THE UNITED STATES

STRATEGIC BOMBING SURVEY

Reports Pacific war

KAWASAKI AIRCRAFT INDUSTRIES COMPANY, INC.

(Kawasaki Kokuki Kogyo Kabushiki Kaisha)

CORPORATION REPORT NO. IV

(Air Frames and Engines)

Aircraft Division

May 1947

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This report was written primarily for the use of the United States 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 the 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.

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KAWASAKI CORPORATION

(Corporation Report No. IV)

THE CORPORATION AND ITS IMPORTANCE IN THE AIRCRAFT INDUSTRY

TRODUCTION

This company occupied the number three place Japan's aircraft industry. In over-all produc- it accounted for 17 percent of the combat frames and 12 percent of combat engines nufactured in 1944, the industry's peak year. operated 3,217,814 square feet of productive frame floor area and 2,155,680 square feet of ine floor area before the air raids. By the end he war, air frame floor area in production was uced to 100,000 square feet and engine floor a to 1,202,300 square feet.

ll production went to the Army. Kawasaki's ncipal airplanes were Tony (Ki–61 and Ki–100), mall fighter in liquid-cooled and radial-engine dels resembling the Me–109; Lily (Ki–48), a t bomber with two radial engines; and Nick, -place, twin-engine fighter (Ki–45) in conven- al and night-fighter versions. Randy (Ki–102), production toward the end of the war, was a gle-place, improved Nick.

The company's own engine in various models s a liquid-cooled Daimler-Benz design, manu- tured under German license (Ha–60, Model 22 l Ha–60, Model 33). At Army request late in war, the company manufactured Ha–35, del 21, a Mitsubishi radial developing 1970 sepower at take-off. Both radials were shipped Nakajima's Koizumi plants for use in Oscar l Frank fighters, respectively. The Ha–115 s later destined for Ki–115, the Nakajima cial attack plane.

The corporation was a completely owned sidiary of Kawasaki Heavy Industries Com- y, Ltd. The aircraft division of the parent pany was organized in 1918, and for the first years of its existence conducted its manufactur- activities in the facilities of Kawasaki Heavy lustries Co., Ltd., at Kobe.

n 1937 air frame manufacturing activities were oved from the parent corporation and a plant cted at Kagamigahara, north of Nagoya. In early 1939, engine manufacturing also was separated from the Kawasaki Heavy Industry facilities and a plant was started at Akashi just west of Kobe on the Inland Sea. A subsidiary unit of the air frame division, operated under the Kagamigahara management, was set up at Akashi in the same plant area as the engine facilities.

The main office of the corporation, which exercised supervision over all air frame and engine activities, was at Akashi. Kawasaki, because of its relatively compact organization, managed to retain financial and management control of its plants. With production centralized in two large permanent plants, and later dispersion chiefly into defunct spinning mill facilities, the company's relative wartime expansion was small compared to Nakajima and Mitsubishi.

There was considerable evidence of foreign influence on design of products throughout the history of the company. In 1919 the company purchased the license to manufacture the French Salmson airplane and engine. In 1926 Kawasaki purchased the license from Germany to manufacture BMW engines, and in 1927 designed and built the type 87 heavy bomber around two of these engines. There were 25 of these built in the Kobe facilities.

However, outside of licensing agreements entered into prior to the war, there was no evidence the company had direct liaison with German business contacts after hostilities started. Foreign equipment at Kawasaki plants for study was received from the Army.

In plant investigations, the Akashi plant site was studied as an entity. From an operational standpoint, however, the Akashi facilities were sharply divided, with one geographically grouped section of buildings within the plant enclosure devoted to air-frame manufacture and reporting to the management of the air-frame division at Kagamigahara. In addition to the main plants at Akashi and Kagamigahara, the company had smaller air frame assembly plants at Miyakonojo

in southeast Kyushu and at Ichinomiya between Nagoya and Gifu.

In addition to Akashi, other plants producing complete engines were at Takatsuki, halfway between Osaka and Kyoto, and at Futami about 20 miles west of Kobe. The Kobe casting and forging and the Sakai casting and forging subsidiaries also operated under the engine division.

Through the late 20's and early 30's the company received sizeable Army orders, prompted by the impending Chinese war, which built up to a 1,000-unit order for type 98 light bombers in 1935. Kawasaki was apparently strong in Army favor, even in those days (Appendix A). However, there was a tendency, almost a well-defined policy on the part of the company, to keep the government's influence as small as possible. In fact Kawasaki at first was in a position to refuse certain types of work from the government, as in 1943 when the company turned down an Army invitation to undertake experiments on jet and rocket planes. Toward the end of the war, however, because of failure of its own liquid-cooled engine, Kawasaki was being forced by the Army to manufacture successful Nakajima and Mitsubishi designs.

ORGANIZATION AND OPERATION

Managing director of the company was Masayuki Nemoto, a forceful executive who, in addition to his management duties, directly supervised the company's engine-manufacturing activities. His immediate subordinate was Hisashi Tojo, brother of Hideki Tojo, Japan's wartime premier. Tojo was manager of the company's air frame manufacturing plants.

Tokyo representative of the company and government liaison man was Sei Yamasaki. This man spent 5 years in Germany during which time he negotiated a licensed agreement for Kawasaki on the Daimler-Benz engine. These three men were the dominating factors in the company's operations (Appendix B). All were cooperative in furnishing requested information.

Examination of the heavily damaged plants revealed very little of mass-production technique in either engine or air-frame manufacture. Kawasaki methods in air-frame manufacture appeared to be those of the prewar, small order, aircraft industry of the United States.

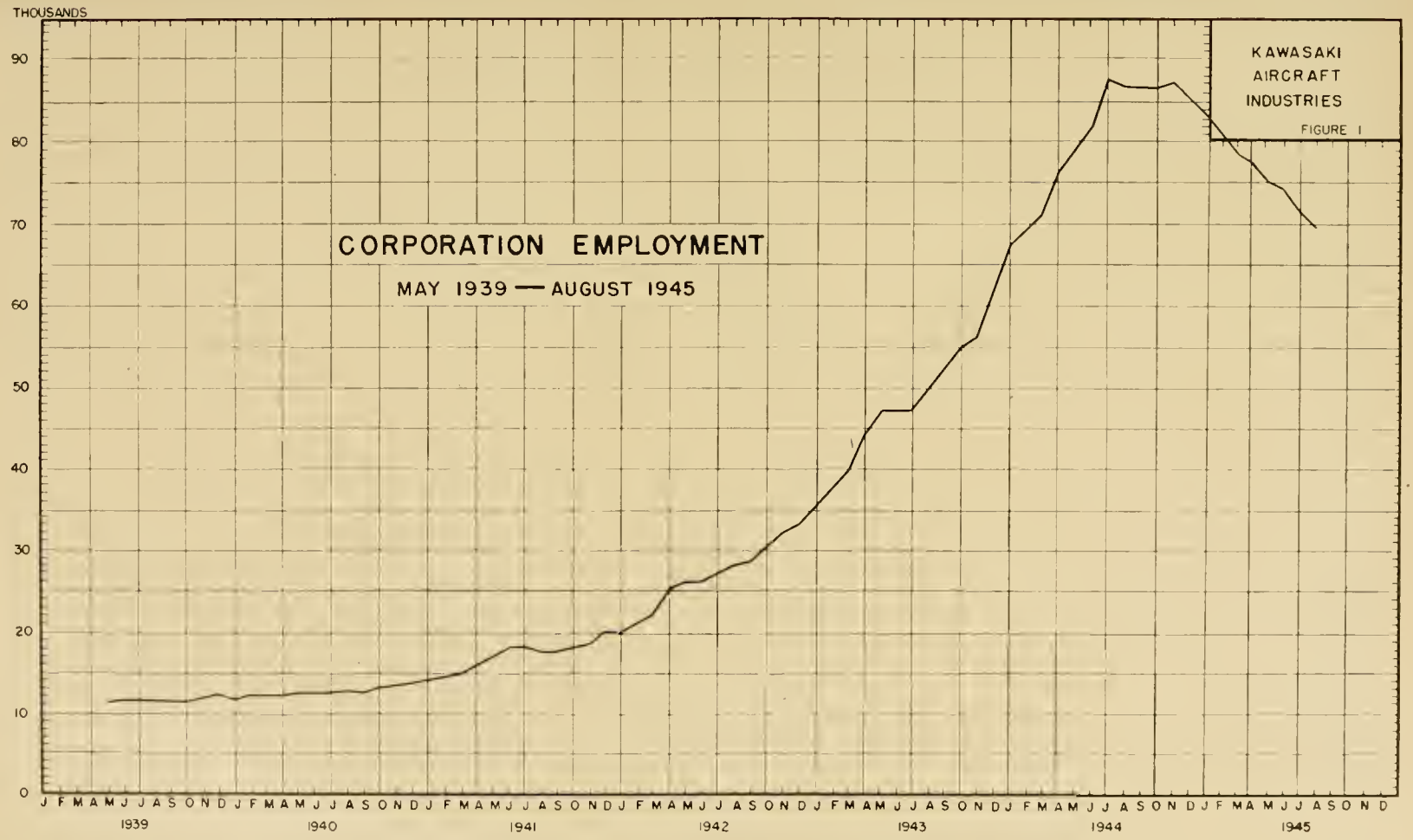
As previously indicated, Kawasaki's production was largely concentrated in large, self-suffic units, rather than being a series of "feeder" sh Akashi, Futami and Takatsuki all produ complete engines. Their only feeder units v the Hokuben gear plant and the Kobe and S casting and forging plants.

Complete air frames were produced at Kag gahara, Akashi, Ichinomiya, and Miyakon Only Miyakonojo depended on other plants parts (Appendix C).

The company hoped to go on a mass-produc basis with Ki–61 Tony, but about the time were tooling up toward 500 per month produc the "bugs" in their liquid-cooled engine fo suspension of the contract. In the en division orders were not of a quantity to di mass production on their liquid-cooled en Toward the end of the war, when the com was switching to Nakajima and Mitsubishi ra they might have developed semimass produ techniques.

The Kawasaki aircraft industries reache employment peak of 87,121 persons in July (Fig. 1). Of these, 64,494 were employed i air frame plants and 22,627 in the engine faci At this time approximately 19 percent o employees in the air-frame plant and 7 pe in the engine plant were students. Twenty percent of the labor force in air frames and cent in engines were women. Just as the com reached this employment peak a heavy t Army inductions caused a drop in employ that resulted in a serious production probler

During the latter half of 1944 and during 1945, 50 percent of the air-frame employees nonproductive. Throughout the middle an years of the war 50 percent of the labor fo both engine and air-frame facilities were scripted from other occupations under the Go ment labor program. Even though the com could fill the draft quotas with its least s workers, the draft seriously drained bot engine and air-frame plants of skilled pers Turn-over in both divisions of the company about 1 percent per month. Absenteeism d late 1944 and 1945 ran as high as 8 to 10 pe illustrating the basic weakness of the conscr program. Thus a combination of factors i ing the Army draft, unskilled conscripted wo absenteeism and a serious typhoid fever epi in early 1944, dropped the company's pr


THOUSANDS
90
80
70
60
50
40
30
20
10
0
KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 1
CORPORATION EMPLOYMENT
MAY 1939 — AUGUST 1945
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

tivity far below what its total employment figures should indicate (appendix D).

Until May 1943 the company was on a single, 8-hour shift basis. In the second half of 1943 the company put on a determined drive to get all departments on two 10-hour shifts. By the middle of 1944 they had succeeded in doing this for about 66 percent of the engine facilities and 45 percent of the total air-frame plants.

BRIEF DISCUSSION OF APPENDED PLANT REPORTS

Detailed plant reports have been written on Kagamigahara (USSBS Aircraft Division Report IV–1) air-frame works and the Akashi (USSBS Aircraft Division Report IV–2) engine and air-frame works. These reports are appended. (For notes on the Miyakonojo works see reference item No. 1.)

Kagamigahara and Akashi were inspected by Field Team No. 3 of the Aircraft Division, United States Strategic Bombing Survey, and comprehensive interrogations of plant executives down through the level of department heads were held.

Supplemental to the information in this report, the plant reports contain plant lay-outs, bomb plots, dispersal charts, plant flow sheets, and photographs of air raid damage.

THE DISPERSAL PROGRAM

The company had recognized by the middle of 1944, to some extent the need for dispersal, and tooling had been increased at large parts plants so that they might produce complete air frames and engines. This was their first dispersal program. The engine division's plants at Futami and Takatsuki, both converted spinning mills, were in this category and the air-frame division's facilities at Miyakonojo and Ichinomiya were of this type. Early in 1945 these four plants were able to produce complete units in limited quantity. These plants, except Miyakonojo, were self-sufficient. Another dispersal unit consisted of a series of workshops in the Gifu area feeding components to Kagamigahara. This first dispersal program was carried out almost without production loss as it really consisted of increased emphasis on existing facilities.

As a result of the November and December B–29 bombings as well as those that followed, the government, on 4 April 1945, promulgated its dispersion order which specified a general m ment underground if possible.

As a result, the divisions of the comp planned a second dispersal program. The en division's liquid-cooled facilities in the Takat spinning mill were to move back into a ne series of mountain tunnels partially complete the war's end. The Futami radial engine faci were to disperse to a group of 25 small spin mills and reverted buildings in the forest Ishihara (Fig. 5, USSBS Aircraft Division R IV–2). The Akashi air-frame facilities we move into a like installation at Miki. Kagamigahara air-frame facilities were to b up in a series of three assembly lines stret through the mountains and forests with underground installations at Mino, Watchi, Misunami (Fig. 3, USSBS Aircraft Division R IV–1). The production loss to dispersal in second program would have occurred in the summer and early fall of 1945 when move into forest and underground locations would been at their peak.

Transportation was, of course, a terrific h cap to dispersion. Railroads were overtaxed loads which normally would have been carri sea, and improvised transportation such as t had to be used over narrow and bad roa remote sites. As dispersion got under way to underground installations, an effort was made to improve the roads with hard surfac move which might have revealed such sit aerial reconnaissance.

Food was scarce at dispersal sites and n of the workers, who were installed in ba without their families, was bad.

THE AIR ATTACKS

AIR ATTACKS ON PLANTS

Air attacks against the company's two sites at Akashi and Kagamigahara were a models of success considering their effe production. The first strikes crippled bo badly that they never played an important p war production again. Due to economic par and a deteriorating materials situation, it have been a long uphill struggle for them so, even if the war had continued.

On 19 January 1945, the Akashi engine air-frame works of the company were bombed

(-pound high-explosive bombs and every impor-
t building was blanketed with explosives
(SSBS Aircraft Division Report IV–2, Appendix
). Production was cut to a driblet in both
iframe and engine branches. Machines, how-
r, were only slightly damaged and if their
ibersal program had been successful they would
t have been "in the war." This plant was hit
gin on 22 and 26 June with 4,000-pound bombs,
r its machines had been dispersed, but some
tctural damage was inflicted.
The Kagamigahara air-frame facilities also were
ed on 22 and 26 June. Hits were scored on
important buildings (USSBS Aircraft Division
ort IV–1, Appendix F) including several whose
ipment, such as the heat-treating facilities, the
)0-ton hydraulic press, and the acetylene gas
y em, could not be replaced. About 17 percent
the machine tools were seriously damaged.
ost all of the buildings were burned out, but
nout serious structural damage.
The Miyakonojo plant of Kawasaki in Kyushu
hit three times by planes raiding the three
rby airfields. Task Force 58 fighters did a small
unt of damage on 18 July 1945. On 6 August
5, Army fighters devoted more effort to build-
s and burned 95 percent of them. Major
hinery was destroyed by this raid. On 12
gust, Army fighters burned out the coastal
azaki components branch 50 miles to the east.

ATTACKS ON URBAN AREAS

rea attacks came too late in the Akashi area
ave any effect on that plant. The plant had
n completely smashed as a productive unit
re the heaviest Kobe area raids of July were
ied out. Also, the company had carried out its
ial dispersion program for the engine section of
Akashi plant prior to these raids. The area
s may have retarded the secondary dispersion
gram for engines and the primary dispersion of
Akashi air-frame branch to Miki.
n July, prior to the 22 and 26 June raids which
pled the Kagamigahara air-frame plant of the
pany, the Ichinomiya factory had been con-
ed to construction of complete airplanes and
company had built a series of Gifu workshops
dispersion measure. These were expanded
r the raids. The area raids on the cities of
nomiya and Gifu burned out these facilities,
pletely nullifying the division's dispersion pro-
gram. The division started the second dispersion program previously mentioned, but transportation and food difficulties made it an almost inevitable failure. Previously the 16 March area raid against the city of Kobe burned out 80 percent of the Kobe and Sakai casting and forging companies, which supplied both engine and air-frame branches.

PRODUCTION STATISTICS

From January 1941 through August 1945, Kawasaki produced a grand total of 8,269 air frames under plans calling for 11,662. Over the same period the corporation produced a total of 10,274 engines compared with a planned production of 15,402.

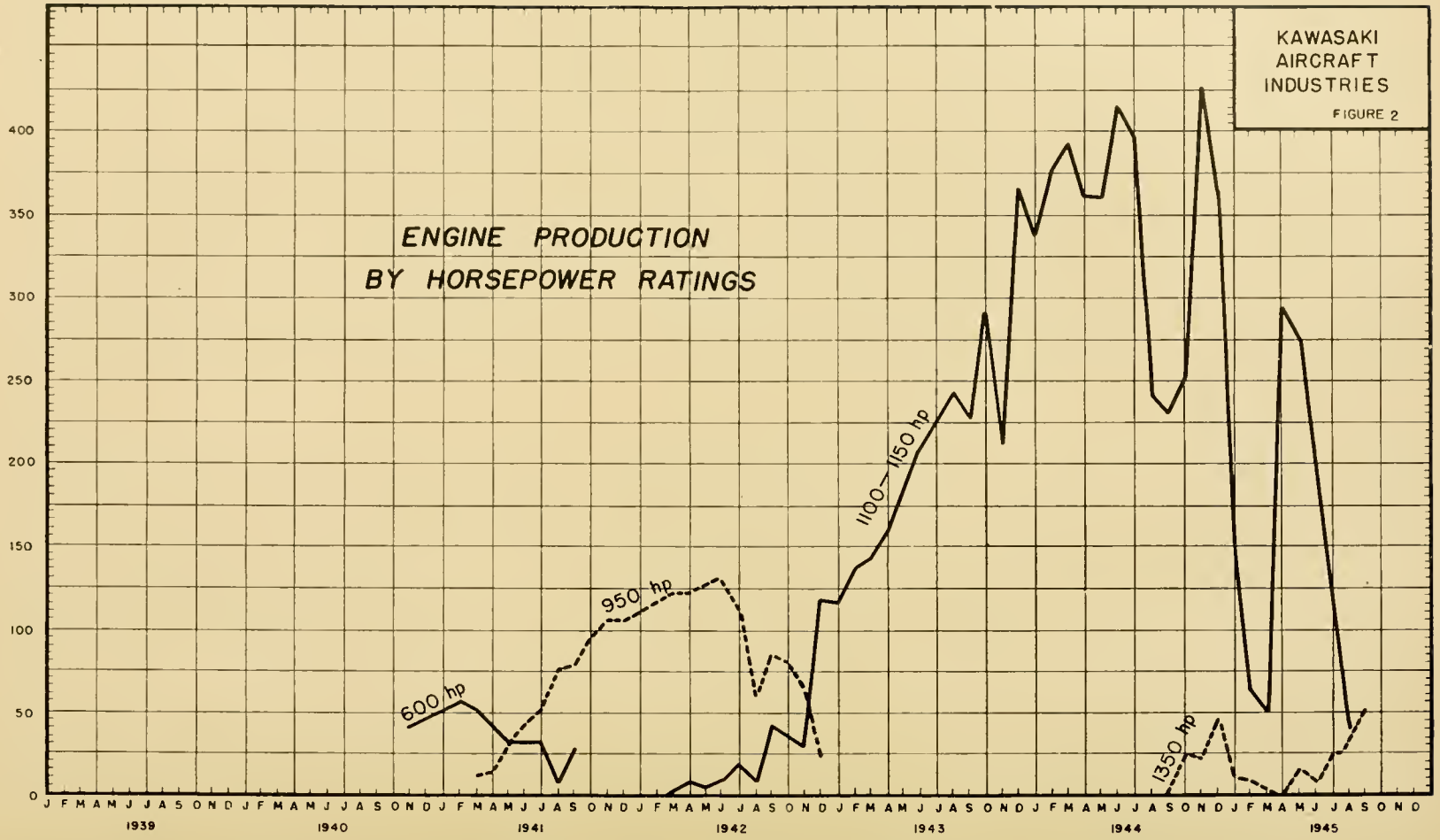
The company's high month in engine production was November 1944, with a total of 496 engines (Appendix E). By this time the company had shifted the major part of its engine production from liquid-cooled to air-cooled and 257 of this total were Nakajima-designed Ha–115 (Fig. 2).

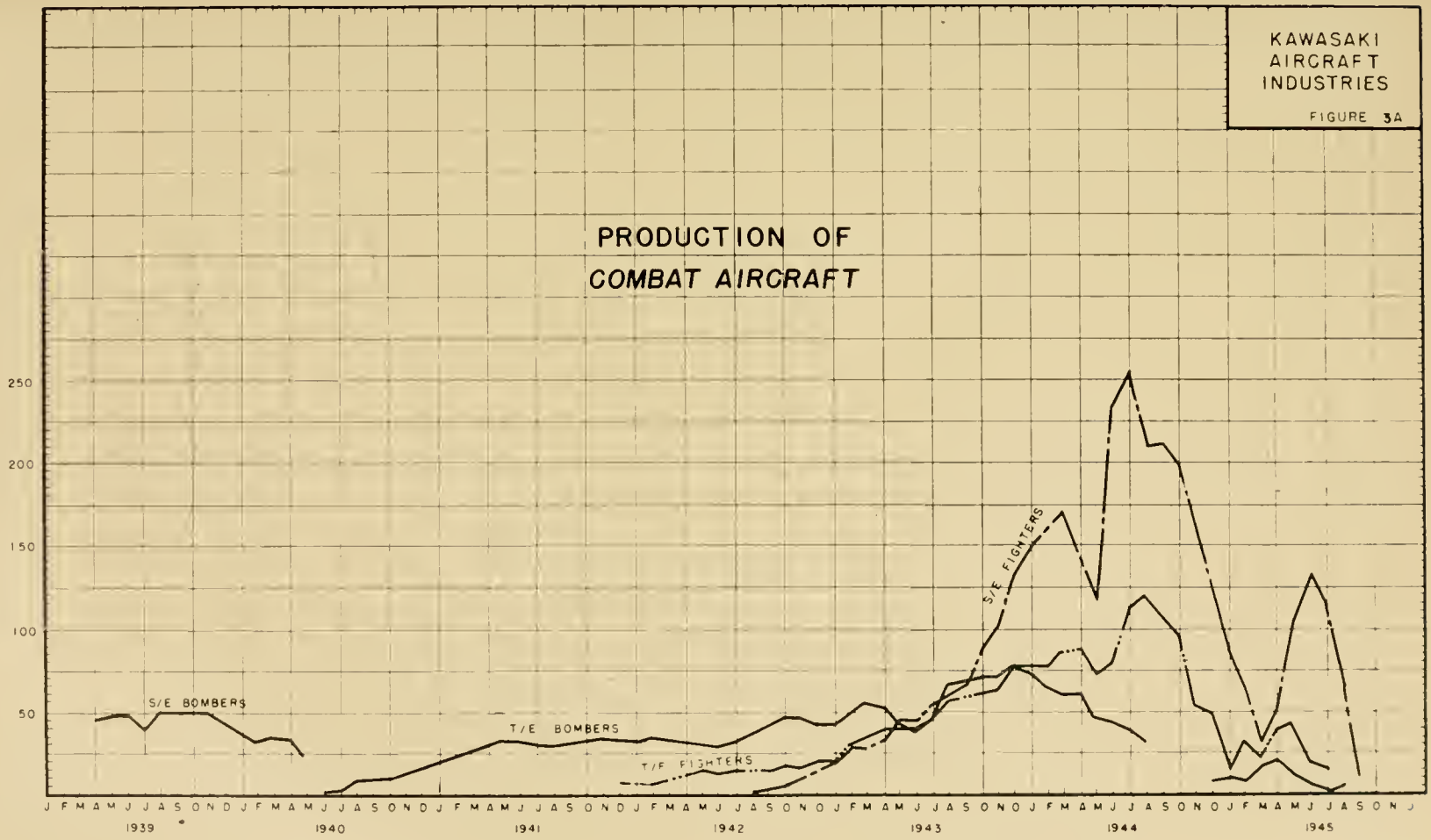
The 19 January 1945 raid smashed the Akashi engine plant when it was in high gear (USSBS, Aircraft Division Report IV–2, Fig. 3). The Futami facilities, producing air-cooled engines, were well into production by 19 January 1945, and by May were producing 285 units—the engine division's entire production for the month.

