month and (which) resulted in good success only temporarily."

Second phase—Decline continuing to the end of the war. A steep decline in over-all production levels in this industry began abruptly in December 1944, and continued with little interruption until the end of the war.

The initial impetus of the long decline resulted from sharp drops in December and January at four of the largest factories (Daido Steel Co.'s Hoshizaki and Tsukiji plants, the No. 10 plant of Mitsubishi Aircraft Engine, and Nagoya Screw Co.) due to the 7 December earthquake, to decreases in receipts of fuel and raw materials, and to spill-overs from the December precision attacks. Those four plants contributed almost two-thirds of the total 2-months decline for the industry. After January, the over-all production decline was largely the result of additional drops in output at the same four plants, and of sharp drops beginning in January and February at two other important factories: the Kobe Steel Works and the Mitsubishi No. 12 Works.

Daido Steel Co. Hoshizaki factory. At this plant, the sharp December-January drop was owing to the 7 December earthquake (about 80 percent for that cause, according to the factory's own report), component shortages (10 percent), bomb damage (7 percent), and labor difficulties (3 percent). After January, production began a slow rise that lasted until May. That rise was

the result of efforts to increase production of steel helmets in response to governmental prodding. In June, however, output at the plant fell off precipitously, mostly as the result of bomb damage sustained in the mid-May area raids (about 80 percent for that cause), but also partially as the result of productive hour losses owing to air alerts and to the undertaking of necessary repair work (10 percent), component shortages (5 percent), and dispersal (5 percent).

Daido Steel Co. Tsukiji factory. Production fell sharply in December owing to the earthquake, and fuel and raw material shortages largely resulting from transportation bottlenecks. In the next month, production at this plant recovered, but after February it again fell off rapidly, chiefly as the result of continued fuel shortages, of a decline in the productive hours worked by its labor force, and of further drops in its receipts of raw materials. Probably owing to a determination to conserve stocks, its raw material inventories were not heavily invaded, but even if stocks had been used, raw material receipts were so low that production at late 1944 levels could not have been maintained for more than the first 3 months of 1945. The decline in material receipts was ascribed by the management to a shortage of transportation.

Mitsubishi No. 10 Works. The sharp December-January drop at this plant was due to fuel and raw material shortages and to labor difficulties, and in the succeeding months those two factors caused the decline to continue at much the same rapid rate. At this plant, inventories of raw materials were generally too small to have permitted the maintaining of peak production levels for more than a few weeks.

Nagoya Screw Co. The December-January decline at this plant resulted from labor difficulties, raw material and fuel shortages, and bomb damage by the December precision attacks. After January, production continued to drift lower through May, but the mid-May area raids, which destroyed 61.5 percent of this plant's productive floor area and 86.1 percent of its plant and equipment, forced June and July production almost to zero. In August this plant apparently unloaded stocks, and an illusory "production" rise resulted.

Kobe Steel Works Nagoya plant.—Production held near the peak level until February 1945 when a steep 4-months decline began that dropped output by 63 percent. After a moderate recovery in June, production leveled off in July, the last full month of the war. The management ascribed the

February–May decline chiefly to labor absenteeism and inefficiency, with shortages of raw material and fuel also major, though less important, causes.

Mitsubishi No. 12 Works.—At this plant production rose through February 1945, but then declined through the end of the war. The rise through February was the result of government orders fixing production levels, as was the decline from February through May. After May, raw material receipts failed, and the plant's management ascribed the post-May production decline chiefly to that failure, although the plant had large raw material inventories which were drawn upon only slightly and which would have supported peak production for several months.

At the other large plants returning complete factor questionnaires, the story was similar. Production at Daido Steel Co.'s Atsuta plant continued to rise through December 1944, then fell off slightly in January 1945 owing to a drop in productive hours. After that, it held steady through February and March, only to drop sharply in May and June because of (1) continued absenteeism and worker inefficiency and (2) declines in raw material receipts aggravated by the destruction of raw material stocks in the area raid of 19 March; an August recovery was due to an improvement of the fuel situation. Labor difficulties, and shortages of components, fuel, and raw materials (in that order, with labor difficulties by far the most important), were responsible for declines at the Hagino and Kamiida plants of Okuma Iron Works, although there were sizable raw material and component inventories at those plants. To a large extent, however, available materials were of inferior quality, or were substitutes for materials formerly available, and in both cases they required special processing or greater care and skill in handling. The difficulties this caused were aggravated by the declining efficiency of the labor force. At the Showa Works of the Okamoto Industrial Co., production began to decline in January and February 1945 because of preparations for dispersal, and then fell to zero in March as the result of heavy damage in the area raids of that month; thereafter, no production ever was achieved. At Chuo Spring Co., dispersal accounted for most of a post-April decline.

At the great Sumitomo plant, the 7 December earthquake drove production down suddenly in December, but there was a complete recovery in

the following month. After that, a steep decline began that continued to the end of the war, despite temporary improvements in March and June resulting from all-out production drives in "Tokuku (special attack) weeks". The chief causes of this decline were "extreme shortages" of raw aluminum, shortages of "auxiliary material" (oil, fuel, coal, coke, gas), and heavy bomb damage (destroying about two-thirds of the plant's productive floor area and equipment), with labor absenteeism and inefficiency, and dispersal, contributing to a lesser degree. The shortages of "auxiliary materials" were principally caused, the management said, by inadequacies of the transportation system.

Peak production at the Mitsubishi Aircraft Engine Ozone factory was reached in December 1944 and January 1945. By May, that factory's output had dropped to 50 percent of peak, and the area attack of 14 May burned out practically all of the plant's productive facilities, completely halting production. The Ozone factory was important chiefly as a supplier of engine bolts and small parts to the great Mitsubishi No. 4 Aircraft Engine Works but, as already mentioned in the report on the aircraft industry, output at the No. 4 Works had dropped to negligible levels early in the raid period, and therefore it was not affected by production declines at the Ozone plant. The post-January decline also had little effect on productive activity at the Ozone factory's second most important customer: the Mitsubishi No. 16 Aircraft Engine complex in Ogaki, which had been developed from plant and equipment transferred from the dispersing No. 4 Works. This lack of effect was because production at the Ogaki No. 16 complex had been held back by stoppage in Ozone's manufacture of a single item—rear casings for engines—after a spillover from one of the mid-December precision attacks had destroyed the special machinery of American design for making those casings at the Ozone plant. The Mitsubishi Co. took several months to redesign and assemble new machinery at the Ogaki complex.

A review of the questionnaires returned by the factories not already discussed shows that a general decline also was seen at those factories and that the causes of that decline were about the same as those described above, and were of about the same relative importance.

Relative importance of factors influencing production. It appears from the above discussion that the chief causes of the over-all decline in the

output of the industry were a reduction of receipts of raw materials and fuel, and growing absenteeism and inefficiency of labor. The 7 December earthquake played a large part in the initial stage of the decline, and later on, bomb damage, especially in the March and May area raids, was an important factor.

Raw materials and fuel. Falling receipts of raw materials and fuel were a front-rank cause of the production decline in this industry. Almost every major factory whose production fell off ascribed a large part of its difficulties to failures in its supply of basic materials and fuel.

1. Sumitomo, the industry's largest factory, in explaining an 80 percent production drop that took place between November 1944 and the June precision attacks, said in part: "With the extreme shortage of raw aluminum, production had to depend on low-grade material and the stoppage of transportation resulted in a shortage of auxiliary materials of production, especially in oil, fuel, coal, coke, gas, causing the operation of the plant to stand still. * * * In 1945, efforts were made to sort and reclaim material shortage by altering standard specifications for the composition, but the progress in this line was very slow."
2. Daido Steel Co.'s Hoshizaki factory, second largest in the industry, reported: "The shortage of supply and deterioration in quality of raw materials and auxiliary materials were remarkable. (Various efforts in order to overcome the difficulty in securing them were immense: (1) Shortage of good scrap led to the necessity of much selection of scrap before charging. Due to the poor quality of scrap, damage of the arc furnaces was promoted and the percentage of good ingots decreased. (2) Carbon electrodes always were short since the beginning of 1943. (3) Magnesia clinker shortage was due to the difficulty in transportation from Manchuria and Korea. Dolomite clinker was substituted, but that also became short owing to transportation difficulties, and crude dolomite ore had to be used."

3. The Okuma Iron Works' Hagino and Kamiida plants jointly stated: "As for steel, it was very difficult to seek for one of moderate kind and type and measure, but we endeavored to make use of stocks by the device of heat treatment, the change of design, temper, cutter, etc. As for pig iron, it was also very hard to get suitable materials, so we made efforts to allot the materials of casting that were the most useful, and practiced to allot much amount of old iron and so on in store."

It was, of course, to be expected that although the large end-product industries, aircraft and ordnance, were not greatly affected by raw material shortages, such shortages would be found to have seriously hampered the metals and metal products industry, which came much earlier in the production pipe line and which naturally would be much sooner affected by such shortages.

Labor. Growing absenteeism among workers and declining efficiency of those reporting for work were major causes of the steady production decline that this industry experienced after November 1944, ranking about level with the raw materials and fuel situation in this respect. The managements of factory after factory complained of the effects of accumulated fatigue, disrupted transportation, evacuation, fear of attack, and food shortages, on the attendance and productivity of labor. Typical examples of those complaints follow:

1. Sumitomo Light Metals Co. ascribed much of its production decline to the fact that "as the raids increased in intensity, the number of absent workers increased, the ratio of workers reporting to work to the total number falling below 60 percent."
2. The Nagoya plant of Kobe Steel Works reported that labor absenteeism was the chief cause of the production decline at that plant, and ascribed that absenteeism chiefly to food shortages that forced workers to leave work and to forage in the country in order to supplement official rations. That plant also stated that fatigue definitely helped cause production slumps, and that the decline in output also could be credited in part

to the growing use of women and students, who maintained high attendance records but were from 20 percent to 40 percent less efficient than men.

3. The Hagino and Kamiida plants of Okuma Iron Works reported jointly that labor inefficiency and absenteeism were the chief causes of their production declines, and said: "Laborers had decreased gradually due to mobilization, and moreover they were tired themselves physically and mentally, and they were absent, as their families had to be removed to other places. As the damages of air attacks were frequent, a great many workers suffered, consequently they were forced to stay at their homes. Means of communication and transportation were destroyed day by day. While working they always were anxious about bombing and wasted many hours to avoid it and defend themselves. The influence on production was great. Sometimes nutriments and tonics were delivered to workers to cure their physical fatigue. Medical science of prevention was prevailed upon."

4. Daido Steel Co.'s Hoshizaki plant credited labor difficulties with much less influence on production than the earthquake and bomb damage, but said: "Labor shortage was not almost caused numerically (i. e. total number of employees did not decline) but many skilled laborers entering service were substituted by unreliable student workers only so far as to the number. And moreover the frequency of air raids brought dullness and overwork, both of which resulted in (substantial) loss of output."

The complaints given above include references to "the growing use of women and students" and to the replacement of skilled laborers by "unreliable students only so far as to the number." The factory questionnaires for plants in the metals and metal products industry (including the Sumitomo Co.) show that, of a total December 1944 industrial labor force of 90,054 workers, 13,349, or 15 percent were women and 19,791, or 22 percent, were students; together, women and students rep-

resented nearly three-eighths of the industry's total labor force.

The number of workers employed by the industry rose steadily until the end of March 1945, and although it dropped after that, the total decline was relatively much less than the decline in production (Exhibit M). On the other hand, the total number of productive hours worked monthly began to decline in December 1944 and the decline continued to the end of the war, with the rate of decline in close agreement with the rate of decline in production. Comparison of the trends in labor force, productive hours worked, and production, suggests that absenteeism contributed more to the production drop than did decreased worker efficiency.

Bomb damage. Air attacks destroyed about one-third of the pre-raid productive floor area of the industry (including the Sumitomo plant):

TABLE 12

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, METALS AND METAL PRODUCTS INDUSTRY

Pre-raid total productive floor area, 12,098,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec-----	37, 000	0. 3		
1945—Jan-----	1, 000	{Negligible}	5, 000	{Negligible}
Feb-----	9, 000	. 1		
Mar-----	178, 000	1. 5	783, 000	6. 5
Apr-----	136, 000	1. 1		
May-----			1, 782, 000	14. 7
June-----	1, 048, 000	8. 7		
July-----				
Aug-----				
Total-----	1, 409, 000	11. 6	2, 570, 000	21. 3

Total destruction by all attacks, 3,979,000—32.9 percent.

NOTE.—The above figures, showing destruction of productive floor area, do not fully measure the relative destruction of productive facilities by precision and area attacks. In terms of plant and equipment, precision attacks destroyed 15.8 percent of the pre-raid industry, while area attacks destroyed 20.6 percent.

The first attacks that caused heavy damage to the industry were the mid-March and the more destructive mid-May area raids, which together destroyed over one-fifth both of the pre-raid pro-

ductive floor area and of the pre-raid plant and equipment, with damage by the May raids over twice as great as that by the March raids. The early precision attacks caused relatively little damage. On 9 and 26 June, however, heavy precision attacks hit the main Sumitomo factory, knocking out 56 percent of its productive floor area and 52 percent of its plant and equipment; the 26 June attack alone accounted for about four-fifths of this damage. While the June precision attacks destroyed only 60 percent as much productive floor area as did the May area raids, the June attacks destroyed nearly as much plant and equipment (¥50,597,000 worth as against ¥53,197,000 worth); accordingly, the relative effectiveness of the June precision attacks in destroying productive facilities was much greater than is indicated in the preceding table.

In terms of their direct effect on productive activity in the metals and metal products industry, the area raids were more important than were the precision attacks, and the March area raids had relatively greater importance than the physical damage table indicates. The March raids hit the industry while production was still at about 70 percent of peak levels; the May area raids found production at 58 to 60 percent of peak; and the heaviest damage from the June precision attacks occurred at a time when production had already dropped to 33 percent or less of peak, and when the Sumitomo factory on which they fell was at only 20 percent of its peak.

The direct effect of air attacks on this industry may be summed up as follows: The area raids sharply accelerated the rate of production decline in the weeks that followed them, and contributed substantially to the over-all drop in industrial output. The precision attacks were a secondary cause of the initial December 1944–January 1945 plunge, but had little direct effect thereafter except in June, when they fortified the continuing effects of the earlier area raids.

Earthquake. The earthquake of 7 December struck a sudden, sharp blow to the industry. It was chiefly responsible for the abrupt December drop in production at the Hoshizaki and Tsukiji plants of Daido Steel and at the Sumitomo plant, and that drop accounted for most of that month's decline in the output of the industry as a whole. The effects of the earthquake were quickly shaken off, however, and it must be ranked well behind

the air attacks in terms of real long-term impact on production in the industry.

Dispersal. Dispersal was not a major cause of production declines in this industry, although it did contribute to drops in output at a few factories. In general, what dispersal there was did not get under way until the late spring of 1945, and was ineffective, and little production was realized at the dispersal sites. The following examples illustrate the ineffectiveness of dispersal:

1. The large Hoshizaki plant of Daido Steel Co. planned dispersal of all its cartridge-making plant and equipment, and about 44 percent of its special steel capacity—20 percent to Korea, and 24 percent to places in Aichi and Gifu Prefectures. Dispersal of the cartridge plant was to begin 1 June 1945, and was to be finished 1 September; that of the special steel facilities was to begin 1 June, and was to be completed in Gifu and Aichi by the end of October 1945, and in Korea by the end of April 1946. By the end of the war, all of the cartridge plant and machinery had been moved; of the dispersing special steel facilities, two-fifths were at the new sites, and one-fourth (including that bound for Korea) was en route; of five new factories planned, two were completed, and a third was about 80 percent finished. No production was realized at any of the new sites.
2. Sumitomo's great Nagoya plant was ordered on 1 April 1945 to disperse all of its casting facilities, and on 16 May 1945 to move 30 percent of its fabrication facilities. By the end of the war over 80 percent of the casting plant and equipment and all of the casting workers had been moved, but "although the majority of facilities was dispersed, large-scale production was just about to begin and actually no effective production was realized." Only a small part of the fabricating facilities was actually moved. In the words of the company, "the effect of dispersal was to decrease production, sacrificing a great length of time under air raids, when manpower and material were ex-

tremely difficult to be had under war-time conditions."

3. The large Hagino and Kamiida factories of the Okuma Iron Works (both in north Nagoya) planned dispersal to Aichi Prefecture, and actually moved 30 percent of the planned total of plant and machinery, but while the two factories did not suffer production losses because of the dispersal, neither did they realize any production at the dispersed sites.

Components. By and large, component shortages were not an important cause of production declines in this industry. At the Hagino and Kamiida plants of Okuma Iron Works, component shortages stood second to labor problems as a cause of decline. The management of those plants ascribed the shortages to decreases in the output of component suppliers caused in turn by raw material shortages, bomb damage, and interference with operations by frequent alerts and attacks. At Daido Steel Co.'s Hoshizaki plant, before ingots were rolled they were sent to local plants for the removal of surface defects. The nondefect ingots may be considered "components." Deficiencies in local transportation (by truck, ox-cart) interfered with carrying the ingots to and from the "subcontracting" firms, and brought about ingot shortages that caused about one-tenth of a plunge in December-January and one-tenth of a sharp drop in June. Those shortages were greatly overshadowed, however, by the earthquake (causing 80 percent of the December-January plunge) and bomb damage (7 percent of the December-January plunge and 80 percent of the June drop). None of the other important factories complained of component receipts, and the total contribution that failures in those receipts made to the production decline of the industry must be considered relatively small.

Electrical Equipment Industry

General. Nagoya's electrical equipment industry, which made electrical instruments and instrument parts (vital to both the aircraft and ordnance industries), insulators, and other communications equipment, turned out about 4 percent of the city's total production in 1944, and employed about 6 percent of the city's labor force as of December of that year.

As in the industries already discussed, the bulk of this industry was concentrated in a few plants. A single factory—the Mitsubishi Electrical Equipment Co., located about 1,000 feet from the great Mitsubishi No. 4 Aircraft Engine plant in northeast Nagoya—produced more than 50 percent of the industry's entire 1944 output and employed nearly 50 percent of its December 1944 labor force, and at the five next largest factories—the Japan Insulator Co., the Japan Special Ceramics Co., the No. 1 Factory of Tokai Electrode Co., the Takaoka Mfg. Co., and the Oe Factory of Daido Steel Co.—the 1944 production and labor force each aggregated another 30 percent of the industry tools.

Production trends (Exhibit O). In this industry, productive activity falls into three phases: (1) between October 1943 and September 1944, output rose erratically to a peak nearly twice as high as the mean for those 12 months; (2) wide production swings continued during the next 6 months, with average output still about 15 percent higher than the October 1943–September 1944 base; (3) in April 1945, production broke sharply and thereafter declined rapidly and steadily until the end of the war. In July output was only 20 percent of the September 1944 peak, or 39 percent of the October 1943–September 1944 average. In each phase, the trend was determined by developments at the large factories named above, and may be analyzed in terms of those developments (Exhibits P and Q).

First phase. During the first phase, output increased at all the large factories; those increases were to be expected in view of the general rise in activity in the aircraft industry—a principal customer. An intermediate peak reached in March 1944 resulted from (1) Mitsubishi Electric Equipment Co.'s practice of putting on end-of-quarter production drives during which all available parts and components were assembled to bring production totals for the quarter up as high as possible, and (2) fluctuations in output at Daido Steel Co.'s Oe Factory and at the Takaoka Mfg. Co. plant resulting from irregularities in their receipts of raw materials and components. (If Mitsubishi Electric Equipment Co.'s production in each quarter is spread evenly over the 3 months of that quarter to balance early emphasis on parts manufacture against later emphasis on assembly, the September peak would be 146.9 percent of the

October 1943–September 1944 base, instead of 193.3 percent as presently appears.)

Second phase. This phase covered the last quarter of 1944 and the first quarter of 1945; average monthly output was about the same in both quarters although, as a result of Mitsubishi Electric Equipment Co.'s end-of-quarter drives, there were fairly wide fluctuations from month to month with output falling in the initial month of each quarter considerably below output for the preceding month and then rising rapidly in the last 2 months of the quarter. Average monthly production in this 6 months period was about 20 percent lower than the average for the last preceding quarter, and about 40 percent lower than the September peak. The drop was mainly owing to production declines at the Mitsubishi factory. At that factory, average output September to December 1944 was only 60 percent of the average during the preceding quarter; and the drop was largely due to a "shortage of labor and machines" and to a "decrease of capacity by dispersal."

At the other plants production continued to rise through November 1944, then fell off rapidly in December and January, mainly owing to the effects of the earthquake. As those effects wore off, increases in February output at Japan Insulator Co., Japan Special Ceramics Co., and Tokai Electrode No. 1 Factory, resulted in a temporary recovery in aggregate production, despite continuing declines at the Takaoka and Daido Steel factories, where output fell owing to declines in raw material and component receipts and to a drop in productive hours worked. By March, however, total non-Mitsubishi output had again fallen and was even slightly lower than in January.

Third phase. In April, over-all output for the industry fell off suddenly, and thereafter it continued to decline rapidly. Over three-fourths of the April–July decline occurred at the Mitsubishi Electrical Equipment Co., where production fell chiefly because of dispersal, although irregularities and deficiencies in raw material receipts, and labor inefficiency and absenteeism, hampered operations at that plant throughout the period. In addition, spill-overs from the 7 April precision attack on the neighboring Mitsubishi No. 4 Aircraft Engine plant destroyed 15 percent of the Electrical Equipment Co.'s pre-raid productive floor area, and the mid-May area raids knocked out an additional 19 percent. This damage also helped force down production.

At the other factories, production also fell in April (continuing the decline that followed the temporary February upswing), but then recovered briefly in May, owing to rises at Japan Insulator Co. and Daido Steel's Oe plant, before resuming the decline that then continued to the end of the war. The largest individual April drop took place at the Japan Insulator Co., whose output fell for the following reasons, listed in order of importance: (1) abandonment of one kiln owing to "inability to obtain the coal, and the obscurity of getting it in the future", (2) dispersal, (3) increased absenteeism following the mid-March area raids, and (4) component shortages owing to the effects of the raids.

NOTE.—As shown by Exhibit O, there was a sharp drop in April, and a partial recovery in May, in the industry's consumption of electric power. Most of the sudden swing in those two months apparently was due to a temporary power failure at the Tokai Electrode No. 1 factory. That factory's production already had been cut in half 1 month earlier, however, and failed to show any marked reaction to the power difficulties in April.

In May temporary improvements in component and raw material receipts at Daido Steel's Oe plant and at Japan Insulator Co. caused a temporary recovery in aggregate non-Mitsubishi output, but thereafter that output fell rapidly.

Relative weight of factors. During the raid period the principal cause of the decline in the industry's output probably was dispersal, but raw material, labor, and component shortages, ranked close behind it.

Dispersal. This was the chief cause of the post-March production decline at Mitsubishi Electrical Equipment Co., and it contributed to the sharp April drop at Japan Insulator Co. Those two companies produced about two-thirds of the 1944 output of the industry. The Mitsubishi plant reported: "About 65 percent of Nagoya Work's machinery was already dispersed at the war's end. But as dispersal was not carried out before the air raids began, we could not continue our work regularly during and after dispersal. So we could not avoid about 45 percent drop of production temporarily, but expected it would soon recover as most of our dispersed shops are located out of the city area and could continue our work even under air attacks."

Raw materials and fuel. Shortages of raw materials and fuel hampered most of the plants. At Mitsubishi Electrical Equipment Co., "most of

the time, they were short, sometimes none at all." At Japan Insulator Co., crude petroleum shortages caused the factory to stop firing its muffle kiln in December, and coal shortages made it shut down a tunnel kiln in April. The latter action was the chief cause of the steep April production decline at that factory.

Labor. Labor shortages were cited by most of the factories as causes of production declines. Mitsubishi reported that labor was chronically short: "By the government's initiative we employed about 3,000 students, but their usefulness even now is doubtful due to time lost for training." Japan Insulator Co. stated: "The percentage of attendance was gradually falling down, because of the successive air raids. We can ascribe the reasons as due to the dispersal of labor's housing at first. But of course, it was aggravated by the transportation difficulties. At this occasion we must especially recognize a remarkable increase of absenteeism for long periods.

Components. Component shortages would have had a very serious effect on this industry had not other factors already reduced component needs by the time receipts began to fall off. As it was, they had less influence than raw material and labor shortages. Mitsubishi Electrical Equipment Co. said: "We usually depended on our subcontractor factories and things were smooth until the end of 1944. But since the beginning of 1945, most of them were damaged directly or indirectly, and one after the other dropped from usefulness. As countermeasures, we planned to make some ourselves but already too late: the war soon ended." But this company also reported that the destruction of component sources did not in fact play any substantial part in causing declines in its own output since it had large component inventories, and since other causes forced its own production down so sharply after March that its component needs were greatly reduced.