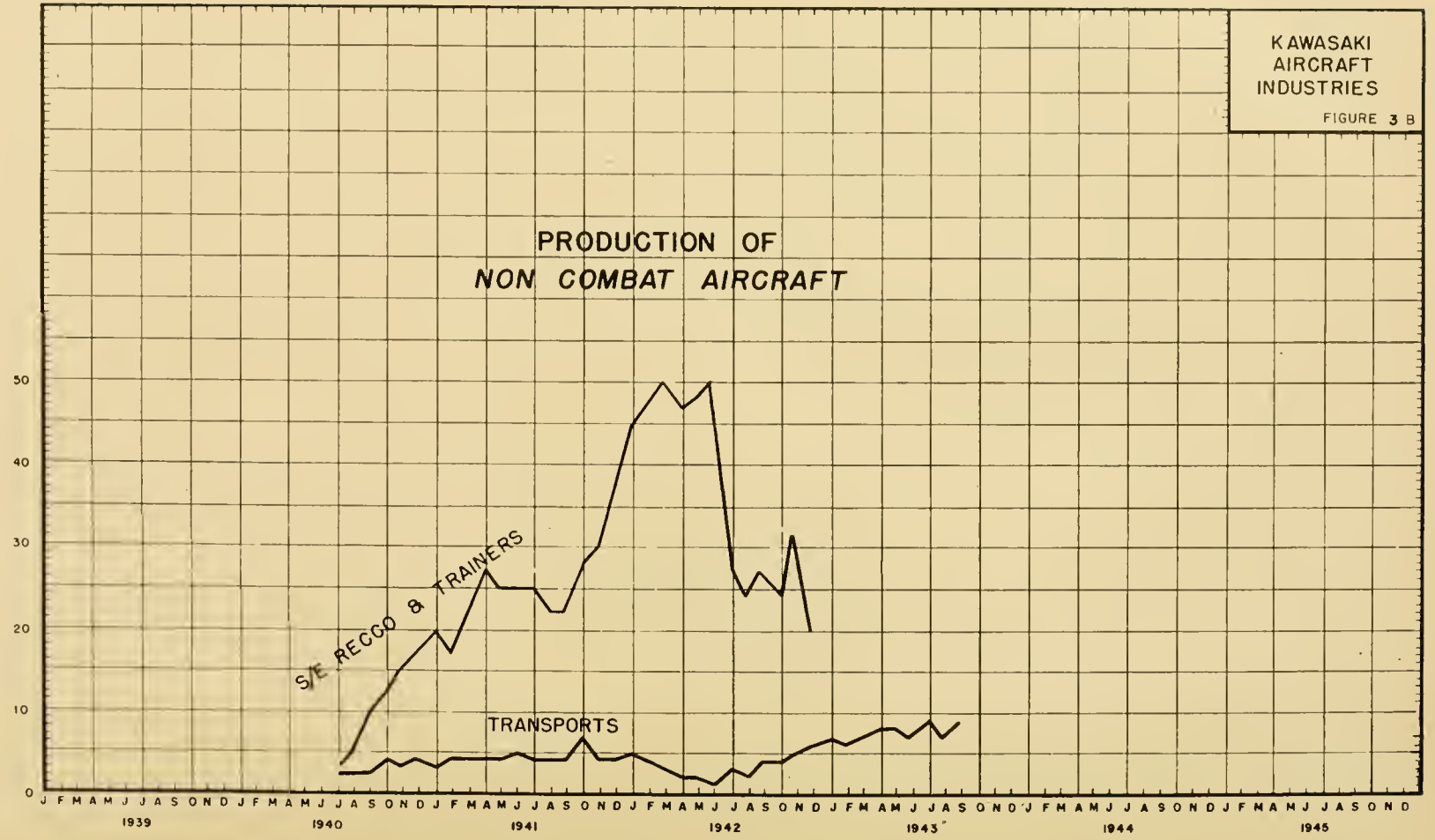
The peak month of air-frame production was July 1944, in which 407 air frames were produced, 330 of which were Tonys, liquid-cooled engine fighters (Appendix E).

After July, air frame production began to slump and continued downward throughout the remainder of 1944 and 1945 (Figs. 3a and 3b). This was caused chiefly by a shortage of liquid-cooled engines from Akashi, and design modifications dictated by combat failures in Tony. A secondary factor was the sharp inroads into the skilled labor supply by the Army draft. Damages caused by the 19 January 1945 attack on the Akashi facilities accentuated this air frame production slump.

Growth of the company's production capacity in both air frames and engines was a steady development fed by military orders since 1927 when the company designed the type 87 heavy bomber. Even before the war the company was executing 1,000-plane orders and in 1941 had a monthly production rate of about 80 airplanes and engines. In 1942 this had been upped to approximately


KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 2
ENGINE PRODUCTION
BY HORSEPOWER RATINGS
600 hp
950 hp
1100—1150 hp
1350 hp
400
350
300
250
200
150
100
50
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945


KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 3A
PRODUCTION OF
COMBAT AIRCRAFT
250
200
150
100
50
S/E BOMBERS
T/E BOMBERS
T/F FIGHTERS
S/E FIGHTERS
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J
1939
1940
1941
1942
1943
1944
1945


KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 3 B
PRODUCTION OF
NON COMBAT AIRCRAFT
S/E RECCO & TRAINERS
TRANSPORTS
0
10
20
30
40
50
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

air frames per month and 125 engines. Dur- 1943 production averaged 225 air frames per nth and 325 engines.

Government orders ran about 10 percent below maximum machine tool capacity of the plant. wever, with a severe shortage of skilled labor varying shortages of both engine components air frame accessories this maximum production ential is a very theoretical figure. This is ught out by the fact that the percentage of pletion on Government air frame contracts 84 percent in 1939, 45 percent in 1943, 66 cent in 1944, and about 25 percent in 1945.

The company's record was no better on engines. ring the first half of 1944 the company com- ted production schedules for liquid-cooled gines; but during the latter half of the year they y met 50 percent of schedules. By January 5 there were 364 Tonys complete except for iid-cooled engines. The Tonys eventually re converted to air-cooled radial installations. ring the spring of 1945 the Futami facilities re able to meet 75 percent of the Government edule for air-cooled engines.

Both direct attacks against the Kawasaki air- ft facilities and area raids knocked out 66 per- t of the engine production, or an estimated 93 engines lost to combat use, and 53 percent the air frame production, or an estimated 2,040 mbat air frames lost, during the first 7 months 1945. The effects of the 22 and 26 June air ds on the large Kagamigahara air frame plant ich came close at the end of the war would have gmented this loss had the war continued.

INTELLIGENCE EVALUATION

War Department Military Intelligence Service 2 production estimates for fighters at the Kawa- ki facilities were very accurate (Fig. 4). Esti- ates of production trends lagged only about a nth behind the actual trends. Estimates on mber (Lily) production were not, however, as ose. Intelligence estimates were 46 percent low f 1942 production, a miscalculation of 200 planes. 1943 bomber estimates were very good (Fig. 5).

In November 1944 Lily was taken out of production but intelligence estimates showed continuation of production on planes at the rate of 60 per month until the end of the war.

Estimates on engine production were excellent (Figs. 6*a* and 6*b*).

No intelligence seems to be available that Peggys (Ki–67) were being assembled at the Kagamigahara plant beginning in December 1944 or that the existence here of the radio-controlled Baka "I–GO–B" was known. Production averaged about 15 to 20 per month. Another intelligence oversight was in evaluating the Miyakomojo factory of the company as an engine parts plant. This was entirely devoted to Tony manufacture, the first one coming off the assembly line in May 1945.

The evaluation of a plant's productive capacity was made only on a basis of roof damage sustained. For this reason, the Akashi plant was bombed, although almost all of its machinery had been removed to dispersal sites.

Kawasaki's experimental planes were of incidental intelligence interest. Bob (Ki–64), the tandem-in-line engine fighter, was test-flown in early 1944. It did not go into production because the type of engines around which it was built were found to be unsatisfactory. The mockup had been built for a four-engine bomber (Ki–91) which had a 5,000-mile range with a 4-ton load. The Ki–108 was a single-place fighter with pressurized cabin unit. High performance was claimed for this plane. About to go into production was the Baka I–GO–B, which carried a 660-pound war head. Frances was to be the mother plane for this projectile. All experimental air-frame work was done at Kagamigahara.

REFERENCE ITEM

Reference Item 1. Miyakomojo plant report, Kawasaki Corporation.

Reference item is filed with the USSES records, Aircraft Division, Adjutant General's Office, War Department, Washington, D. C.

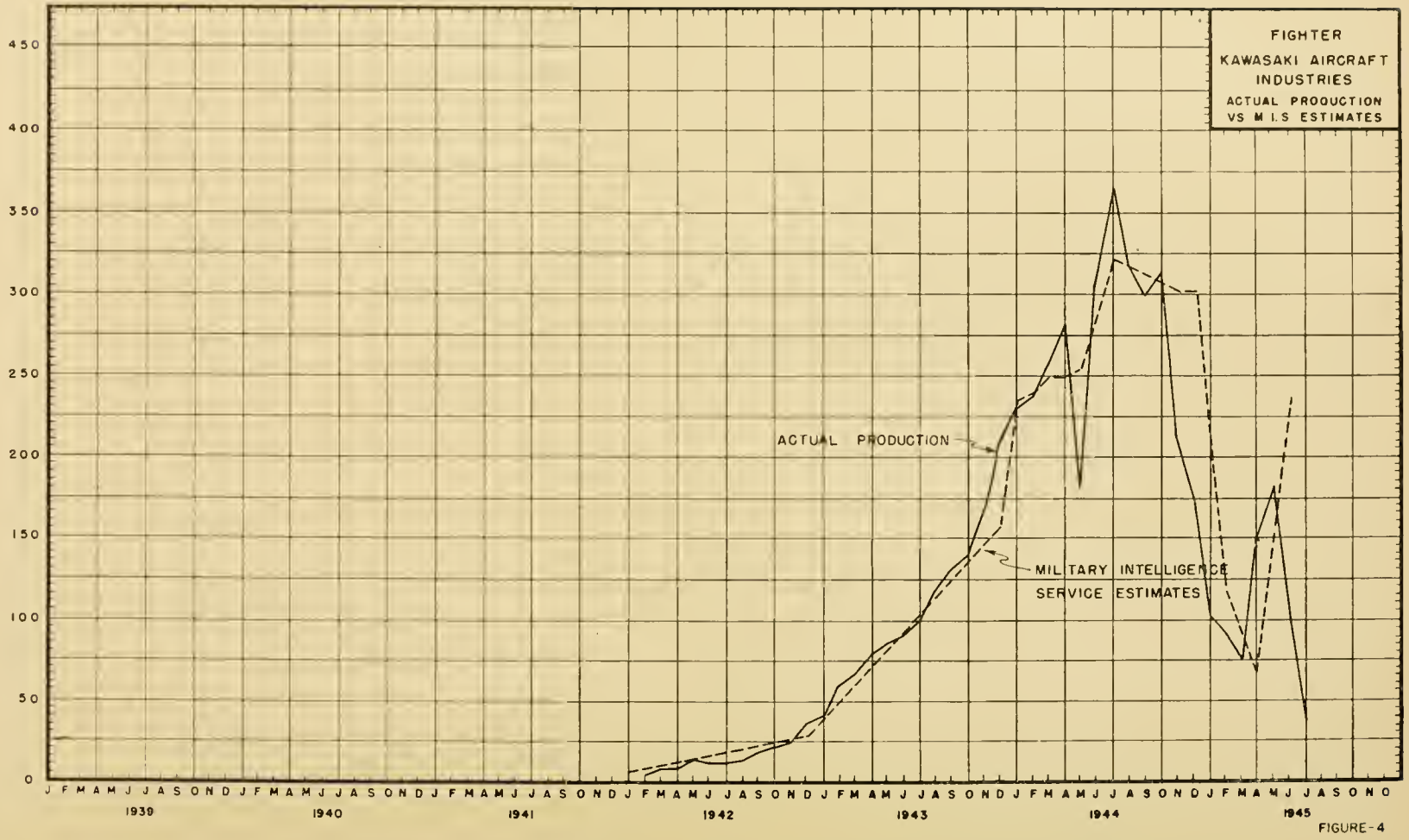

FIGHTER
KAWASAKI AIRCRAFT INDUSTRIES
ACTUAL PRODUCTION VS M.I.S ESTIMATES
ACTUAL PRODUCTION
MILITARY INTELLIGENCE SERVICE ESTIMATES
450
400
350
300
250
200
150
100
50
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N O
1939
1940
1941
1942
1943
1944
1945

FIGURE-4

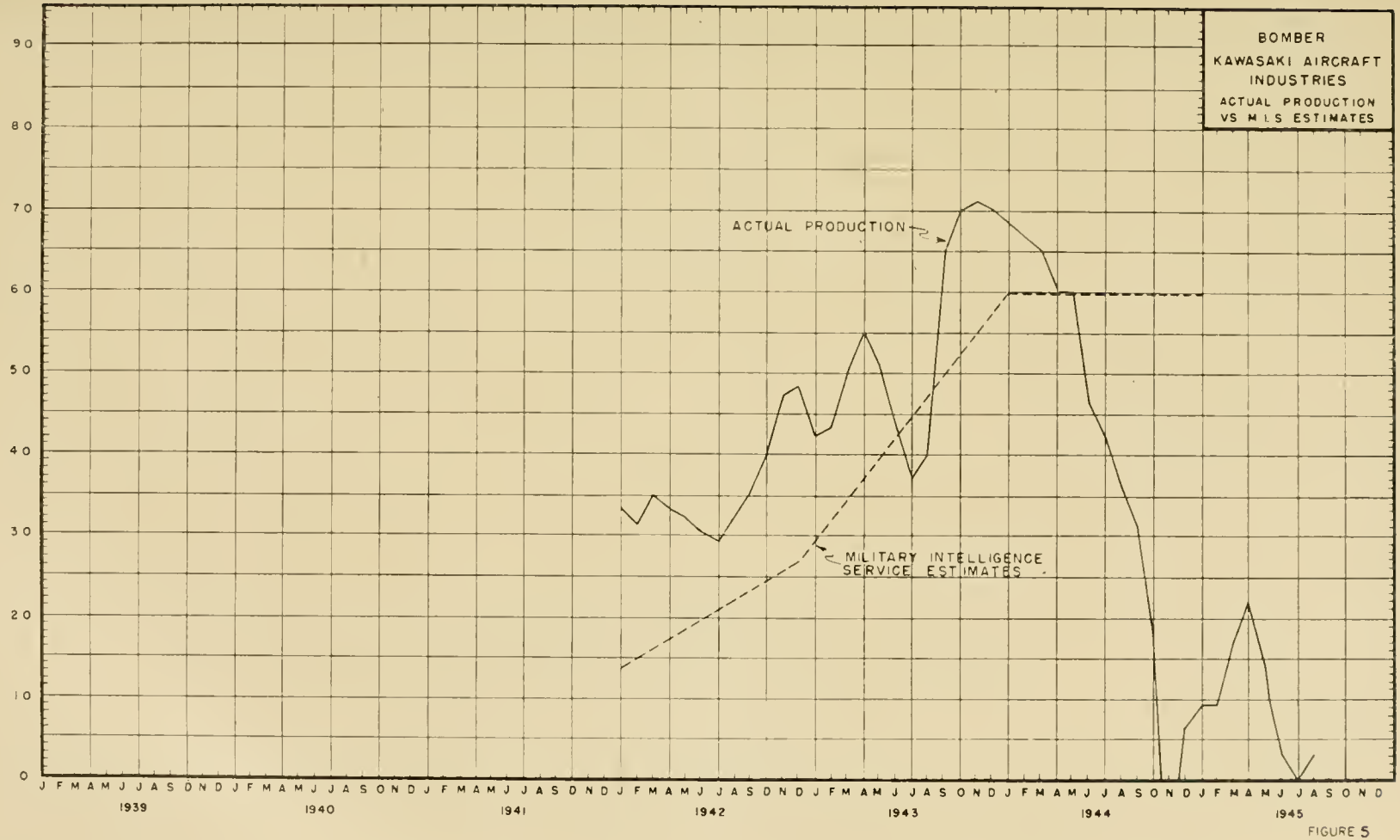
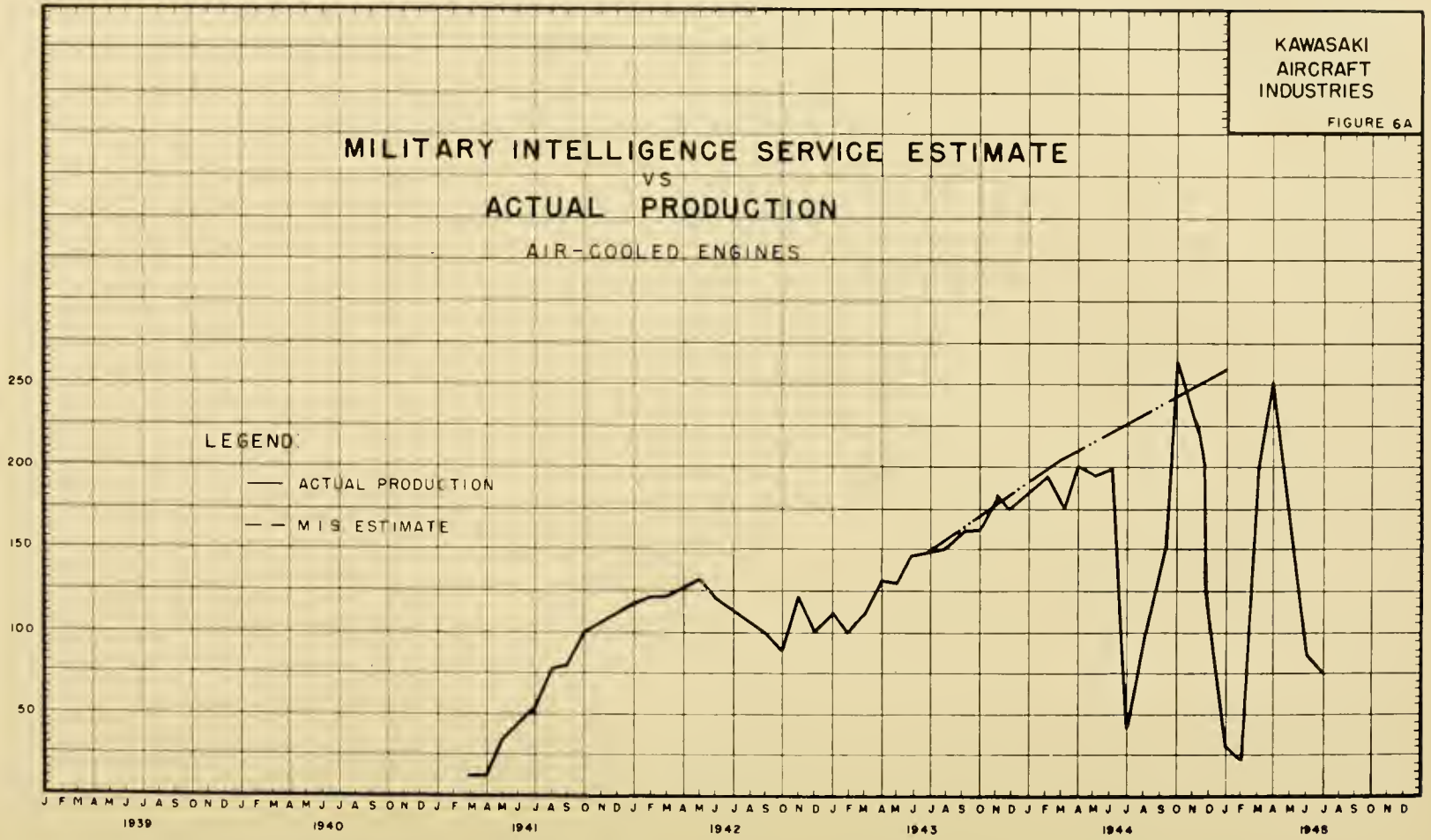
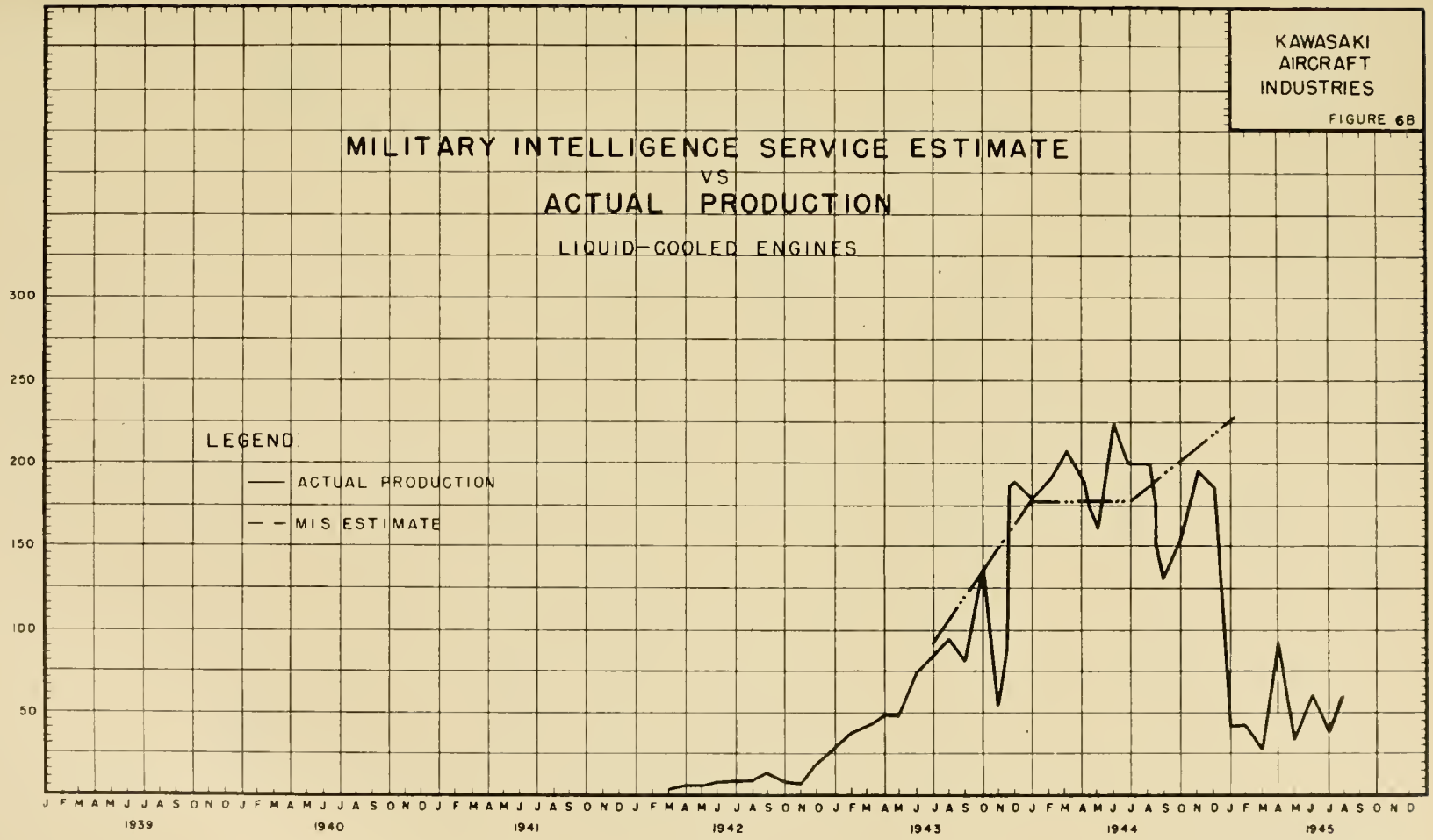

BOMBER
KAWASAKI AIRCRAFT INDUSTRIES
ACTUAL PRODUCTION VS M I S ESTIMATES
ACTUAL PRODUCTION
MILITARY INTELLIGENCE SERVICE ESTIMATES
90
80
70
60
50
40
30
20
10
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

FIGURE 5


KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 6A
MILITARY INTELLIGENCE SERVICE ESTIMATE
VS
ACTUAL PRODUCTION
AIR-COOLED ENGINES
LEGEND
ACTUAL PRODUCTION
M I S ESTIMATE
250
200
150
100
50
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945


KAWASAKI
AIRCRAFT
INDUSTRIES
FIGURE 68
MILITARY INTELLIGENCE SERVICE ESTIMATE
VS
ACTUAL PRODUCTION
LIQUID-COOLED ENGINES
LEGEND
ACTUAL PRODUCTION
MIS ESTIMATE
300
250
200
150
100
50
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

APPENDIX A

1930–39 Air-Frame and Engine Production

	1928–1929	1930–1931	1932, 1933–1934	1935–1936	1937, 19
Type 88 Recco (BMW engines)	300				
Type 92 fighter (BMW engines)		300			
Type 93 light bomber (BMW engines)			250		
Type 95 fighter (HA 9 engines)				800	
Type 98 light bomber (HA–9 engines)					

APPENDIX B

ORGANIZATION CHART

KAWASAKI AIRCRAFT INDUSTRIES COMPANY, LTD.