At Japan Insulator Co., the second largest factory in the industry, component shortages ranked behind fuel shortages, dispersal, and absenteeism, as a cause of the steep April production decline. The management of that factory reported: "As a result of the big air raids in the previous month, the supplying capacity of the components makers of parts for general insulators was largely influenced, and we order the makers of parts for the acid-proof porcelains to change some of their lines

to parts for the general insulators." This company also named component shortages as ranking after absenteeism as the cause of a July drop in its output.

Bomb Damage. Air attacks, especially the area raids, destroyed about 34 percent of the pre-raid productive floor area in this industry:

TABLE 13

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, ELECTRICAL EQUIPMENT INDUSTRY

Pre-raid total productive floor area, 3,646,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec.....				
1945—Jan.....				
Feb.....				
Mar.....	60, 000	1. 6	136, 000	3. 7
Apr.....	148, 000	4. 1		
May.....			886, 000	24. 3
June.....				
July.....	16, 000	. 4		
Aug.....				
Total.....	224, 000	6. 1	1,022,000	28. 0

Total destruction by all attacks, 1,246,000—34.1 percent.

As is shown by Table 13, the mid-May area raids caused the heaviest damage. Those raids practically wiped out five of the smaller factories of the industry, and the mid-March raid did the same to an additional one; 99 percent of the aggregate productive floor area and 82 percent of the aggregate plant and equipment of the six plants was destroyed. However, the 1944 production of the six plants aggregated only 7.5 percent of the total for the industry. The mid-May raids also destroyed 19 percent of the productive floor area of Mitsubishi Electrical Equipment Co. and 17 percent of its plant and equipment, but that factory was dispersing and consequently the effect on production was not great.

In general, therefore, direct bomb damage had relatively little effect on output in the industry—much less than dispersal (which was an indirect effect of air attacks), and less even than shortages of labor, raw materials, and components.

Vehicles and Rolling Stock Industry

General. This industry accounted for only 1.4 percent both of Nagoya's 1944 industrial production and of its December 1944 labor force. It was made up of just three factories, and only one of those was large. At that one, the Japan Vehicle Co. whose principal products were locomotives, freight cars, cutters, and boats, was concentrated 97 percent of the industry's 1944 labor and production.

Production trends (Exhibit R). Production in this industry rose rapidly from October 1943 through August 1944. In September 1944 a steep decline began that continued through July, 1945, despite moderate recoveries in November 1944, and March 1945. In July 1945, output was only 3.1 percent of the August 1944 peak, and only 3.9 percent of output in November 1944, the last pre-raid month. Since the Japan Vehicle Co. was such a large part of the industry, the above trends may be analyzed in terms of developments at that factory alone.

The decline from August through November 1944 was due entirely to government orders; pursuant to those orders, production of cutters and boats by the Vehicle Co. was practically discontinued in September 1944.

After November 1944, the decline may be regarded as falling into two phases separated by a leveling-off in February and a moderate recovery in March: the first phase was a 2-month drop in December 1944 and January 1945; the second was a long, steep decline from March through July, during which the aggregate drop was about two and one half times as great as the aggregate drop in the first phase. In order of importance, the causes of the drop in the first phase were shortages of steel, a lack of wheel and axle sets for freight cars, and a drop in the attendance of labor. In the February and March period of leveling-off and moderate recovery, there were slight improvements in steel and component receipts and in the productive hours worked by the industry's labor.

The second phase began with an abrupt drop in April, production falling in that month alone almost twice as far as it had in December-January. The management of the Vehicle Co. stated that the causes of this April drop were chiefly a sharp reduction in steel receipts and a practically complete failure of component receipts (axletrees, tires, and air brakes, for locomotives and springs for freight cars). Growing absenteeism (reach-

ing 34 percent in April) also contributed, though to a lesser extent.

The continuing decline in May through July was ascribed by the management to the following causes, listed in order of importance: (1) bomb damage, which destroyed 30.4 percent of the pre-raid productive floor area, 15.2 percent of the pre-raid plant and equipment, and considerable stocks of critical raw materials and components; (2) absenteeism, which averaged about 50 percent for the 3 months and which was largely raid-caused; (3) continuing shortage of steel, axletrees, tires, air brakes, and springs, and (4) during the last 2 months, a decline in receipts of coal and coke.

Relative importance of factors. A review of this factory's completed questionnaire, and of a narrative report it submitted, indicated that the chief cause of the decline in the raid period was component and raw material shortages, that the next most important cause was labor absenteeism, and that the third was bomb damage.

Components. As stated above, failures and irregularities in the supply of components for locomotives and freight cars were the chief cause of the decline in output of the Vehicle Co. plant during the raid period. All the components mentioned came from the Osaka-Kobe area, except springs, which came from Tokyo. On the causes of the failures of component receipts the management had the following to say: "The transportation office, the control association and makers did their best jointly to acquire the parts of rolling stock from all component makers. But due to the repeated air raids against parts factories, their productive power was destroyed completely and our exertion proved fruitless."

Raw materials. Declining receipts of steel complemented the components shortages and shared with them the primary responsibility for the production decline in the raid period. Steel receipts in the 8 months December 1944-July 1945 were only 6,286 tons, as compared with 16,832 tons in the last 8 months of the pre-raid period. The plant's management reported: "We did our best to acquire iron and steel materials by the united purchase from all makers through the Control Association of Rolling-stock and Transportation Office, and negotiated individually with an iron manufacturer. "(The last probably is a euphemism for black market purchases.) But we could not acquire fully because of preferential allotments."

Labor. After November 1944, the labor force

figures held up far better than did production, but the hours worked by that force fell sharply. In July 1945, hours worked were only 9.3 percent of the November 1944 total while the number of workers was still 72.6 percent of the November figure. According to the management, the great increase in absenteeism reflected by these figures was caused by the burning-out of workers' homes, by the disruption of local transportation, and by the food situation which led workers to seek additional food supplies in the country. That absenteeism was a major cause of the collapse of this industry, although it ranked behind raw material and component shortages in this respect.

Bomb damage. The following table summarizes bomb-damage, which ranks third among the factors causing the production decline in this industry:

TABLE 14

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, VEHICLES AND ROLLING STOCK INDUSTRY

Preraid total productive floor area, 811,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec.....				
1945—Jan.....	37, 000	4. 5		
Feb.....				
Mar.....				
Apr.....				
May.....			223, 000	27. 5
June.....	24, 000	3. 0		
July.....				
Aug.....				
Total.....	61, 000	7. 5	223, 000	27. 5

Total destruction by all attacks, 284,000—35.0 percent.

As is seen in Table 14, the May area raids caused the greater part of the damage to productive floor area. However, the June precision attack, which destroyed only one-ninth as much floor area, knocked out 60 percent as much plant and equipment as did the May area raids.

Chemical Industry

The 1944 production of this industry was less than 1 percent of the total for all industries in Nagoya, and the industry employed less than 1 percent of the city's total industrial labor force. After a moderate decline from October 1943

through January 1944, production in the industry rose rapidly through October 1944, when it reached a peak 64.2 percent higher than the mean for the preceding 12 months. After that it fell off sharply until, in July 1945, it equalled only 11.4 percent of the October peak. About 83 percent of the decline was concentrated in four factories: The Toa Synthetic Chemicals Co.; the Toyo Synthetic Chemicals Co.; the Sakura Rubber Co.; and the Kokka Rubber Products Co. (Exhibits S and T).

The dip in October 1943–January 1944 was owing almost entirely to a drop in production at the Toa plant caused by changes in its raw material receipts and in the total hours worked by its labor. An August 1944 drop at this factory, caused by the same factors, was partly offset by rises at the other factories, whose production increased throughout the first year of the period covered by this report. In September 1944 the rate of increases rose sharply (1) at the Toyo plant, owing to increased demand for its products (followed by an enlargement of its labor force and a lengthening of its work day in an effort to meet that demand), and increases in its receipts of raw materials, and (2) at the Sakura factory, owing largely to a similar increase in demand and to the institution of what its management called "all night work" to meet that increase.

After October 1944, the output of the industry dropped about 60 percent in 3 months. Four-tenths of that drop was registered at the Toa plant, where production fell because of a decline in raw material receipts, an increase in absenteeism, and the earthquake of 7 December. Another three-tenths was about evenly divided between the Kokka Rubber Products Co., which was virtually wiped out in the 3 January area attack, and the Sakura plant, where raw material and component receipts declined. Two-tenths more took place at three small plants that completely stopped production as the result of bomb damage and the earthquake.

After a minor recovery in February (largely reflecting improved component and material receipts at the Sakura plant), production fell an additional 28.6 percent from peak levels, for a total drop by July of 88.6 percent. Three-quarters of this second drop came at the Toyo plant, which was almost completely destroyed in the March and May area raids.

In sum, the principal cause of the production drop in this industry was bomb damage, with

declines in raw material receipts also an important cause. About one-third of the total decline was in factories whose production dropped because the factories were almost completely wiped out by those attacks, and bomb damage contributed to causing declines at other plants.

TABLE 15

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, CHEMICAL INDUSTRY

Pre-raid total productive floor area, 1,008,000 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec				
1945—Jan			75, 000	7. 4
Feb				
Mar			56, 000	5. 6
Apr				
May			190, 000	18. 8
June				
July				
Aug				
Total			321, 000	31. 8

Total destruction by all attacks, 321,000—31.8 percent.

Shipbuilding

General. Only about 1 percent of Nagoya's 1944 production and labor force was accounted for by the shipbuilding industry. There were 2 shipbuilding companies in Nagoya, and only 1, Nagoya Shipbuilding Co., made a complete return to the factory questionnaire. The factory making an incomplete return, Aichi Wooden Shipbuilding Co., employed only 185 workers in December 1944 as compared with 4,250 for Nagoya Co. and its total 1944 output was only ¥2,069,219 as compared with Nagoya Co.'s ¥26,808,210.

Production, and reasons for production changes (Exhibit U). Production at the Nagoya Co. fluctuated widely during the pre-raid period. That company in preparing its return allocated to each month during which work on a vessel proceeded that proportion of the value of the finished vessel that was owing to work done in that month. In other words, the production it reported represents the value added in each month to work in process. Accordingly the pre-raid fluctuations do not reflect the occasional completion of a vessel or group of vessels with their entire value credited to the

month in which they were completed, but rather represent actual fluctuations in activity at the plant. The first of those fluctuations, a December 1943–February 1944 decline, was largely due to a drop in the labor force of the company. The succeeding rise to a peak in April 1944 reflected an increase in the number of workers and a substantial improvement in raw material receipts. A sharp slump through July 1944 and an equally sharp recovery in August through November of that year were both caused chiefly by changes in the raw materials situation.

After November 1944, the output at this company plunged 89.2 percent in three months. According to the management, the causes of that plunge were the earthquakes of 7 December 1944 and 13 January 1945, a sharp drop in raw material receipts, a decline in worker attendance, and the dispersal of some of the company's facilities. In March, April, and May, there was a moderate recovery, probably reflecting the wearing-off of the effects of the earthquake.

All in all, the drop in production was probably caused chiefly by the effects of the earthquake and by shortages and fluctuations in the supply of raw materials. Worker absenteeism also contributed, but to a lesser extent.

For the most part bomb damage affected auxiliary shops. The details of that damage are summarized in Table 16.

TABLE 16

NAGOYA—PRODUCTIVE FLOOR AREA DESTROYED, SHIPBUILDING INDUSTRY

Pre-raid total productive floor area, 932,100 square feet.

Month	Destroyed by precision attacks		Destroyed by area attacks	
	Square feet	Percent of pre-raid	Square feet	Percent of pre-raid
1944—Dec	24, 000	2. 6		
1945—Jan				
Feb				
Mar				
Apr	6, 000	. 6		
May			78, 000	8. 4
June				
July				
Aug				
Total	30, 000	3. 2	78, 000	8. 4

Total destruction by all attacks, 108,000—11.6 percent.

Destruction of plant and equipment amounted to 22.8 percent of the pre-raid total (21 percent in the May area raids); however, that destruction had little effect on operations.

The return filed by the Aichi Wooden Shipbuilding Co. does not show month-by-month activity, but instead credits all output to the month in which vessels were launched. Accordingly, in the last year of the war production is shown only for September 1944, March 1945, and August 1945. In those months, apparently, small vessels on which work had been proceeding simultaneously, were launched in groups as was a common practice in small Japanese shipyards. While fluctuations in productive activity are not available, electric power consumption figures show a drop in December-January, and a slight recovery in March-April followed by a further decline to the end of the war.

At this plant, the earthquake caused "a collapse of the plant's facilities", raw material receipts dropped sharply in 1945, and absenteeism rose during the raid period. The 17 May area raid destroyed 68 percent of the pre-raid productive floor area and 58 percent of the pre-raid plant and equipment. There was some dispersal in July and August 1945. Accordingly, although details of month-by-month productive activity are not known, it appears that much the same factors were operating at this plant as forced production down at Nagoya Shipbuilding Co.

Miscellaneous Industries

The industries discussed in the earlier pages of this chapter produced 97 percent of Nagoya's 1944 industrial output. The remaining 3 percent came from a group of miscellaneous industries (Exhibit V). Since the group is a miscellany, no attempt is made to treat it as a whole. However, the group contains four good-sized plants that together accounted for about half of its aggregate output, and trends at those factories are briefly described below (exhibit W).

Aichi Chemical Industrial Co. This plant was fairly large, employing 1,300 workers in December 1944. Its output rose strikingly in May to September 1944; but then fell off in 2 months to only 29 percent of September levels. Thereafter it declined fairly steadily until, in July, it was only 5 percent of those levels. The steep October-November decline was almost entirely due to the dispersal of facilities for making safety glass,

bulletproof glass, and bonding materials, which cut production of those items from ¥2,607,000 (or 78 percent of the plant's entire output) to zero. The later decline was owing to dispersal of other facilities, to bomb damage, and to the 7 December earthquake. During the entire period irregularities in the receipt of raw materials hampered operations.

Japan Porcelain Co. This plant, which employed more than 2,000 workers in December 1944, was the largest grinding wheel factory in Japan; its manufacturing capacity made up about one-fifth of the total for the entire national industry. Its output increased steadily through November 1944. After that it fell off steadily until the end of the war, except for a temporary rise in May; in July its production was 58 percent of the November peak. The May rise was owing to a production drive coupled with increased material receipts. The decline in the other months was due to increasing absenteeism, decreasing material receipts, preparations for dispersal, and bomb damage, with those four causes ranking about equal.

Daito Manufacturing Co. This company (December 1944 labor force, 1,551) manufactured fabrics and worsted yarns. Official orders to increase production caused a considerable increase in its activity from June through October 1944. Thereafter its production levels, while erratic, fell off generally, chiefly because of restrictions on its use of electric power, but also partly because of a considerable drop in the size of its labor force and a rise in absenteeism.

Watanabe Food Manufacturing Co. This food factory had a December 1944 force of 516. Its production was somewhat erratic but reached a peak in November 1944. It then dropped sharply in December owing chiefly to changes in demand, official orders to cut production, and declining receipts of materials for confections. Except for a recovery in April, May, and June, owing chiefly to official orders to increase output, the December 1944 level was roughly maintained for the rest of the war.

Summary

General. Considered as a whole, Nagoya's industry reached its peak levels in the fall of 1944, but then fell 77.5 percent in the eight months December 1944-July 1945. As appears by Exhibits X and Y, there were two rather distinct phases to the fall: the first, a sudden plunge during the

TABLE 17
NAGOYA—PRODUCTION DECLINES DURING RAID PERIOD

Industry	Nov. 1944 output (thou- sands of yen)	Decline in output during raid period					
		Dec. 1944 through Jan. 1945		Feb. 1945 through July 1945		Dec. 1944 through July 1945	
		Decline in yen (thou- sands)	Decline from Nov. 1944 (percent)	Decline in yen (thou- sands)	Decline from Jan. 1945 (percent)	Decline in yen (thou- sands)	Decline from Nov. 1944 (percent)
Aircraft ¹ -----	129, 794	92, 115	71. 0	26, 722	70. 9	118, 837	91. 6
Ordnance-----	45, 947	14, 479	31. 5	18, 172	57. 7	32, 651	71. 1
Metals ² -----	91, 088	17, 640	19. 4	42, 505	57. 9	60, 145	66. 0
Electrical-----	14, 724	4, 297	29. 2	5, 743	52. 5	10, 040	68. 2
Vehicles-----	4, 741	1, 541	32. 5	3, 014	94. 2	4, 555	96. 1
Chemical-----	3, 132	1, 697	54. 2	1, 022	71. 2	2, 719	86. 8
Shipbuilding-----	3, 110	1, 801	57. 9	543	41. 5	2, 344	75. 4
Miscellaneous-----	12, 033	3, 999	33. 2	625	7. 8	4, 624	38. 4
All industry-----	304, 569	137, 569	45. 2	98, 346	58. 9	235, 915	77. 5

¹ Excludes output at Mitsubishi No. 5 Aircraft plants outside Nagoya.

² Includes output at Sumitomo Light Metals Co.

first 2 months of the raid period; and the second, a slower but still rapid decline to the end of the war, with a moderate acceleration of the rate of decline in June, after the mid-May area raids. Table 17 shows the amount of the decline in each industry during each phase and during the entire raid period.

First phase of decline. In the 8 months December 1944-July 1945 over-all production fell ¥235,915,000; of that total, ¥137,569,000 came in the 2-months first phase, with the three industries, aircraft, metals and metal products, and ordnance, alone dropping ¥124,234,000 in the 2 months. The ¥137,569,000 first-phase drop amounted to a decline of 45.2 percent from November levels.

In the aircraft industry, output fell 71 percent in this phase and the ¥92,115,000 decline resulting formed two-thirds of the aggregate decline for all industry. In this phase the decline in the aircraft industry's output was caused chiefly by the initial precision attacks and the dispersal program those attacks precipitated, but also in part by the 7 December earthquake.

In the metals and metal product industry, output fell only about 19 percent in this phase for a ¥17,640,000 drop that made up about one-eighth of the aggregate drop for all industry in this phase. Difficulties in obtaining raw materials and components, and the earthquake, were considered the chief causes of this first-phase drop in metals output, with labor shortages, and, to a lesser extent, bomb damage, also contributing.

At the ordnance factories, production fell over 31 percent or ¥14,479,000, to contribute one-ninth of the aggregate for the phase. Raw material shortages and the earthquake were by far the most important causes of this initial drop in this industry although bomb damage also played a part in forcing production down.

In the other industries considered as a whole, the chief factors ranked about in the following order, though the differences were not great: absenteeism, the earthquake of 7 December, raw material shortages, and dispersal or preparations for dispersal.

Second phase of decline. After January, the over-all rate of decline slowed; nevertheless there was a ¥98,346,000 decline in the next 6 months which amounted to a drop of almost 60 percent from January levels.

Aircraft again had the highest rate of decline among the major industries—71 percent from January levels—but its production had already been so reduced in the first phase that even at that high rate, the drop in its output amounted to only ¥26,722,000 or about three-tenths of the aggregate drop during this second phase for industry as a whole. At the aircraft factories, bomb damage and dispersal continued to be the chief factors causing declines, although raw material, component, and labor shortages, exercised more influence in this phase than they had during the December-January drop.

In the metals industry, a 58 percent drop from January figures resulted in a ¥42,505,000 decline

that made up about four-tenths of the aggregate second-phase drop for all industry. Raw material and labor shortages (ranking about equal) were by far the most important causes of this phase of the decline in this industry. Bomb damage and dispersal also had some effect, but were considerably less responsible for the decline than either of the other two causes.

In the ordnance industry, whose production also fell off 58 percent from January levels, the decline amounted to ¥18,172,000, or about two-tenths of the aggregate for all industry. Bomb damage and dispersal were the chief causes of this second-phase decline in ordnance production, although raw material shortages continued to trouble the industry, and there were some component shortages. For the other industries as a whole, the chief cause of the decline in this phase probably was dispersal, followed fairly closely by raw material and component shortages, bomb damage, and absenteeism.

Over-all decline in raid period. Over the entire two-phase period, over-all output dropped 77.5 percent. About nine-tenths of that drop took place in the three largest industries, with the aircraft industry alone contributing nearly half of it, and the metals and metal products industry over one-fourth.

All in all, bomb damage and the convulsive dispersal efforts into which the air attacks prodded Nagoya's industry were the most important causes of the drop; together they probably exercised twice as much influence as any other factor, although such measurement, of course, cannot be made with any exactness because of the interaction of the factors. Bomb damage and dispersal had their greatest effect in the aircraft industry, whose production fell 92 percent during the raid period principally because of those two factors, and in the ordnance industry, which was hit hard by area and precision attacks during the last 3 months of the war.

Raw material shortages were probably the next most important among the factors. Those shortages had their greatest influence in the metals and metal products, ordnance, and vehicles industries. While, as the war actually developed, those short-

ages were less important in forcing down production than bomb damage and dispersal, the trend of material receipts and the testimony of leading industrialists indicate that the decline of material supplies alone would eventually have forced production down to levels as low as those to which it was driven by all factors combined, but would have taken some months longer to do so.

Labor difficulties troubled management in all Nagoya's industries, even in ordnance (whose labor force and productive hour figures held up fairly well until July 1945). Those difficulties had their greatest effect in the metals and metal products industry, where they shared with material shortages the chief responsibility for production declines. For Nagoya's industry as a whole, however, they caused less difficulty than did the drop in raw material receipts (roughly estimated relative weight: drop in materials receipts—five, labor difficulties—four) and overall, they rank third among the factors that led to the decline in the city's output.

Declines in component receipts would have had a serious effect on production if the other factors had not already so reduced production levels at customer factories that the component needs of those factories fell about as rapidly as did their component receipts. As it was, component shortages did not play a large part in forcing the collapse of Nagoya's industry. They were, it is true, important causes of the failure of the dispersed factories of the aircraft industry to get into production, but they played only a small part in cutting production at the original Nagoya plants.

The only other factor to reach major stature was the 7 December 1944 earthquake. Relatively its greatest effect was in the ordnance and the metals and metal products industries, although it also had important effects in the aircraft industry—for example, knocking out the Dotoku plant of Mitsubishi No. 5 complex. In general, however, the influence of the earthquake was short-lived, and it is probable that Nagoya's industry would have quickly recovered to earlier levels had it not been for the other factors.

SECTION III

NAGOYA

IMPORTANCE OF LARGE AND SMALL FACTORIES, AND SIZE OF INDUSTRIAL SAMPLE COVERED BY USSBS

CHAPTER I

SOURCES OF INFORMATION

In Nagoya and its environs, the Urban Areas Division submitted questionnaires to all factories whose labor force was 50 workers or more at any time during the war, and whose records or management survived the air attacks and could be located. Returns to those questionnaires were received from 306 factories, including 78 that employed 500 or more workers each. Of those 306 returns, 238 were completely filled out and 68 were in some respects incomplete, usually because the records of the reporting factory had been destroyed in the air raids. Of the 78 factories employing 500 or more workers each, 67 made complete returns and 11 made incomplete ones.

A total of 292 of the reporting factories, including 67 of those employing over 500 workers, were located within the city of Nagoya; the remaining 14 were located near the city and formed an economic part of it. No return was filed by Mitsubishi No. 3 Aircraft assembly complex, which included the largest assembly plant in Nagoya and which had moved to Suzuka in February 1945, or by the Mitsubishi Aircraft Engine Ozone factory. However, much detailed information on both was collected in other ways.

The information reported by the 292 factories in the city, and the information on the No. 3 complex, and the Ozone factory, together with annual statistics on local industry compiled by the Nagoya City Administration, make it possible to observe trends in 1942, 1943, and 1944, in the relative contribution to Nagoya's industrial structure made by factories of various sizes, and to calculate the coverage of Nagoya's industry that the Survey obtained through factory questionnaires and through other sources of information.

CHAPTER II

TRENDS IN SIZE AND RELATIVE IMPORTANCE OF FACTORIES

Table 18 breaks down Nagoya's factories (those inside the city limits only) into groups according to worker strength, and shows for each group (1) its total production in 1942, 1943, and 1944, and (2) its aggregate worker strength in December of those years.

As is shown by Table 18, during the 3 years 1942-44 there was a definite movement in Nagoya's industry towards concentrating both its labor force and its productive effort in the larger factories. In 1942, only 24.4 percent of the city's output was accounted for by factories employing over 500 workers each; in 1944, such factories accounted for 82.1 percent of that output. Their share of the labor force also increased enormously, growing from 28.2 percent in 1942 to 71.0 percent in 1944. Correspondingly, there was a decline during the 3 years in the importance of smaller factories; the output of those employing less than 50 workers fell from 17.5 percent of the total in 1942 to 2.8 percent or less in 1944, while for factories employing from 10 to 50 workers, the decline was from 29.4 percent to 7.7 percent or less.