(Masayoki Nemoto, *Managing Director*)

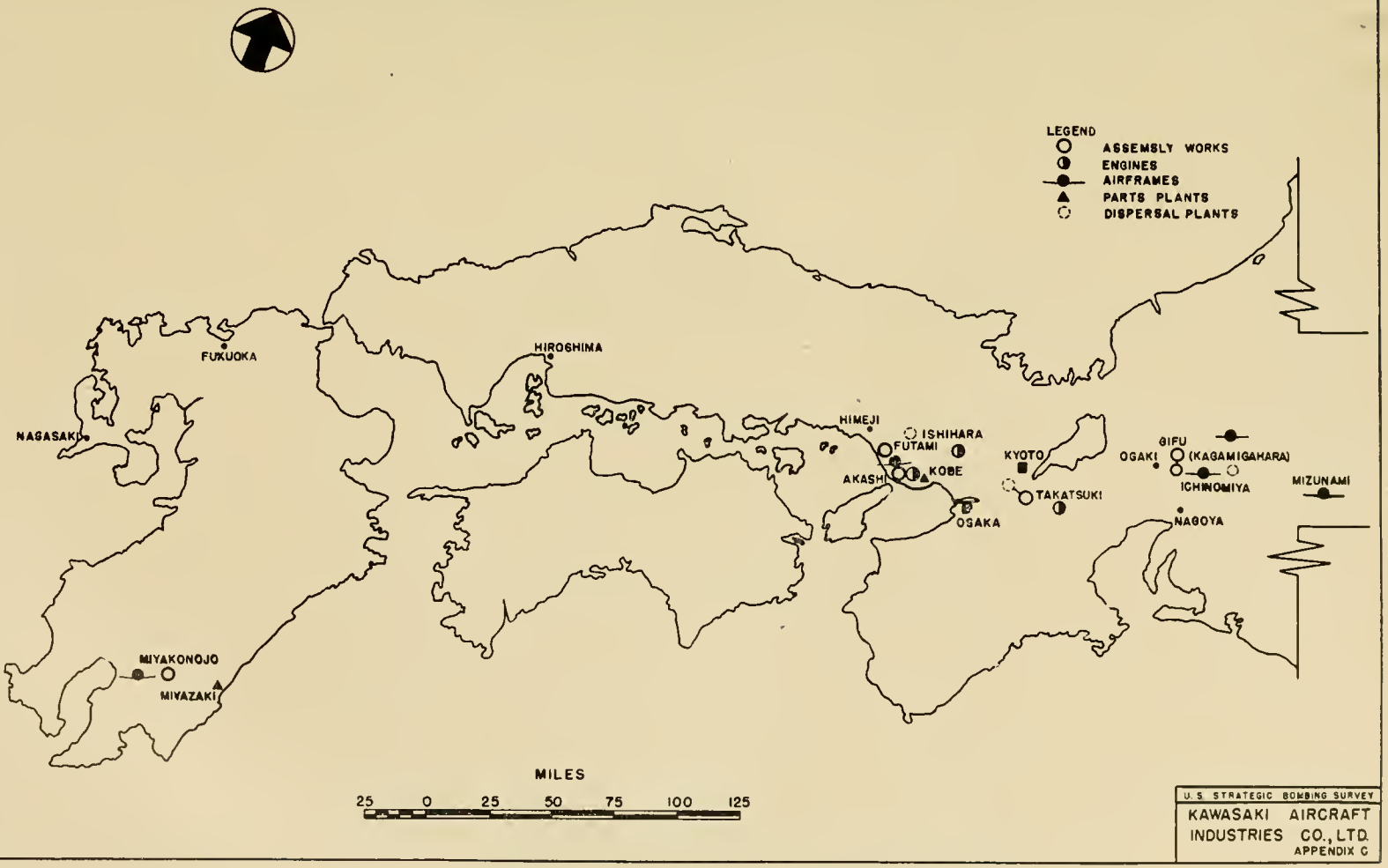
Head office—Chief, Masayoki Nemoto.
Engine division—Masayoki Nemoto.

Akashi plant—(Masayoki Nemoto, *Supt.* Hokuban plant.
Takatsuki plant—(T. Tominaga, *Chief*) Kobe, casting and forging plant.
Futami plant.
Sakai casting and lead-bronze plant.

Air-frame division—Hisashi Tojo.

Akashi airplane plant—Toshikuni Tateyama, *Manager.*
Gifu plant (Kagamigahara)—Hisashi Tojo, *Manager.*
Miyakonojo plant—Toshikuni Tateyama, *Manager.*
Mr. Ishii, *Asst. Manager.*
Ichinomiya plant—Kinzo Tanaka, *Manager.*
Tokyo agency—Sei Yamasake, *Chief.*

FACILITY LOCATIONS



U.S. STRATEGIC BOMBING SURVEY
KAWASAKI AIRCRAFT INDUSTRIES CO., LTD.
APPENDIX C

APPENDIX D

EMPLOYMENT STATISTICS

AIRCRAFT DIVISION

Employment ..... Manufacturer, Kawasaki; Plaut, Corporation

Year	Total	Air frames	Engines
1930			
1931			
1932			
1933			
1934			
1935			
1936			
1937			
1938			
1939:			
January			3,156
February			3,215
March			3,251
April			3,587
May	11,195	7,628	3,567
June	11,661	8,065	3,596
July	11,545	7,971	3,574
August	11,263	7,716	3,547
September	11,310	7,738	3,572
October	11,347	7,745	3,602
November	11,909	8,269	3,640
December	12,184	8,435	3,749
1940:			
January	11,957	8,244	3,713
February	12,052	8,202	3,850
March	12,133	8,248	3,885
April	12,161	7,881	4,280
May	12,578	8,341	4,234
June	12,543	8,330	4,213
July	12,458	8,203	4,255
August	12,496	8,277	4,219
September	12,732	8,522	4,210
October	13,012	8,572	4,440
November	13,255	8,419	4,836
December	13,667	8,571	5,096
1941:			
January	14,075	8,739	5,336
February	14,572	9,007	5,565
March	14,678	8,943	5,735
April	15,929	9,198	6,731
May	16,820	9,635	7,185
June	18,064	10,340	7,724
July	18,184	10,542	7,642
August	17,730	10,006	7,724
September	17,737	9,534	8,203
October	18,083	9,628	8,455
November	18,544	10,009	8,535
December	20,156	10,848	9,308

Year	Total	Air frames	Engines
1942:			
January	20,006	10,733	
February	21,429	11,288	
March	22,271	11,966	
April	25,780	12,592	
May	26,034	17,148	
June	26,252	17,247	
July	27,606	18,280	
August	28,108	18,645	
September	28,891	19,145	
October	30,702	19,240	
November	32,548	20,702	
December	33,459	21,463	
1943:			
January	35,408	23,141	
February	37,872	24,752	
March	39,726	26,310	
April	44,488	29,258	
May	47,467	31,518	
June	47,486	30,996	
July	47,694	31,081	
August	50,538	33,398	
September	52,557	34,741	
October	55,179	37,298	
November	56,775	38,226	
December	62,741	43,244	
1944:			
January	67,951	48,425	
February	69,546	47,272	
March	71,640	50,041	
April	76,187	54,231	
May	79,151	56,658	
June	81,900	59,690	
July	87,121	64,494	
August	86,956	63,841	
September	86,720	64,511	
October	86,700	64,312	
November	87,143	64,142	
December	85,380	62,447	
1945:			
January	83,243	60,622	
February	80,849	59,207	
March	78,403	58,555	
April	77,540	59,023	
May	75,221	58,359	
June	74,265	57,955	
July	71,848	55,339	
August	69,893	55,120	

APPENDIX E

KAWASAKI AIRCRAFT INDUSTRIES CO., LTD.—TOTAL AIR FRAME PRODUCTION

1939

	4	5	6	7	8	9	10	11	12	Total
Total actual production	46	47	47	38	50	50	60	60	44	427
Total planned production	58	75	76	70	64	61	60	66	66	586
Ki-32:										
Actual	40	47	47	38	30	50	50	60	44	422
Planned	68	75	76	68	60	36	52	48	46	648
RO-Type:										
Actual										
Planned					2	2	4	6	4	18
Ki-36										
Actual										
Planned			1	2	2	3	4	2	6	20
Ki-55										
Actual										
Planned										
Ki-56										
Actual										
Planned										
Ki-45 and Ki-45N										
Actual										
Planned										
Ki-48I:										
Actual										
Planned										
Ki-48II										
Actual										
Planned										
Ki-61I										
Actual										
Planned										
Ki-61II										
Actual										
Planned										
Ki-67										
Actual										
Planned										
Ki-100										
Actual										
Planned										
Ki-102AD, Ki-102B, Ki-102A										
Actual										
Planned										

1940

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total actual production	33	32	35	31	21	12	17	13	19	22	29	33	278
Total planned production	49	36	23	46	40	21	23	37	51	67	64	60	627
Ki-32:													
Actual	33	32	35	31	21								135
Planned	43	32	20	31	21								150
RO-Type:													
Actual													
Planned	2	2	4	4	2	1	1	2	6	2	3	1	30
Ki-36													
Actual						2	5	10	12	15	18	20	82
Planned	4	2	4	6	10	8	8	12	15	18	16	22	123
Ki-55													
Actual													
Planned								3	5	6	10	6	30
Ki-56													
Actual													
Planned										1	3	4	8
Ki-45 and Ki-45N													
Actual													
Planned													
Ki-48I:													
Actual							2	3	6	7	10	13	41
Planned				5	10	12	16	20	25	30	32	39	183
Ki-48II													
Actual													
Planned													
Ki-61I													
Actual													
Planned													
Ki-61II													
Actual													
Planned													
Ki-67													
Actual													
Planned													
Ki-100													
Actual													
Planned													
Ki-102AD, Ki-102B, Ki-102A													
Actual													
Planned													

1941

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total actual production	35	45	55	57	60	61	57	56	67	70	70	91	733
Total planned production	84	85	77	71	75	74	60	79	70	64	58	61	864
Ki-32:													
Actual													
Planned													
RO-Type:													
Actual	3	3	4	4	5	4	4	3	5	3	3	2	43
Planned	2	4	2										8
Ki-36													
Actual	16	20	27	15	11	10	8	21	29	30	31	36	245
Planned	23	30	25	28	30	29	22	23	22	20	16	18	293
Ki-55													
Actual		2	6	10	14	15	13	0	1	0	5	9	75
Planned	12	10	8	5	8	12	12	15	10	12	12	8	124
Ki-56													
Actual								1	2	2	2	3	10
Planned	4	8	2	2	2	4	5	5	2	0	1	3	35
Ki-45 and Ki-45N													
Actual								1	1	3	4	6	15
Planned							1	4	9	10	10	15	49
Ki-48I:													
Actual	16	29	25	29	30	32	32	30	30	32	34	35	344
Planned	33	36	40	36	35	30	23	26	24	20	15	12	340
Ki-48II													
Actual													
Planned								1	3	2	4	5	15
Ki-61I													
Actual													
Planned													
Ki-61II													
Actual													
Planned													
Ki-67													
Actual													
Planned													
Ki-100													
Actual													
Planned													
Ki-102AD, Ki-102B, Ki-102A													
Actual													
Planned													

1942

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total actual production	85	89	93	93	88	72	69	77	81	97	98	92	1,034
Total planned production	83	79	79	68	74	90	97	106	115	131	152	162	1,215
Ki-32:													
Actual													
Planned													
RO-Type:													
Actual													
Planned													
Ki-36													
Actual	30	33	33	30	18								144
Planned	14	12	10										36
Ki-55													
Actual	12	17	14	19	22	27	24	27	24	31	30		239
Planned	15	20	18	20	12	15	10	12	10	8	6	6	152
Ki-56													
Actual	4	3	2	2	2	3	3	4	4	5	6	7	45
Planned	2	5	8	2	0	1	3	2	6	2	4	8	34
Ki-45 and Ki-45N													
Actual	6	5	9	10	14	12	13	13	15	16	15	22	130
Planned	13	18	20	21	20	16	15	12	13	9	14	10	187
Ki-48I:													
Actual	33	31	33	32	29	12							172
Planned	10	12	6										30
Ki-48II													
Actual				1	3	18	29	32	35	40	47	49	253
Planned	8	12	16	24	35	48	54	62	58	76	80	63	567
Ki-61I													
Actual								1	3	5	10	15	34
Planned				1	7	10	15	18	24	36	48	50	209
Ki-61II													
Actual													
Planned													
Ki-67													
Actual													
Planned													
Ki-100													
Actual													
Planned													
Ki-102AD, Ki-102B, Ki-102A													
Actual													
Planned													

1943

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total actual production	91	111	124	139	143	132	146	175	193	217	238	275	1,984
Total planned production	174	174	188	180	180	152	154	157	179	186	230	262	2,196
Ki-32:													
Actual													
Planned													
RO-Type:													
Actual													
Planned													
Ki-36													
Actual													
Planned													
Ki-55													
Actual													
Planned	4	0	2										6
Ki-56													
Actual	7	8	8	8	6	9	7	9					64
Planned	2	4	6	10	10	10	10						62
Ki-45 and Ki-45N													
Actual	20	29	35	39	40	40	40	50	58	60	53	78	563
Planned	28	22	18	38	44	50	52	50	56	56	80	78	574
Ki-48I:													
Actual													
Planned													
Ki-48II													
Actual	42	43	50	55	81	43	37	50	65	70	71	70	647
Planned	84	88	90	62	48	30	32	39	40	36	38	42	628
Ki-61I													
Actual	22	32	31	37	44	40	53	60	70	87	104	130	710
Planned	36	60	72	70	58	62	60	58	76	80	92	100	854
Ki-61II													
Actual													
Planned								1	7	12	30	42	82
Ki-67													
Actual													
Planned													
Ki-100													
Actual													
Planned													
Ki-102AD, Ki-102B, Ki-102A													
Actual													
Planned													

1944

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total actual production	304	310	322	290	240	352	407	354	330	330	223	179	3,641
Total planned production	283	308	306	285	350	378	384	404	414	273	302	300	3,987
Ki-32:													
Actual													
Planned													
RO-Type:													
Actual													
Planned													
Ki-36													
Actual													
Planned													
Ki-55													
Actual													
Planned													
Ki-56													
Actual													
Planned													
Ki-45 and Ki-45N													
Actual	76	78	88	68	62	70	110	115	107	90	42	14	938
Planned	66	82	60	15	63	103	107	108	100	81	35	18	897
Ki-48I:													
Actual													
Planned													
Ki-48II													
Actual	77	73	65	60	60	46	42	36	31	18			508
Planned	40	46	52	65	55	55	60	45	28				436
Ki-61I													
Actual	150	150	145	142	116	236	254	198	164	174	101	53	1,891
Planned	112	140	162	205	211	218	223	235	234	150	130	100	2,140
Ki-61II													
Actual	1	3	36					1	36	41	71	70	239
Planned	46	40	32				1	12	47	27	57	100	362
Ki-67													
Actual												6	6
Planned												12	12
Ki-100													
Actual													
Planned													
Ki-102AD, Ki-102B, Ki-102A													
Actual							1	4	2	7	9	36	60
Planned					1	2	8	4	5	15	40	70	140

1945

	1	2	3	4	5	6	7	8	9	10	11	12	Total	Grand total
Total actual production	110	99	92	172	195	109	37	13					827	8,010
Total planned production	430	640	835	217	275	320	330	360	370	170	175	180	4,302	13,677
Ki-32:														
Actual														677
Planned														698
RO-Type:														
Actual														43
Planned														36
Ki-36														
Actual														472
Planned														472
Ki-55														
Actual														311
Planned														312
Ki-56														
Actual														119
Planned														120
Ki-45 and Ki-45N														
Actual	2	2	1	4	6	4	2	0					21	1,687
Planned	30												30	1,727
Ki-48I:														
Actual														557
Planned														556
Ki-48II														
Actual														1,408
Planned														1,646
Ki-61I														
Actual	19												19	2,654
Planned	100	100	160										300	3,503
Ki-61II														
Actual	68	56	15	19	7								165	404
Planned	120	250	300	25	30	30	40	40	40	30	30	30	945	1,389
Ki-67														
Actual	9	8	17	22	13	3	0	3					75	81
Planned	40	60	103	30	40	30	50	60	70	30	25	30	580	592
Ki-100														
Actual		1	36	89	131	88	23	10					378	378
Planned	50	100	150	100	140	170	180	200	200	130	120	130	1,650	1,650
Ki-102AD, Ki-102B, Ki-102A														
Actual	12	32	23	38	38	14	12	0					169	228
Planned	100	130	180	62	76	80	60	60	60				807	947

For total Corporation engine production, see Aircraft Division Report IV-2 (Akashi plant).

KAWASAKI KAGAMIGAHARA

(Plant Report No. IV–1)

THE PLANT AND ITS FUNCTION IN THE AIRCRAFT INDUSTRY

TRODUCTION

'he Kagamigahara works (Kagamigahara Seis-sho), sometimes referred to as the Gifu works, Kawasaki Aircraft Industries Co., Ltd., was acent to and slightly north of the Kagamiga- a military airport and about five miles east of town of Gifu. This area is 18 miles north of goya. The works consisted of 24 large, embly-type buildings and hangars with numer- smaller office and service-function structures. al floor area was 2,152,09 square feet (Appen- A).

The Kagamigahara works was the largest plant l headquarters for the air-frame division. The rks was also the center for a dispersal network plants and workshops scattered throughout the gamigahara (Gifu) area. A few elements of s network were located over 100 miles distant the northeast coast of Honshu. As head- rters for the air-frame division, Kagamigahara ected units at Akashi, Miyakonojo on Kyushu, l Ichinomiya which produced complete aircraft. The Kagamigahara management, in turn, re- ted to the general manager or managing ector for all the corporation's aviation activities o was headquartered at Akashi. This man was ponsible to topside management of Kawasaki avy Industries Co., Ltd., holding company for th aviation and shipbuilding interests, located Kobe.

Until 1937 the aviation activities of Kawasaki re housed with its shipbuilding activities at obe. At this time the airframes organization oved to Kagamigahara and started construction hich was to be augmented many times over the xt eight years.

The works was entirely financed with corpora- n money derived from private capital. hroughout its history Kagamigahara was an my contractor. Relationships between manage- ent and government agencies were harmonious. isashi Tojo, superintendent of the air-frame vision and head of the Kagamigahara plant, was a brother of Hideki Tojo, prime minister in the "Pearl Harbor cabinet".

The Army Ki–61 Tony single-engine fighter was the organization's chief product. Through 1943 and 1944 this plane was powered with a liquid-cooled engine. In 1945 it was converted to a radial installation and its designation changed to Ki–100. In its liquid-cooled version this plane was an almost exact duplicate of the German Me 109. Its engine was of a Daimler-Benz design.

Six months before the end of the war the works' production was shifted to Mitsubishi's twin-engine bomber Peggy, Ki–67. By the end of the war, however, the company had completed only a few of these planes.

During the middle war years Kagamigahara produced the twin-engine bomber Lily Ki–48, and the twin-engine fighter Nick Ki–45.

Prior to the war and during early 1942 the organization had been producing trainers and transports including Ki–56 Thalia, a version of the Lockheed 18; the Ro transport, also a twin-engine transport; the Ki–36 Ida; the Ki–55 reconnaissance plane; and Ki–32 Mary, light bomber. The latter two were single-engine aircraft.

PLANT ORGANIZATION AND OPERATION

As previously mentioned, managing director of this works and of the air-frame division was Hisashi Tojo. His assistant was Masayoshi Yako and the factory manager was Kanabei Tanaka. To this top level of authority nine major department heads reported. Managers at 13 branch plants and workshops, which formed the expanded and dispersed Kagamigahara organization, also reported to these three men. During plant visits and interrogations they furnished the major part of the information on the organization.

The departmental organization of the works was extremely detailed with many fine shadings of authority which at times may have produced some friction. However, a well-integrated top management may have been able to keep the

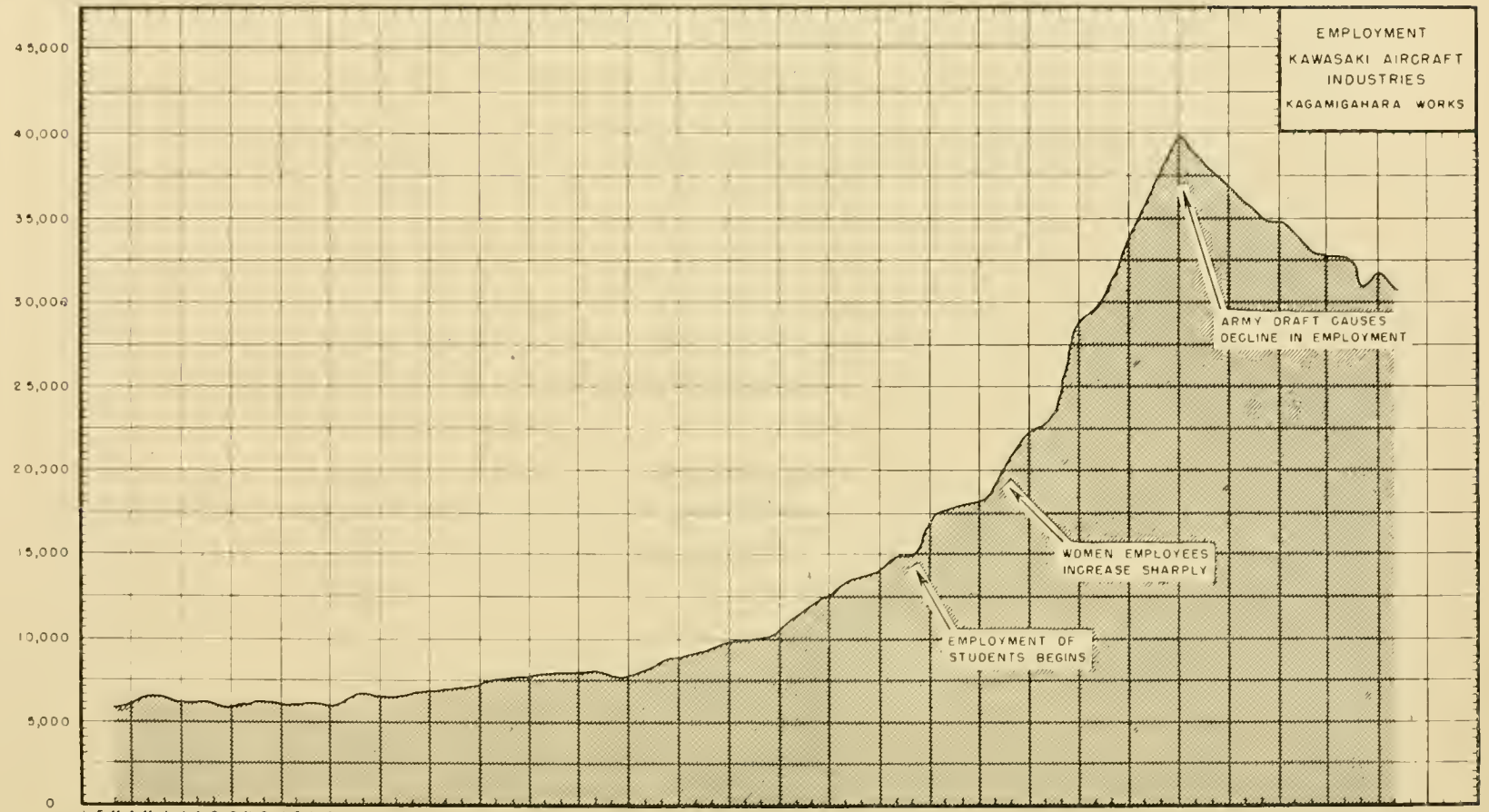

EMPLOYMENT
KAWASAKI AIRCRAFT
INDUSTRIES
KAGAMIGAHARA WORKS
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
ARMY DRAFT CAUSES
DECLINE IN EMPLOYMENT
WOMEN EMPLOYEES
INCREASE SHARPLY
EMPLOYMENT OF
STUDENTS BEGINS
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

FIGURE-1

es of authority from snarling. The specializa-
n of departments as illustrated by the works
ganization chart (Appendix B) is almost an
ict duplicate of the average large American
nt chart.