The great growth of the large factories and the correlative decline of the small ones reflect a policy of the Japanese Government. In May 1943, that government began its War Mobilization program, which had as its purpose the concentration of war industry into large easily controlled factories. The program was to be completed by July 1944. It was hoped that this concentration would eliminate much administrative confusion, shorten industrial pipe lines, and lighten the burden on transportation. In addition it was recognized that

the large factories were more efficient than the very small ones. (In 1943, output per worker averaged about ¥7,300 in the factories employing 500 or more workers each, and only ¥4,720 in those employing under 10 workers each.)

The government effected the desired concentration of war industry into the large factories principally through its control of labor and raw material supplies. Priorities on those supplies generally were denied the smaller factories and work-

shops, and many were forced out of business or compelled to merge with larger plants. However, the aggregate worker strength of factories employing less than 500 workers did not decrease much. The great increase in worker strength of the large factories was made not so much by taking workers from the small factories as by absorbing almost all the labor flocking to the city from the countryside, as well as almost all the students and women that were mobilized as workers.

TABLE 18
NAGOYA—RELATIVE IMPORTANCE OF FACTORIES BY SIZE (Worker Strength)—
1942, 1943, 1944

[Figures for all years are only approximate. See note below]

Size	Number of factories at end of year			Annual production (thousands of yen)			Number of plant workers at end of year		
<i>Number of workers per factory</i>									
	1942	1943	1944	1942	1943	1944	1942	1943	1944
Under 10.....	16,749	12,675	6,970	165,030	135,148	107,066	40,196	28,339	19,451
10 to 50.....	1,640	1,617	1,617	276,020	292,341	292,341	33,415	33,690	33,690
50 to 500.....	320	361	225	270,350	347,571	280,519	38,866	42,813	38,086
Over 500.....	31	52	65	229,783	1,529,821	3,122,705	44,132	209,821	222,730
Total.....	18,740	14,705	8,877	941,183	2,304,881	3,802,631	156,609	314,663	313,957

In terms of percentage of total

Under 10.....				17.5	5.9	2.8	25.7	9.0	6.2
10 to 50.....				29.4	12.6	7.7	21.3	10.7	10.7
50 to 500.....				28.7	15.1	7.4	24.8	13.6	12.1
Over 500.....				24.4	66.4	82.1	28.2	66.7	71.0
Total.....				100.0	100.0	100.0	100.0	100.0	100.0

NOTE to Table 18.—The 3 city branches of Nagoya Arsenal are not included in any of the figures since the annual statistics (compiled by Nagoya City Administration) from which figures for 1942 and 1943 are taken do not include factories under direct military control; of those factories only the 3 city branches of the Arsenal are important in size and volume of production. For 1944, Nagoya City Administration supplied complete data only for factories employing less than 5 workers. In the 5 to 10, and in the 10 to 50 worker categories, figures for 1943 were carried forward; inspection of the trends apparent in 1942 and 1943 indicates that this procedure probably results in overstating the 1944 size and importance of factories in those categories. 1944 data for all factories employing 50 or more workers (except for the Mitsubishi No. 3 assembly complex, and the Mitsubishi Aircraft Engine Ozone factory) were taken from 289 factory questionnaires collected by USSBS from Nagoya factories. No questionnaire was returned by No. 3 complex, which moved to Suzuka in February 1945, or by the Ozone Engine factory, but figures for both have been supplied on the basis of detailed information available in other forms. The December 1944 worker strength of the No. 3 plant is known to be about 15,000, but while its output of finished planes also is known in detail, the yen value of that output is not known. Comparing plane output of the plant with plane output at Nagoya's Mitsubishi No. 5 assembly complex, which had a 1944 production figure of ¥315,000,000, leads to the conclusion that 1944 production at the No. 3 complex was certainly not less than ¥40,000,000, and that figure has been adopted for inclusion in the table. Similarly, the Ozone factory's December 1944 labor strength was 4,000; and comparison with the Mitsubishi No. 10 plant, which was engaged in similar work, indicates a 1944 production of ¥40,000,000.

CHAPTER III

PERCENTAGE OF NAGOYA'S INDUSTRY COVERED BY SURVEY

In Table 18, the Nagoya arsenal plants in the city were omitted so that statistics for 1942, 1943, and 1944, could be presented on a comparable basis to

permit the observation of trends. To present a complete picture of industry in the city, so that a calculation may be made of the percent of industry covered by the Survey's factory questionnaires and other sources of information, the arsenal plants should be included in the figures. This is accomplished in Table 19.

TABLE 19

NAGOYA—1944 RELATIVE IMPORTANCE OF FACTORIES INSIDE CITY LIMITS

Factories employing	Number of factories, Dec. 1944	1944 production—thousands of yen	Plant workers, Dec. 1944, number of workers
		<i>Percent</i>	<i>Percent</i>
Under 10 workers.....	6, 970	107, 066 (2. 7)	19, 451 (5. 9)
10 to 50 workers.....	1, 617	292, 341 (7. 5)	33, 690 (10. 3)
50 to 500 workers.....	225	280, 519 (7. 1)	38, 086 (11. 6)
Over 500 workers.....	68	3, 256, 940 (82. 7)	237, 231 (72. 2)
Total.....	8, 880	3, 936, 866 (100. 0)	328, 458 (100. 0)

Table 19 indicates a total December 1944 labor force of 328,458, as compared to a total of 334,000 estimated by the Nagoya city authorities. The city labor figures include all workers residing in the city, regardless of where they worked; but the factories, of course, reported all their workers, regardless of where they resided. However, city labor officials and leading industrialists were of the opinion that, at least until the mass evacuation that followed the air attacks, the number of Nagoya residents employed in factories outside Nagoya was roughly equal to the number of non-resident workers employed by factories in the city. Accordingly, 334,000 may be taken as roughly the total number of workers estimated by the City Administration to have been employed in Nagoya as well as the number of workers estimated to have resided there. It follows that the factories making returns, both complete and incomplete, to the questionnaires, plus Mitsubishi No. 3 assembly complex and Mitsubishi Aircraft Engine Ozone factory, accounted for between 82 percent and 84 percent of the city's labor force. A reference to the returns shows that the factories making complete returns accounted for 69 percent to 71 percent of that labor force. Similarly, it is estimated that all factories replying to the questionnaires, plus the No. 3 complex and the Ozone factory, accounted for 89 percent to 90 percent of the yen output of the city, with the figure for factories making complete returns being about 70 percent to 71 percent. This estimate allows for (1) the probability that the output of No. 3 complex is understated and (2) the possibility that data for factories employing an aggregate of up to 6,000 persons are missing from the table. A check of the files of the Commerce and Industry section of the Nagoya Regional Administration Office, as well as of all United States target information, indicates that all of the large (i. e. 500 or more workers)

factories in the city, except the Mitsubishi No. 3 assembly complex and the Mitsubishi Aircraft Engine Ozone factory, made returns, and any missing plants are therefore undoubtedly in one of the less important categories. Finally, complete questionnaires were also received from all but one of the important factories located just outside the Nagoya city limits and that one submitted a partly completed return; in Section II of this report, those factories have been treated as a part of the city's industrial structure.

CHAPTER IV

IMPORTANCE OF SMALL INDUSTRY IN NAGOYA

General. It has been almost a tradition in thinking about Japan's industry to ascribe a significant role to "home industry," that is, to industry made up of small workshops operated in their homes by single families, sometimes with the help of a few neighbors. Home industry may be taken as roughly equivalent to that composed of factories employing under 10 workers each. Whatever was the case before the war, by the time the raids began, home industry had almost disappeared from Nagoya. As is shown by Table 19, at the very most such industry did not contribute over 2.7 percent of the industrial output of the city in 1944, and it probably contributed less.

Even the broader category of industry that might be called "small industry," that is, industry composed of factories employing 50 or less workers each, had become relatively unimportant in Nagoya; in 1944 it accounted for only 10 percent or less of the city's production.

It may be argued that, while the output of small industry was only a small fraction of the total output of the city, the components produced by those factories were essential to the industrial life of

the city, so that successful attack on those factories would cripple production. However, investigations conducted in Nagoya indicate that (1) components produced by those factories were important only to part of the city's industry, with that part accounting for only a small portion of Nagoya's total industrial output, and (2) the attack that cut the production of those factories also cut production and reduced component requirements of the industries supplied by them, so that destruction of the small factories actually had, and could have had, very little effect on over-all output.

Investigation of component suppliers. As a first step in those investigations the Survey consulted leading officials from all governmental departments concerned with industry in Nagoya. It was the consensus of those officials that there was little basis in fact for the contention that Nagoya's industry was dependent on components made by small factories. To check their opinion, representative factories in six industries (aircraft, ordnance, metal products, vehicles, chemicals, and electrical equipment) were required to submit information on their sources of important component supplies. The factories selected were those the officials had named as most likely to rely on small suppliers for critical components. In the aggregate they accounted for 19 percent of the total 1944 production of the city. A summary of the information submitted by those factories follows.

Aircraft

Aichi Eitoku assembly plant. This plant obtained no critical components from small factories, but did use several small factories for subcontracting work.¹ The Aichi officials offered the following comment on the importance of those small factories:

"They rendered us service in only one process—the finishing of components by such methods as plating, rough and simple machining, pressing, welding, etc. Such being the case, we did not take them seriously. Considering the decrease in our own production, their assistance was sufficient.

¹ The number and location of those subcontracting plants follows:

	Dec. 44	Jan. 45	Feb.	Mar.	Apr.	May	June	July
In Nagoya.....	40	35	35	20	30	10	10	5
Outside Nagoya..	30	30	30	30	35	40	40	40

We did not order important components from those small factories."

Ordnance

Nagoya Arsenal's Atsuta Factory. This plant received no important components from small factories. Nine small plants in Nagoya and 6 outside the city supplied unimportant, non-critical components.

Metals and Metal Products

Sumitomo Light Metals Co. No components were received from small factories and no castings were finished by small factories.

Daido Steel Co.'s Hoshizaki Factory. This plant sent ingots to about 15 small plants in Nagoya to have surface defects removed by lathes or planes; on being returned, the ingots were rolled by the Daido plant. Transportation difficulties interfered with this process, and this interference contributed in a small way (5 percent to 10 percent) to production declines at the big plant.

Okuma Iron Works. No important components were received from small factories.

Vehicles and Rolling Stock

Japan Vehicle Co. No important components were received from small factories.

Chemicals

Aichi Chemical Industrial Co. This company received components from 20 small plants in Nagoya and from five outside the city. Company officials asserted however, that "we did not suffer any shortage of components, because we had a relatively large number of subfactories. Moreover, during the latter part of the war, our own production was reduced considerably due to preparations for dispersal, and this diminished our demand for component deliveries."

Electrical Equipment

Japan Insulator Co. This plant received components from 23 small plants in Nagoya and four outside. Some component shortages followed the air attacks, but their effect on production was much less than those of bomb damage to the factory, fuel shortages, and labor shortages due to raid-caused absenteeism.

Mitsubishi Electrical Equipment Co. This plant received components from 11 plants in Nagoya, and from 10 in neighboring towns and counties (Kuwana, Niwa, Atsumi, Suzuka, and Gifu). Of the plants in Nagoya, 5 were small,

with a total labor force of 119 in December 1944, as compared with a labor force of 647 in the 6 larger plants. Only 1 plant outside of Nagoya was small (33 workers in December 1944) and the remaining 10 employed 1,417 workers in December 1944. Six of the Nagoya plants were heavily damaged in the March area raids, and 2 more were hit in May and June; however, the Mitsubishi company reported that it was not handicapped by component shortages, since its production declined from other causes with the result that its component needs were cut.

Further investigation. To carry the check further, the Survey required a representative number of the component suppliers (both large and small) of the above factories to furnish similar information on their own sources of parts. Only one-third of those canvassed received from other plants any parts going into the components delivered to the factories first listed. During the raid period (December 1944–July 1945) the value of the parts so received—all of them coming from small factories—equalled only 16 percent of the value of the components into which they were manufactured. In every case but one, the component supplier itself made some parts of the type so received, with the parts made by the suppliers

aggregating 59 percent of the total of such parts made and received. The extent to which those suppliers could have expanded their own manufacture of those parts in the event of a failure of receipts from the other factories is not known; it seems likely, however, that some expansion would have been possible.

Summary. All in all, the above information, when reviewed in the light of the industry-by-industry analysis of the effect of component supplies on production during the last years of the war (Sec. II, Ch. V) indicates that small industry actually was of minor importance to the maintenance of over-all production levels in Nagoya. It also seems clear that any practicable attacks designed to destroy that small industry would necessarily have fallen heavily on large industry also, and thus directly caused production declines at the large plants. Component requirements of the large plants would then have been so cut that the destruction of the small component suppliers would have had little effect on production at the large plants, and the reduction of over-all output would have been directly ascribable to the damage to large plants, rather than to the loss of small industry.

SECTION IV

EFFECTS OF AREA ATTACKS ON SATELLITE CITIES IN NAGOYA

Introduction

In June 1945, the Twentieth AF launched a series of area attacks against secondary Japanese cities. Among the targets of those attacks were five satellite cities of Nagoya—Gifu, Ogaki, Ichinomiya, Okazaki, and Kuwana. The primary objective of the attacks on those five cities was to break the will of the people to continue the war. The secondary objective was to destroy industry in the cities, and particularly to defeat Nagoya's dispersal program by knocking out the dispersed factories at their new sites and by scattering and demoralizing the labor force on which those factories would have to draw. Those objectives dif-

fered from the objectives of the raids on Nagoya in the emphasis placed on the destruction of morale. At Nagoya the chief objective had been the destruction of industry, and effects on morale had been a secondary objective only.

CHAPTER I

HISTORY OF THE ATTACKS

This series of area attacks opened on 9 July with a 899-ton incendiary attack on Gifu and closed on 28 July with a 659-ton incendiary attack on Ogaki. Seven raids were made and 4,743 tons of IB and 818 tons of HE were dropped.

TABLE 20

AREA ATTACKS ON NAGOYA'S SATELLITE CITIES

City	Date of attack	Tons of bombs dropped—	
		IB	HE
Gifu.....	9 July	899	-----
Ichinomiya.....	12 July	772	-----
	28 July	869	-----
Kuwana.....	16 July	693	-----
	24 July		818
Okazaki.....	19 July	851	-----
Ogaki.....	28 July	659	-----
Total.....		4, 743	818

NOTE.—There were also 2 precision attacks, on 22 and 26 June, on the Kawasaki Aircraft complex in the Gifu area; in those attacks, a total of 739 tons of HE was dropped.

CHAPTER II

DIRECT DAMAGE TO PEOPLE

The raids destroyed or badly damaged 44,708 residences, or about 57 percent of the 77,933 pre-raid homes in the 5 cities. A total of 229,186 people or about 49 percent of the pre-raid (June 1945) population of 464,190 were killed, injured, or dehoued, but the number dehoued was by far the greatest. (In Nagoya 47 percent of pre-raid residences were destroyed or badly damaged, and 44 percent of the pre-raid population were killed, injured, or dehoued.)

TABLE 21

DAMAGE TO HOMES AND PEOPLE:— FIVE SATELLITE CITIES

I. Total figures

City	Homes totally destroyed	Homes badly damaged	People killed	People injured	People dehoued
Gifu.....	16, 014	-----	856	1, 205	99, 730
Ichinomiya.....	10, 230	-----	685	702	42, 349
Kuwana.....	6, 663	181	421	372	29, 252
Okazaki.....	6, 370	175	211	357	32, 099
Ogaki.....	4, 886	189	61	124	20, 762
All cities.....	44, 163	545	2, 234	2, 760	224, 192

II. Per ton of bombs

City	Homes destroyed	Homes damaged	People killed	People injured	People dehoued
Gifu.....	17. 8	-----	1. 0	1. 3	110. 9
Ichinomiya.....	6. 2	-----	. 4	. 4	25. 8
Kuwana.....	4. 4	0. 1	. 3	. 2	19. 4
Ogaki.....	7. 5	. 2	. 2	. 4	37. 7
Okazaki.....	7. 4	. 3	. 1	. 2	31. 5
All cities.....	7. 9	. 1	. 4	. 5	40. 3

Almost all the damage was done by IB—the 818-ton HE attack on Kuwana destroyed or badly damaged only 254 residences and killed, injured, or dehoued, only 950 people. For all five cities the number of persons dehoued by incendiary attacks averaged 47 per ton dropped, and the number of homes destroyed averaged 9.3. In general, the damage to residences and the number of people killed, wounded, or dehoued, were both a little higher per ton of bombs dropped in the 5 cities than they were in Nagoya.

CHAPTER III

INDUSTRY — PRODUCTION TRENDS AND EFFECT OF AIR ATTACKS

General

As in Nagoya, the Survey distributed questionnaires to all factories whose labor force was 50 workers or more at any time during the war and whose records or management survived the raids and could be located. Local government officials had record of 110 factories of that worker strength; of those factories, 103 received questionnaires and made returns to them, and only 7 either could not be located or did not reply. It is believed that none of the 7 was large.

In those cities, as in Nagoya, the larger factories dominated industry. In November 1944, the peak month, 83 percent of the total output of the factories making returns was concentrated in 30 plants, about 67 percent of it in the 8 largest. Here again, therefore, trends in over-all industry were determined by developments at the larger factories, and are analyzed terms of those developments (Exhibit AA).

Production Trends

Industrial activity in these five cities falls into four phases: (1) a steady, rapid rise from the beginning of the period studied until November 1944, when production reached levels 71 percent above the mean for the first 12 months; (2) a sudden fall in December 1944 and January 1945; (3) a checking of the fall in February followed by a strong recovery in March and April 1945 to a production level about 92 percent of the November peak; and (4) a sharp post-April decline that continued to the end of the war.

First phase—Rise to peak levels. The steady, rocketing increase in production during this phase came about as industry in the five cities converted more and more to war production and as war fac-

tories established in those cities came into full production. Most of the increase was concentrated in the aircraft and ordnance industries, although all industries expanded to some degree.

Second phase—the December-January Drop. In December 1944 and January 1945 the industry's output fell ¥28,039,274. or 35.2 percent. Most of the over-all decline resulted from the following production declines at individual factories.

A ¥14,323,600 drop at the Greater Japan Arms Co. factory in Okazaki. Production at that factory had increased tremendously during the second half of 1944, principally because "Naval engineers helped the production during June 1944–November 1944." The precipitous December–January decline apparently was due (1) to the withdrawal of that help, and (2) to the fact that "twice earthquakes in December 1944 and January 1945 broke down traffic communication, so that labor and material were often uncertain."

An aggregate drop of ¥5,967,323 at Nisshin Cotton Spinning Co. of Okazaki, at Sumitomo Communications Co. of Ogaki, and at Okamoto Industrial Co. of Ichinomiya. That drop was principally owing to declines in component receipts at those factories, although losses in productive hours owing to air alerts played some part in causing output to fall at the Nisshin Co.

A ¥1,670,249 drop at Toyo Bearing Mfg. Co. of Kuwana resulting from the earthquake, preparations for dispersal, shortage of raw materials, loss of time because of air alerts, and the inefficiency of student labor used at the plant.

A ¥1,560,000 drop at the Ichinomiya plant of Kawasaki Aircraft Co. caused by preparations for a change in model.

A ¥1,499,504 decline at the Gifu complex of Kawasaki Aircraft Co. caused by a change in model and a shortage of aircraft engines.

At most of the remaining factories output fell off owing to declines in total productive hours worked (largely because of air alerts and raw material shortages). Only 7 of the 30 larger plants showed a rise in output during those 2 months; those rises aggregated only ¥1,933,063, much of that occurring at new plants or at plants just getting into production after a change in design or model.

Third phase—Recovery in March and April. The sharp decline was checked in February, and a strong recovery followed in March and April; in

those 2 months production rose ¥21,655,885. Principal causes of the recovery were:

1. A ¥13,099,258 increase in output at the Kawasaki Aircraft Gifu complex, which was just getting into production on a model.

2. A ¥2,778,600 rise at the Mitsubishi No. 16 Aircraft Engine complex at Ogaki, which began operations in March after obtaining men and machines from the dispersing Mitsubishi No. 4 Aircraft Engine plant in Nagoya.

3. A ¥2,148,068 increase at Ichinomiya's Okamoto Industrial Co. resulting from an improvement in component receipts.

4. A ¥650,000 rise at Kawasaki Aircraft Co.'s Ichinomiya plant where production got under way again.

5. A ¥2,908,101 increase at nine of the other large plants, whose output increased for a variety of reasons, including augmented labor force, increased raw material receipts and, at two new plants, the beginning of operations.

Against the increases at these and other factories were set off the following substantial declines:

1. ¥1,393,657 at Ogaki's Sumitomo Communications Co. and Gifu's Kawasaki Machine Works owing to failures in component receipts. (At Kawasaki the "shortness of critical components (W & M Wire) was caused by the destruction of a factory producing the above goods in Kobe.")

2. ¥2,206,800 at Okazaki's Greater Japan Arms Co. owing to a change in machine gun models.

3. ¥475,672 at Gifu's Kagamigahata Precision Machinery Works owing to dispersal, and

4. ¥1,239,200 at Gifu's Mitsubishi Chemical Industries and Ogaki's Special Light Alloy Co. because of raw material shortages and official orders to reduce output.

Fourth phase—Decline to the end of the war. In May a steep decline began that continued to the end of the war. In the 3 months May–July, output fell ¥32,074,082. Most of the decline occurred at the Kawasaki Aircraft complex at Gifu, at the Toyo Bearing Mfg. Co. plant at Kuwana, and at the Okamoto Industrial Co. factory at Ichinomiya.

At the Gifu Kawasaki complex production fell ¥17,238,257. About half of that fall occurred in May and June owing to dispersal, component shortages, and difficulties in getting production started on the new plane model. The other half of the drop came in July, and was caused almost entirely by precision attacks of 22 and 26 June.

Production at the Tokyo Bearing Mfg. Co. plant at Kuwana dropped ¥2,342,367. About half of that drop came in May and June and was owing to labor difficulties (inefficiency of student labor, time lost in alerts), raw material shortages, and dispersal. In July the effects of bomb damage in the 16 July raid on Kuwana was an additional cause of the continuing decline.

At the Okamoto Industrial Co. factory at Ichinomiya, output dropped a total of ¥4,691,652, mainly in June and July. The principal cause of that drop was component shortages.

At the other factories the chief cause of declines in output were labor difficulties and raw materials shortages. At a few factories production rose, but the only rise of any real size was at Mitsubishi No. 16 Aircraft Engine plant which was still expanding production as the No. 4 plant in Nagoya completed dispersal. A smaller rise at Greater Japan Arms Co. in Okazaki reflected the beginning of production on the new machine gun.

Summary

It appears from the above that the chief causes of the production rise to the November 1944 peak were the conversion to war production of the manufacturing resources of the region, and the direct assistance given to the Greater Japan Arms Co. by Navy engineers.

The December-January drop was the result of shortages of labor and technical help, raw materials, and components, ranking in the order named. The labor and raw material shortages were partly due to disruptions caused by the earthquakes of December and January.

In addition, the beginning of frequent air alerts lost much labor time that might otherwise have been devoted to production. The component shortages resulted in part from the effect of air attacks on component manufacturers in other cities.

The sharp recovery in March and April was principally the result of the Kawasaki aircraft complex in Gifu getting into production on a new model. The beginning of production at a few new

plants, notably Ogaki's Mitsubishi No. 16 Aircraft Engine complex, and the resumption of operations at a few others that had changed models, also contributed to the recovery.

The steep May and June decline resulted chiefly from dispersal, and component shortages, that affected production at Gifu's Kawasaki aircraft complex. Declines at the other plants were owing to labor, component, and raw material shortages. In July, the chief cause of the decline was bomb damage—especially in the 22 and 26 June precision attacks on the Kawasaki aircraft complex. In addition, labor and raw material shortages continued to be limiting factors, and dispersal cut production at many of the plants.

CHAPTER IV

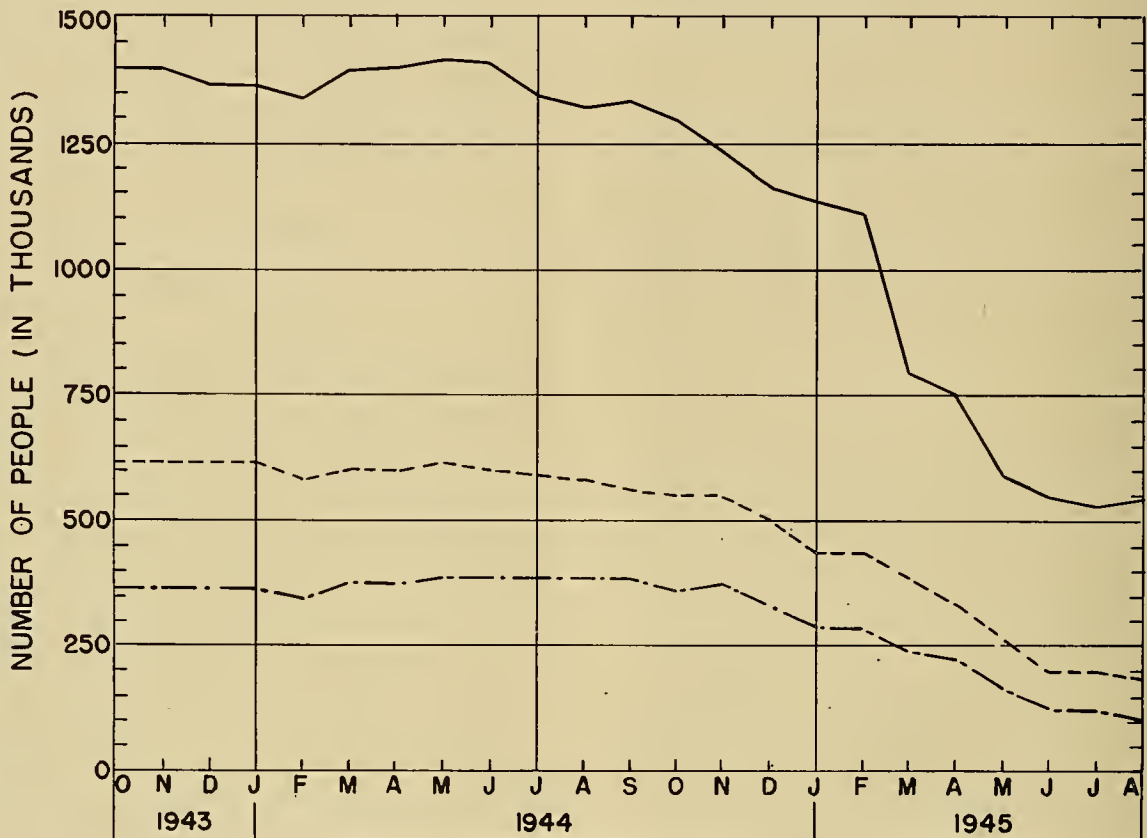
CONCLUSIONS

It is doubted that the July area attacks on the five cities outside Nagoya themselves had a great "net effect" on industrial production in those cities, since (1) much of the July drop resulted from the late June precision attacks on the Kawasaki aircraft complex, and (2) in the rest of industry, production levels had already turned sharply downward before the area raids began. On the other hand, part of the pre-July production declines was the result of indirect effects of the earlier air attacks, and particularly of the earlier urban area attacks, on Nagoya and on Japan's other large urban industrial centers. It is believed that all air attacks launched against Japanese cities, taken together, did play an important role in forcing down industrial production in the five cities studied. Furthermore, the July area raids on the five cities had a pronounced "shock effect" on the people of those cities, dehousing nearly one-half of the total population. The effect on the supply and efficiency of labor, and the general disruption of the economic structure, probably would have insured that the production declines already begun would have continued if the war had gone on.



NAGOYA

POPULATION AND LABOR FORCE



LEGEND:

- TOTAL POPULATION
- TOTAL LABOR FORCE RESIDING IN NAGOYA
- .-.- PRODUCTIVE INDUSTRIAL WORKERS RESIDING IN NAGOYA

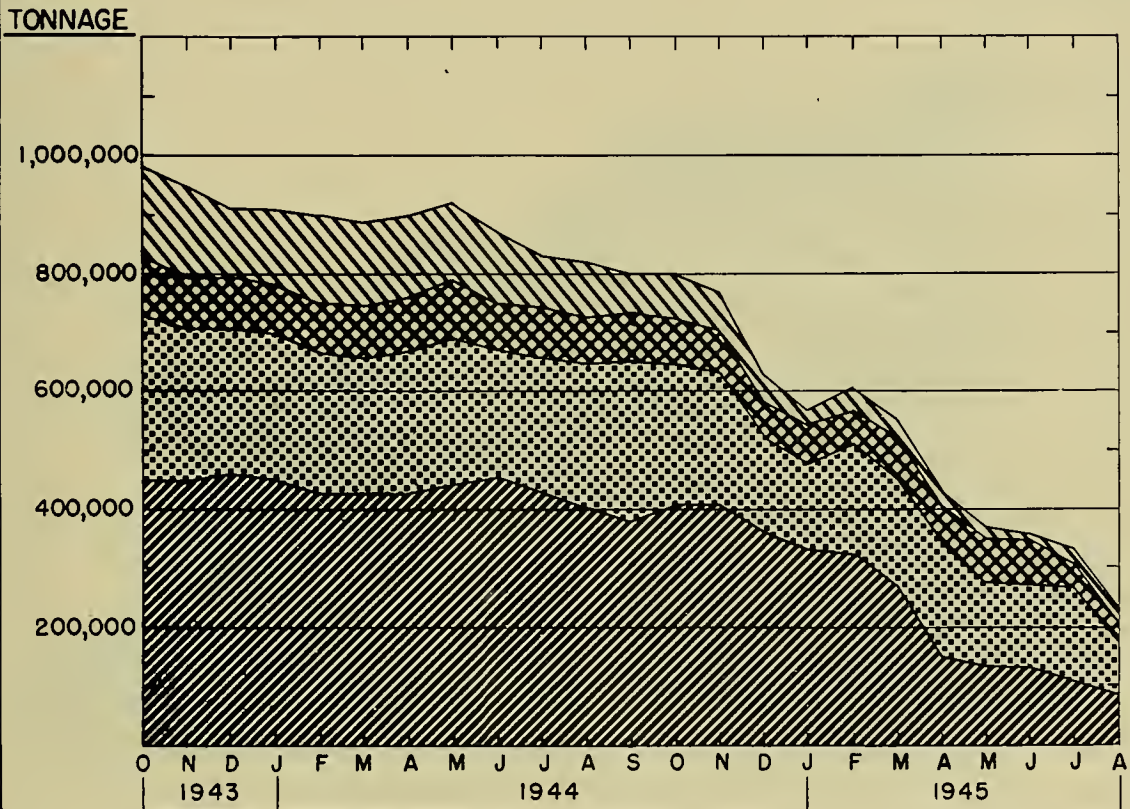
U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

EXHIBIT A

NAGOYA

TOTAL FREIGHT MOVEMENTS BY SHIP, TRUCK & RAIL (WITH RAIL MOVEMENT SUB-DIVIDED INTO EXPORTS & IMPORTS)



LEGEND

-  SHIPPING.
-  TRUCKING.
-  RAIL. (EXPORTS)
-  RAIL. (IMPORTS)

SOURCES: NAGOYA MARITIME BUREAU, TRUCKING,
ASSOCIATION, & GOVERNMENT RAILWAYS.

U.S. STRATEGIC BOMBING SURVEY

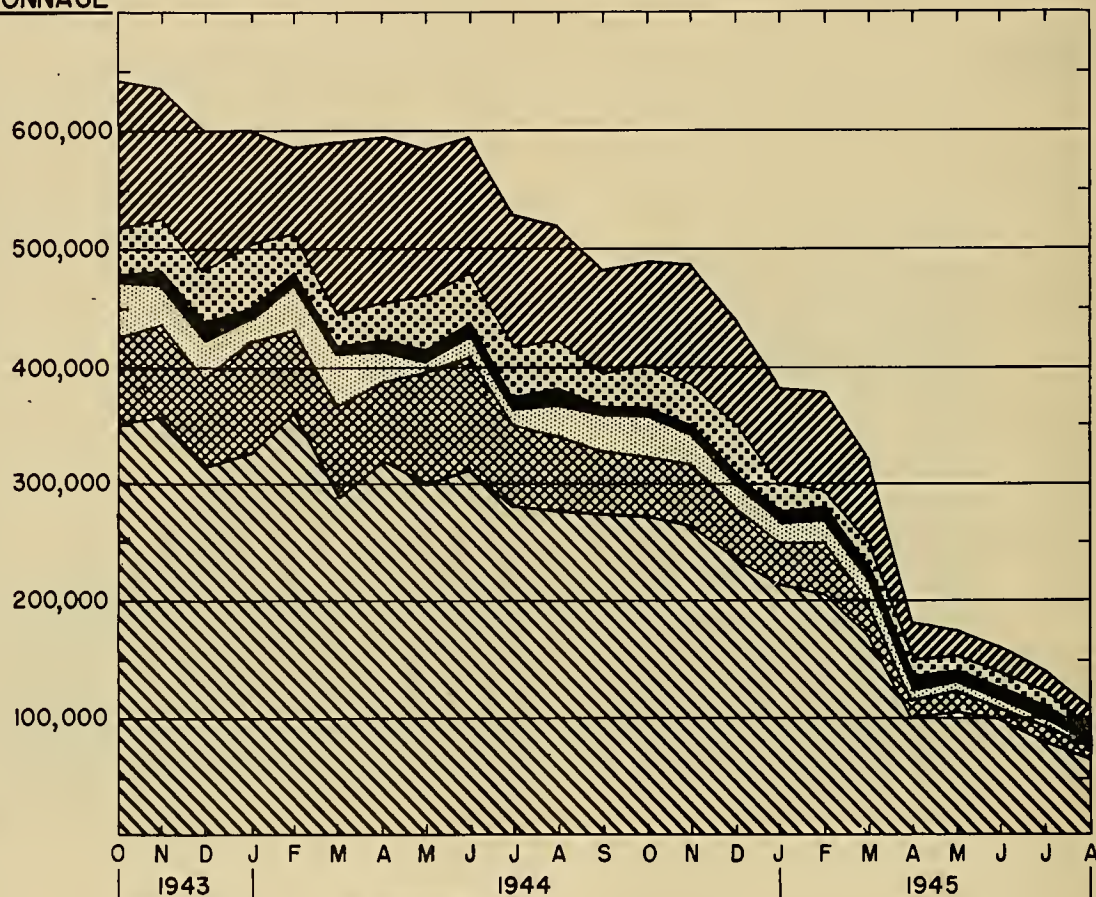
CITY OF NAGOYA

EXHIBIT B







NAGOYA

TOTAL IMPORTS

TONNAGE



LEGEND

-  COAL.
-  IRON & STEEL.
-  MACHINES.
-  FOOD.
-  WOOD.
-  OTHERS.

SOURCES: NAGOYA MARITIME BUREAU,
TRUCKING ASSOCIATION, & GOVERNMENT
RAILWAYS.

U. S. STRATEGIC BOMBING SURVEY

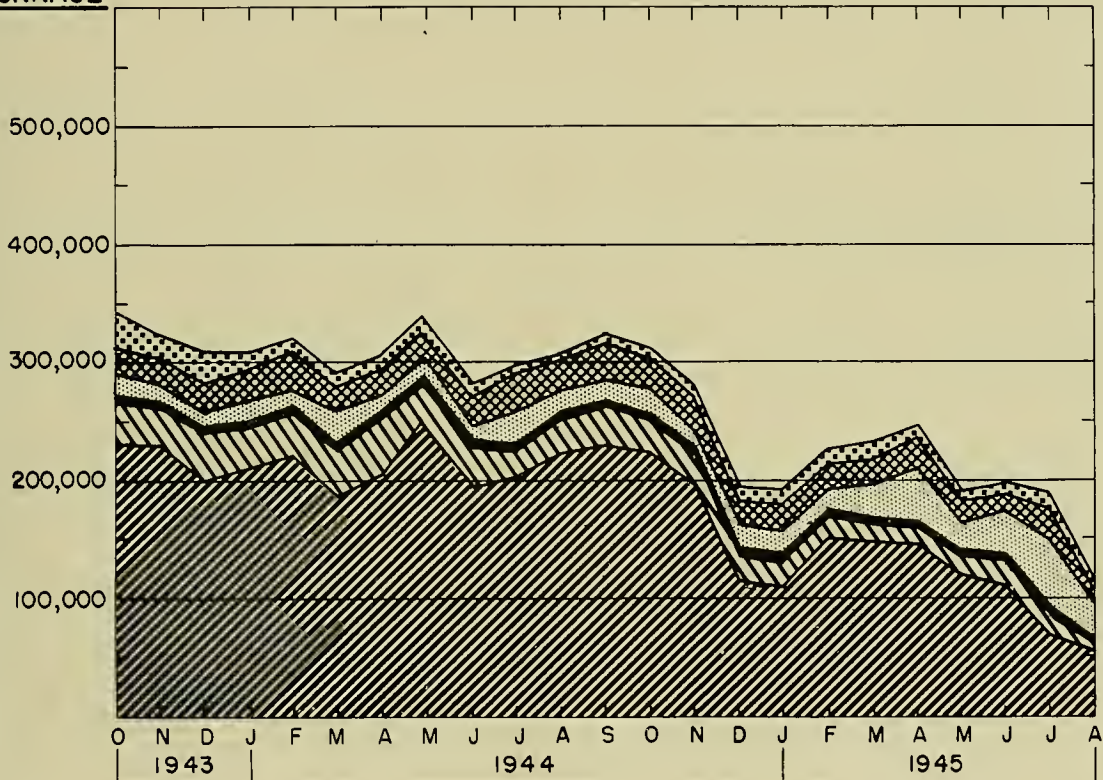
CITY OF NAGOYA

EXHIBIT C







NAGOYA

TOTAL EXPORTS

TONNAGE



LEGEND

-  COAL.
-  IRON & STEEL.
-  MACHINES.
-  FOOD.
-  WOOD
-  OTHERS.

SOURCES: NAGOYA MARITIME BUREAU,
TRUCKING ASSOCIATION, & GOVERNMENT
RAILWAYS.

U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

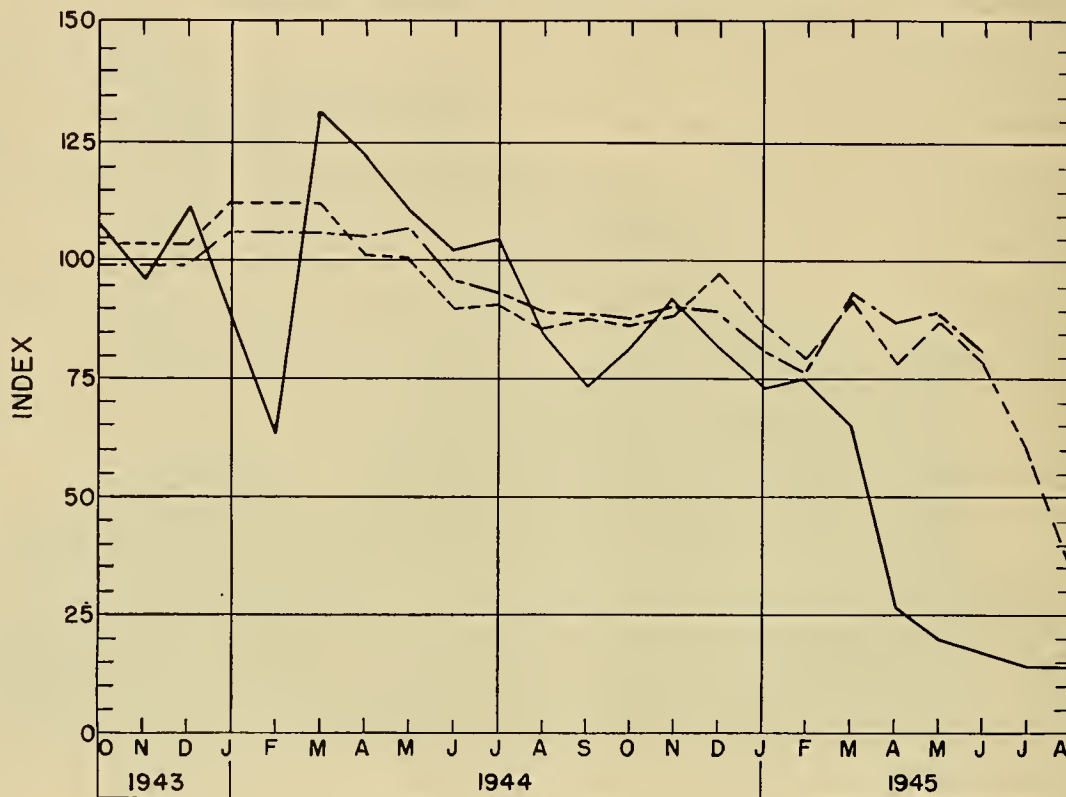
EXHIBIT D

NAGOYA

COAL:

LOCAL IMPORTS COMPARED WITH NATIONAL PRODUCTION AND NATIONAL CARLOADINGS

MONTHLY AVERAGE OCT 1943 - SEP 44 = 100



LEGEND

- COAL IMPORTS 111,126 TONS = 100
- - - NATIONAL PRODUCTION 4,537,000 TONS = 100
- . - NATIONAL CARLOADINGS 4,044,000 TONS = 100

U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

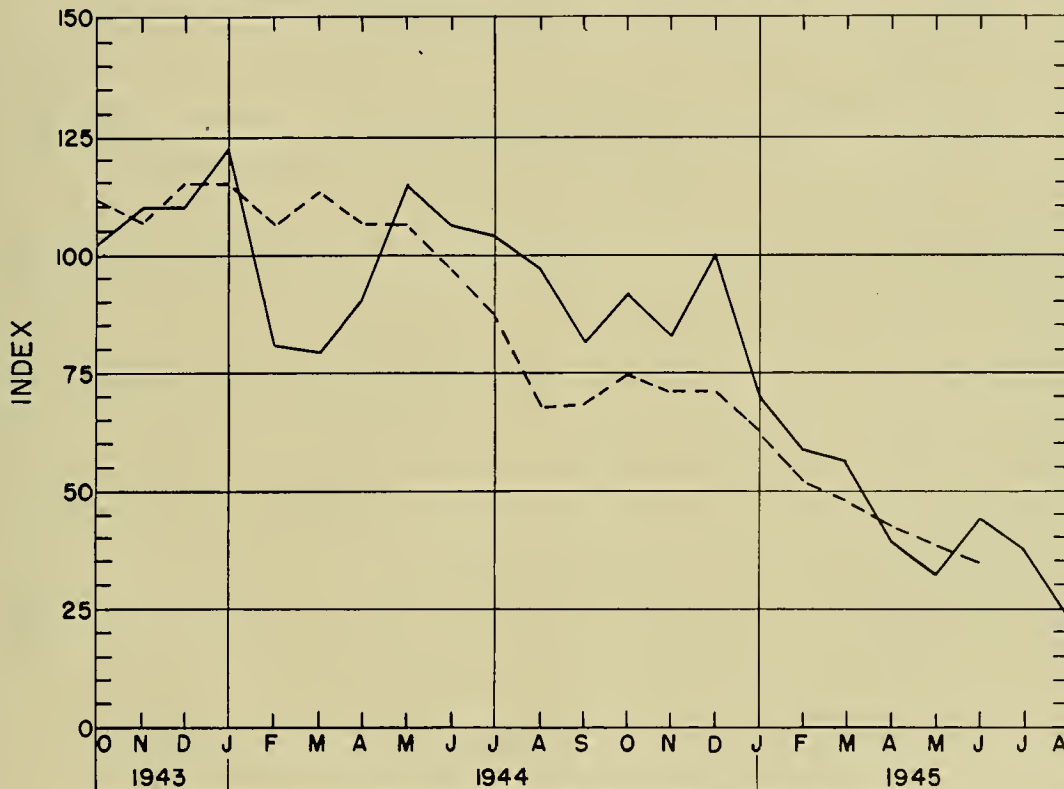
EXHIBIT E

NAGOYA

IRON AND STEEL

LOCAL IMPORTS COMPARED WITH NATIONAL PRODUCTION

MONTHLY AVERAGE OCT 1943 - SEP 44 = 100



LEGEND

- IRON AND STEEL IMPORTS 42,873 TONS = 100
- NATIONAL PRODUCTION OF PIG IRON, OPEN HEARTH BASIC BESSEMER & INGOT STEEL 741,853 TONS = 100

NOTE:

THE NATIONAL PRODUCTION INDEX WOULD BE CHANGED ONLY SLIGHTLY IF ROLLED STEEL PRODUCTION WERE ADDED.

U.S. STRATEGIC BOMBING SURVEY

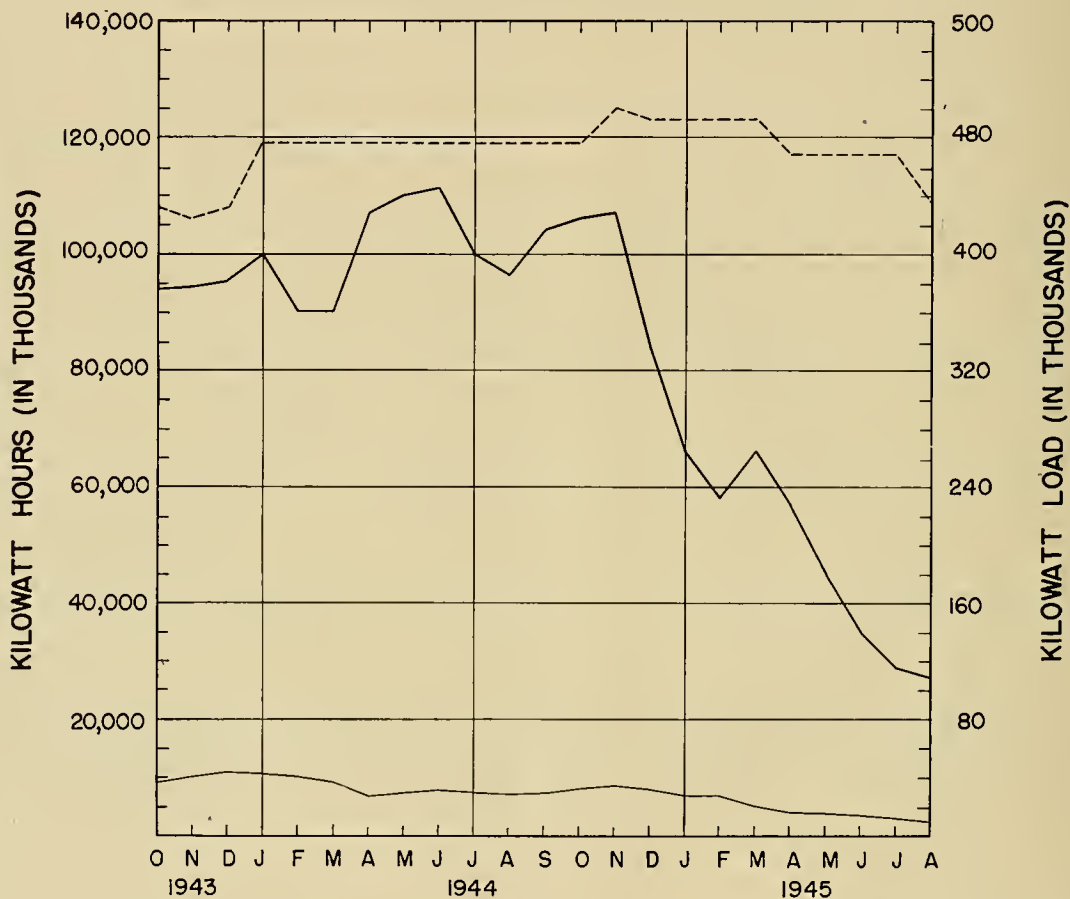
CITY OF NAGOYA

EXHIBIT F

NAGOYA

ELECTRIC POWER CONSUMPTION

OCTOBER 1943 - AUGUST 1945



_____ CONSUMPTION BY INDUSTRY
 (LEFT HAND SCALE)
 _____ CONSUMPTION BY HOMES, TRANSPORTATION, ETC.
 (LEFT HAND SCALE)
 - - - - - TOTAL CAPACITY AVAILABLE
 (RIGHT HAND SCALE)