As shown in the list of building additions over
period of eight years (Appendix A), Kagamiga-
a was the victim of a mushroom growth which
gated any attempts at mass-production lay-out
ong the buildings. This problem was ac-
tuated by two railroad systems, one a main
, and the other a heavily traveled road which
ected the plant area.

ndividually the buildings were of modern steel
l glass construction with spacious assembly
s which were adaptable to some degree of pro-
tion line arrangement. Frequent Army-dic-
ed modifications and perpetual anxiety over
eatened cancellation of Tony contracts because
engine shortages, prevented the organization
m making progress toward assembly-line tech-
ique (Appendix C).

Peak of employment was reached in July 1944
h approximately 40,000 workers (Fig. 1).
wever, only one-half of this group was en-
ged in productive work. Until June 1944
gamigahara was on a single ten-hour shift. In
ne employment had increased to the point
ere about 50 percent of the organization was
le to go on two shifts. This work schedule
s continued until the bombing of 22 and 26
ne 1945. Labor shortage defeated attempts to
a higher percentage of the workers into two
fts.

The employment of student workers started in
rch 1943 and by the end of the war they
counted for 19 percent of the labor force.
is group worked 6 days a week, 9 to 4, alter-
ting classroom technical and academic instruc-
n with apprentice work in the factory.

Kagamigahara was highly dependent on the
overnment's conscription program. It had 10
rcent conscripted labor in 1942, 40 percent in
43, and 50 percent in 1944 and 1945. The
my draft caused some trouble all through the
r but in late 1944 its inroads into the labor
pply, especially of skilled workers, brought
out a critical situation.

Soldiers did not come into the plant until the
ry late days of the war. By August 1945
ere were only 1,100 of them employed at
Kagamigahara. Women consituted 22 percent of labor force at peak employment.

MATERIALS AND COMPONENTS

Direct allocation of materials to the works was made by the Army section of the ministry of munitions. This was an annual program. However, there were quarterly meetings for adjustments. The materials committee of the Aircraft Manufactures Control Association functioned during 1944 but its efforts were highly ineffectual and it was abolished after 1 year.

Materials for the plant came from the following major sources:

Al alloy: Sumitomo Kinzoku K K, Osaka and Nagoya; Furukawa Denki K K, Nikko and Osaka; Tokushu Keigokin K K, Shimonoseki, Nagoya and Kobe.

Special steel: Kawasaki Seihan plant, Nagoya; Daido Seiko K K, Nagoya and Yasuki; Nihon Kokan K K, Kawasaki; Sumitomo Pipe plant, Amagasaki; Nihon Seitatau K K, Yawata.

Copper Alloy: Furukawa Denki KK, Kobe; Kobe Seiko KK, Moji.

As illustrated from the experience of this works, the Japanese were forced to make many substitutions in metals. A threatened shortage of light metals caused the company to begin experimentation in wood fabrication in the fall of 1943. The metals shortage did not develop so seriously as predicted because of bombed-out plants throughout the industry. However, the company was successful in fabricating a complete empennage structure from plywood which earned Army acceptance and would have put this into production in early 1945 if dispersion measures had not interfered. (Photos 1 and 2.)

Selection of the empennage as the structure for this experimentation may have been influenced by the German success in adapting Tony's counterpart, the Me 109, to a plywood tail assembly.

Plywood storage battery racks and ammunition boxes also passed Government tests. However, a model of the company's pilot seat failed. Plant inspection showed that a large part of Kagamigahara's sizeable research facilities were devoted to plywood experimentation. (Appendix D.)

PRODUCTION STATISTICS

Peak production month at Kagamigahara was July 1944 when 296 planes, mostly Tony fighters,

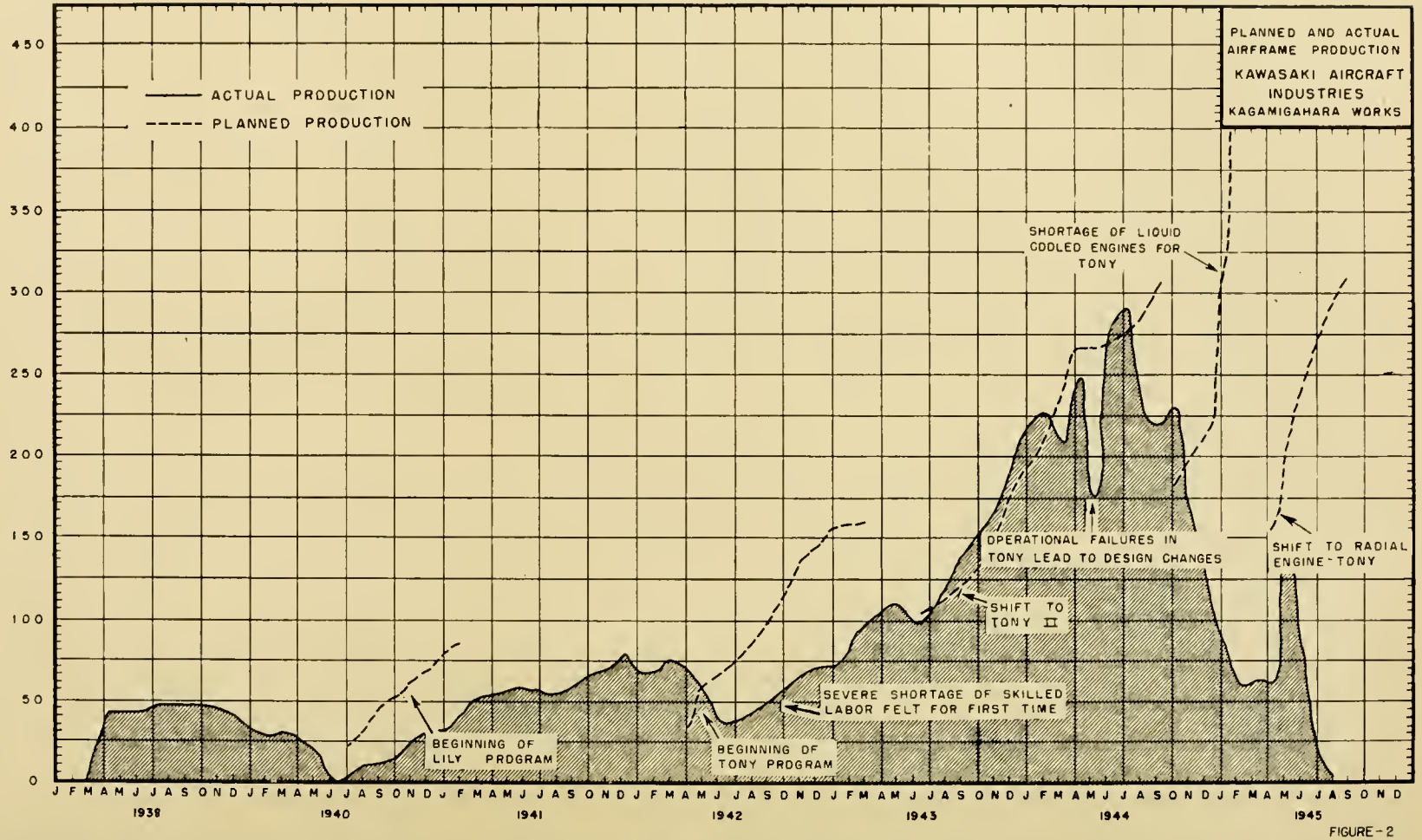

PLANNED AND ACTUAL AIRFRAME PRODUCTION
KAWASAKI AIRCRAFT INDUSTRIES
KAGAMIGAHARA WORKS
ACTUAL PRODUCTION
PLANNED PRODUCTION
450
400
350
300
250
200
150
100
50
0
SHORTAGE OF LIQUID COOLED ENGINES FOR TONY
OPERATIONAL FAILURES IN TONY LEAD TO DESIGN CHANGES
SHIFT TO TONY II
SHIFT TO RADIAL ENGINE - TONY
SEVERE SHORTAGE OF SKILLED LABOR FELT FOR FIRST TIME
BEGINNING OF LILY PROGRAM
BEGINNING OF TONY PROGRAM
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1938
1940
1941
1942
1943
1944
1945

FIGURE-2

e manufactured (Fig. 2). Production had aver-
l about 230 planes per month throughout 1944
il the big drop in November started the down-
d curve. This was caused by Army-dictated
lifications in Tony. (Photos 3 and 4.)
rom 588 planes in 1939, and 326 in 1940,
amigahara's production built up to 718 planes
941, 757 in 1942, 1,518 in 1943, 2,688 in 1944
637 during the last eight months of the war,
tal of 7,232 aircraft. Amount of completion
Government contracts was 84 percent in 1939,
ercent in 1940, 77 percent in 1941, 52 percent
942, 74 percent in 1943, 66 percent in 1944,
about 25 percent during the months of 1945
pendix E).
uring the latter part of 1944 deliveries of
id-cooled engines from Akashi fell below sched-
because of mechanical troubles, and in Janu-
1945 there were 364 Tony air frames awaiting
nes at Kagamigahara. Of these 265 were
verted to radial-engine installation. Liquid-
ed engines finally arrived for the remainder.

BUILDING AND REPAIR OF AIRPLANES

o rebuilding or repair was done in the Kaga-
ahara works proper; however, skilled work-
were dispatched next door to the Kagamiga-
military air depot where extensive work was
e. Most of this work was done by Army
hanics, although company technicians were
d in for extensive and specialized jobs.

VERSION TO EXPERIMENTAL AIRCRAFT

here was a well-developed experimental de-
ment at Kagamigahara and 12 percent of the
ding facilities were devoted to this work. In
ition to one new and very large building used
an experimental shop, there was a modern
d tunnel devoted to flutter research.
he research division reporting directly to the
naging director, included the wind tunnel de-
ment, the flutter research and the material
arch departments. The design and experi-
tal division, which also reported to the
naging director, included the customary group
engineering departments and in addition a
ngth and construction department (static
ing) and the experimental manufacturing
artment.
mong the important projects was Rob (Ki-64),
rge fighter with two liquid-cooled, Ha-60, Model 22 engines, rated at 1,020 horsepower for take-off. The engines were in tandem, one mounted fore and one aft of the pilot. The plane was test flown in early 1944 but troubles with the liquid cooled engines caused a delay in putting the plane into production.

The Ki-91, a four-engine bomber about the size of the B-29 but of much less load-carrying ability was in the mockup stage of development.

Kagamigahara had developed and put into quantity production a radio-controlled "Baka" carrying a 660-lb. war head. This was known as "I-GO-B". Frances or Peggy was intended as the mother plane.

The Ki-108 was an experimental twin-engine fighter with pressurized cabin, a development of Randy—production twin-engine fighter in the Akashi works. They were also experimenting on Randy with an exhaust turbine.

A large amount of German and American equipment in their shops for study indicated that Kagamigahara received good cooperation from Army research agencies (Photo 5).

EFFECTS OF BOMBING

DIRECT ATTACKS

The Kagamigahara works were first hit on 22 June 1945 in a daylight precision raid from 0926 to 0945. Visibility was good and a mixed load of 4,000-lb and 2,000-lb bombs were used with instantaneous fusing. The Peggy final assembly shop, subassembly building, parts-assembly shops, and the administration building were hit.

The raid of 26 June 1945, from 0910 to 1049, using 500-pound high-explosive bombs hit the Tony final-assembly shop, the experimental building, the engineering offices, subassembly shops, workers' dormitories, the school building, and the press shops. This later group of buildings suffered by far the most irreparable damage. This second raid was by far the more damaging (Photos 6 and 7).

All public utilities were knocked out by the raids and company officials reported repair parties were greatly disorganized.

The two raids knocked out every important building in the works. Manufacturing activities were permanently halted (Appendix F).

Most of the buildings were blasted and burnt out, but structural damage was small.

Stocks of raw materials were lost, but many half-finished planes could have been completed through cannibalization.

By the time of the raids, a high percentage of Kagamigahara's machine tools had been dispersed to small workshops and branch plants, most of which were in the nearby area. Only 112 of Kagamigahara's 1,508 machine tools were in the works at the time of the raid. Of this 112 only 4 percent were badly damaged. Subsequent area raids badly damaged 15 percent of the 1,508 machine tools.

If undamaged by air raids, Kagamigahara production would have probably leveled off at about 200 air frames per month through late 1945 and early 1946. Production would have been about equally divided between Tony and Peggy.

The war ended before the company could do more than repair a few of the damaged public utilities and clean out the buildings. However, the following priorities for repair had been set up: flight engineering, assembly buildings, heat-treating facilities, press buildings and experimental shops.

The management planned to resume production at Kagamigahara by utilizing many of the jigs and tools which were not damaged, as well as repairing the main assembly buildings and converting them to a variety of processes.

The complete plant would not have been repaired. Even after repairs, total production would have been small because of the disjointed efforts which Kagamigahara's dispersion had caused.

Probably the most destructive blows at Kagamigahara's production were hits on the heat-treating facilities and near misses which jarred the 2,000-ton hydraulic press sufficiently to cause irreparable damage to the installation.

They also had no hope of re-establishing interior communications and had to depend on messenger service.

After the bombing, despite a previous Army priority on Peggy, the emphasis was shifted to Tony on which there was a better chance of regaining production.

With the 2,600-ton hydraulic press damaged, an attempt was made to use hand molding. Pipe bending was attempted over hand gas burners as a result of cutting off the supply of gas from the main source. Electric welding was also planned as a result of damage to acetylene generators.

In the 22 June 1945 raid 61 people were k and 58 seriously injured. There were no casua in the 26 June 1945 raid.

INTERRUPTIONS DUE TO AREA ATTAC

On 28 July 1945 an incendiary attack ag the city of Ichinomiya completely destroye 470,000-square-foot Ichinomiya Branch fa which was producing Tonys at the rate of 2 month on a rising production curve. The 1945 incendiary raid on the city of Gifu destr the workshops in that city which had been acq as key units in the Kagamigahara dispe plans. These were the last remaining functi units of the once large Kagamigahara networ

Prior to the actual burning out of Ichino and Gifu in July 1945 the population of this had suffered very little inconvenience fro raids. Because the Kagamigahara works been bombed out by the time these raids occ their effects on production were not measu

INTERRUPTIONS DUE TO SUPPLIES

Air attacks had not as yet affected recei materials and supplies. From 1942 on, types of electrical and hydraulic equipment behind delivery schedule because the man turers of this intricate and specialized equip could not expand at the same rate as the air-f plants. The Tokaido district earthquake in also retarded deliveries of these parts and ponents (Appendix D). The effects were about to be felt when the war ended.

DISPERSAL

Fear of air raids had started dispersion o Kagamigahara works in November and Dece 1944 to the Ichinomiya plant. On 4 April the Government ordered the company to beg official dispersion program. This program scheduled for completion in August 1945 Kagamigahara officials estimated it would have been ready for production before Dece 1945.

The first phase of this plan was the acquis of a group of schools and small mills in the of Gifu for conversion to workshops and ho units for 500 to 1,000 employees each. Sh neighborhood yards, and parks in the for

around the Kagamigahara works were made
ly to store parts and assemblies.
The second phase of this first dispersal plan was
zation of the forests and rough terrain of
ntry for large assembly shops and underground
allations. Underground facilities in this net-
k were located at Mizunami, Nakatsugawa,
mi and Wachi. Forest installations were at
o, Katabira, and Akutami. All these loca-
s with the exception of the small shops on the
heast coast of Honshu previously mentioned,
within a 25-mile radius of the main Kaga-
ihara works.
the first dispersion program 1,900,000 square
of facilities had been ordered by the Govern-
t. At the end of the war 1,200,000 square
had been completed and machinery had been
sferred or was in transit.
f the 1,200,000 square feet of completed dis-
al area approximately 25 percent was in under-
nd installations which represented half the
emplated area. The largest underground
allation was at Mizunami with 250,000 square
excavated but largely without lighting or
hinery installations. Tunnels were from 12
0 feet in width and from 15 to 21 feet high.
he area raids on the cities of Ichinomiya and
, which burned out the company's buildings
e, necessitated a second dispersion program.
was an expansion of the first plant through
ddition of many more forest workshops which
formed into three production lines anchored
lino, Kagamigahara and Mizunami (Fig. 3).
ransportation difficulties were a tremendous
licap, despite relatively short hauls, in Kaga-
ihara's dispersion program. The nearby rail-
s could not be used and roads were narrow
overcrowded.
ver a six months' period from March through
ust 1945, company officials estimated that
ersal activities were directly responsible for a
luction loss of 54 Tony aircraft. Considering
low point to which production had fallen due
ther causes, this represented a large part of
works' total possible production during this
od. (Photos 8–10.)

INTELLIGENCE CHECK

s a whole, intelligence information on this
ct, mostly complied by Military Intelligence Service (G–2) was very good. Production estimates were about right. The only omission in this regard was failure to assess any Peggy production at this plant. Proximity of the target to the Kagamigahara military air depot at which all types of planes were serviced and tested may have served to confuse photographic interpretation on this point.

Apparently movement by night of a major proportion of the works' machine tools to dispersed locations also went undetected by photographic intelligence.

The war did not last long enough to prove or disprove the diagnosis that Kagamigahara's productivity had been destroyed by the raids of 22 and 26 June. There is some evidence that after a two- or three-month period of recuperation the works could have resumed about 25 percent of its former assembly functions.

VULNERABILITY

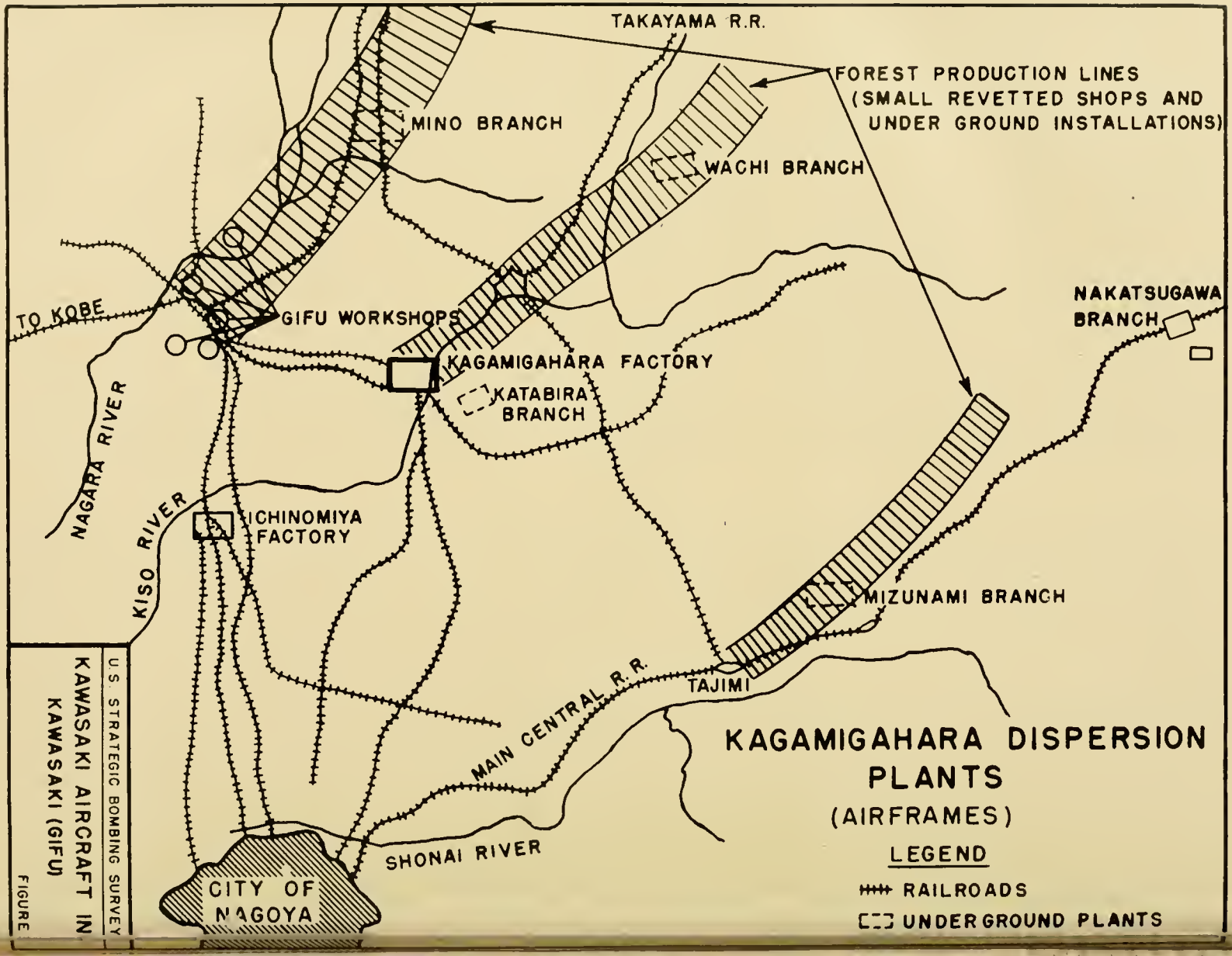
Kagamigahara's most vulnerable facilities as listed by company officials in order of priority were: (1) heat-treating facilities, (2) the 2,000-ton and 1,000-ton hydraulic presses, and (3) its acetylene gas supply. All three were hit in the 22 and 26 June raids.

Most vulnerable factor in the dispersed and branch factory facilities proved to be their inflammability in the area raids on the cities of Gifu and Ichinomiya.

Apparently, from the comments of Kagamigahara officials, the threat of air raids had a disastrous effect on workers' morale. This was a decisive factor in the extensiveness of the dispersal plans.

GENERAL IMPRESSIONS OF PLANT INSPECTION AND INTERROGATION

This was a well-organized plant but the production was disappointing. This was due to the persistence in using the inferior Ha–60, Model 22, liquid-cooled engine supplied by their sister Kawasaki organization at Akashi. This cranky product was never available in sufficient quantities. Even the engines supplied were high in failures. The resulting design changes ordered by the Army because of this, caused innumerable production stoppages. The sense of frustration


TAKAYAMA R.R.
FOREST PRODUCTION LINES
(SMALL REVETTED SHOPS AND
UNDER GROUND INSTALLATIONS)
MINO BRANCH
WACHI BRANCH
TO KOBE
GIFU WORKSHOPS
NAKATSUGAWA
BRANCH
KAGAMIGAHARA FACTORY
KATABIRA
BRANCH
NAGARA RIVER
KISO RIVER
ICHINOMIYA
FACTORY
MIZUNAMI BRANCH
MAIN CENTRAL R.R.
TAJIMI
SHONAI RIVER
CITY OF
NAGOYA
KAGAMIGAHARA DISPERSION
PLANTS
(AIRFRAMES)
LEGEND
RAILROADS
UNDERGROUND PLANTS
KAWASAKI AIRCRAFT IN
KAWASAKI (GIFU)
U.S. STRATEGIC BOMBING SURVEY
FIGURE

l resentment toward their Kawasaki sister nt which this caused among the Kagamigahara nagement officials was apparent. They were verless to secure early redress, however, be- se their managing director was subordinate to managing director of all Kawasaki aviation ivities who served also as manager of the ashi engine plant.

When a complete production stoppage in liquid- led engines finally forced the Army to dictate a switch to radial installation in Tony, it was too late in the war to have any effect.

REFERENCE ITEM

Reference item for this report is filed with the records of the United States Strategic Bombing Survey, War Department, Washington, D. C., care of the Adjutant General.

Reference Item 1. Machine tool damage charts.

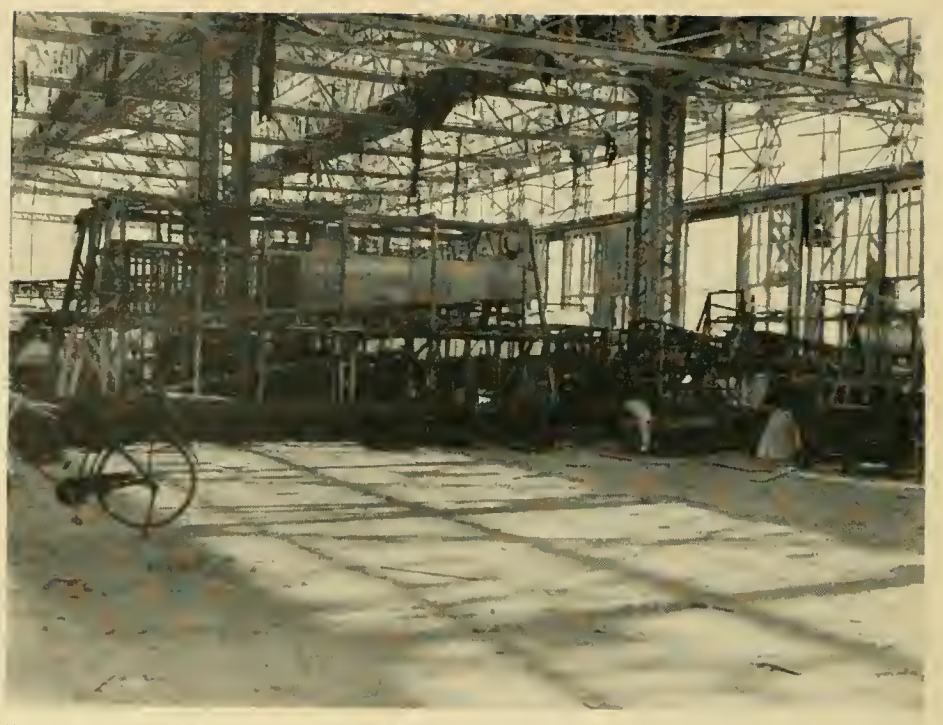


PHOTO No. 1.– Outer wing panel assembly jigs, Kagamigahara plant. As can be seen, jigs were light in construc but adequate.