SOURCE : NAGOYA CITY ADMINISTRATION

U.S. STRATEGIC BOMBING SURVEY

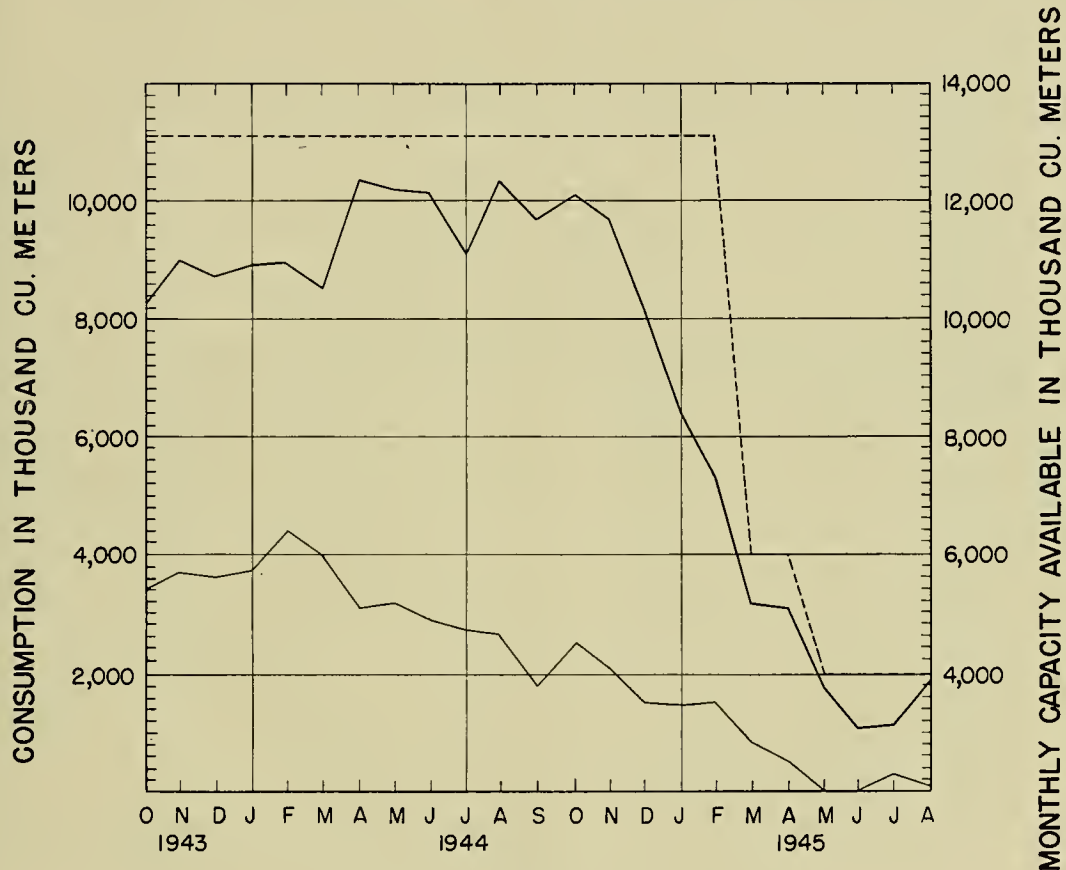
CITY OF NAGOYA

EXHIBIT G

NAGOYA

GAS CONSUMPTION

OCTOBER 1943 - AUGUST 1945



_____ CONSUMPTION BY INDUSTRY
 (LEFT HAND SCALE)
 _____ CONSUMPTION BY HOMES, ETC.
 (LEFT HAND SCALE)
 - - - - - MONTHLY CAPACITY AVAILABLE
 (RIGHT HAND SCALE)

SOURCE: NAGOYA CITY ADMINISTRATION

U.S. STRATEGIC BOMBING SURVEY

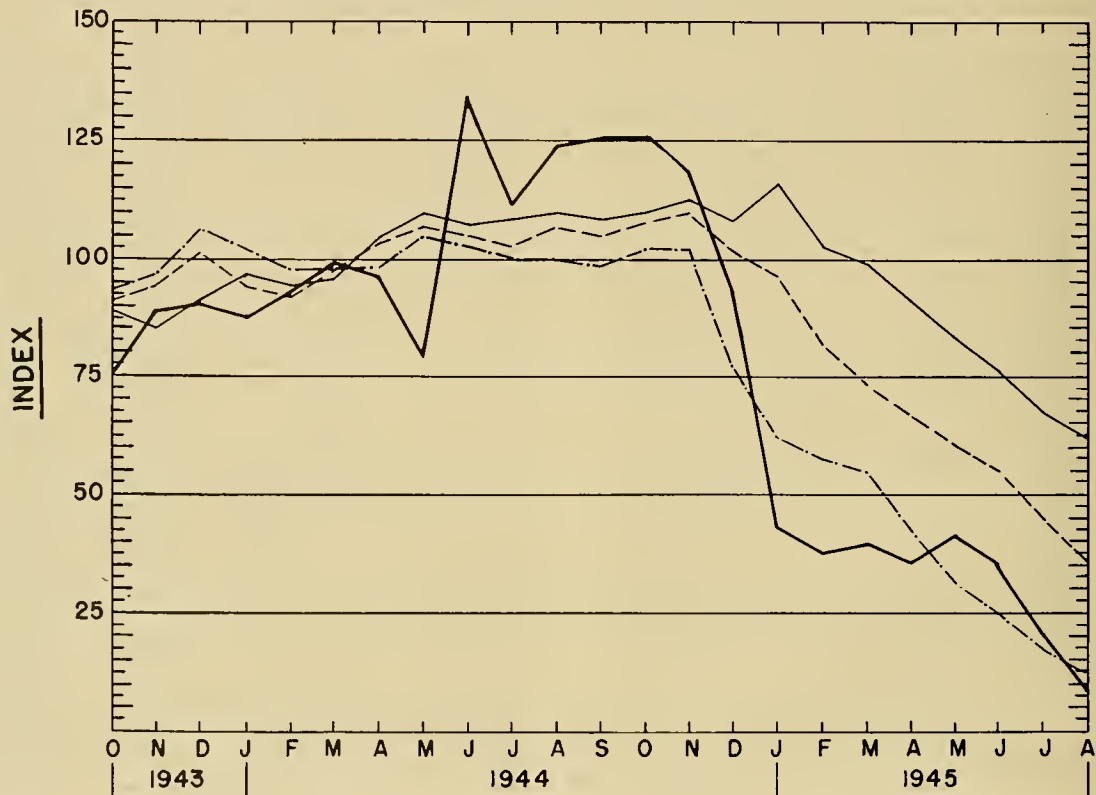
CITY OF NAGOYA

EXHIBIT H

NAGOYA

ACTIVITY IN AIRCRAFT INDUSTRY

MONTHLY AVERAGES OCT. 1943 - SEPT. 1944 = 100



LEGEND

- PRODUCTION (YEN SALES)
YEN 111,626,691 = 100
 - LABOR FORCE
75,846 WORKERS = 100
 - PRODUCTIVE HOURS WORKED
19,457,583 HOURS = 100
 - .-.- ELECTRIC POWER CONSUMPTION
10,643,700 KWH = 100
- SOURCE: U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

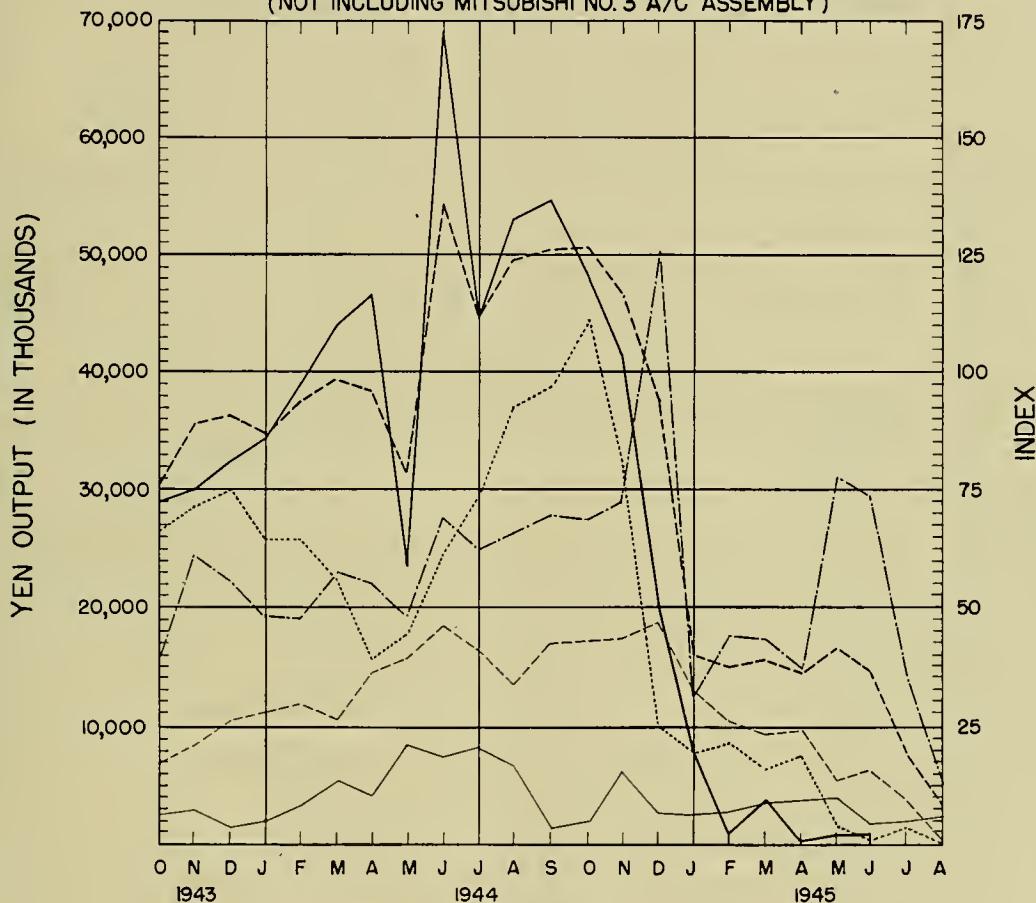
EXHIBIT 1

NAGOYA

AIRCRAFT INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES

(NOT INCLUDING MITSUBISHI NO. 3 A/C ASSEMBLY)



LEGEND

- MITSUBISHI NO. 4 A/C ENGINE
- · - · - MITSUBISHI NO. 5 A/C ASSEMBLY
- OKAMOTO INDUSTRIAL CO. BRAKES & LANDING GEAR
- AICHI EITOKU A/C ASSEMBLY
- AICHI ATSUTA A/C ENGINE
- TOTAL PRODUCTION INDEX MONTHLY AVERAGE - OCT. 1943 - SEPT. 1944 = 100

U.S. STRATEGIC BOMBING SURVEY

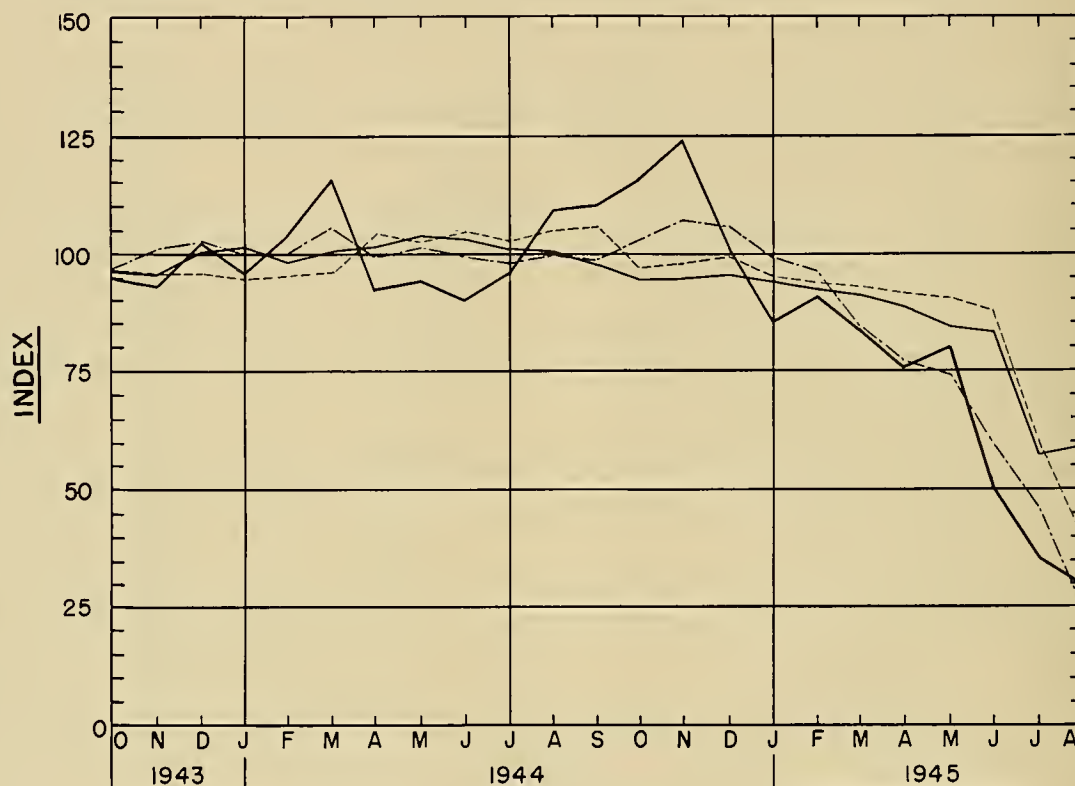
CITY OF NAGOYA

EXHIBIT J

NAGOYA

ACTIVITY IN ORDNANCE INDUSTRY

MONTHLY AVERAGES OCT. 1943- SEPT. 1944=100



LEGEND

- PRODUCTION (YEN SALES)
YEN 37,012,132=100
 - LABOR FORCE
63,733 WORKERS=100
 - - - PRODUCTIVE HOURS WORKED
16,931,500 HOURS=100
 - · · ELECTRIC POWER CONSUMPTION
6,096,751 KWH=100
- SOURCE: U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

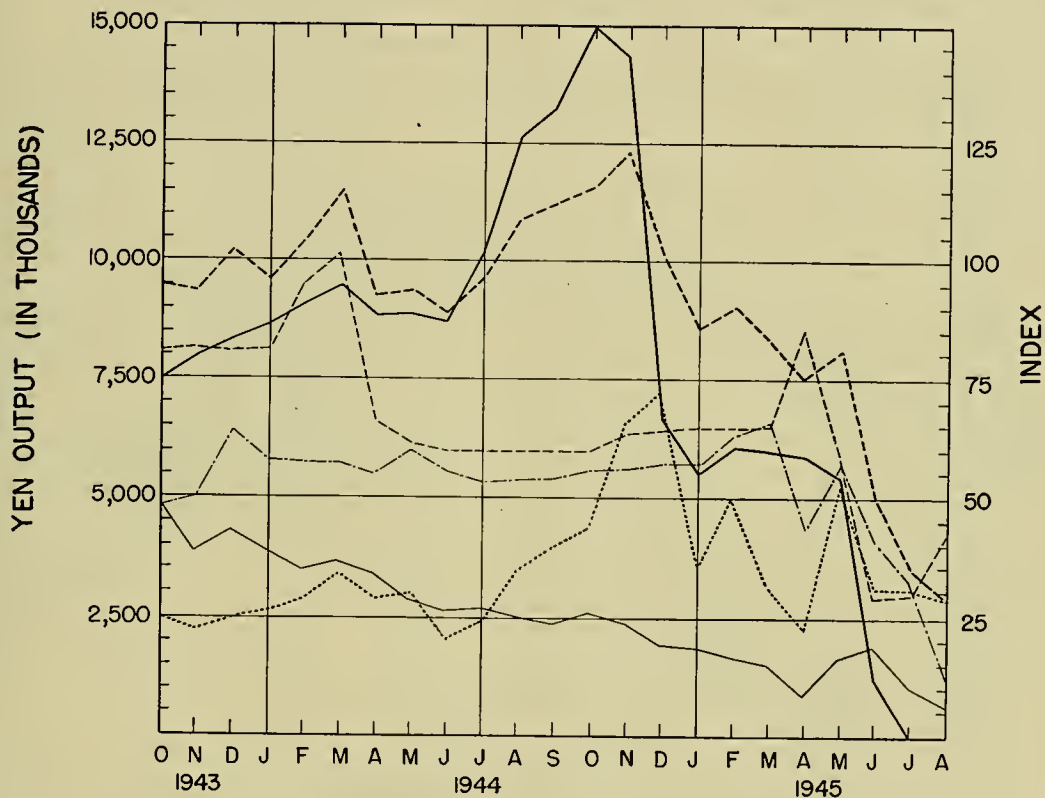
CITY OF NAGOYA

EXHIBIT K

NAGOYA

ORDNANCE INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES



- AICHI CLOCK & ELECTRIC CO. FUNAKATA FACTORY
- NAGOYA ARSENAL - CHIKUSA FACTORY
- NAGOYA ARSENAL - TORIIMATSU FACTORY
- NAGOYA ARSENAL - TAKAKURA FACTORY
- HOWA HEAVY INDUSTRY CO.
- . - . - . TOTAL PRODUCTION INDEX
- MONTHLY AVERAGE - OCT. 1943 - SEPT. 1944 = 100 (RIGHT HAND SCALE)

U.S. STRATEGIC BOMBING SURVEY

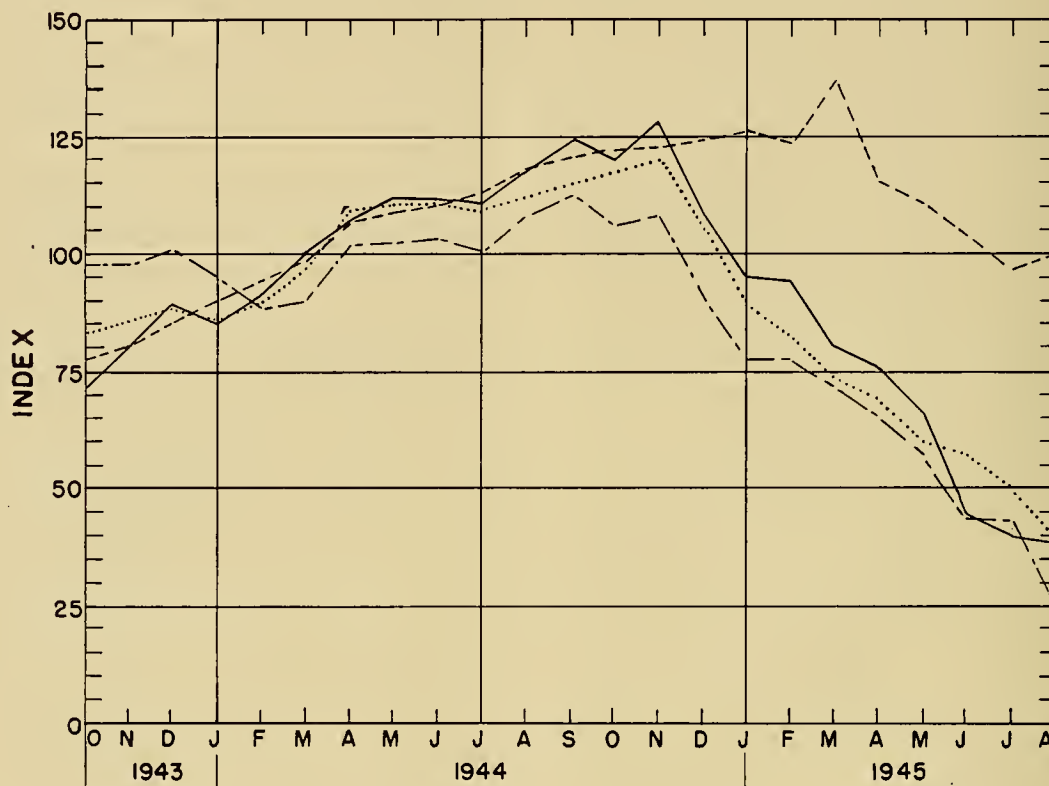
CITY OF NAGOYA

EXHIBIT L

NAGOYA

ACTIVITY IN METALS AND METAL PRODUCTS INDUSTRY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND

- PRODUCTION (YEN SALES)
YEN 54,977,840=100
- LABOR FORCE
63,526 WORKERS=100
- PRODUCTION HOURS WORKED
13,220,174 HOURS=100
- ELECTRIC POWER CONSUMPTION
16,019,763 KWH=100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

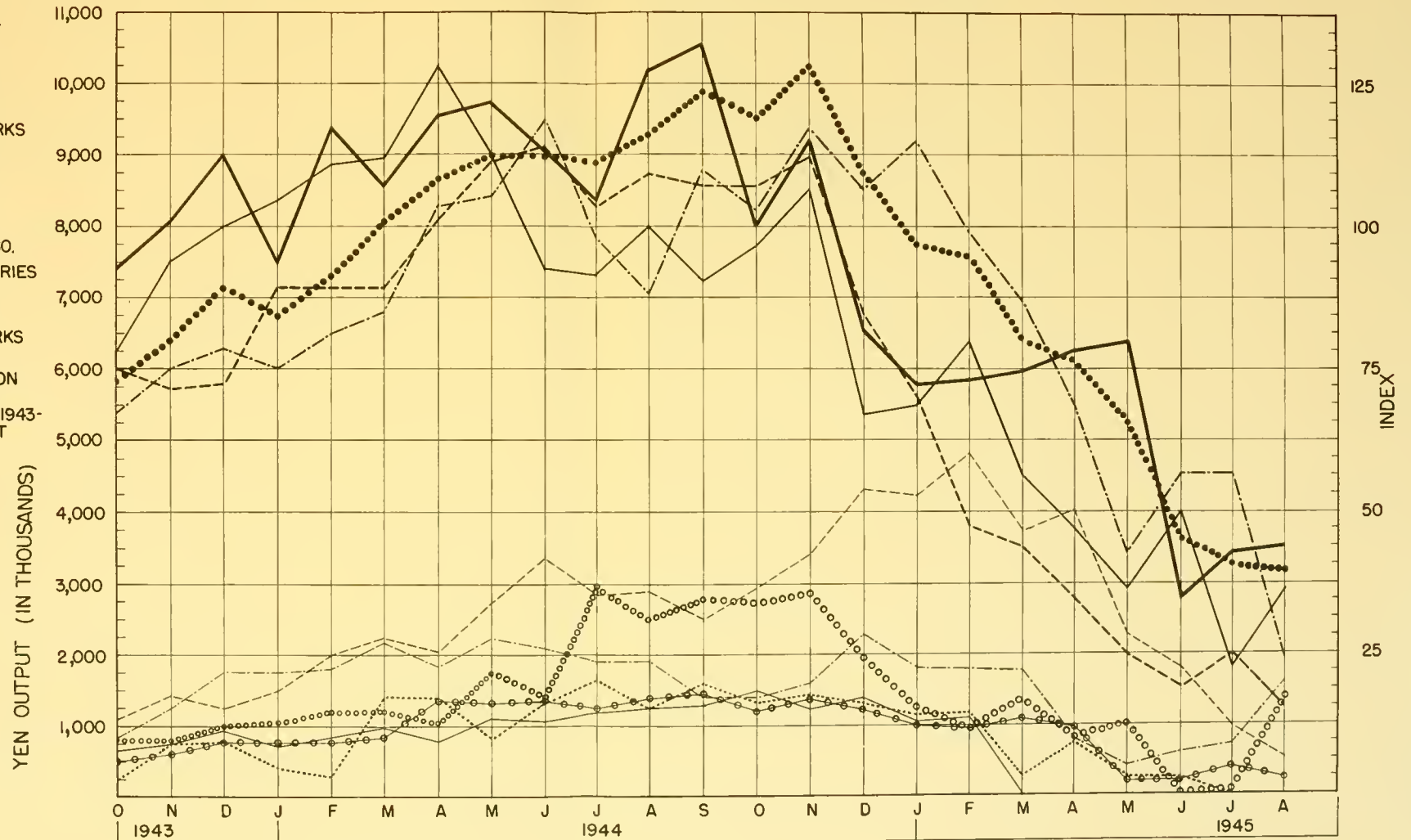
EXHIBIT M

METALS & METAL PRODUCTS INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES

LEGEND

- DAIDO STEEL CO. HOSHIZAKI PLANT
 - DAIDO STEEL CO. TSUKIJI PLANT
 - - - MITSUBISHI A/C NO. 10 FACTORY
 - · - · - KOBÉ STEEL WORKS NAGOYA FACTORY
 - - - MITSUBISHI A/C NO. 12 FACTORY
 - - - DAIDO STEEL CO. ATSUTA PLANT
 - ○ ○ ○ ○ NAGOYA SCREW CO.
 - OKAMOTO INDUSTRIES SHOWA PLANT
 - ○ ○ ○ ○ CHUO SPRING CO.
 - · · · · OKUMA IRON WORKS HAGINO PLANT
 - · · · · TOTAL PRODUCTION INDEX
- (MONTHLY AVERAGE, OCT. 1943-SEPT. 1944=100. USE RIGHT HAND SCALE)



U.S. STRATEGIC BOMBING SURVEY

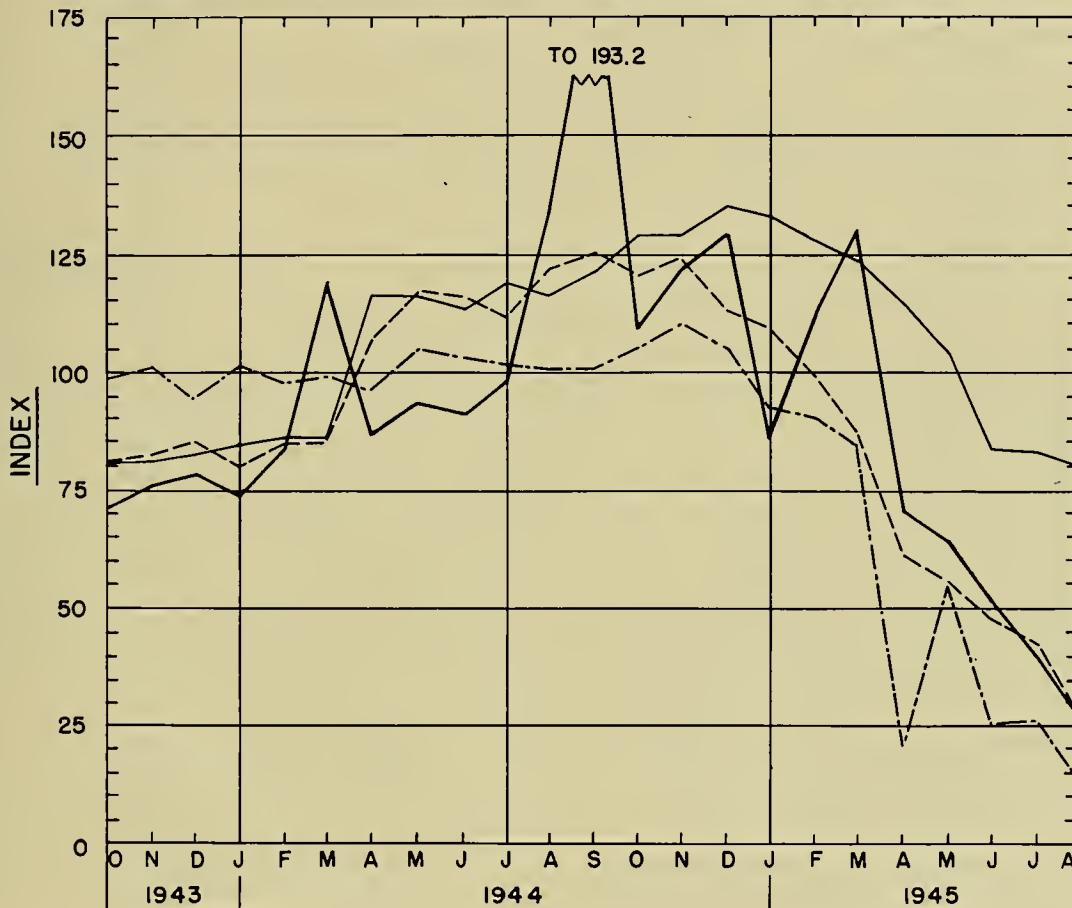
CITY OF NAGOYA

EXHIBIT N

NAGOYA

ACTIVITY IN ELECTRICAL EQUIPMENT INDUSTRY

MONTHLY AVERAGES OCT. 1943- SEPT. 1944= 100



LEGEND

- PRODUCTION (YEN SALES)
YEN 12,144,396 =100
 - LABOR FORCE
13,782 WORKERS=100
 - PRODUCTIVE HOURS WORKED
3,162,083 HOURS=100
 - .-.- ELECTRIC POWER CONSUMPTION
5,050,062 KWH=100
- SOURCE: U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

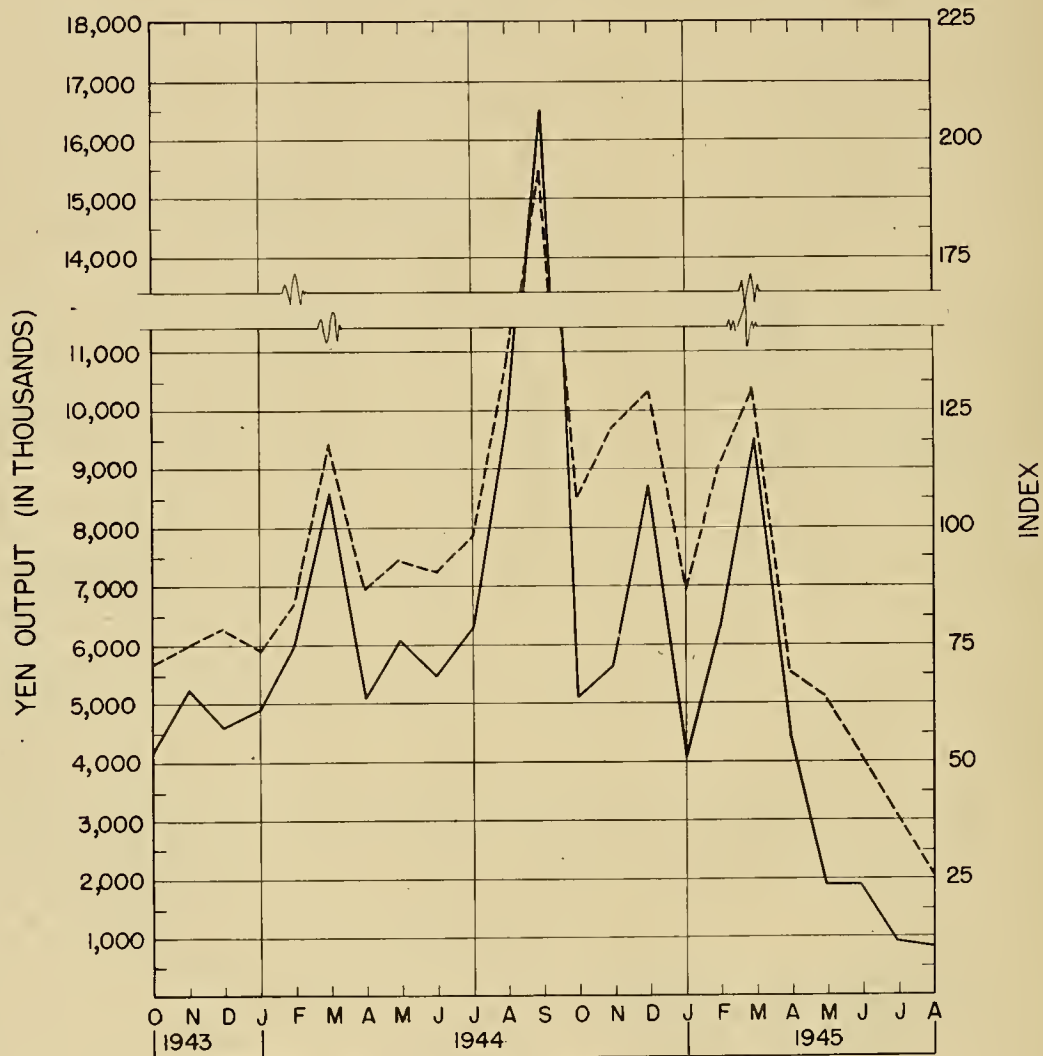
CITY OF NAGOYA

EXHIBIT 0

NAGOYA

ELECTRICAL EQUIPMENT INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES



NOTE: THE NEXT LARGEST FACTORIES, BEING MUCH SMALLER THAN MITSUBISHI CO., ARE SHOWN IN THE NEXT EXHIBIT, ON A YEN OUTPUT SCALE 4 TIMES AS LARGE.

—— MITSUBISHI ELECTRICAL EQUIPMENT COMPANY
 - - - - TOTAL PRODUCTION INDEX
 MONTHLY AVERAGE. OCT. 1943 - SEPT. 1944 = 100
 RIGHT HAND SCALE

U.S. STRATEGIC BOMBING SURVEY

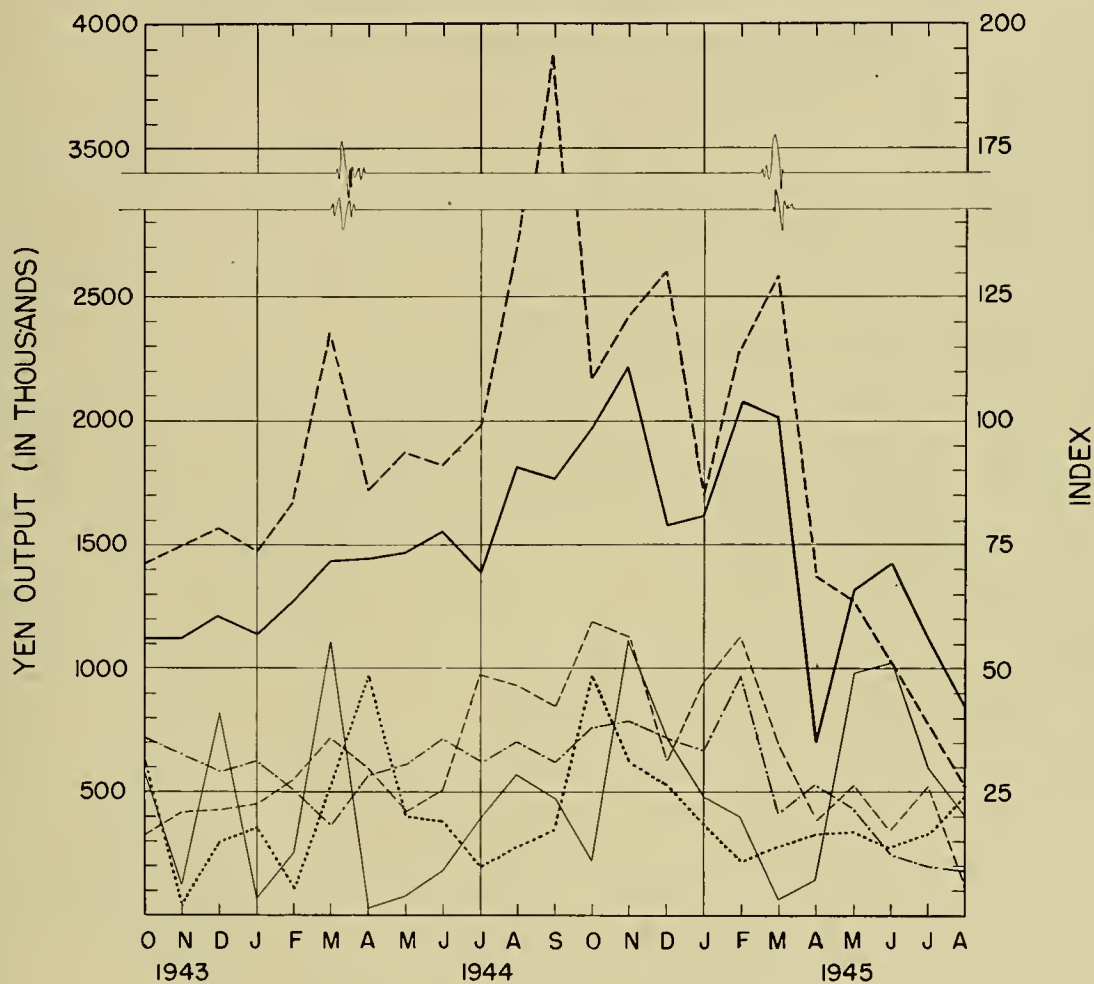
CITY OF NAGOYA

EXHIBIT P

NAGOYA

ELECTRICAL EQUIPMENT INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES



LEGEND

- JAPAN INSULATOR CO.
- - - - JAPAN SPECIAL CERAMICS CO.
- . - . TOKAI ELECTRODE No.1 FACTORY
- — — — DAIDO STEEL, OE FACTORY
- TAKAOKA MFG. CO.

TOTAL PRODUCTION INDEX
MONTHLY AVERAGE - OCT. 1943 -
SEPT. 1944 = 100. USE RIGHT
HAND SCALE.

U.S. STRATEGIC BOMBING SURVEY

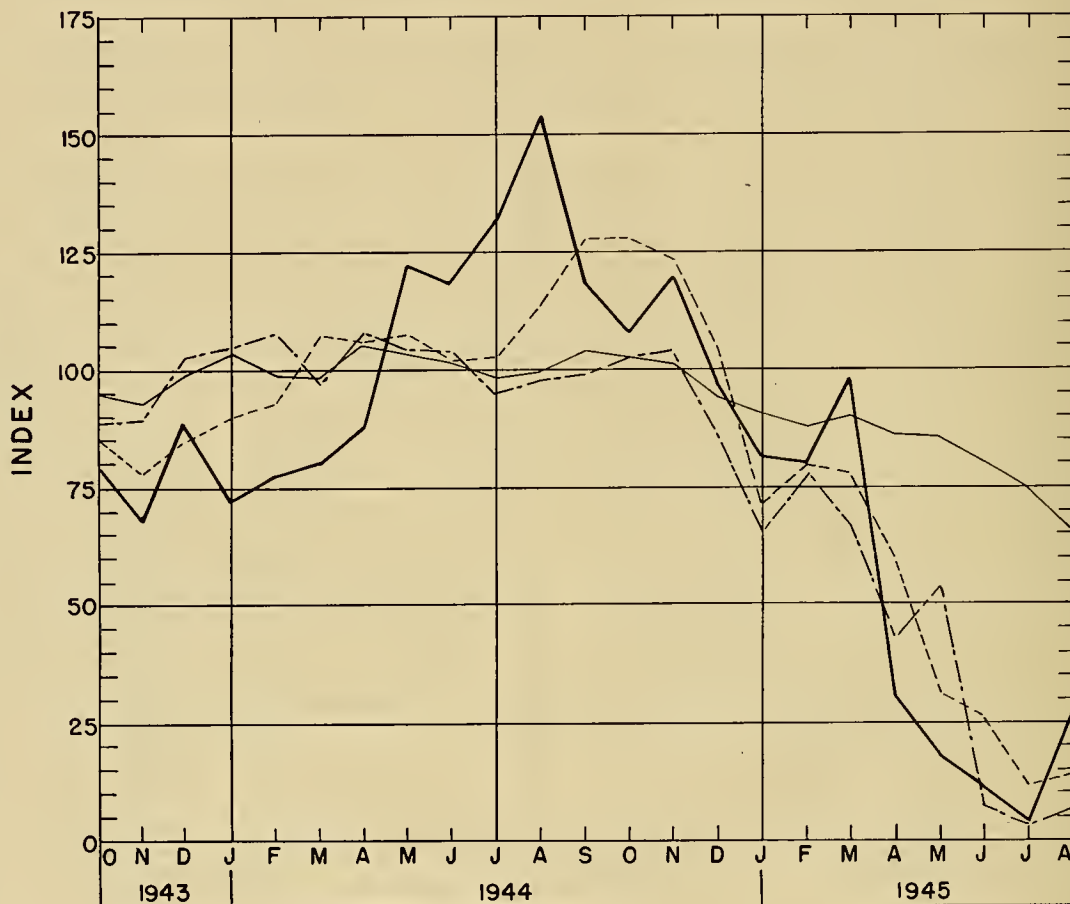
CITY OF NAGOYA

EXHIBIT Q

NAGOYA

ACTIVITY IN VEHICLES AND ROLLING STOCK INDUSTRY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND:

- PRODUCTION (YEN SALES)
YEN 3,949,995 = 100
- LABOR FORCE
4,643 WORKERS = 100
- - - - PRODUCTIVE HOURS WORKED
901,167 HOURS = 100
- - - - ELECTRIC POWER CONSUMPTION
1,350,900 KWH = 100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

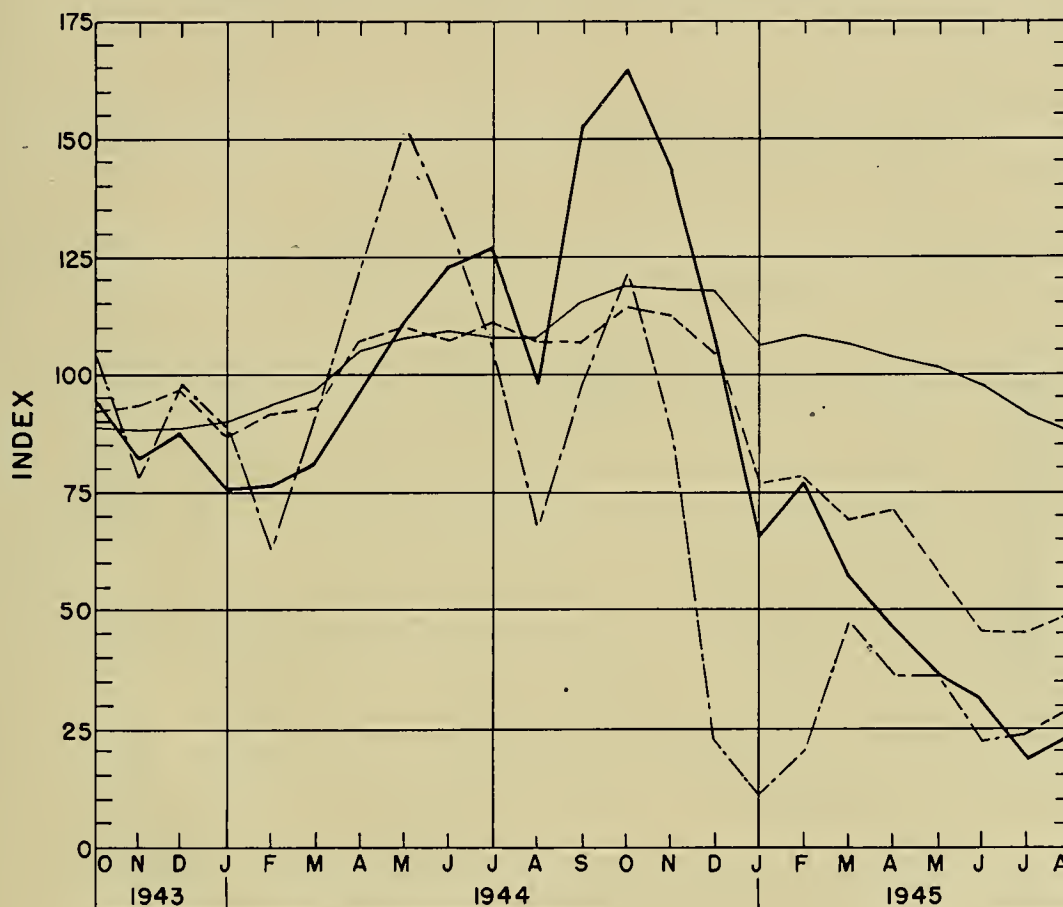
CITY OF NAGOYA

EXHIBIT R

NAGOYA

ACTIVITY IN CHEMICAL INDUSTRY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND

- PRODUCTION (YEN SALES)
YEN 2,205,000=100
- LABOR FORCE
2,034 WORKERS=100
- - - - PRODUCTIVE HOURS WORKED
531,000 HOURS=100
- . - . - ELECTRIC POWER CONSUMPTION
17,180,247 KWH=100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

EXHIBIT S

NAGOYA

CHEMICAL INDUSTRY

YEN OUTPUT IN LARGEST FACTORIES



LEGEND

..... TOA SYNTHETIC CHEMICALS CO.
 ————— TOYO SYNTHETIC CHEMICALS CO.
 - - - - - SAKURA RUBBER CO.
 - . - . - KOKKA RUBBER PRODUCTS CO.
 ———— TOTAL PRODUCTION INDEX
 - - - - - MONTHLY AVERAGE, OCT. 1943 - SEPT. 1944 = 100
 USE RIGHT HAND SCALE

U.S. STRATEGIC BOMBING SURVEY

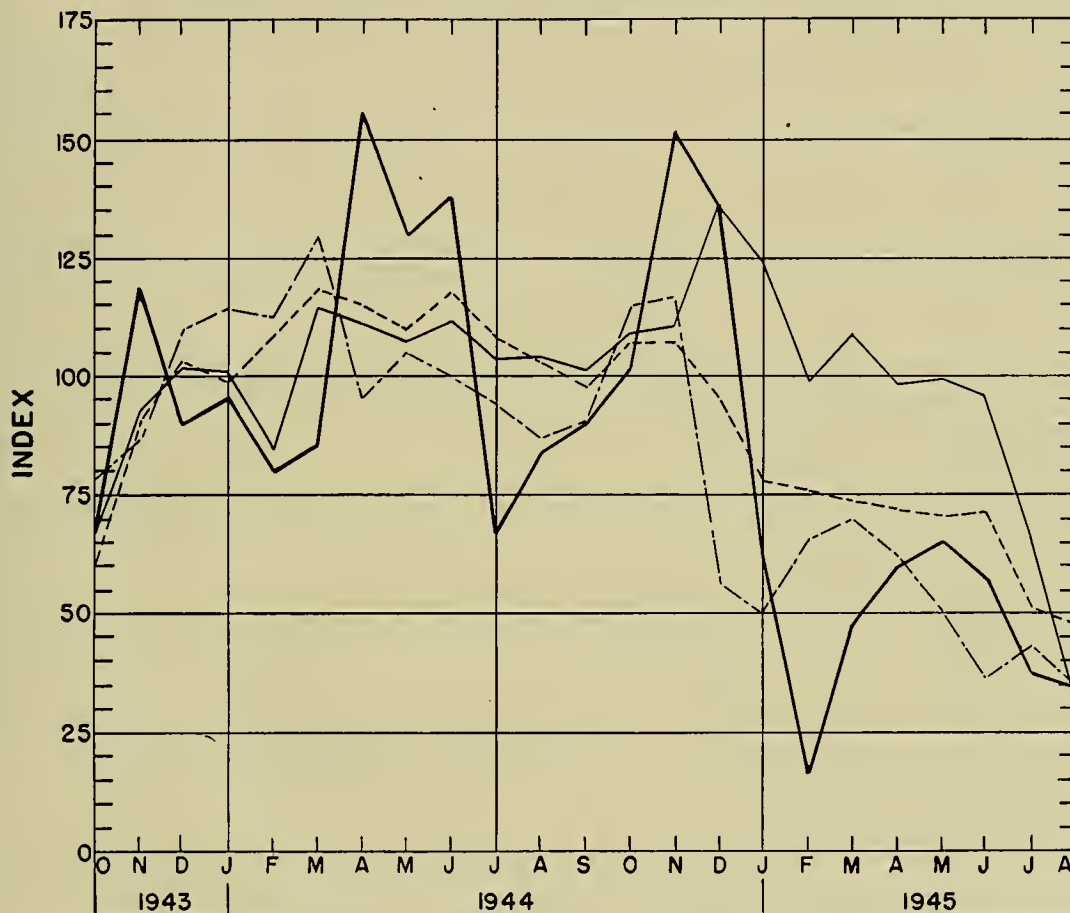
CITY OF NAGOYA

EXHIBIT T

NAGOYA

ACTIVITY IN SHIPBUILDING INDUSTRY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND:

- PRODUCTION (YEN SALES)
YEN 2,046,738 = 100
- LABOR FORCE
3,168 WORKERS = 100
- PRODUCTIVE HOURS WORKED
494,656 HOURS = 100
- .-.-.- ELECTRIC POWER CONSUMPTION
316,500 KWH = 100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

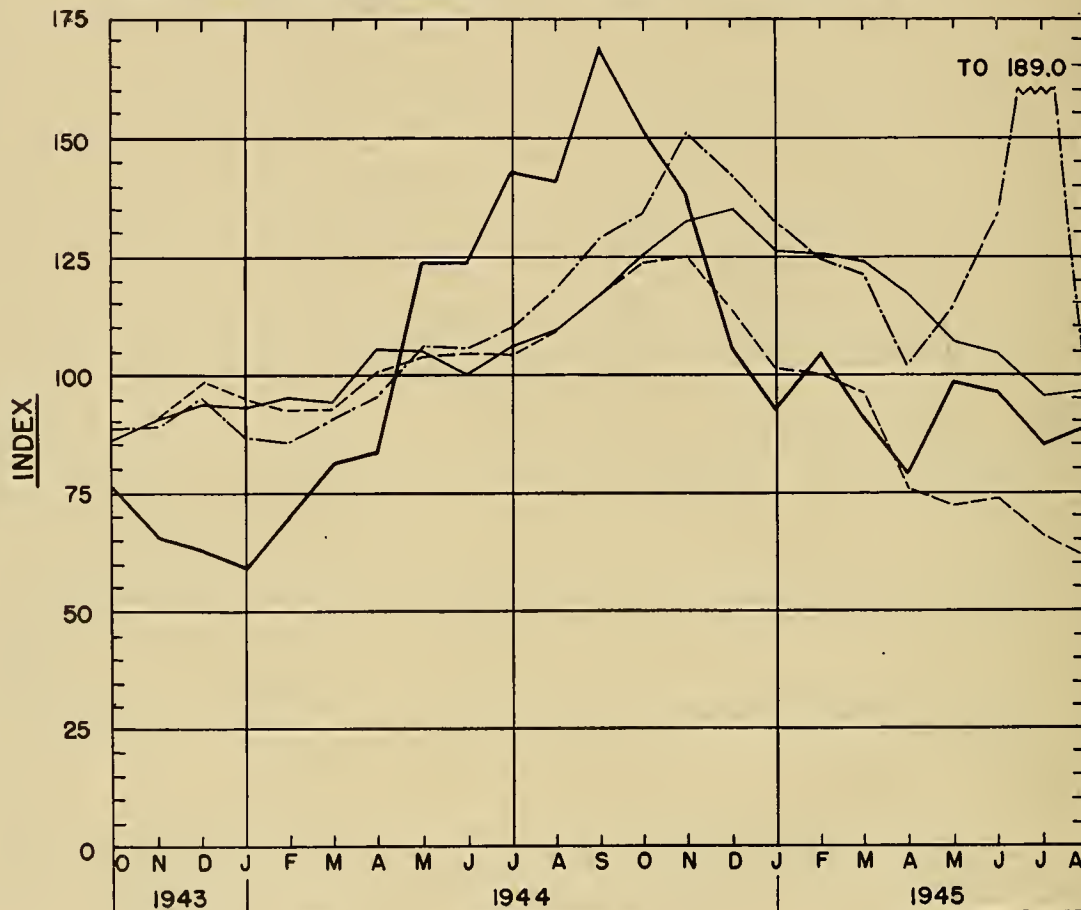
CITY OF NAGOYA

EXHIBIT U

NAGOYA

ACTIVITY IN MISCELLANEOUS INDUSTRIES

MONTHLY AVERAGES OCT. 1943 - SEPT. 1944=100



LEGEND

- PRODUCTION (YEN SALES)
- YEN 8,681,731=100
- LABOR FORCE
- 9,283 WORKERS=100
- - - PRODUCTIVE HOURS WORKED
- - - 2,226,000 HOURS=100
- . - - ELECTRIC POWER CONSUMPTION
- . - - 1,461,654 KWH=100
- SOURCE: U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