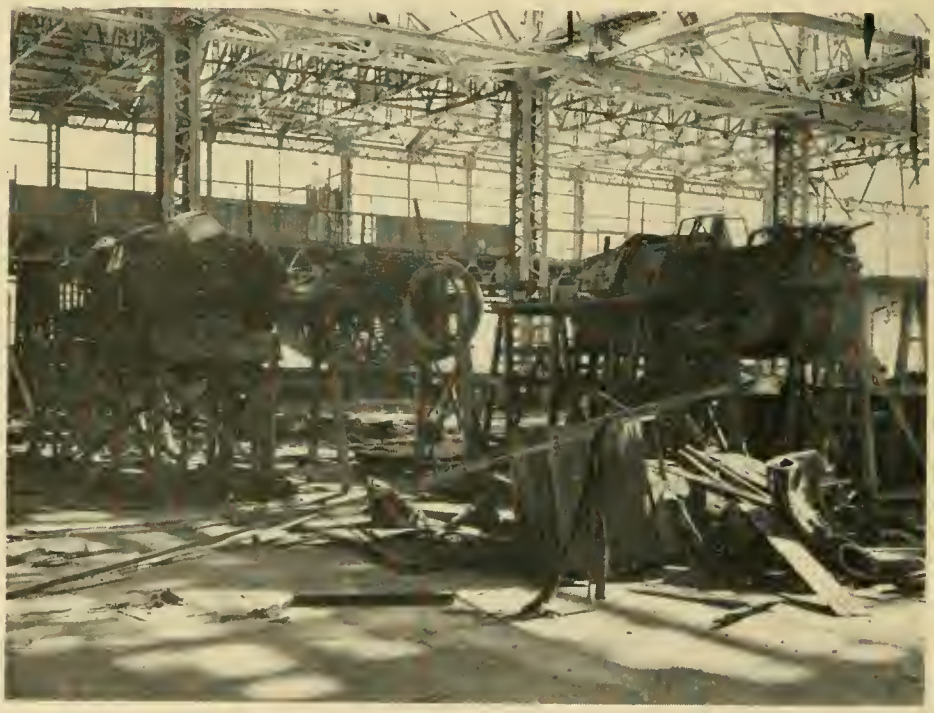


PHOTO No. 2.—Wood mockups in experimental building at Kagamigahara. Many types of American, German d British equipment was found in this building. Interesting was mockup of Japanese power driven turret carry four cannon.

oto No. 3.—Tony, in new radial engine version shown in final assembly building at Kagamigahara. Large arched-roof hangar-type buildings constituted about one-half of the plant's structures.

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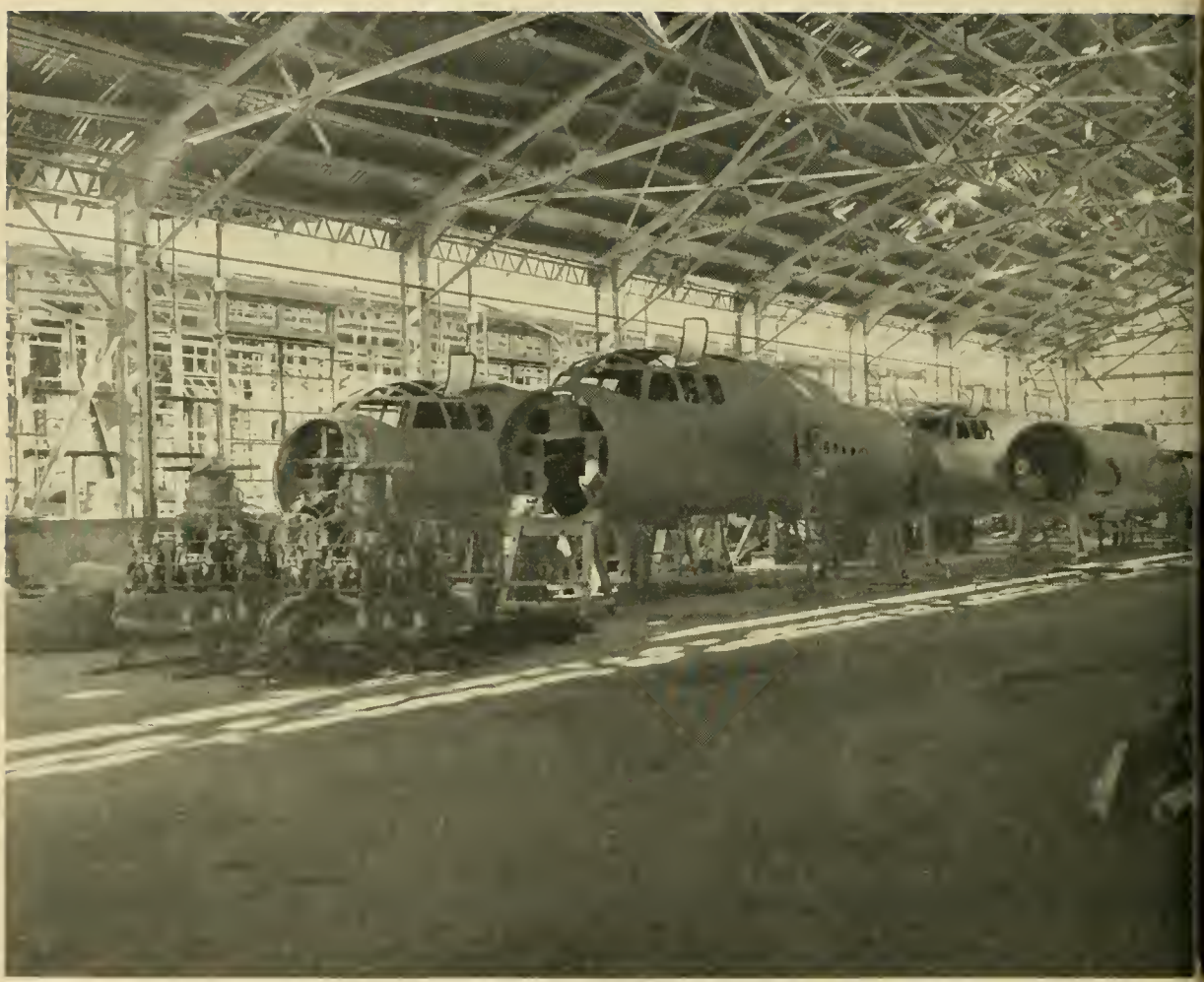


Photo No. 4.—Final assembly line for Peggy (Ki-67) at Kagamigahara. Mitsubishi furnished fuselage assem
Kawasaki manufactured wings and did final assembly.

Photo No. 5.—German engine from Focke-Wolfe 190 fighter found in experimental building at Kagamigahara. This was studied as model in adaptation of Tony from liquid-cooled to radial-engine installation.

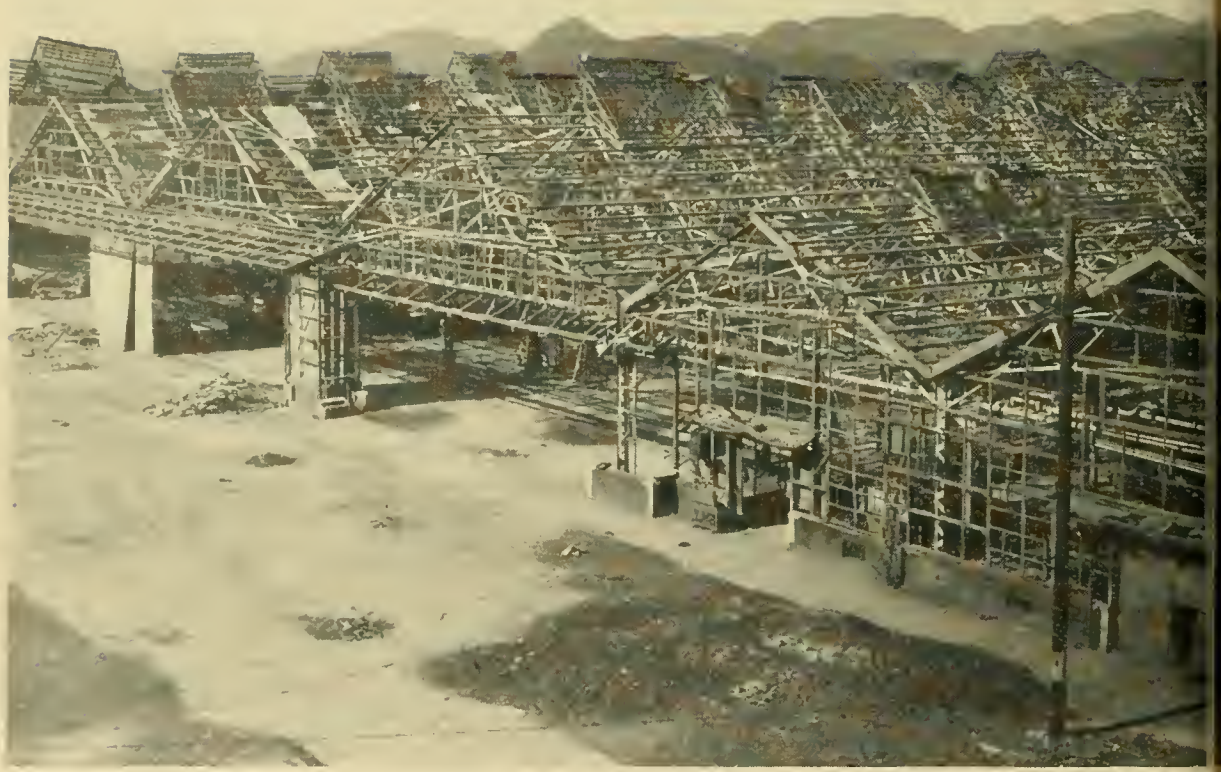
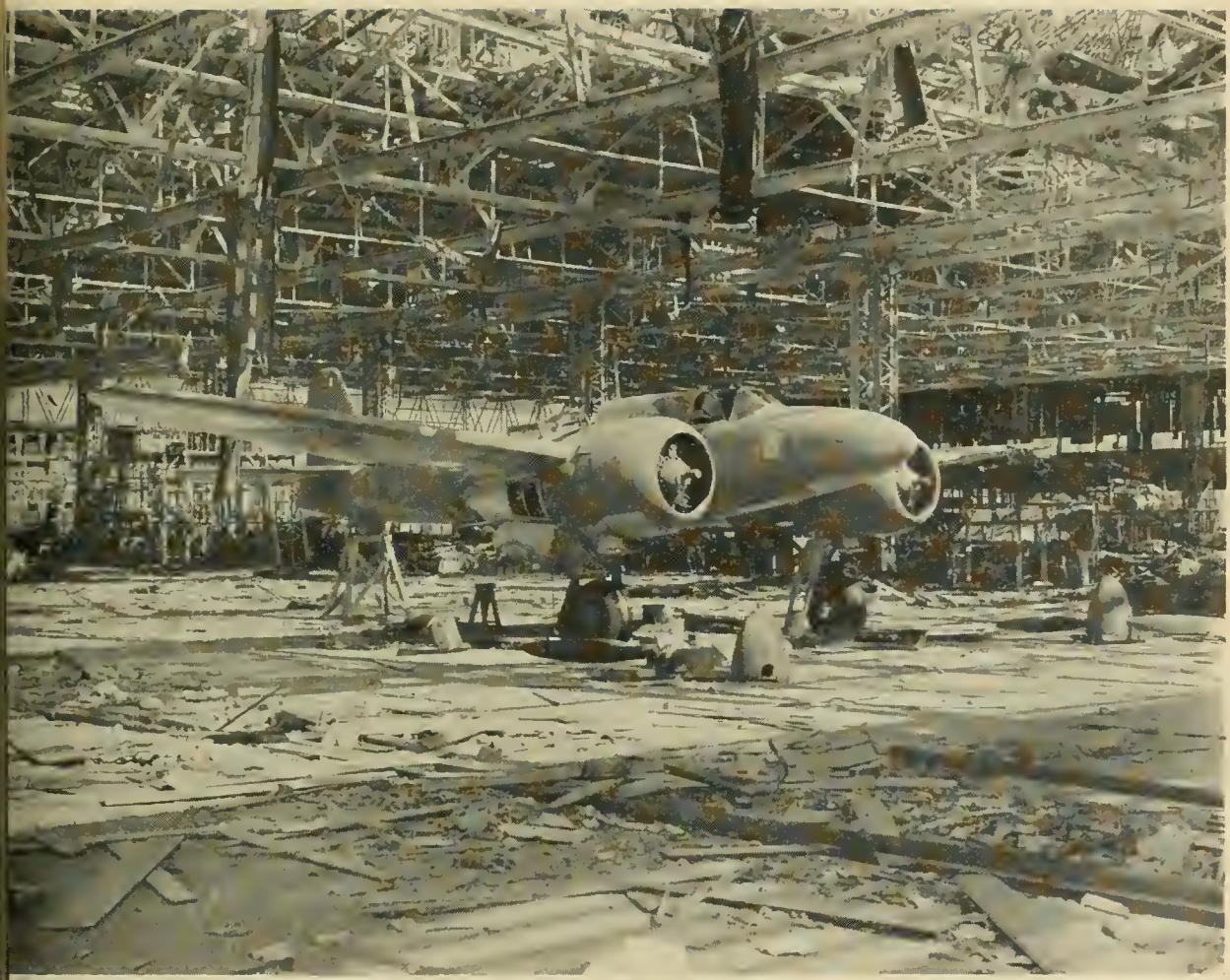


PHOTO No. 6.—Saw-tooth roof-type buildings at Kagamigahara showing light structural damage. The 500-pound explosives of second raid (26 June 1945) did majority of damage on works, including these buildings.



HOTO No. 7.—Randy (Ki-102) fighter in experimental building at Kagamigahara. This plane was manufactured at Akashi and was brought to the experimental center at Kagamigahara. This picture shows in detail typical building damage.

PHOTO NO. 8.—Tony fighter assemblies hidden under the trees about one half mile from Kagamigahara works. T was part of dispersion plan which intended to use main works only as assembly shop for part of output after J raids.

Photo No. 9.—Assemblies in yard of shrine one-half mile from Kagamigahara plant.

Photo No. 10.—Assemblies have crowded objects of worship out from under the roof of this shrine at Kagamigahara.

KAWASAKI (GIFU), APPENDIX A

PLANT EXPANSIONS KAWASAKI AIRCRAFT INDUSTRIES, KAGAMIGAHARA WORKS

June 1937–March 1945

Name of component plant	Date of expansion	Building or shop	Building area (square feet)
Main factory at Kagamigahara.	June 1937	Construction of first building	45, 8(
Do	September 1937–March 1938	Office building, final assembly shop, boiler room, forging shop, heat-treatment shop, etc.	101, 8
Do	April 1938–March 1939	Drafting room, fuselage wing components shop, foundry and press work shop, etc.	140, 0
Do	April 1939–March 1940	Northern press work shop, etc	154, 6
Do	April 1940–March 1941	First ground engineering shop, high pressure oil units work shop, etc.	172, 7
Do	April 1941–March 1942	Covering shop, second ground engineering shop	182, 4
Do	April 1942–March 1943	Third ground engineering shop, cover units work shop, second final assembly shop, etc.	264, 1
Do	April 1943–March 1944	Fourth and fifth ground engineering shops, etc	419, 9
Do	April 1944–March 1945	Third final assembly shop, experimental workshop, etc.	670, 2
Total			2, 152, 0

APPENDIX B

ORGANIZATION CHART

-frame Division, Hisashi Tojo, *Superintendent.*

hi airplane plant—Toshikuni Tateyama, *Superintend-*

Department of general affairs, personnel department, production department, factory manager, technical Department.

migahara (Gifu) plant—Hisashi Tojo, *Superintendent;* Asayoshi Yako, *Assistant;* Kanbei Tanaka, *Factory Manager.*

al board division:

General affairs, estate, document, finance, vigilance, commodities, health and sanitation, medical treatment.

division:

Office labor, factory labor, student labor, dormitories, welfare, health insurance.

rials division:

Materials preparation, parts preparation, materials management, payment inspection, transportation.

blishment division:

Materials, machinery, construction, utilization.

Research division:

Wind-tunnel, flutter research, material research.

Designing and experimental division:

Planning and design, fuselage, wing unit, power plant, armament, drawing, strength and construction, experimental manufacturing.

Planning division:

Planning, industrial affairs, factory power, technical assembling, parts engineering, process management.

Production division:

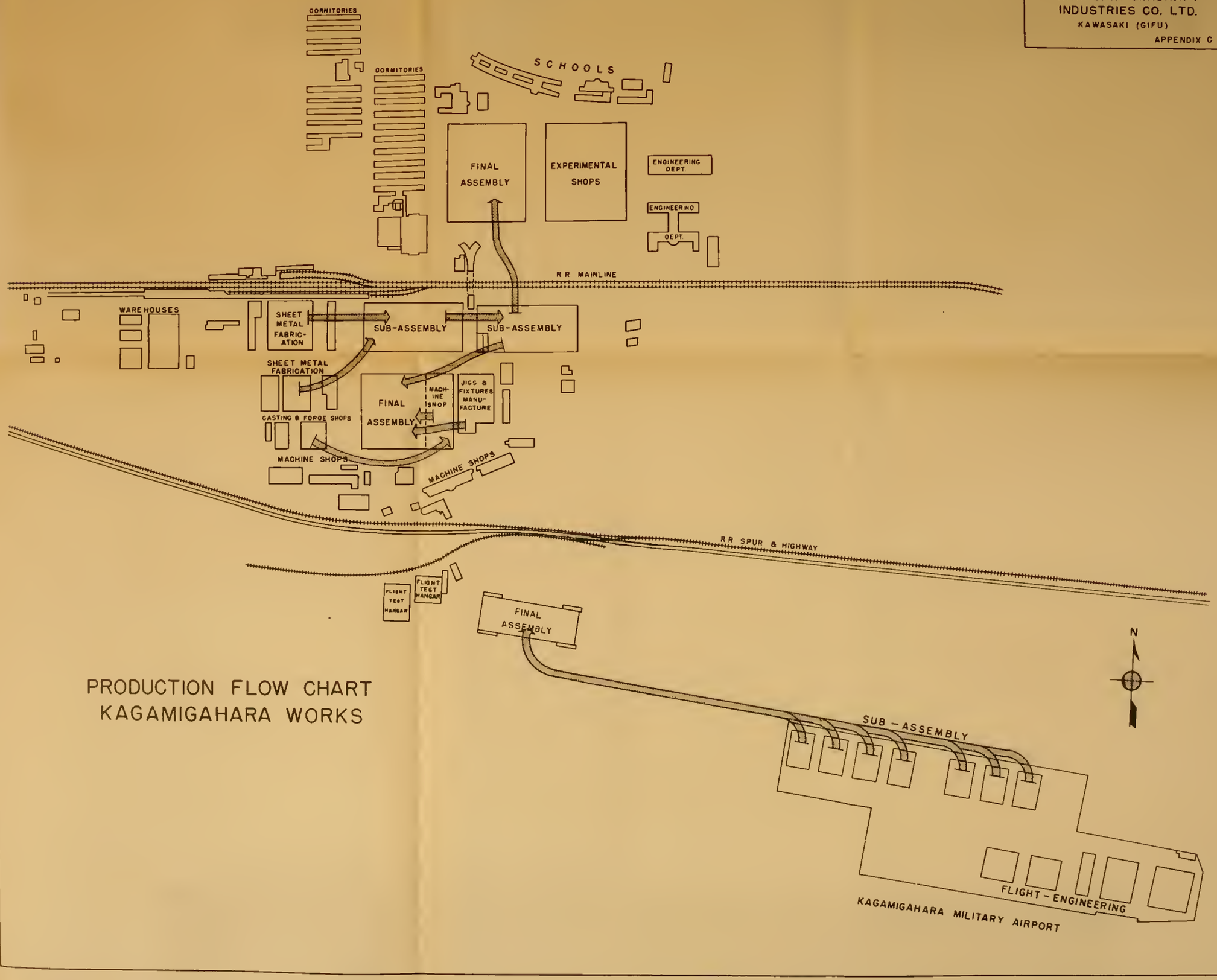
Construction, Misato plant, Sakahogi plant, Nakatsugawa plant, Kiyosu plant.

Inspection division:

Materials inspection, function inspection, production inspection, experimental inspection, flight adjustments, and preparations.

City of Gifu workshops, Kisogawa branch factory, Sakahogi branch factory, Nakatsugawa branch factory, Sabaye branch factory (NW Honshu), Fukui branch factory (NW Honshu), Kawasaki hospital, Young men's school, Ichinomiya factory.

U S STRATEGIC BOMBING SURVEY
KAWASAKI AIRCRAFT INDUSTRIES CO. LTD.
KAWASAKI (GIFU)
APPENDIX C



PRODUCTION FLOW CHART
KAGAMIGAHARA WORKS

216941 O - 47 (Face p. 30)

KAWASAKI (GIFU), APPENDIX D

CRITICAL SHORTAGES IN ACCESSORIES

(Actual statistics lost in bombing, information supplied from memory of plant officials)

and month	Name of parts	Actual delivery (percent)	Supplier	Address
1942				
	Ki-48, Oleo	90	Kayaba Manufacturing Co	Shitawia, Siba-ku, Tokyo.
	do	80	do	Do.
	do	75	do	Do.
	Ki-48, Oleo and tail wheel	80	do	Do.
	Ki-45	85	Okamoto Ind. Co	Tachiwaka Kasadera-cho, Minami-ku, Nagoya.
	Ki-48, oil system selecting cock	60	Shimazu Manufacturing Co	Hamai-cho, Mibu, Chuk-yo-Ku, Kyoto.
	do	85	do	Do.
	do	80	do	Do.
	do	75	do	Do.
	do	55	do	Do.
	do	80	do	Do.
	do	55	do	Do.
	do	85	do	Do.
	do	60	do	Do.
1943				
	Ki-61, oil system selecting cock	60	Shimazu Manufacturing Co	Do.
	do	50	do	Do.
	do	55	do	Do.
	do	60	do	Do.
	Ki-45, Ki-48, Oleo	80	Kayaba Manufacturing Co	Do.
	do	85	do	Do.
	Ki-61, oil system pressure tank	60	Shimazu Manufacturing Co	Do.
	do	60	do	Do.
	Ki 61, Ki-48, ball bearing	70	Toyo Bearing Manufacturing Co	Aza-Tsuchijima Oaza-Higashi-kata, Kuwana.
	do	60	do	Do.
	do	60	do	Do.
	Ki-61, Ki-48, ball bearing	60	do	Do.
	Ki-61, under carriage wheel	80	Okamoto Ind. Co	Do.
	do	70	do	Do.
	do	85	do	Do.
	do	65	do	Do.
	do	85	do	Do.
1944				
	Ki-61, electrical parts	70	Koito Manufacturing Co	Udo-mura, Abe-gun Shizuoku-pref.
	do	65	do	Do.
	do	60	do	Do.
	do	65	do	Do.
	do	70	do	Do.
	Ki-61, Type 9F, full gauge	50	Itanu Factory, Mitsubishi Denki Co	Sonoda-mura Kawabe-gun, Hyogo-pref.
	Ki-61, electric controlled oil system	65	Toa Kukuhoki Co	Nagane-mura, Hamaha-gun, Shizuoka-pref.
	Ki-61, L selecting valve	40	do	Do.
	do	65	do	Do.
	do	40	do	Do.
	do	60	do	Do.
	do	50	do	Do.
	do	60	do	Do.
	do	60	do	Do.
	do	65	do	Do.
1945				
	Ki-61, fuel pressure control valve	65	Chukyo Machinery Manufacturing Co.	Komaki-cho, Kasugai-gun, Aichi-pref.
	do	60	do	Do.
	Ki-61, fuel flexible tube	70	Toyo Aosei-Kako Co	Masaki-cho Naka-ku Nagoya.
	Ki-61, fuel pressure control valve	60	do	Do.
	do	65	do	Do.
	do	60	do	Do.
	do	65	do	Do.

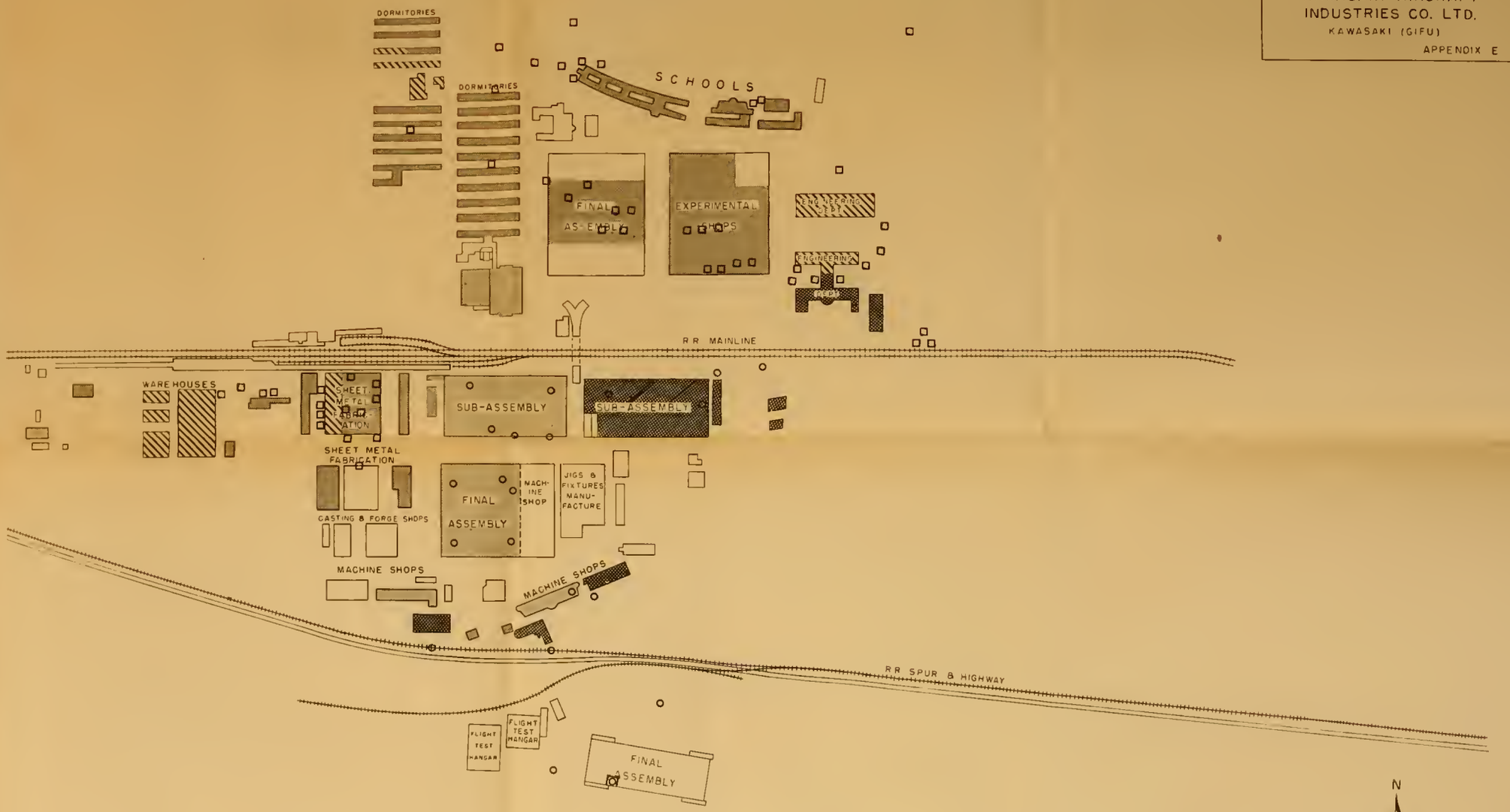
REMARKS

Engines for "Ki-61" always were in short supply from August 1942, till the end of war, and it beeame a great difficulty to perform the program of airplane action. (Supplier was Akashi Engine Factory, Kawasaki Airplane Mfg. Co.)

Inertia starters for "Ki-67" were in short supply from December 1944, till the end of war, and it was never flown. (Supplier was Tokyo Instrument Co.)

For general electrical equipment for "Ki-61" some troubles in each month from February 1944 till the end of war.

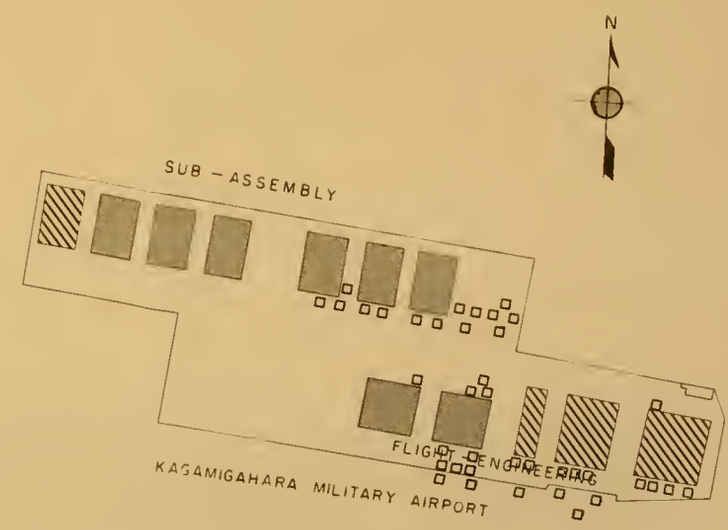
U S STRATEGIC BOMBING SURVEY
KAWASAKI AIRCRAFT
INDUSTRIES CO. LTD.
KAWASAKI (GIFU)
APPENDIX E



BOMB PLOT
KAGAMIGAHARA WORKS

LEGEND

JUN 22 RAID	JUN 26 RAID	
○	□	INDICATES BOMB HIT
■	▨	COMPLETELY BURNT DOWN OR COMPLETELY DAMAGED
▭	▭	HALF BURNT DOWN OR HALF DAMAGED



716941 O - 47 (Face p. 381)

KAWASAKI AKASHI

(Plant Report No. IV–2)

THE PLANT AND ITS FUNCTION IN THE AIRCRAFT INDUSTRY

TRODUCTION

The Akashi works (Akashi Seisukusho) of wasaki Aircraft Industries Co. Ltd., was located out two miles northwest of the town of Akashi. was on the shores of Akashi Strait of the Inland a and 12 miles to the west of Kobe.

The facilities, which combined an air-frame and craft engine works, contained a floor area of ghtly over 3,300,000 square feet. This in- ded 8 assembly buildings, 4 machine shops and buildings devoted to fabrication. Ten addi- nal buildings were used for inspection and search and the remaining structures were used warehouses, welfare and service buildings. ost buildings were of modern light-steel frame d glass construction (Appendix A).

The engine facilities of Akashi constituted 287,700 square feet of productive floor area and e air-frame organization occupied 1,047,700 uare feet of productive floor area.

The Akashi works, general headquarters for all e Kawasaki aviation activities, constituted one the two large units of Kawasaki Aircraft Indus- ies Co. Ltd. The other was located at Kaga- igahara (USSBS Aircraft Division Airframes lant Report IV–1). Akashi was the corpora- on's largest works and headquarters for the gine division.

An air-frame works had been added to the large gine facilities at Akashi early in 1941 to produce mplete aircraft. This works was under the ganizational structure of the Kagamigahara air- ame management. However, in such matters employment, air-raid defense, etc. it operated nder the over-all Akashi organization.

The plants at Futami and Takatsuki, conceived parts plants for Akashi, but later converted into dependent units producing complete engines by e dispersal program, operated under the Akashi gine-division management.

Other offshoots of the Akashi engine division ere the Sakai casting and forging plant, the Kobe casting and forging plant, and the Hokuban plant which produced gears.

The Akashi facilities were a wholly-owned unit of Kawasaki Aircraft Industries Co. Ltd., which in turn was a subsidiary of Kawasaki Heavy Industries Co. Ltd. The aviation branch had been organized in 1918 and the company had been able to retain complete financial control of all its facilities. Construction of the Akashi works was started in 1937 when the aircraft activities left Kobe. Akashi was entirely an Army contractor.

The history of Kawasaki's production was one of steady growth, fed by military orders from the end of World War I into World War II.

The company began building the French Salmson airplane and engine under license in 1919. In 1926 it purchased the license to manufacture the Bavarian motor works (Bayerische Motern-werke) engine, and in 1927 designed the Type 87 heavy bomber which was powered with two BMWs. In 1928 the company received an order for 300 Type 88 reconnaissance planes, also powered with Kawasaki manufactured BMWs. An order for 300 Type 92 fighters was given the company in 1930. The power plant was an improved BMW. During 1933 the company executed an order for 250 Type 93 light bombers powered by the BMW, Model 9. In 1935 it started manufacturing the Type 95 fighter of the China campaigns on an order for 800. This fighter was powered by the Ha–9, a liquid-cooled engine manufactured by the company. In 1938 an order for 1,000 Type 98 light bombers powered with Ha–9 model was received.

Most important products of Akashi's engine facilities were its line of liquid-cooled engines. These were Ha–60 Model 22, rated at 1,150 horsepower for takeoff, and Ha–60 Model 33, rated at 1,350 horsepower for take-off, both outgrowths of the Daimler-Benz design purchased from Germany in 1937. They were used in Tony fighters.

The Akashi facilities also produced the Ha-35 Model 22, and the Ha–35 Model 32—Nakajima-designed radials, rated at 1,100 horsepower and 1,150 horsepower for take-off, respectively. They were used in Oscar fighters and Ki–115, the Nakajima suicide plane. A late product was the Ha–45 Model 21, Nakajima 1,970 horsepower radial, used primarily in Frank fighters.

Primary products of the air-frame facilities were Nick, Ki–45, a twin-engine fighter in conventional and night-fighter versions and Randy, Ki–102, also a twin-engine fighter but of single-place design and higher performance.

ORGANIZATION AND OPERATION .

A key figure in the Akashi works was Masayoki Nemoto who was (1) managing director of all Kawasaki aviation activities, (2) managing director of the Kawasaki engine division and (3) managing director of the Akashi works itself. Toshikuni Tateyama was superintendent of the air-frames division reporting to the air-frame management of Kagamigahara and, through them, to Nemoto (Appendix B).

All department heads of both engine and air-frame facilities attended interrogations at the Akashi works. The Sakai and Kobe casting and forging plants were also represented at these meetings. Nemoto's presence also assured complete cooperation in securing information for this report.

The plant was organized on fairly well-established flow-line principles (Appendix A): but, with destruction of the buildings almost complete, and all machinery removed, it was impossible to reconstruct the details of fabrication and assembly. Frequent design changes and production stoppages, however, probably discouraged any attempt at real mass production in the engine factory. The air-frame facilities were never anything other than a small-order plant operating under job-shop practices. As previously mentioned, the individual buildings were spacious and modern.

Top employment in the engine plant was in November 1944 with 23,001 workers. At no time was the employment of women above a level of 5 percent. Students constituted about 7 percent of the labor force in November 1944. Conscripted labor never was more than 10 percent of the workers.

Only after production had halted in 19 were soldiers brought into the plant. Th total was 717 at the high point.

The engine-plant employment increased stead through many difficulties, such as the Ar draft, until bombing knocked out the plant January 1945 (Fig. 1). Average monthly wa at Akashi was 150 yen.

In June 1943 the engine plant went on two hour shifts. Through 1944 and 1945 about percent of the plant's departments were on double shift. A shortage of skilled work prevented the entire personnel from going on t basis. Labor turn-over was from 1 to 2 perc per month.

Air-frame employment at Akashi reached peak in August 1944 with 23,798 workers (Fig. Students constituted 25 percent of this gr and women about 5 percent. It succeeded putting only about 30 percent of the organizat on this basis by mid-1944. There were no soldi in the air-frame departments.

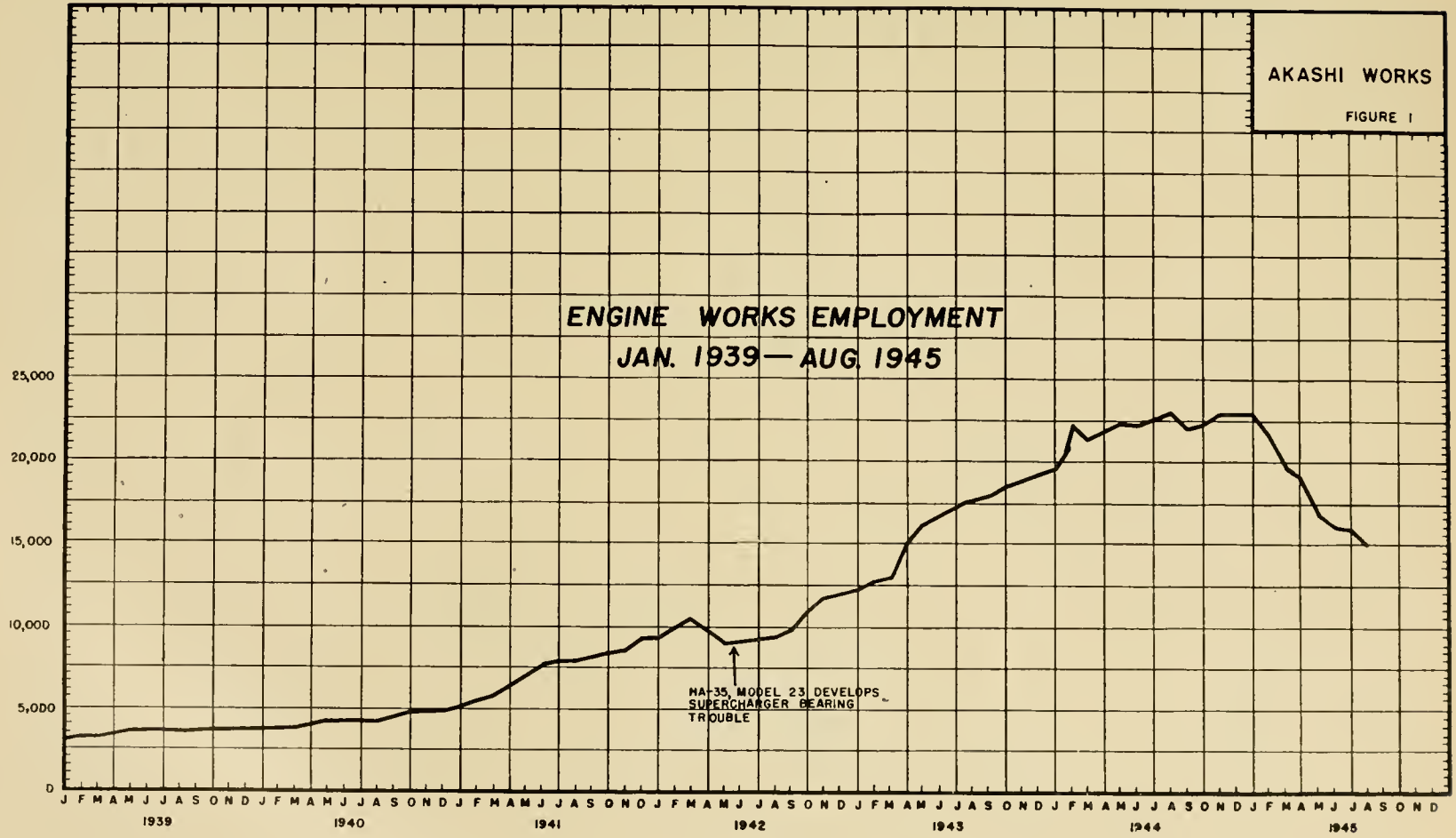
The engine and air-frame branches functio under a common personnel department and is possible, because of the labor shortage, t most skilled workers were of necessity channe into the engine organization. This left the frame organization extremely short.

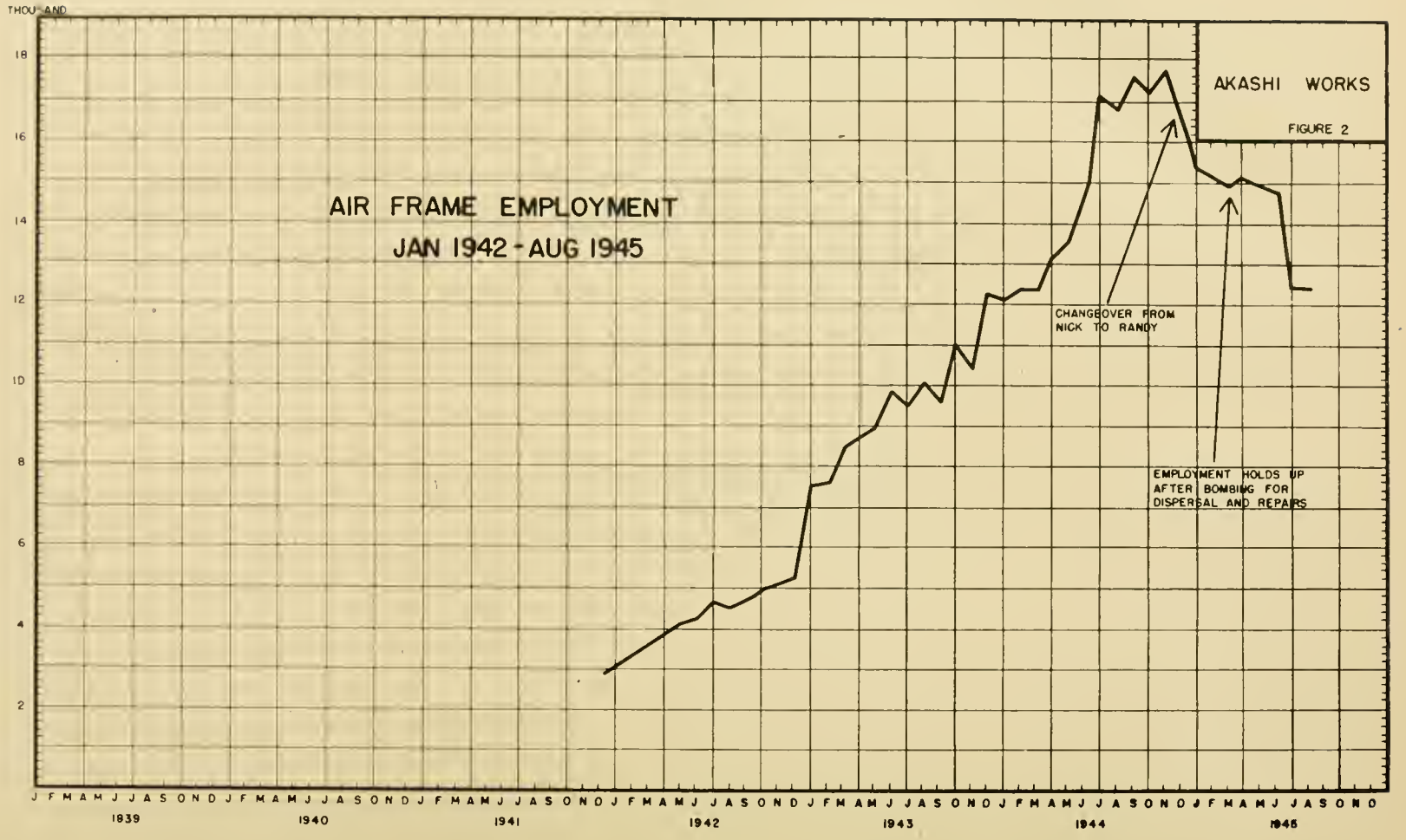
MATERIALS AND COMPONENTS.

Allocation of materials for engine manuf turers was made by the Army section of ministry of munitions on the customary amo basis with readjustments made quarterly. Cl material sources were as follows:

Materials	*Suppliers*	*Location*
Al and Mg castings.	Kobe Kinzoku plant of Kawasaki.	Kobe.
	Tojo Koku Kinzuoku K K	Nishinomiy
	Sumitomo Kinzoku K K.	Nagoya.
Al forgings	Sumitomo Kinzoku K K.	Katada.
	Kobe plant of Kawasaki	Kobe.
Special steel	Daido Seiko K K	Nagoya.
	Nippon Tokushuko K K.	Tokyo.
Steel forgings.	Kobe Kinzoku K K	Kobe.
	Sumitomo Kinzoku K K.	Osaka.
	Kobe Seiko K K	Kobe.
	Kawasaki Seihan plant	Nishinomiy

The material department for air frames Akashi was in reality a branch of the cent material department for the entire air-frame


AKASHI WORKS
FIGURE 1
ENGINE WORKS EMPLOYMENT
JAN. 1939—AUG. 1945
25,000
20,000
15,000
10,000
5,000
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945
MA-35, MODEL 23 DEVELOPS SUPERCHARGER BEARING TROUBLE


THOU AND
18
16
14
12
10
8
6
4
2
AIR FRAME EMPLOYMENT
JAN 1942 - AUG 1945
AKASHI WORKS
FIGURE 2
CHANGEOVER FROM NICK TO RANDY
EMPLOYMENT HOLDS UP AFTER BOMBING FOR DISPERSAL AND REPAIRS
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

ization which was at Kagamigahara (USSBS craft Division Airframes Plant Report -1). Akashi's material sources and shortages e identical to those enumerated in the Kaga-ahara plant report.

ODUCTION STATISTICS

kashi's engine division produced a total of 359 units against 15,772 ordered and 13,840 acity during the period April 1939–August 1945 pendix C).

Planned production for the air-frame division alled 2,714 units from September 1941 through tember 1945, while actual production, which ed in August 1945, was 1,945 completed air nes (Appendix D).

lighest monthly engine production for Akashi 450 units during November 1944. Average nthly production during 1944 was 350 units month (Fig. 3). This was about equally ided between liquid-cooled and radial engines. During the first half of 1944 the company was to meet government production schedules percent. However, due to the Army draft l mechanical troubles they met only 57 percent heir quota during the latter half of the year. nufacture of liquid-cooled engines was ham-ed by main bearing, supercharger, oil and ling-system failures.

Shortages of materials and mechanical failures ughout the war thus prevented the type of e production scheduling which means mass duction and an efficient shop. Splitting the at between the manufacture of liquid-cooled l radial engines was probably another factor venting mass production.

Production of Nick fighters in the Akashi air ne division reached its peak in August 1944 h 119 units produced (Fig. 4). At this time version was begun to the Randy fighter and duction slumped. The shortage of electrical ipment, pet cocks and plungers resulting from Tokaido district earthquake was another tor in the slump which occurred during this iod. It was primarily a disruption of the nsportation system resulting from the earth-ake rather than damage to the equipment plants ich produced the shortages. During 1944 the nt met 80 percent of its government schedules.

During the spring of 1944 the plant had been delayed in reaching its production peak due to a typhoid-fever epidemic.

REBUILDING AND REPAIR

According to company officials, inferior materials accounted for 53 percent of all engines returned to Akashi for factory rework and overhaul during 1944 and 1945.

Engines were sent from Kagamigahara, Tachikawa, Osaka and Tachiarai Army air depots. Kagamigahara furnished by far the largest number of these overhaul jobs. Of the 867 engines repaired and overhauled, 457 contained poor quality materials, 229 were damaged through rough service treatment, 145 were routine service overhauls, 29 suffered battle damage and seven were training engines.

After the crippling raid of 19 January 1945, the engine division was able to produce 292 engines in May 1945. Two hundred of these came from the undamaged Futami plant and 92 from Akashi, however, representing cannibalizations and the assembly of parts produced before the bombing.