U.S. STRATEGIC BOMBING SURVEY

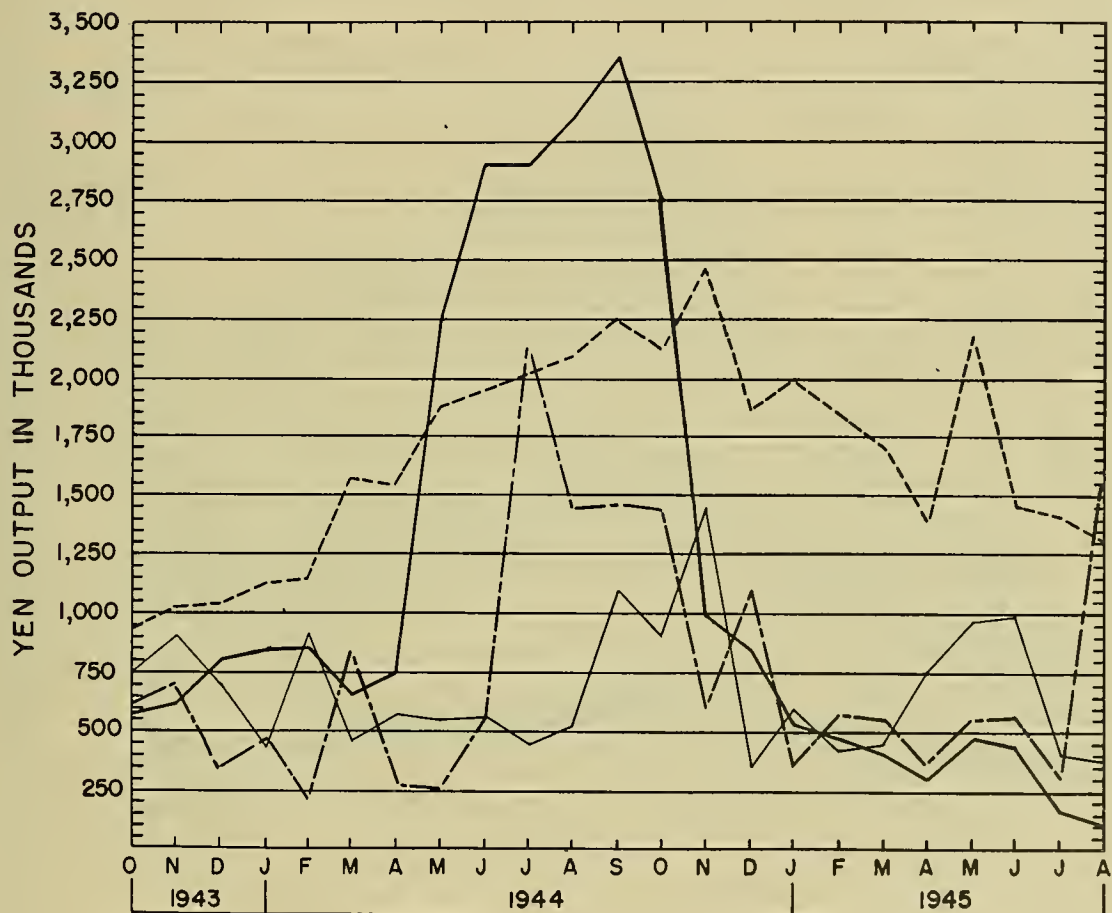
CITY OF NAGOYA

EXHIBIT V

NAGOYA

MISCELLANEOUS INDUSTRIES

YEN OUTPUT IN LARGEST FACTORIES



LEGEND

- AICHI CHEMICAL CO.
- JAPAN PORCELAIN CO.
- . - . - DAITO MFG. CO.
- WATANABE FOOD MFG.

U.S. STRATEGIC BOMBING SURVEY

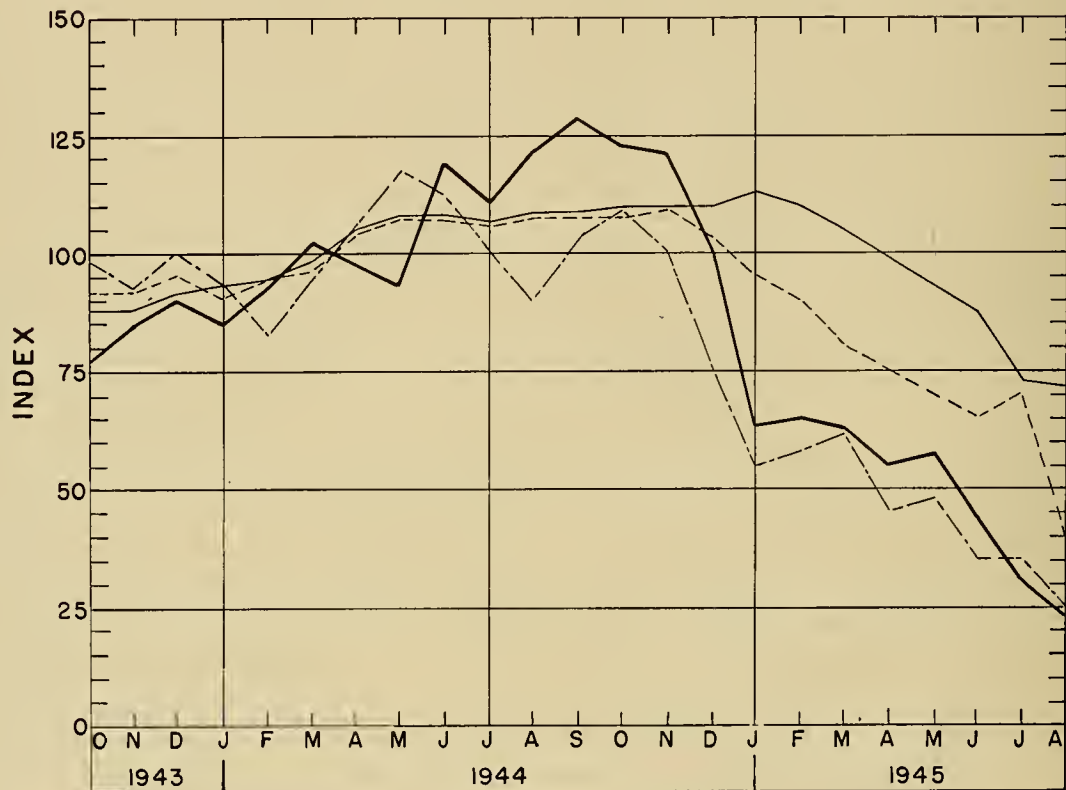
CITY OF NAGOYA

EXHIBIT W

NAGOYA

OVERALL INDUSTRIAL ACTIVITY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND:

- PRODUCTION (YEN SALES)
YEN 233,552,781=100
- LABOR FORCE
236,020 WORKERS=100
- - - - PRODUCTIVE HOURS WORKED
57,090,000 HOURS=100
- - - - ELECTRIC POWER CONSUMPTION
58,058,367 KWH=100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

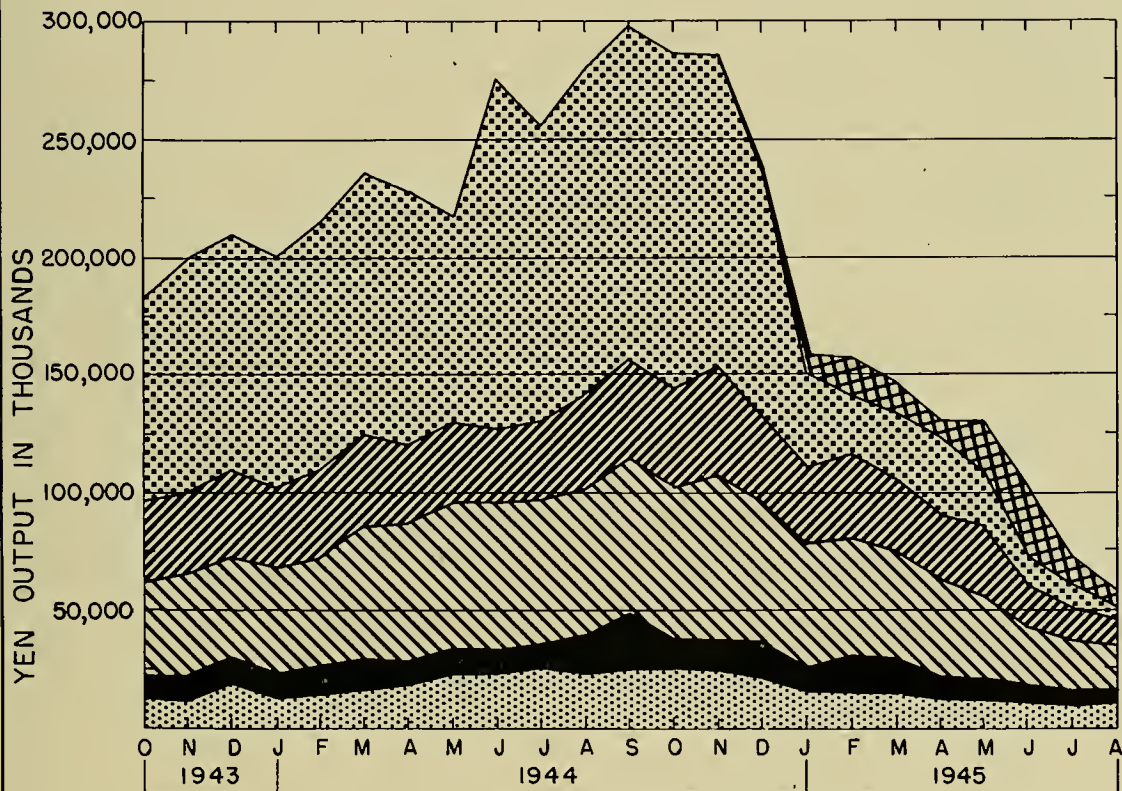
U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA







EXHIBIT X

NAGOYA

TOTAL INDUSTRIAL PRODUCTION



LEGEND

-  AIRCRAFT.
-  ORDNANCE.
-  METALS & METAL PRODUCTS.
-  ELECTRICAL EQUIPMENT.
-  OTHERS.
-  MITSUBISHI ARMY AIRCRAFT PRODUCTION AT
DISPERSED SITES OUTSIDE NAGOYA, BUT
INCLUDED IN THE STATISTICS SUBMITTED
BY THE #5 COMPLEX.

U.S. STRATEGIC BOMBING SURVEY

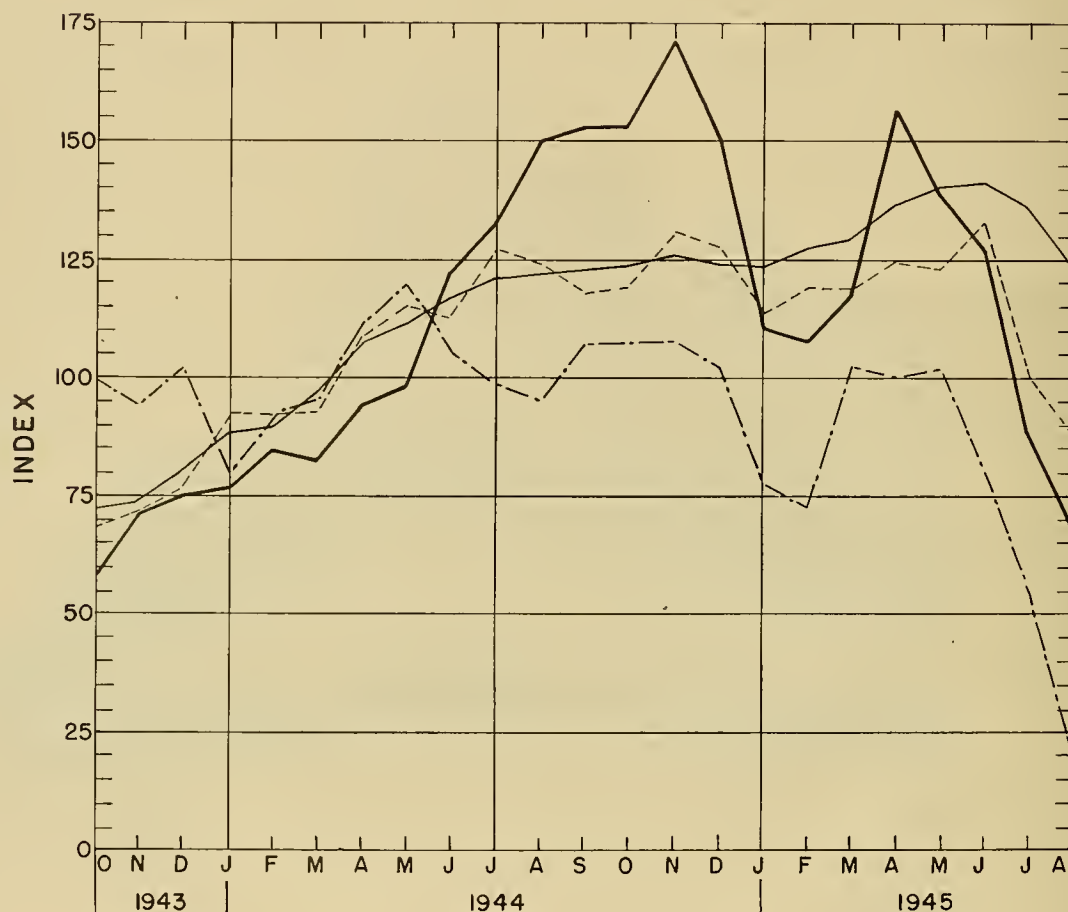
CITY OF NAGOYA

EXHIBIT Y

SELECTED CITIES OUTSIDE NAGOYA

OVERALL INDUSTRIAL ACTIVITY

MONTHLY AVERAGE OCT. 1943—SEPT. 1944 = 100



LEGEND:

- PRODUCTION (YEN SALES)
YEN 46,604,945=100
- LABOR FORCE
75,626 WORKERS=100
- - - PRODUCTIVE HOURS WORKED
17,377,551 HOURS=100
- . - ELECTRIC POWER CONSUMPTION
19,024,159 KWH=100

SOURCE:
U.S.S.B.S. INDUSTRIAL QUESTIONNAIRES

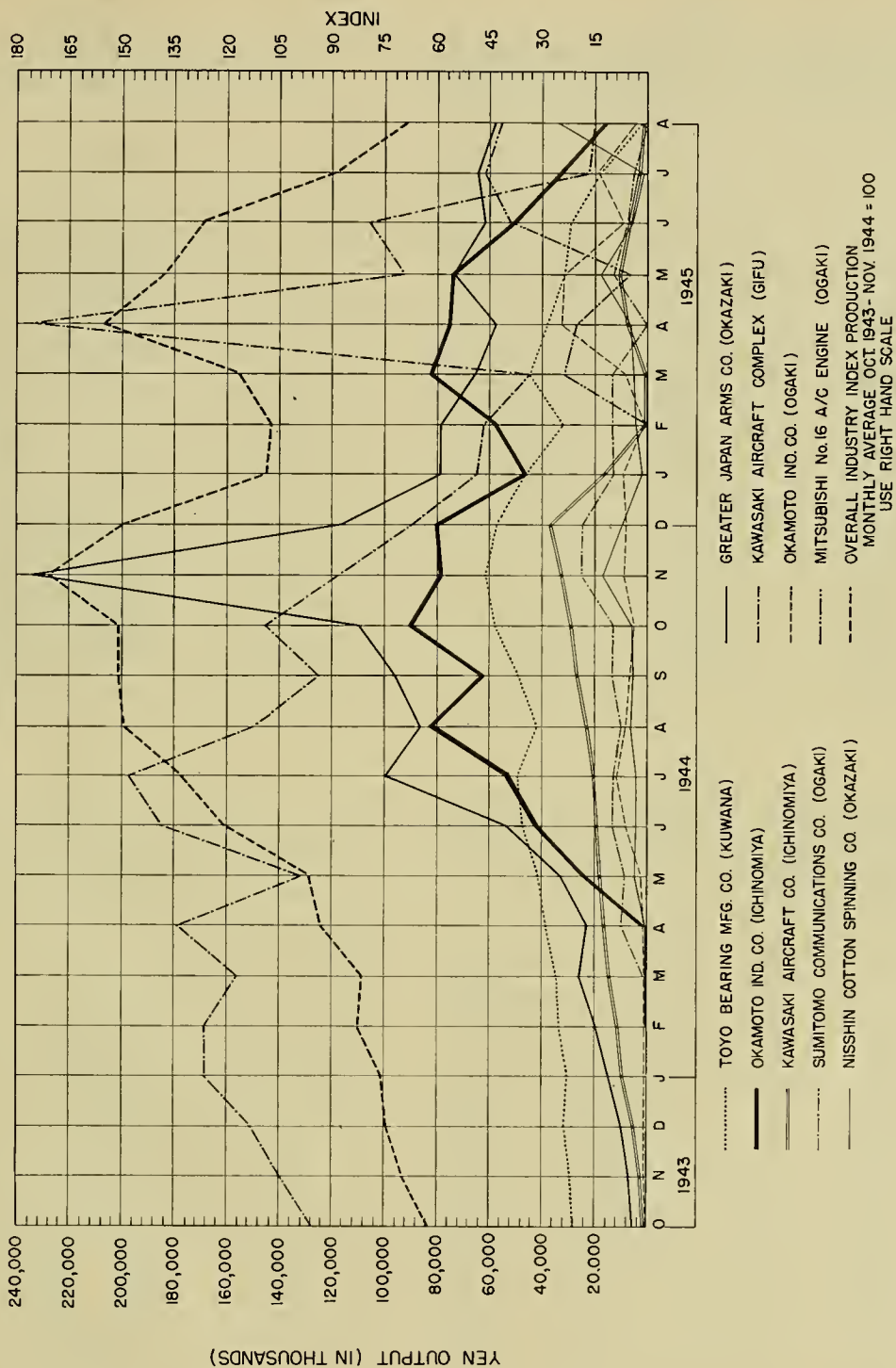
U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

EXHIBIT 2

SELECTED CITIES OUTSIDE NAGOYA

YEN OUTPUT IN LARGEST FACTORIES



U.S. STRATEGIC BOMBING SURVEY

CITY OF NAGOYA

EXHIBIT AA

BB-1

NAGOYA—LOCAL COAL IMPORTS COMPARED WITH NATIONAL PRODUCTION AND NATIONAL CARLOADINGS

	Local imports	National Production	National Carloadings
		<i>Thousand tons</i>	<i>Thousand tons</i>
1943—Oct.....	118, 773	4, 646	4, 014
Nov.....	106, 552	4, 646	4, 014
Dec.....	123, 695	4, 646	4, 014
1944—Jan.....	98, 914	5, 105	4, 318
Feb.....	69, 424	5, 105	4, 318
Mar.....	145, 317	5, 105	4, 318
Apr.....	137, 673	4, 583	4, 282
May.....	124, 370	4, 542	4, 340
June.....	114, 435	4, 099	3, 877
July.....	116, 616	4, 105	3, 813
Aug.....	95, 087	3, 919	3, 649
Sept.....	82, 655	3, 987	3, 578
Oct.....	89, 935	3, 936	3, 561
Nov.....	102, 548	4, 020	3, 706
Dec.....	91, 761	4, 408	3, 716
1945—Jan.....	81, 820	3, 941	3, 288
Feb.....	83, 791	3, 636	3, 104
Mar.....	72, 341	4, 159	3, 802
Apr.....	29, 149	3, 601	3, 535
May.....	22, 570	3, 715	3, 612
June.....	20, 104	3, 561	3, 275
July.....	16, 095	2, 712	-----
Aug.....	15, 806	909	-----

BB-2

NAGOYA—IRON AND STEEL: LOCAL IMPORTS COMPARED WITH NATIONAL PRODUCTION

	Local iron and steel imports	National production of pig iron, open hearth, basic Bessemer, and ingot steel
	<i>Tons</i>	<i>Tons</i>
1943—Oct.....	43, 711	825, 140
Nov.....	47, 187	821, 187
Dec.....	47, 325	849, 693
1944—Jan.....	52, 478	846, 345
Feb.....	34, 669	786, 615
Mar.....	34, 244	841, 051
Apr.....	38, 694	786, 650
May.....	49, 166	785, 476
June.....	45, 504	711, 027
July.....	44, 769	646, 498
Aug.....	41, 894	495, 817
Sept.....	34, 832	506, 735
Oct.....	39, 251	558, 980
Nov.....	35, 411	527, 511
Dec.....	42, 850	528, 654
1945—Jan.....	30, 062	470, 040
Feb.....	25, 251	387, 705
Mar.....	23, 891	360, 292
Apr.....	16, 677	324, 436
May.....	13, 691	288, 949
June.....	18, 921	258, 149
July.....	15, 983	-----

BB-3

NAGOYA—ACTIVITY IN AIRCRAFT INDUSTRY

	Production (yeu sales)	Labor force	Productive hours worked	Electric power consumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct.....	85, 678	67, 597	17, 681	9, 771
Nov.....	99, 092	64, 474	18, 362	9, 844
Dec.....	101, 649	68, 849	19, 727	10, 985
1944—Jan.....	97, 421	72, 388	18, 328	10, 824
Feb.....	104, 775	71, 317	17, 989	10, 228
Mar.....	110, 698	73, 485	19, 153	10, 350
Apr.....	107, 816	80, 294	20, 114	10, 728
May.....	88, 601	82, 848	20, 849	10, 905
June.....	150, 609	81, 730	20, 424	10, 873
July.....	125, 117	81, 483	19, 959	10, 797
Aug.....	138, 184	83, 265	20, 876	10, 906
Sept.....	140, 880	82, 464	20, 029	10, 739
Oct.....	141, 122	83, 559	21, 041	11, 184
Nov.....	130, 262	85, 670	21, 325	11, 190
Dec.....	104, 791	82, 596	19, 854	7, 308
1945—Jan.....	47, 655	88, 296	18, 697	5, 896
Feb.....	42, 245	85, 534	15, 864	5, 988
Mar.....	43, 095	75, 328	14, 254	5, 333
Apr.....	40, 545	68, 730	13, 007	3, 422
May.....	46, 245	62, 606	11, 739	2, 533
June.....	40, 665	58, 177	10, 764	1, 989
July.....	21, 421	51, 085	8, 821	1, 315
Aug.....	8, 841	47, 017	7, 038	977

BB-4

NAGOYA—ACTIVITY IN ORDNANCE INDUSTRY

	Production (yeu sales)	Labor force	Productive hours worked	Electric power consumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct.....	35, 227	60, 984	16, 095	5, 835
Nov.....	34, 635	61, 049	16, 218	6, 175
Dec.....	37, 850	63, 747	16, 279	6, 234
1944—Jan.....	35, 762	64, 640	16, 067	6, 081
Feb.....	38, 832	62, 998	16, 195	6, 076
Mar.....	42, 606	64, 005	16, 392	6, 406
Apr.....	34, 089	64, 919	17, 742	6, 006
May.....	34, 894	65, 870	17, 515	6, 203
June.....	32, 871	65, 582	17, 723	6, 037
July.....	35, 876	64, 426	17, 425	5, 985
Aug.....	40, 543	64, 598	17, 736	6, 102
Sept.....	40, 965	61, 973	17, 791	6, 021
Oct.....	43, 089	59, 864	16, 351	6, 272
Nov.....	45, 947	60, 360	16, 661	6, 548
Dec.....	37, 641	60, 802	16, 815	6, 490
1945—Jan.....	31, 468	59, 873	16, 128	6, 052
Feb.....	33, 720	59, 309	15, 836	5, 863
Mar.....	31, 110	58, 595	15, 693	5, 144
Apr.....	28, 147	56, 603	15, 645	4, 713
May.....	30, 184	53, 951	15, 355	4, 486
June.....	18, 221	52, 883	14, 817	3, 586
July.....	13, 296	36, 852	19, 894	2, 855
Aug.....	10, 708	37, 164	7, 060	1, 593

BB-5

NAGOYA—ACTIVITY IN METALS AND
METAL PRODUCTS INDUSTRY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct	39,946	50,079	10,994	15,609
Nov	43,912	51,537	11,367	15,619
Dec	48,904	53,994	11,769	16,169
1944—Jan	46,162	57,419	11,180	15,169
Feb	49,805	59,766	11,852	14,170
Mar	55,444	62,382	12,832	14,556
Apr	59,132	67,978	14,415	16,262
May	61,681	69,413	14,748	16,333
June	61,700	70,464	14,776	16,589
July	61,140	71,724	14,595	16,317
Aug	63,920	73,090	14,961	17,206
Sept	67,979	74,468	15,153	18,238
Oct	65,315	77,444	15,516	17,102
Nov	70,529	77,857	15,756	17,294
Dec	59,696	78,697	13,916	14,378
1945—Jan	52,905	79,206	12,100	12,412
Feb	52,027	79,002	12,456	12,386
Mar	43,647	87,213	9,789	11,631
Apr	41,797	74,153	9,229	10,583
May	36,139	70,367	8,062	9,259
June	24,814	66,483	7,543	7,057
July	22,515	61,494	6,772	6,890
Aug	21,724	63,627	5,334	4,313

BB-7

NAGOYA—ACTIVITY IN VEHICLE AND
ROLLING STOCK INDUSTRY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct	3,126	4,412	766	1,214
Nov	2,719	4,326	706	1,218
Dec	3,520	4,604	772	1,384
1944—Jan	2,870	4,783	812	1,416
Feb	3,067	4,623	841	1,465
Mar	3,179	4,574	974	1,316
Apr	3,448	4,899	953	1,438
May	4,850	4,791	964	1,408
June	4,681	4,702	913	1,413
July	5,204	4,577	929	1,289
Aug	6,080	4,601	1,029	1,324
Sept	4,656	4,828	1,155	1,326
Oct	4,250	4,771	1,159	1,386
Nov	4,741	4,729	1,114	1,400
Dec	3,786	4,380	934	1,146
1945—Jan	3,200	4,195	641	887
Feb	3,177	4,076	723	1,048
Mar	3,896	4,170	700	900
Apr	1,190	4,010	542	575
May	706	3,972	278	731
June	438	3,727	236	103
July	186	3,479	104	63
Aug	1,033	3,033	122	81

BB-6

NAGOYA—ACTIVITY IN ELECTRICAL
EQUIPMENT INDUSTRY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct	8,728	11,091	2,542	5,011
Nov	9,195	11,138	2,601	5,141
Dec	9,584	11,330	2,714	4,756
1944—Jan	8,968	11,606	2,570	5,069
Feb	10,172	11,791	2,689	4,925
Mar	14,324	11,822	2,692	4,996
Apr	10,532	15,991	3,398	4,911
May	11,359	15,882	3,713	5,287
June	11,039	15,579	3,652	5,218
July	11,992	16,366	3,535	5,130
Aug	16,370	16,047	3,852	5,071
Sept	23,468	16,735	3,987	5,086
Oct	13,171	17,696	3,788	5,347
Nov	14,724	17,752	3,921	5,604
Dec	15,775	18,706	3,562	5,326
1945—Jan	10,427	18,274	3,434	4,675
Feb	13,753	17,665	3,145	4,505
Mar	15,721	17,196	2,765	4,234
Apr	8,357	15,641	1,952	1,011
May	7,739	14,400	1,751	2,734
June	6,312	11,533	1,503	1,260
July	4,684	11,483	1,315	1,359
Aug	3,278	11,098	814	692

BB-8

NAGOYA—ACTIVITY IN SHIPBUILD-
ING INDUSTRY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	<i>Thousand yen</i>	<i>Number of workers</i>	<i>Thousand hours</i>	<i>Thousand kw.-hr.</i>
1943—Oct	1,416	2,160	297	248
Nov	2,430	2,960	457	274
Dec	1,848	3,220	516	350
1944—Jan	1,936	3,160	494	363
Feb	1,619	2,660	386	354
Mar	1,746	3,600	580	409
Apr	3,178	3,500	565	298
May	2,646	3,380	540	331
June	2,815	3,540	579	317
July	1,378	3,300	528	297
Aug	1,711	3,340	514	275
Sept	1,839	3,200	480	284
Oct	2,048	3,440	530	363
Nov	3,110	3,500	533	368
Dec	2,782	4,250	466	177
1945—Jan	1,309	3,920	386	158
Feb	335	4,120	376	209
Mar	982	3,460	366	223
Apr	1,247	3,100	357	201
May	1,324	3,140	356	157
June	1,170	3,040	356	115
July	766	2,060	250	135
Aug	705	1,044	231	109

BB-9

NAGOYA—ACTIVITY IN CHEMICAL
INDUSTRY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	Thousand yen	Number of workers	Thousand hours	Thousand kw.-hr.
1943—Oct	2,054	1,824	489	17,731
Nov	1,801	1,814	490	13,347
Dec	1,941	1,815	512	16,804
1944—Jan	1,663	1,831	460	15,187
Feb	1,677	1,867	486	11,005
Mar	1,782	1,948	491	15,602
Apr	2,105	2,139	567	21,093
May	2,455	2,210	586	26,102
June	2,702	2,221	570	22,451
July	2,775	2,197	587	18,254
Aug	2,183	2,205	568	11,614
Sept	3,324	2,338	567	16,974
Oct	3,620	2,419	607	20,878
Nov	3,132	2,404	597	15,246
Dec	2,324	2,386	555	3,793
1945—Jan	1,435	2,155	411	1,816
Feb	1,687	2,202	413	3,476
Mar	1,244	2,168	367	8,118
Apr	1,015	2,107	378	6,224
May	788	2,052	304	6,218
June	675	1,987	239	3,768
July	413	1,863	239	4,121
Aug	512	1,787	260	5,098

BB-11

NAGOYA—ACTIVITY IN ALL
INDUSTRIES

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	Thousand yen	Number of workers	Thousand hours	Thousand kw.-hr.
1943—Oct	182,789	206,259	50,800	56,714
Nov	199,493	205,683	52,234	52,926
Dec	210,789	216,284	54,463	58,083
1944—Jan	199,904	224,463	53,048	55,368
Feb	216,011	223,815	53,496	49,525
Mar	236,880	230,580	55,195	54,947
Apr	227,495	249,590	60,010	62,129
May	217,236	254,193	61,235	68,103
June	277,197	253,097	60,970	64,445
July	255,841	254,058	59,877	59,675
Aug	281,217	257,377	61,985	54,222
Sept	297,781	256,846	61,777	60,562
Oct	285,168	260,934	61,755	64,488
Nov	284,478	264,580	62,680	59,862
Dec	235,951	264,379	58,624	40,696
1945—Jan	156,433	267,670	54,067	33,831
Feb	156,058	263,636	51,043	35,308
Mar	147,548	249,642	46,068	37,349
Apr	129,379	235,220	42,812	28,229
May	131,747	220,492	39,459	27,791
June	100,724	207,595	37,089	19,837
July	70,691	177,216	38,867	19,496
Aug	54,508	173,806	22,229	14,412

BB-10

NAGOYA—ACTIVITY IN MISCELLA-
NEOUS INDUSTRIES

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	Thousand yen	Number of workers	Thousand hours	Thousand kw.-hr.
1943—Oct	6,614	8,112	1,937	1,296
Nov	5,710	8,385	2,033	1,309
Dec	5,494	8,725	2,174	1,401
1944—Jan	5,222	8,636	2,137	1,269
Feb	6,064	8,793	2,058	1,254
Mar	7,101	8,764	2,081	1,313
Apr	7,194	9,870	2,257	1,393
May	10,750	9,799	2,320	1,533
June	10,781	9,279	2,333	1,548
July	12,358	9,985	2,319	1,606
Aug	12,225	10,231	2,449	1,725
Sept	14,668	10,840	2,614	1,893
Oct	13,188	11,741	2,763	1,957
Nov	12,033	12,308	2,773	2,212
Dec	9,155	12,562	2,522	2,079
1945—Jan	8,034	11,751	2,269	1,935
Feb	9,115	11,728	2,229	1,832
Mar	7,852	11,512	2,135	1,766
Apr	6,782	10,876	1,703	1,500
May	8,622	10,004	1,614	1,674
June	8,431	9,765	1,632	1,959
July	7,409	8,900	1,472	2,758
Aug	7,707	9,036	1,370	1,549

BB-12

SELECTED CITIES OUTSIDE NAGOYA,
OVER-ALL INDUSTRIAL ACTIVITY

	Production (yen sales)	Labor force	Productive hours worked	Electric power con- sumption
	Thousand yen	Number of workers	Thousand hours	Thousand kw.-hr.
1943—Oct	29,553	54,554	12,005	18,727
Nov	33,005	56,096	12,379	18,150
Dec	34,829	60,576	13,345	19,400
1944—Jan	35,510	65,928	16,305	15,217
Feb	39,317	67,952	15,965	17,349
Mar	38,287	72,817	16,170	18,122
Apr	43,683	80,889	18,630	21,181
May	45,439	84,679	19,935	22,985
June	56,856	88,558	19,524	20,177
July	62,115	91,537	22,159	18,606
Aug	69,847	91,652	21,673	18,034
Sept	70,849	92,281	20,440	20,478
Oct	71,015	93,105	20,641	20,530
Nov	79,549	94,892	22,787	20,590
Dec	69,669	94,360	22,277	19,449
1945—Jan	51,451	94,311	19,577	14,789
Feb	50,280	96,832	20,714	13,884
Mar	54,688	97,980	20,724	19,602
Apr	72,769	103,483	21,655	19,096
May	64,572	105,685	21,359	19,380
June	59,393	106,429	22,829	15,198
July	40,895	102,951	17,337	10,328
Aug	32,202	93,474	15,393	4,460

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: Overall 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, Germany
- 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 Neustaedter Flugzeugwerke, Wiener Neustadt, Austria

Aero Engines Branch

- 15 Bussing NAG 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 Bayerische 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 Metallgussgesellschaft G m b H, Leipzig, Germany
- 23 Aluminiumwerk G m b H, Plant No. 2, Bitterfeld, Germany
- 24 Gebrueder Giuliani 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 Leichtmetallgiessereien, 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

Abrasive 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, Frankfurt on Main, Germany

MILITARY ANALYSIS DIVISION

- 59 The Defeat of the German Air Force
- 60 V-Weapons (Crossbow) Campaign
- 61 Air Force Rate of Operations
- 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 & Vol 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 Opel, Russelheim, Germany
- 82 Daimler Benz-Gaggenau Works, Gaggenau, Germany
- 83 Maschinenfabrik Augsburg-Nurnburg, Nurnburg, 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-Nurnburg A G, Augsburg, Germany
- 94 Blohm and Voss Shipyards, Hamburg, Germany
- 95 Deutsche Werke 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 Vulkan, 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 Friedrich 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 Bohlen, Germany
- Wintershall A G, Luetzkendorf, Germany
- 117 Ludwigshafen-Opau 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 Schoenebeck 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

OVER-ALL ECONOMICS EFFECTS DIVISION

- 134 Over-all Economic Effects Division Report

Gross National Product-----	}	Special papers
Kriegseilberichte-----		which together
Hermann Goering Works-----		comprise the
Food and Agriculture-----		
- 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
- 150 S. N. C. A. S. E. Aircraft Plant, Toulouse, France
- 151 A. I. A. Aircraft Plant, Toulouse, France
- 152 V Weapons in London
- 153 City Area of Krefeld
- 154 Public Air Raid Shelters in Germany
- 155 Goldenberg Thermal Electric Power Station, Knap-sack, Germany
- 156 Brauweiler Transformer & Switching Station, Brau-weiler, Germany
- 157 Storage Depot, Nahbollenbach, Germany
- 158 Railway and Road Bridge, Bad Munster, Germany
- 159 Railway Bridge, Eller, Germany
- 160 Gustloff-Werke Weimar, Weimar, Germany
- 161 Henschell & Sohn G m b H, Kassel, Germany
- 162 Area Survey at Pirmasens, Germany
- 163 Hanomag, Hanover, Germany
- 164 M A N Werke Augsburg, Augsburg, Germany
- 165 Friedrich Krupp A G, Essen, Germany
- 166 Erla Maschinenwerke G m b H, Heiterblick, Ger-many
- 167 A T G Maschinenbau G m b H, Mockau, Germany
- 168 Erla Maschinenwerke G m b H, Mockau, Germany
- 169 Bayerische Motorenwerke, Durrerhof, Germany
- 170 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
- 171 Submarine Pens Deutsche-Werft, Hamburg, Germany
- 172 Multi-Storied Structures, Hamburg, Germany
- 173 Continental Gummiwerke, Hanover, Germany
- 174 Kassel Marshalling Yards, Kassel, Germany
- 175 Ammoniawerke, Merseburg-Leuna, Germany
- 176 Brown Boveri et Cie, Mannheim, Kafertal, Germany
- 177 Adam Opel A G, Russelsheim, Germany
- 178 Daimler-Benz A G, Unterturkheim, Germany
- 179 Valentin Submarine Assembly, Farge, Germany
- 180 Volkswaggonwerke, Fallersleben, Germany
- 181 Railway Viaduct at Bielefeld, Germany
- 182 Ship Yards Howaldtswerke, Hamburg, Germany
- 183 Blohm and Voss Shipyards, Hamburg, Germany

- 184 Daimler-Benz A G, Mannheim, Germany
- 185 Synthetic Oil Plant, Meerbeck-Hamburg, Germany
- 186 Gewerkschaft Victor, Castrop-Rauxel, Germany
- 187 Klockner Humboldt Deutz, Ulm, Germany
- 188 Ruhroel Hydrogenation Plant, Bottrop-Boy, Germany
- 189 Neukirchen Eisenwerke A G, Neukirchen, Germany
- 190 Railway Viaduct at Altenbecken, Germany
- 191 Railway Viaduct at Arnsburg, Germany
- 192 Deurag-Nerag Refineries, Misburg, Germany
- 193 Fire Raids on German Cities
- 194 I G Farbenindustrie, Ludwigshafen, Germany, Vol I & Vol II
- 195 Roundhouse in Marshalling Yard, Ulm, Germany
- 196 I G Farbenindustrie, Leverkusen, Germany
- 197 Chemische-Werke, Huels, Germany
- 198 Gremberg Marshalling Yard, Gremberg, Germany
- 199 Locomotive Shops and Bridges at Hamm, Germany

TRANSPORTATION DIVISION

- *200 The Effects of Strategic Bombing on German Trans-
portation
- 201 Rail Operations Over the Brenner Pass
- 202 Effects of Bombing on Railroad Installations in
Regensburg, Nurnberg and Munich Divisions
- 203 German Locomotive Industry During the War
- 204 German Military Railroad Traffic

UTILITIES DIVISION

- *205 German Electric Utilities Industry Report
- 206 1 to 10 in Vol I "Utilities Division Plant Reports"
- 207 11 to 20 in Vol II "Utilities Division Plant Reports"
- 208 21 Rheinische-Westfalische Elektrizitaetswerk A G

Pacific War

OFFICE OF THE CHAIRMAN

- *1 Summary Report (Pacific War)
- *2 Japan's Struggle to End The War
- *3 The Effects of Atomic Bombs on Hiroshima and
Nagasaki

CIVILIAN STUDIES

Civilian Defense Division

- 4 Field Report Covering Air Raid Protection and Allied
Subjects, Tokyo, Japan
- 5 Field Report Covering Air Raid Protection and Allied
Subjects, Nagasaki, Japan
- *6 Field Report Covering Air Raid Protection and Allied
Subjects, Kyoto, Japan
- 7 Field Report Covering Air Raid Protection and Allied
Subjects, Kobe, Japan
- 8 Field Report Covering Air Raid Protection and Allied
Subjects, Osaka, Japan
- 9 Field Report Covering Air Raid Protection and Allied
Subjects, Hiroshima, Japan—No. 1
- *10 Summary Report Covering Air Raid Protection and
Allied Subjects in Japan
- *11 Final Report Covering Air Raid Protection and
Allied Subjects in Japan

Medical Division

- *12 The Effects of Bombing on Health and Medical Serv-
ices in Japan
- *13 The Effects of Atomic Bombs on Health and Medical
Services in Hiroshima and Nagasaki

Morale Division

- *14 The Effects of Strategic Bombing on Japanese Morale

ECONOMIC STUDIES

Aircraft Division

- *15 The Japanese Aircraft Industry
- *16 Mitsubishi Heavy Industries, Ltd.
Corporation Report No. I
(Mitsubishi Jukogyo KK)
(Airframes & Engines)
- *17 Nakajima Aircraft Company, Ltd.
Corporation Report No. II
(Nakajima Hikoki KK)
(Airframes & Engines)
- *18 Kawanishi Aircraft Company
Corporation Report No. III
(Kawanishi Kokuki Kabushiki Kaisha)
(Airframes)
- *19 Kawasaki Aircraft Industries Company, Inc.
Corporation Report No. IV
(Kawasaki Kokuki Kogyo Kabushiki Kaisha)
(Airframes & Engines)
- *20 Aichi Aircraft Company
Corporation Report No. V
(Aichi Kokuki KK)
(Airframes & Engines)
- *21 Sumitomo Metal Industries, Propeller Division
Corporation Report No. VI
(Sumitomo Kinzoku Kogyo KK, Puropera Seizosho)
(Propellers)
- *22 Hitachi Aircraft Company
Corporation Report No. VII
(Hitachi Kokuki KK)
(Airframes & Engines)
- *23 Japan International Air Industries, Ltd.
Corporation Report No. VIII
(Nippon Kokusai Koku Kogyo KK)
(Airframes)
- *24 Japan Musical Instrument Manufacturing Company
Corporation Report No. IX
(Nippon Gakki Seizo KK)
(Propellers)
- *25 Tachikawa Aircraft Company
Corporation Report No. X
(Tachikawa Hikoki KK)
(Airframes)
- *26 Fuji Airplane Company
Corporation Report No. XI
(Fuji Hikoki KK)
(Airframes)
- *27 Showa Airplane Company
Corporation Report No. XII
(Showa Hikoki Kogyo KK)
(Airframes)
- *28 Ishikawajima Aircraft Industries Company, Ltd.
Corporation Report No. XIII
(Ishikawajima Koku Kogyo Kabushiki Kaisha)
(Engines)
- *29 Nippon Airplane Company
Corporation Report No. XIV
(Nippon Hikoki KK)
(Airframes)
- *30 Kyushu Airplane Company
Corporation Report No. XV
(Kyushu Hikoki KK)
(Airframes)
- *31 Shoda Engineering Company
Corporation Report No. XVI
(Shoda Seisakujo)
(Components)
- *32 Mitaka Aircraft Industries
Corporation Report No. XVII
(Mitaka Koku Kogyo Kabushiki Kaisha)
(Components)

- *33 Nissan Automobile Company
Corporation Report No. XVIII
(Nissan Jidosha KK)
(Engines)
- *34 Army Air Arsenal & Navy Air Depots
Corporation Report No. XIX
(Airframes and Engines)
- *35 Underground Production of Japanese Aircraft
Report No. XX

Basic Materials Division

- *36 Coal and Metals in Japan's War Economy

Capital Goods, Equipment and Construction Division

- *37 The Japanese Construction Industry
- *38 Japanese Electrical Equipment
- *39 The Japanese Machine Building Industry

Electric Power Division

- *40 The Electric Power Industry of Japan
- *41 The Electric Power Industry of Japan (Plant Reports)

Manpower, Food and Civilian Supplies Division

- *42 The Japanese Wartime Standard of Living and Utilization of Manpower

Military Supplies Division

- *43 Japanese War Production Industries
- *44 Japanese Naval Ordnance
- *45 Japanese Army Ordnance
- *46 Japanese Naval Shipbuilding
- *47 Japanese Motor Vehicle Industry
- *48 Japanese Merchant Shipbuilding

Oil and Chemical Division

- 49 Chemicals in Japan's War
- 50 Chemicals in Japan's War—Appendix
- 51 Oil in Japan's War
- 52 Oil in Japan's War—Appendix

Over-all Economic Effects Division

- *53 The Effects of Strategic Bombing on Japan's War Economy (Including Appendix A: U. S. Economic Intelligence on Japan—Analysis and Comparison; Appendix B: Gross National Product on Japan and Its Components; Appendix C: Statistical Sources).

Transportation Division

- *54 The War Against Japanese Transportation, 1941-1945

Urban Areas Division

- *55 Effects of Air Attack on Japanese Urban Economy (Summary Report)
- *56 Effects of Air Attack on Urban Complex Tokyo-Kawasaki-Yokohama
- *57 Effects of Air Attack on the City of Nagoya
- *58 Effects of Air Attack on Osaka-Kobe-Kyoto
- 59 Effects of Air Attack on the City of Nagasaki
- 60 Effects of Air Attack on the City of Hiroshima

MILITARY STUDIES

Military Analysis Division

- 61 Air Forces Allied with the United States in the War Against Japan
- 62 Japanese Air Power
- 63 Japanese Air Weapons and Tactics
- 64 The Effect of Air Action on Japanese Ground Army Logistics
- 65 Employment of Forces Under the Southwest Pacific Command
- 66 The Strategic Air Operations of Very Heavy Bombardment in the War Against Japan (Twentieth Air Force)
- 67 Air Operations in China, Burma, India—World War II
- 68 The Air Transport Command in the War Against Japan
- 69 The Thirteenth Air Force in the War Against Japan
- 70 The Seventh and Eleventh Air Forces in the War Against Japan
- 71 The Fifth Air Force in the War Against Japan

Naval Analysis Division

- *72 The Interrogations of Japanese Officials (Vols. I and II)
- *73 Campaigns of the Pacific War
- *74 The Reduction of Wake Island
- *75 The Allied Campaign Against Rabaul
- 76 The American Campaign Against Wotje, Meloelap, Mille, and Jaluit (Vols. I, II and III)
- *77 The Reduction of Truk
- 78 The Offensive Mine Laying Campaign Against Japan
- 79 Report of Ships Bombardment Survey Party—Foreword, Introduction, Conclusions, and General Summary
- 80 Report of Ships Bombardment Survey Party (Enclosure A), Kamaishi Area
- 81 Report of Ships Bombardment Survey Party (Enclosure B), Hamamatsu Area
- 82 Report of Ships Bombardment Survey Party (Enclosure C), Hitachi Area
- 83 Report of Ships Bombardment Survey Party (Enclosure D), Hakodate Area
- 84 Report of Ships Bombardment Survey Party (Enclosure E), Muroran Area
- 85 Report of Ships Bombardment Survey Party (Enclosure F), Shimizu Area
- 86 Report of Ships Bombardment Survey Party (Enclosures G and H), Shionomi-Saki and Nojima-Saki Areas

- 87 Report of Ships Bombardment Survey Party (Enclosure I), Comments and Data on Effectiveness of Ammunition
- 88 Report of Ships Bombardment Survey Party (Enclosure J), Comments and Data on Accuracy of Firing
- 89 Reports of Ships Bombardment Survey Party (Enclosure K), Effects of Surface Bombardments on Japanese War Potential

Physical Damage Control

- 90 Effect of the Incendiary Bomb Attacks on Japan (a Report on Eight Cities)
- 91 The Effects of the Ten Thousand Pound Bomb on Japanese Targets (a Report on Nine Incidents)
- 92 Effects of the Atomic Bomb on Hiroshima, Japan
- 93 Effects of the Atomic Bomb on Nagasaki, Japan
- 94 Effects of the Four Thousand Pound Bomb on Japanese Targets (a Report on Five Incidents)
- 95 Effects of Two Thousand, One Thousand, and Five Hundred Pound Bombs on Japanese Targets (a Report on Eight Incidents)
- 96 A Report on Physical Damage in Japan (Summary Report)

G-2 Division

- 97 Japanese Military and Naval Intelligence
- 98 Evaluation of Photographic Intelligence in the Japanese Homeland, Part I, *Comprehensive Report*
- 99 Evaluation of Photographic Intelligence in the Japanese Homeland, Part II, *Airfields*
- 100 Evaluation of Photographic Intelligence in the Japanese Homeland, Part III, *Computed Bomb Plotting*
- 101 Evaluation of Photographic Intelligence in the Japanese Homeland, Part IV, *Urban Area Analysis*
- 102 Evaluation of Photographic Intelligence in the Japanese Homeland, Part V, *Camouflage*
- 103 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VI, *Shipping*
- 104 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VII, *Electronics*
- 105 Evaluation of Photographic Intelligence in the Japanese Homeland, Part VIII, *Beach Intelligence*
- *106 Evaluation of Photographic Intelligence in the Japanese Homeland, Part IX, *Artillery*
- *107 Evaluation of Photographic Intelligence in the Japanese Homeland, Part X, *Roads and Railroads*
- 108 Evaluation of Photographic Intelligence in the Japanese Homeland, Part XI, *Industrial Analysis*