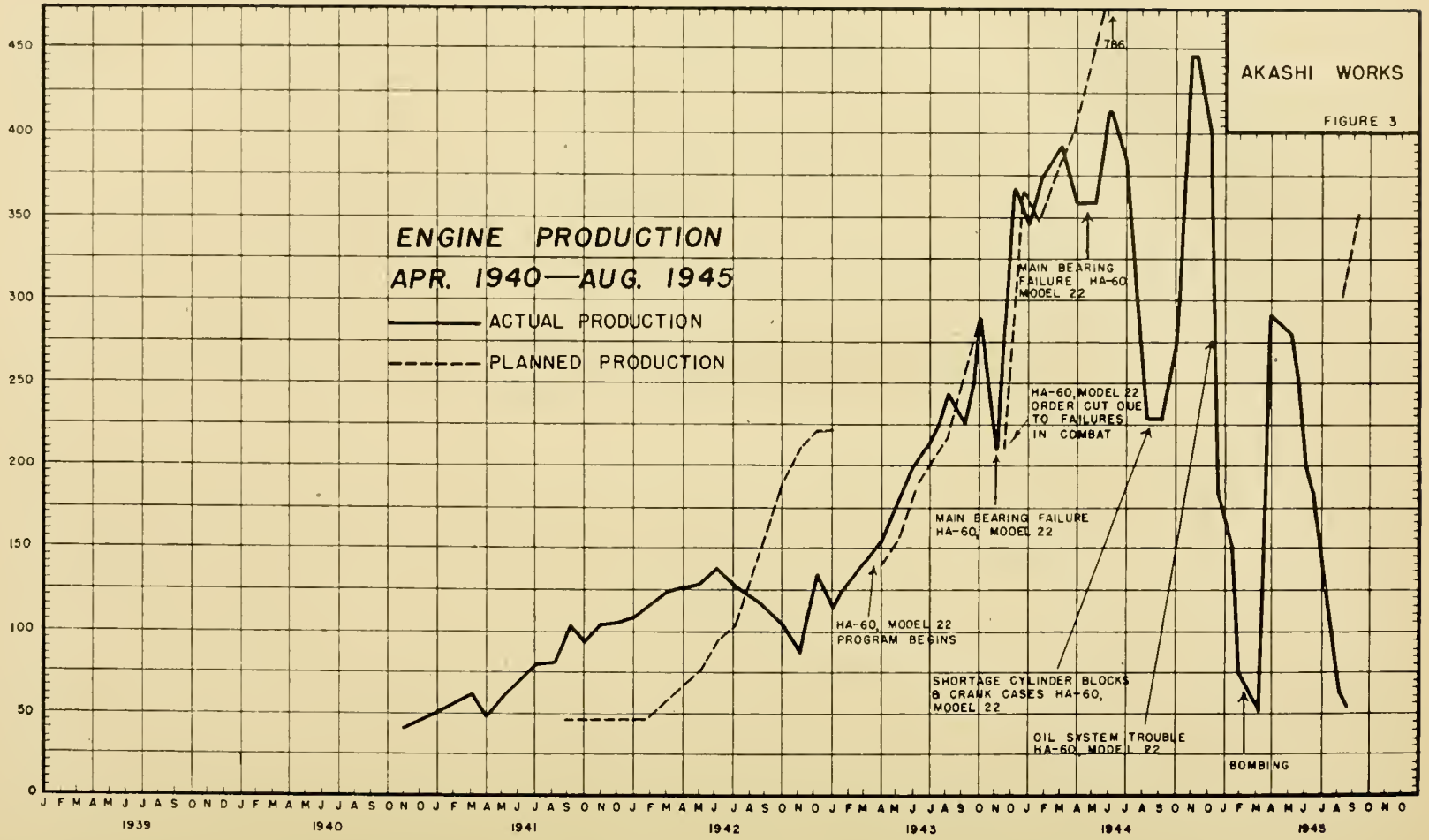
At Akashi there had been no conversion to substitute wooden assemblies and parts which had been developed at Kagamigahara.

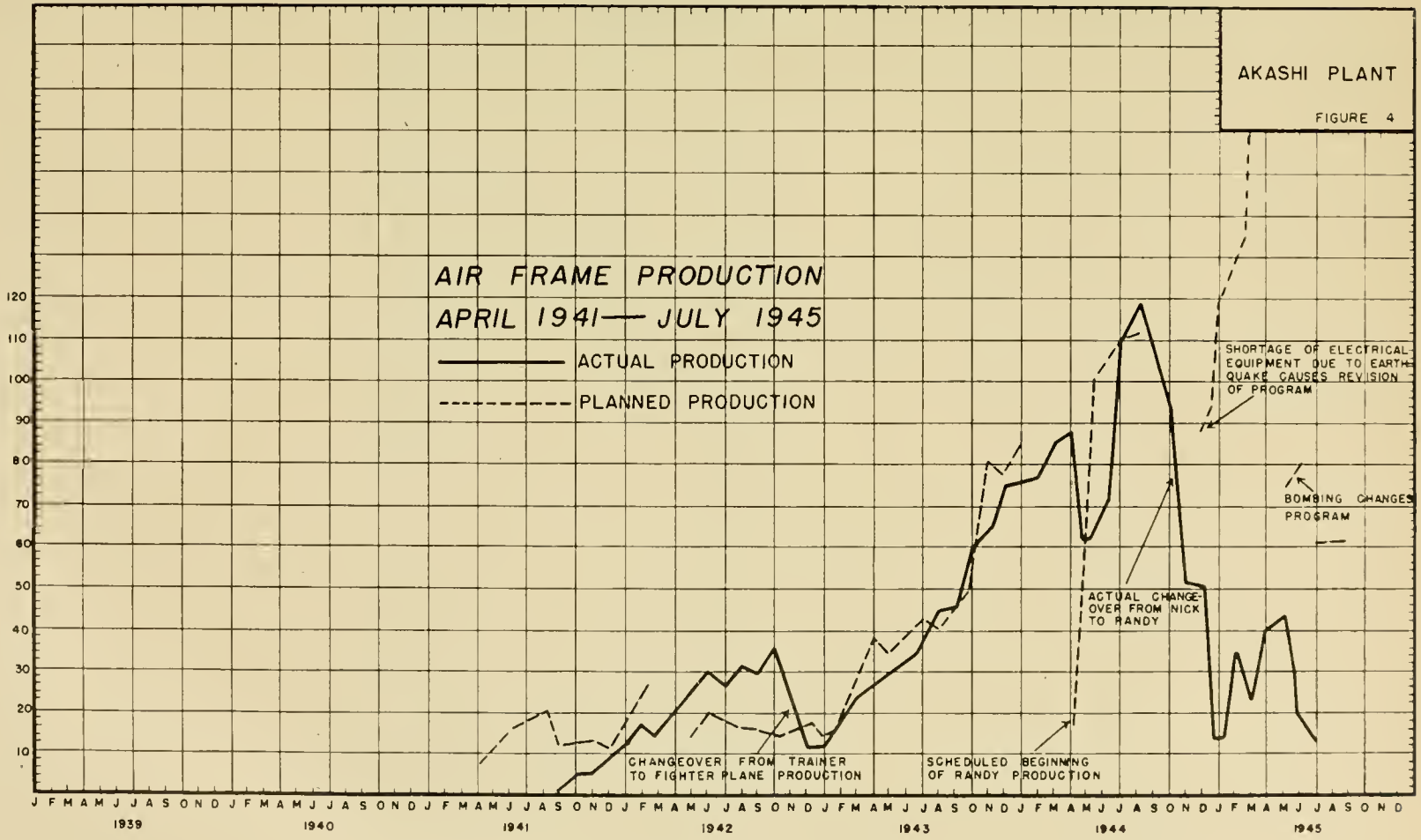
DIVERSION TO EXPERIMENTAL ENGINES

Very little of Akashi's engine facilities was devoted to experimental work beyond some exhaust thrust utilization on the engines used in the fighter Randy. The company preferred to buy foreign designs or produce other Japanese models. Two engines of Ha-240 designation, liquid-cooled and rated at 1,800 horsepower take-off, had been built but failed in tests.

At the end of the war the primary experimental effort of the company was devoted to supercharging the Ha-60, Model 33 liquid-cooled engine of 1,350 horsepower at take-off. No jet or rocket work was done by the company. The Army requested the company to undertake some of this work in 1943 but the company was permitted to refuse the undertaking.

All planes from this works were delivered to the Osaka military air depot. There was no rebuilding or repair of aircraft at Akashi.


AKASHI WORKS
FIGURE 3
ENGINE PRODUCTION
APR. 1940—AUG. 1945
ACTUAL PRODUCTION
PLANNED PRODUCTION
786
MAIN BEARING FAILURE HA-60 MODEL 22
HA-60, MODEL 22 ORDER CUT DUE TO FAILURES IN COMBAT
MAIN BEARING FAILURE HA-60, MODEL 22
HA-60, MODEL 22 PROGRAM BEGINS
SHORTAGE CYLINDER BLOCKS & CRANK CASES HA-60, MODEL 22
OIL SYSTEM TROUBLE HA-60, MODEL 22
BOMBING
0
50
100
150
200
250
300
350
400
450
1939
1940
1941
1942
1943
1944
1945


AKASHI PLANT
FIGURE 4
AIR FRAME PRODUCTION
APRIL 1941— JULY 1945
ACTUAL PRODUCTION
PLANNED PRODUCTION
SHORTAGE OF ELECTRICAL EQUIPMENT DUE TO EARTHQUAKE CAUSES REVISION OF PROGRAM
BOMBING CHANGES PROGRAM
ACTUAL CHANGE-OVER FROM NICK TO RANDY
CHANGEOVER FROM TRAINER TO FIGHTER PLANE PRODUCTION
SCHEDULED BEGINNING OF RANDY PRODUCTION
120
110
100
90
80
70
60
50
40
30
20
10
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941
1942
1943
1944
1945

Attack data

Intelligence data	First attack	Second attack	Third attack
Date and hour of attack	Jan. 19, 1945—1450	June 22, 1945	June 26, 1945.
Duration	1450–1524		
Attacking unit	20th AF	20th AF	20th AF.
Altitude	25,100–27,400	18,000–19,600	16,000–26,200.
Number of aircraft over target.	62	25	31.
HE—Number, weight and type.	620 X, 500-lb.	72 X, 4,000-lb	93 X, 4,000-lb.
HE—Fusing	Inst. nose, non-delay tail.	Inst. nose, non-delay tail.	Inst. nose, non-delay tail.
On-the-ground findings			
HE—Number in plant area.	275	40	14.
HE—Number of building hits.	111	10	7.
HE—Number of UXB	30	0	0.

EFFECTS OF BOMBING

DIRECT ATTACKS

Although production in engines and air frames had started into decline a short time before the B–29s struck, the three smashing raids of 19 January, 22 June and 26 June 1945 achieved the result of preventing any possible recovery. These raids accounted for 485 tons of high explosives in the plant area and severely damaged 3,156,000 square feet of the works' 3,300,000 square feet of factory area.

Parenthetically, it might be noted that a fourth raid on the plant on 8 June 1945, bombing through nine-tenths cloud-cover, which hit only the village of Akashi, killed 104 workers, and seriously injured 83 in their homes.

Heaviest casualties occurred in the 19 January 1945 raid when 268 workers were killed and 99 injured at their machines. Damage to machine tools was light.

The first attack on Akashi, on 19 January 1945 between 1450 and 1524 hours, was in large force. One hundred and fifty-five tons of 500-pound high-explosive bombs were used for blanket disruptive effect. Every important building in the engine and air-frame branches was hit and production in both was cut 90 percent (Appendix E 1). The bombs caused great damage to roofs and disruption to the works; however, machine-tool damage was small; only 3 percent were seriously damaged and 7 percent slightly damaged (Photos 1–3).

In the air-frame division the acetylene tank had been blown off and the plant was forced to adopt electric welding. The heat-treating furnace also was damaged, preventing further hea[t]ment of steel parts after welding was stopped.

Coincidentally with the attack the Army [in]creased orders on the liquid-cooled engine [in]increased demand for the radial Ha–35 Mod[el] of Nakajima design which was to be used i[n] Nakajima suicide plane, Ki 115.

From the 25 airplanes badly damaged by [the] 19 January 1945 raid, enough parts were [ca]nibalized to produce 12 complete planes.

Following this disastrous attack, the comp[any] moved 94 percent of all machine tools to dispe[rse] locations. Therefore, when the 20th Air F[orce] again bombed Akashi in small force on 22 [June] 1945 (Appendix E 2) and again on 26 June [1945] (Appendix E–3) it was attacking what amounte[d] almost an empty plant, intended only for lim[ited] assembly operations. These raids were [with] 4,000-pound high explosives, fuzed instantaneo[usly] for maximum roof damage and blast effects in [and] the buildings. These attacks completed destru[c]tion of the buildings and ended any hope [the] company had for using the Akashi works [for] limited assembly work (Photos 4–9).

The series of raids on the Akashi plant probably knocked out a potential engine production of [150] liquid-cooled engines per month during 1[945]. Under the plan to convert Kawasaki complet[ely] to radial engines of the Ha–35 Model 32 [with] 1,150-horsepower take-off rating, and H[a–43] Model 21, rated at 1,970-horsepower at take-off, a potential of 200 engines per month during [1945] might have been realized. The estimate exclu[des] consideration of the material shortage factor w[hich] might have curtailed production seriously in [late] 1945.

In addition the raids knocked out a potent[ial] production of about 100 twin-engine fighters [per] month during 1945.

All utilities at Akashi had been damaged by the 19 January 1945 raid (Appendix 4). It was [18] February before these, including the st[eam] facilities, had been repaired. In the engine pl[ant] it was 5 March before the planned partial build[ing] repairs had been accomplished. In the air-fra[me] plant temporary repairs were completed by [7] April.

In the engine branch, after repair of the uti[li]ties section, the following repair priorities were placed on buildings: First group—jig and fixtu[re] shop, heat treating and plating shop, assem[bly]

Photo No. 1. Engine plant machine shops damaged by light (500-lb.) HEs of 19 January 1945 raid. Limited structural damage was caused by 22 and 26 June 1945 raids.

PHOTO No. 2.—Detail of engine machi shops damaged by 500-lb. HEs in January 1945 attack. Only 7 percent machinery was damaged. Machinery w removed to disposal sites following tl attack.

PHOTO No. 3. — Looking south toward engine-parts assembly shops. Most damage occurred in 19 January 1945 attack by 500-lb. HEs.

op; second group—machine shop, trial shop, rts-assembly office, shipping shop, hospital, ing room; third group—production office and rehouses.

In the air-frame branch the first priority was en the flight-engineering shop. Here planes re cannibalized and about a dozen were de- ered in this manner in the ensuing months. cond and third priorities were given to the ain assembly shop and parts assembly shop.

All repairs were of a temporary nature; yet 146,790 yen were expended in repairs after the tack of 19 January. Critical building materials the amount of 226 tons were utilized.

OUNTERMEASURES

Air-raid alarms were received by phone from e Akashi post office or through the Osaka oadcasting station. At times alarms would me by phone from the Himeji Army divisional adquarters.

Students and women would be sent from the ildings into the shelters 20 to 30 minutes before e raid was expected to reach the area. Anti- craft personnel would also leave their jobs at e same time. Regular personnel would leave eir work 10 minutes before the attack began. he remaining supervisory staff went to the elters 5 minutes before the appearance of the mbers, while key air-raid wardens stayed at eir posts until the bombs practically were lling.

The evacuation of personnel from the works as scribed above was directed by public address stem and signal flags of different colors. These llow, black, red, and white flags in the order med would correspond to our condition red, ndition green, etc.

After the 19 January raid some attempt was ade to redesign parts of the engine so that manu- cturing man-hours would be decreased. Test nning time also was reduced; the acceptance andards of materials were lowered and some lerances were lowered in the machining of parts.

NTERRUTPIONS DUE TO ALERTS AND AREA ATTACKS.

Since the 19 January attack which stopped roduction at Akashi was also the first raid in the rea, no measureable production loss due to air lerts was experienced. After 19 January, however, area raids retarded recovery and dispersion. Destroyed homes, lack of sleep, transportation disruption, etc., brought about an absentee rate of 8 to 10 percent during this period. The disruption to transportation also slowed the dispersal of tools to new plant sites.

Production never was hampered because of area-power loss. The company had taken the initiative in providing itself with an alternate power source to augment its regular supplier, the Kobe Electric Company. The alternate source of equal output was the Shikima Steam Engine Power Company. The Akashi works also had a stand-by alternating current generator of 35 kilowatts which in emergency could be used for illumination and the public address system.

INTERRUPTIONS DUE TO SUPPLIES

Most of Akashi's suppliers were located in such cities as Osaka, Kobe, Nagoya, and Tokyo, and their destruction would have slowed the Akashi plant in due time. However, Akashi's activities had been so curtailed by the early 19 January 1945 attack that later area raids on the big cities had no measurable effect on its production. However, there were critical shortages in ferrode plate, nitrized steel, intake chambers, crankcases and crankshafts, injection pumps, and flexible pipe, most of which were in short supply all during the war.

In April, May, and June 1944, a local shortage in acetylene gas developed, in addition to shortages in lubricating oils and radiators in the same period.

DISPERSAL

The Akashi engine facilities were dispersed into two locations under the first plan beginning in November 1944. Liquid-cooled engines were to be produced in a spinning mill at Takatsuki and one-radials in a spinning mill at Futami. These facilities totalled about one-half the area of the Akashi plant. The Takatsuki plant had produced 13 engines up to the end of the war and Futami about 1,200 engines.

In the spring of 1945 the Government felt that even more complete dispersion was necessary. As a result, the liquid-cooled engine facilities were in the process of dispersion to a system of tunnels in two forested hills north of Takatsuki (Photos 10–12), and the Futami facilities were moved to a

PHOTOS 4–9.—Views of Akashi plant buildings damaged and destroyed by June 1945 attacks in which 4,000-lb. H fused instantaneously were used.

PHOTO NO. 5.

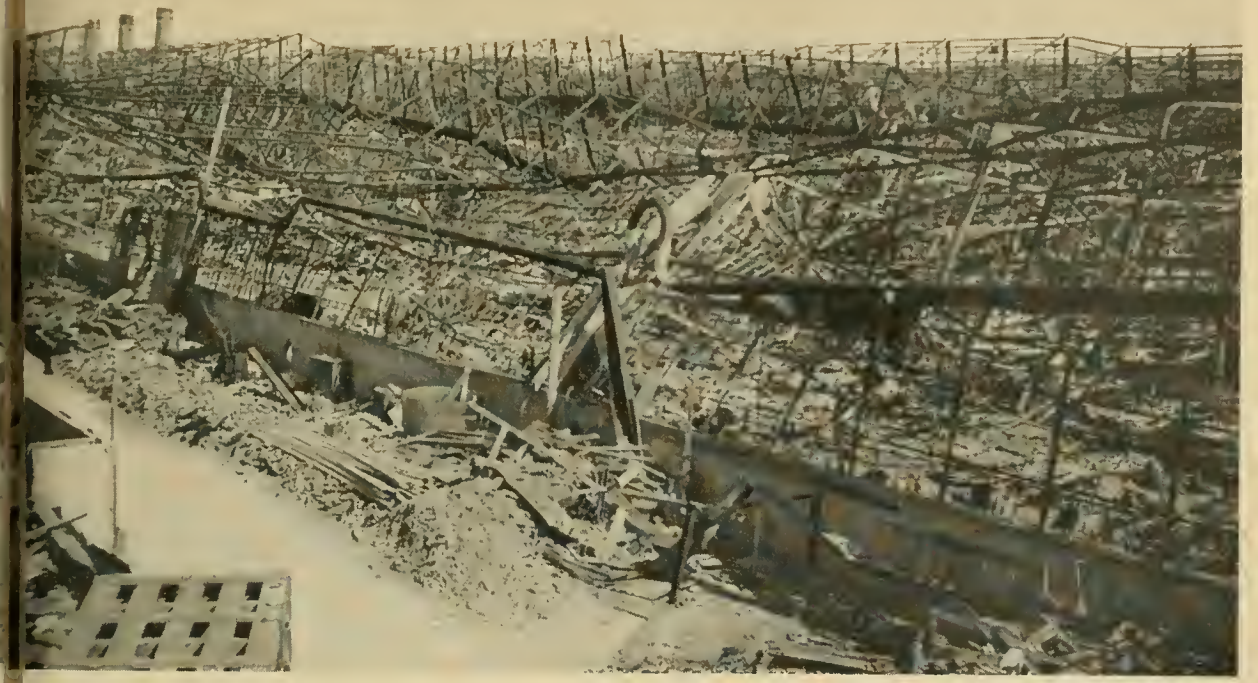


Photo No. 6.

Photo No. 7.

Photo No. 8.

Photo No. 9.

twork of small spinning mills and forest huts ound Ishihara, far back in the hills north of itami. The Takatsuki branch was scheduled r a production of 200 engines per month and the itami branch for 250. Both were scheduled to ch full production under their second dispersion ogram late in 1945 (Fig. 5).

The air-frame division was scheduled to move o a dispersed location at Miki but never was le to carry out the program.

Morale of the workers, who were living in rracks at the dispersed sites without their nilies, was low. Transportation for material d machinery was very difficult. Food was rce at dispersed locations and communications tween plants were frequently cut.

INTELLIGENCE CHECK

War Department Military Intelligence Service -2) monthly production estimates were phenomlly close throughout 1944; however, estimates radial-engine production during 1944 were 80 cent low. Kawasaki had been in production radials throughout 1943 without any estimate MIS during this period.

Monthly estimates on Nick twin-engine fighters re excellent and were within a few percent of ual production.

Photographic intelligence was fairly accurate. wever, the movement of almost all machine ls from the works after the 19 January 1945 d escaped notice. The result was an overimate of the amount of productivity still aining in the works, and the raids of 22 and June with 4,000-pound high-explosives were ost wasted.

VULNERABILITY

Most vulnerable feature of the engine plant loubtedly was its precision machinery in the chine-shop buildings. Failure to damage serily any appreciable percentage of this machinery might eventually have negated the effect of the 19 January raid which put Akashi out of business. The 4,000-pound bombs in quantity, fused for a slight delay, would have been necessary to do this job.

It was mentioned by officials at this plant that the destruction of their heat-treating process and acetylene gas facilities was one of the most effective results of the raids.

GENERAL IMPRESSIONS OF PLANT INSPECTION AND INTERROGATION

Akashi personnel, following the orders of managing director Nemoto, were very cooperative and provided all the requested information as well as certain voluntary material which was not necessary for this report. The interrogations gave the impression of a well-organized but rather inflexible organization dominated by the above-mentioned Nemoto.

The inferior quality of its liquid-cooled engine was the chief factor in the company's failure to account for a larger percentage of the country's total engine and aircraft production. With a good power-plant design staff, and the product which might have resulted therefrom, the company might have accounted for about 25 to 30 percent of the country's engine production rather than 15 percent. There would have been a similar increase in air frame production if Tony had been equipped originally with an air-cooeds engine. This was the result of the company' policy of depending on engines of foreign design.

REFERENCE ITEM

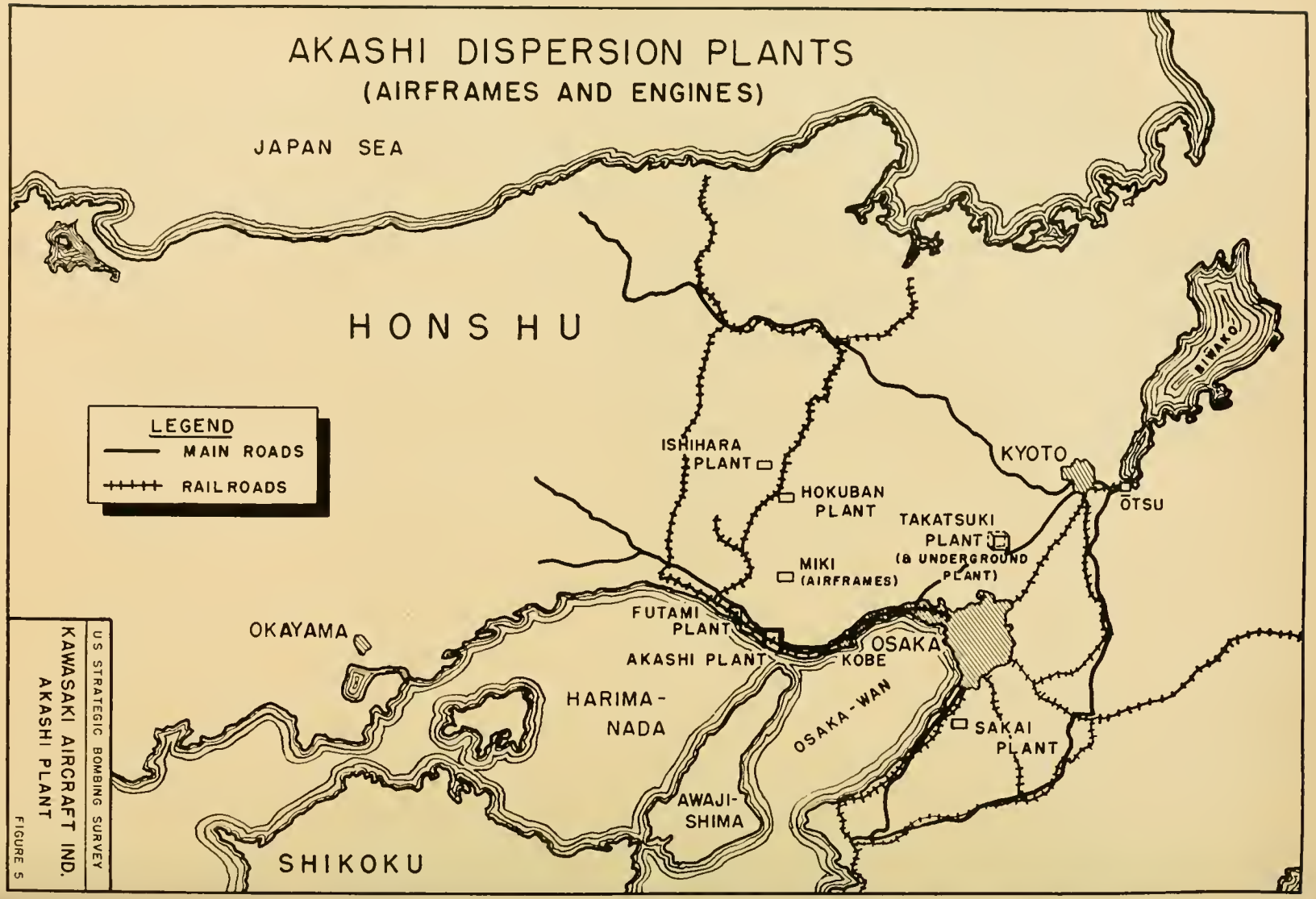
Reference item for this report is filed with the records of the United States Strategic Bombing Survey, War Department, Washington, D. C., care of the Adjutant General.

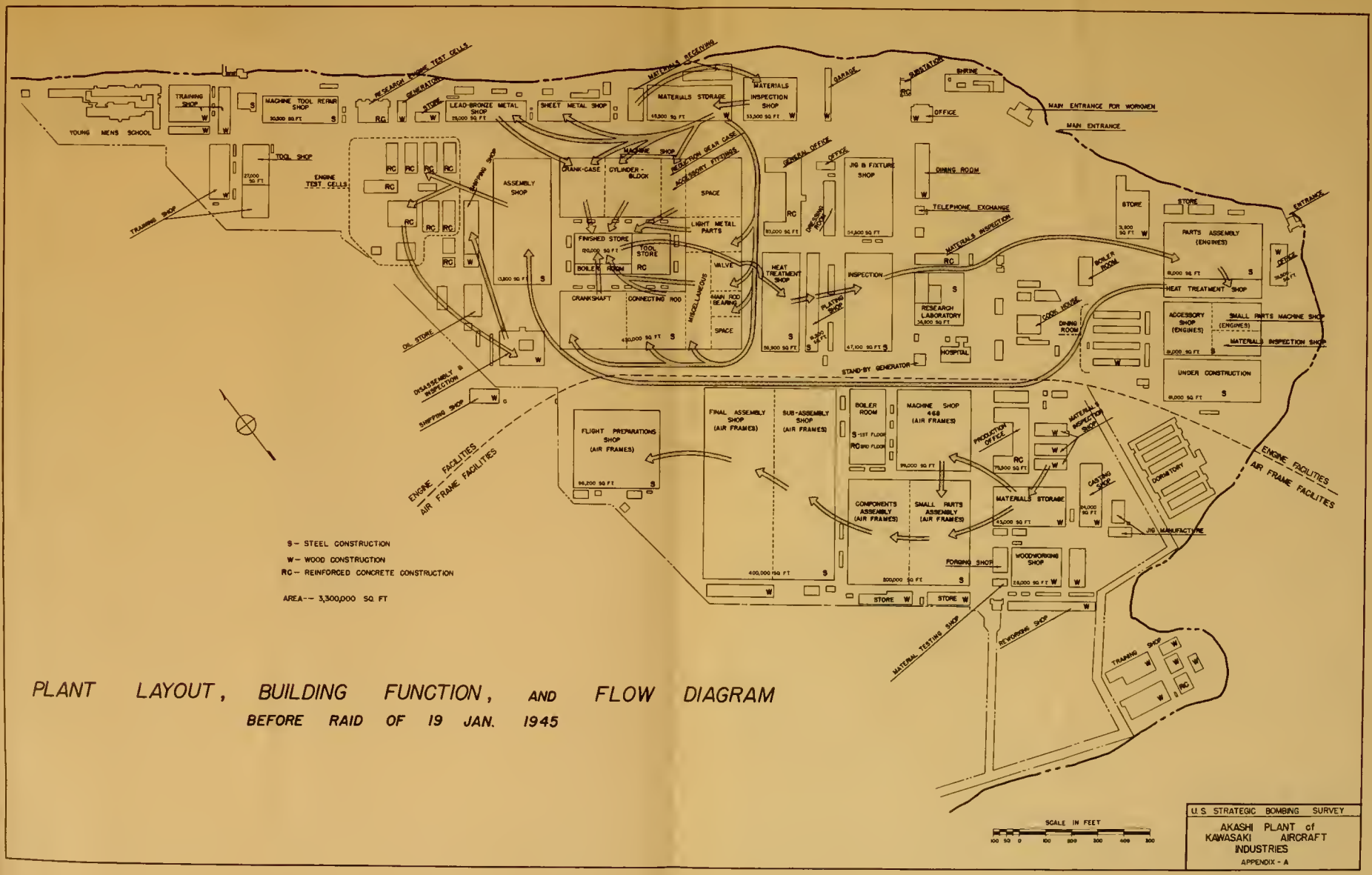
Reference Item 1.—Machine tool damage tables.

Photo No. 10.—Tunnel mouths at Takatsuki underground engine-dispersal plant. Note netting over entrances a crude hoists for handling machinery. Only rough steep trails led to this remote location.

Photo No. 11.—Close-up showing crude construction of Takatsuki tunnels. Most of tunnels were not faced and had b constructed early in war by Korean slave labor as an ammunition dump.

PHOTO 12.—Trellis at Takatsuki for hauling machinery to tunnels.


AKASHI DISPERSION PLANTS
(AIRFRAMES AND ENGINES)
JAPAN SEA
HONSHU
LEGEND
MAIN ROADS
RAILROADS
ISHIHARA PLANT
HOKUBAN PLANT
MIKI (AIRFRAMES)
TAKATSUKI PLANT (& UNDERGROUND PLANT)
KYOTO
OTSU
BIWAKO
FUTAMI PLANT
AKASHI PLANT
OSAKA
KOBE
SAKAI PLANT
OSAKA-WAN
HARIMA-NADA
OKAYAMA
AWAJI-SHIMA
SHIKOKU
U.S. STRATEGIC BOMBING SURVEY
KAWASAKI AIRCRAFT IND.
AKASHI PLANT
FIGURE 5



PLANT LAYOUT, BUILDING FUNCTION, AND FLOW DIAGRAM

BEFORE RAID OF 19 JAN. 1945

U.S. STRATEGIC BOMBING SURVEY

AKASHI PLANT of KAWASAKI AIRCRAFT INDUSTRIES

APPENDIX - A

716941 O - 47 (Face p. 58)

APPENDIX B

ORGANIZATION CHART

AKASHI PLANT

Masayoki Nemoto, *Manager*

orporation head office—Masayoki Nemoto *Chief.*

Deputy of general affairs, finance, headquarters of technical director.

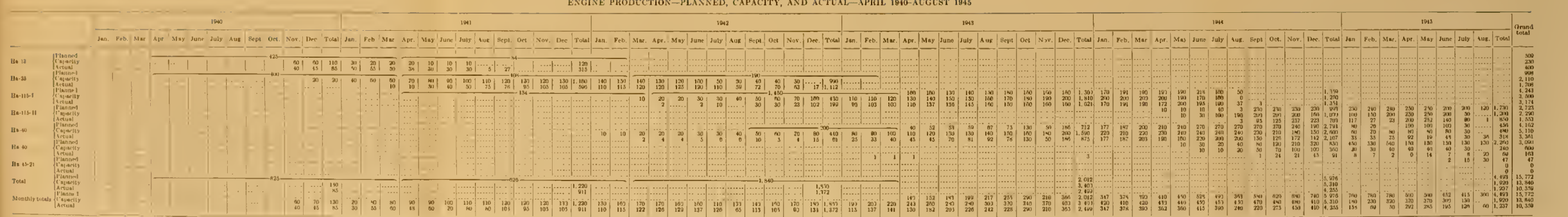
Head office engine division:

Akashi—Planning, equipment, production, technical, inspection, Takatsuki plant, Futami plant, Hokuban plant, Kobe casting and forging plant, Saka casting and lead-bronze plant.

NOTE: For organization chart of Akashi division see Kagamigahara plant report.

APPENDIX C

ENGINE PRODUCTION—PLANNED, CAPACITY, AND ACTUAL—APRIL 1940–AUGUST 1945

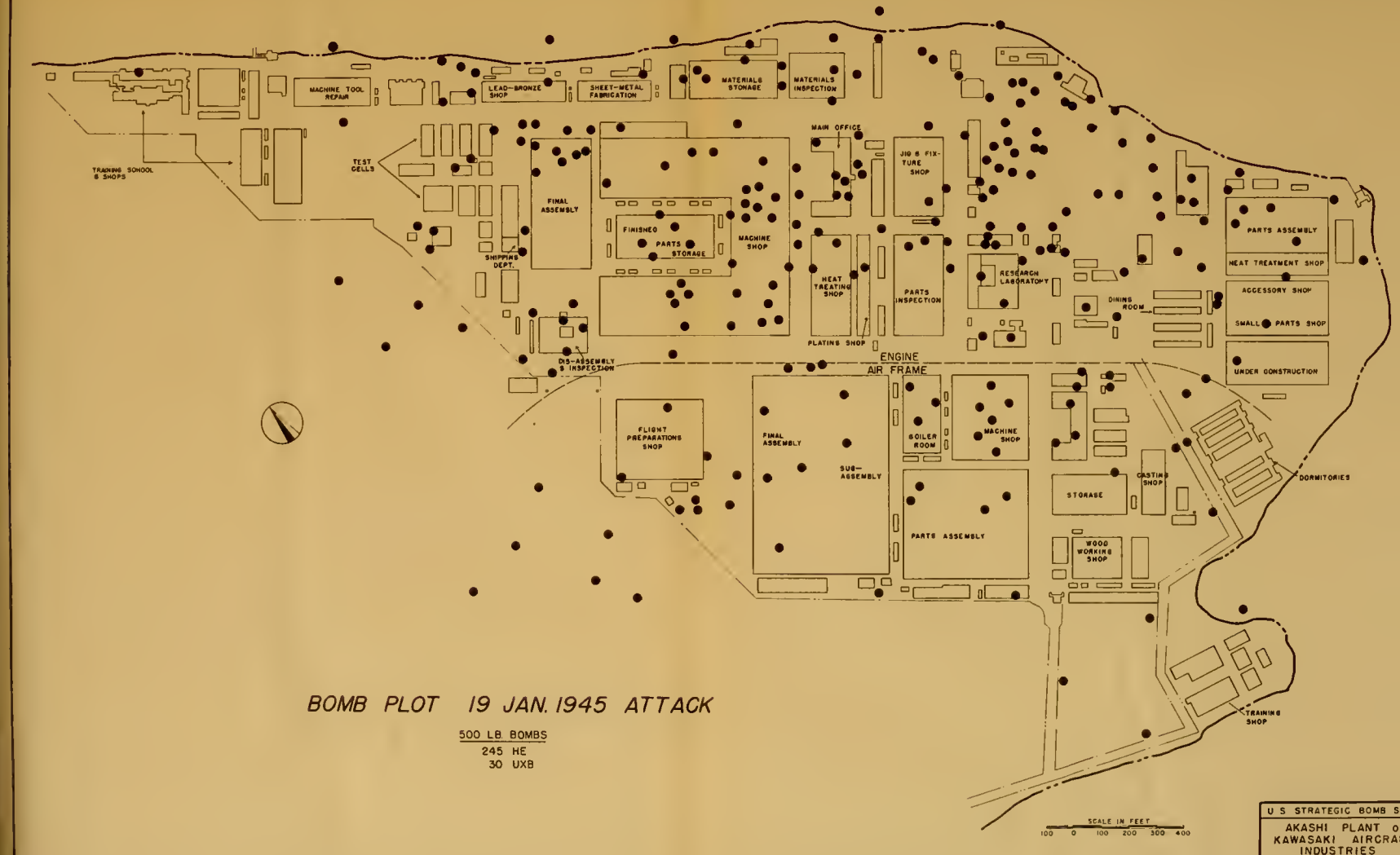


APPENDIX D

KAWASAKI AIRCRAFT INDUSTRIES CO., LTD.—AKASHI AIRPLANE PLANT—AIRFRAME PRODUCTION—PLANNED AND ACTUAL—SEPTEMBER 1941-SEPTEMBER 1945

		1941					1942												1943												1944												1945												Grand total
		Sept.	Oct.	Nov.	Dec.	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Total	
Ki-55	Planned	(52)				-95									-105																																						
	Actual	1	0	5	9	15	12	17	14	18	29	27	24	27	24	31	20	236																																				25
Ki-56	Planned	(18)				-21									-31								10	10	10	10					40																							1[illegible]
	Actual									1	2	3	3	4	4	5	6	7	35	7	8	8	8	8	9	7	9				64																									9[illegible]
Ki-45	Planned														-72								(36)								-643																					1,02
	Actual														1	0	0	5	6	5	10	15	19	21	23	30	36	45	60	63	75	402	76	78	86	{(63) 15}	73	83	48	6	12	16	17	18	288	20													21	89
Ki-45N	Planned																																			10	20	59	102	88	65	38		382																38
	Actual																																		1	22	42	80	102	95	78	40	13	473															47
Ki-102A0	Planned																																											13														1
	Actual																																			(1)	(2)	(3)	(4)	(3)	4	2		13																3
Ki-102B	Planned																																										300														86
	Actual																																									4	2		13													
Ki-102A	Planned																																									(2)	(15)	(40)	(70)	300	(100)	{(73) 57}	180	50	50	50	60	60	60	567	86
	Actual																																									3	7	36	46	12	32	23	38	38	14	12	0		169	21
	Planned																																														12	25	50					67	6
	Actual																																														0	0	0					0	
Total	Planned					-185									-208																-996														-927									-397		2,71
	Actual	1	0	5	9	15	12	17	14	19	31	30	27	31	29	36	26	12	277	12	18	23	27	29	32	37	45	45	60	63	75	466	76	78	86	88	62	70	111	119	109	97	51	50	997	14	34	24	42	44	18	14	0		190	1,94
Monthly totals.	Planned																																																					
	Actual																																																					

Figures in parentheses represent planned production carried forward from previous fiscal year.



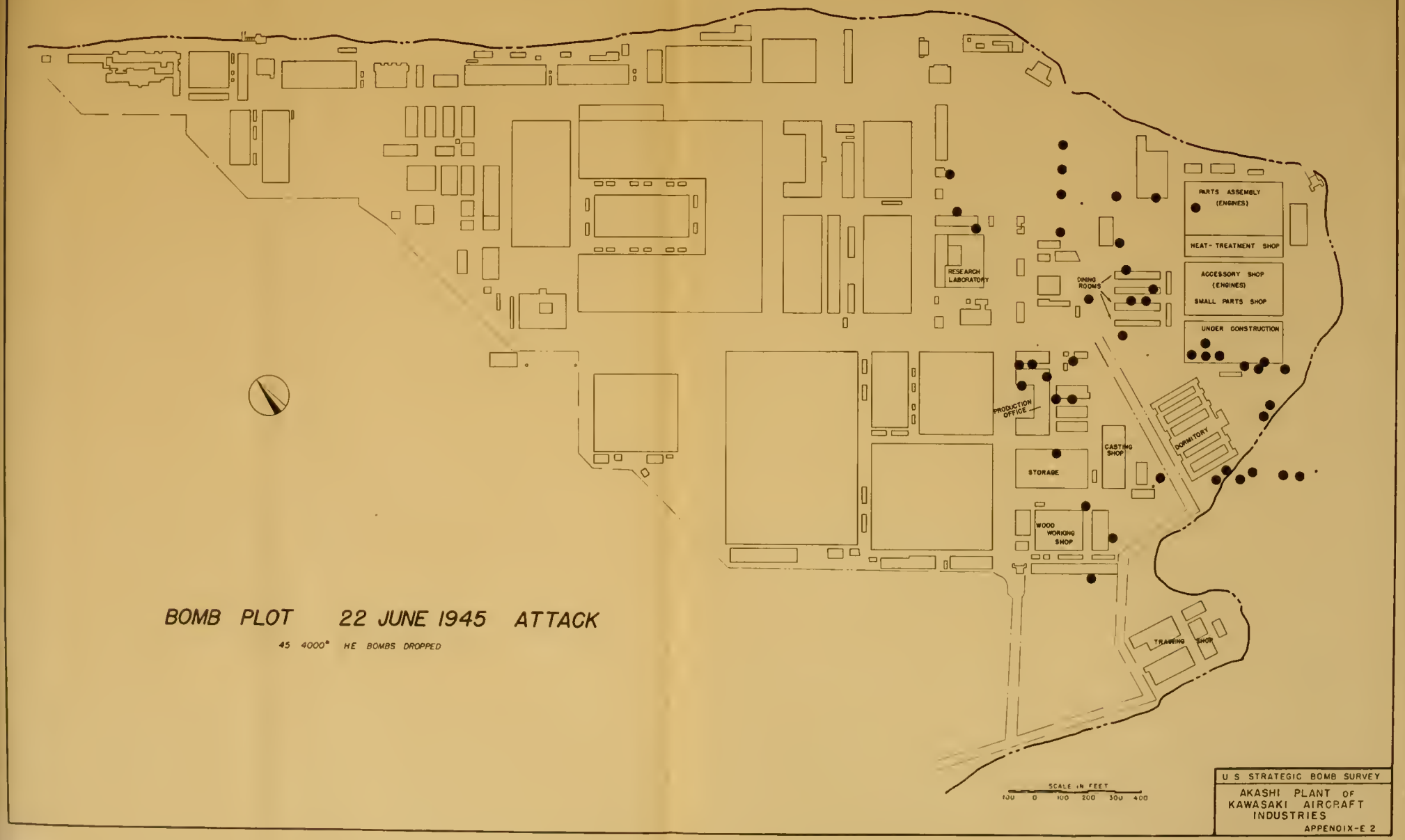
BOMB PLOT 19 JAN. 1945 ATTACK

500 LB BOMBS
245 HE
30 UXB

U S STRATEGIC BOMB SU

AKASHI PLANT OF KAWASAKI AIRCRAF INDUSTRIES

APPENDIX



BOMB PLOT 22 JUNE 1945 ATTACK

45 4000# HE BOMBS DROPPED

U S STRATEGIC BOMB SURVEY

AKASHI PLANT OF KAWASAKI AIRCRAFT INDUSTRIES

APPENDIX-E 2

T16941 O - 47 (Face p. 58) No. 4

BOMB PLOT 26 JUNE 1945 ATTACK

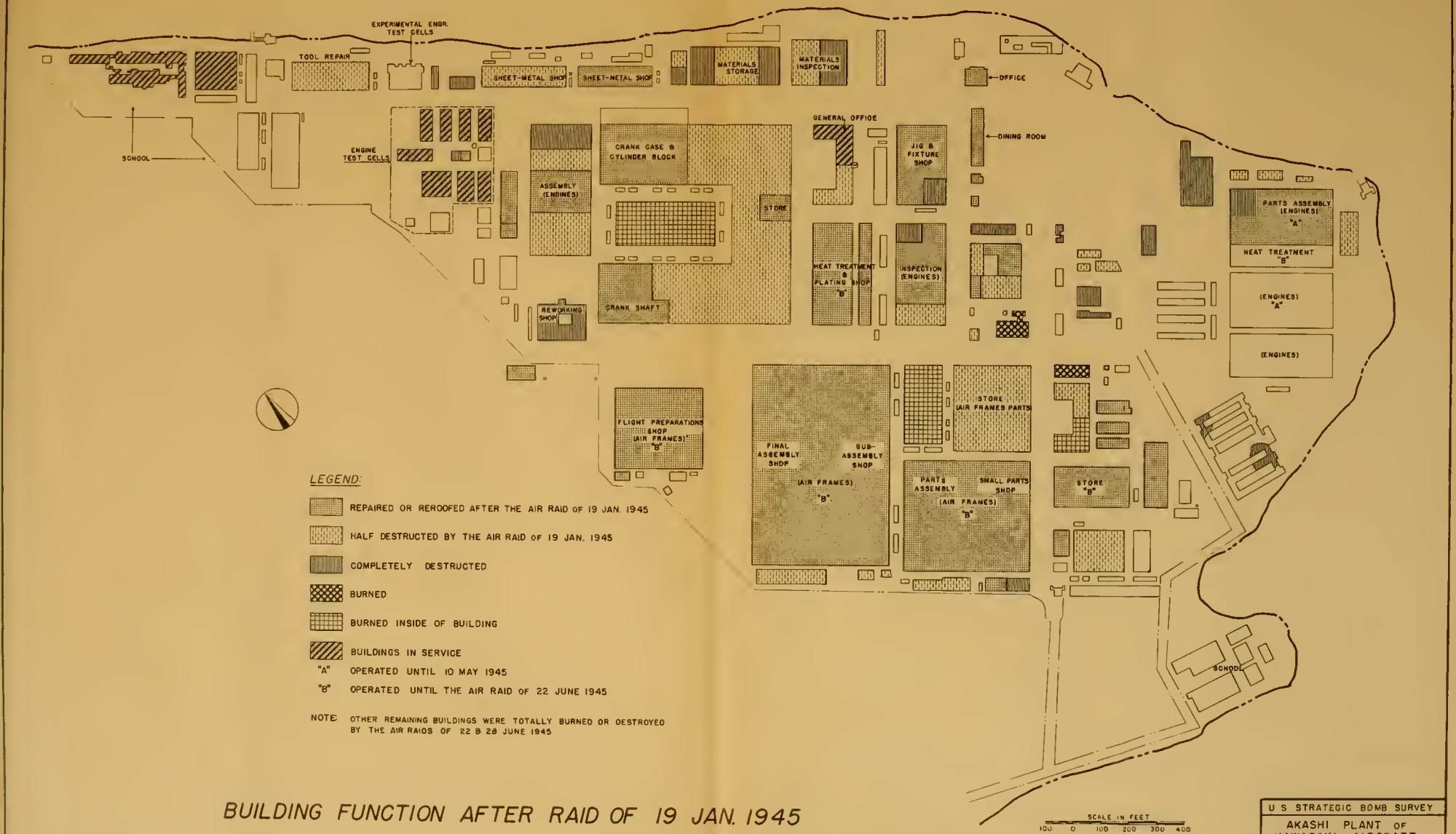
20 4000# HE BOMBS DROPPED

U S STRATEGIC BOMB SURVEY

AKASHI PLANT OF KAWASAKI AIRCRAFT INDUSTRIES

APPENDIX-E 3

716941 O - 47 (Face p. 58) No. 5



BUILDING FUNCTION AFTER RAID OF 19 JAN. 1945

U S STRATEGIC BOMB SURVEY

AKASHI PLANT OF KAWASAKI AIRCRAFT INDUSTRIES

APPENDIX E-4

718941 O - 47 (Face p. 58) No. 8

UNITED STATES STRATEGIC BOMBING SURVEY

LIST OF REPORTS

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

European War

OFFICE OF THE CHAIRMAN

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

AIRCRAFT DIVISION

(By Division and Branch)

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

Airframes Branch

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

Aero Engines Branch

5 Bussing NAG Flugmotorenwerke G m b H, Brunswick, Germany
6 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
Bavarian Motor Works Inc, Eisenach & Durrerhof, Germany
8 Bayerische Motorenwerke A G (BMW), Munich, Germany
9 Henschel Flugmotorenwerke, Kassel, Germany

Light Metal Branch

0 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 Giulini G m b H, Ludwigshafen, Germany
25 Luftschiffbau, Zeppelin G m b H, Friedrichshafen on Bodensee, Germany
26 Wieland Werke A G, Ulm, Germany
27 Rudolph Rautenbach Leichmetallgiessereien, Solingen, Germany
28 Lippewerke Vereinigte Aluminiumwerke A G, Lunen, Germany
29 Vereinigte Deutsche Metallwerke, Heddernheim, Germany
30 Duerener Metallwerke A G, Duren Wittenau-Berlin & Waren, Germany

AREA STUDIES DIVISION

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

CIVILIAN DEFENSE DIVISION

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

EQUIPMENT DIVISION

Electrical Branch

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

Optical and Precision Instrument Branch

*50 Optical and Precision Instrument Industry Report

Abrasives Branch

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

Anti-Friction Branch

*53 The German Anti-Friction Bearings Industry

Machine Tools Branch

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

MILITARY ANALYSIS DIVISION

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

MORALE DIVISION

*64b The Effects of Strategic Bombing on German Morale (Vol. I and 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-Nurnberg, Nurnberg, Germany
84 Auto Union A G, Chemnitz and Zwickau, Germany
85 Henschel & Sohn, Kassel, Germany
86 Maybach Motor Works, Friedrichshafen, Germany
87 Voigtlander, Maschinenfabrik A G, Plauen, Germany
88 Volkswagenwerke, Fallersleben, Germany
89 Bussing NAG, Brunswick, Germany
90 Muehlenbau Industrie A G (Miag) Brunswick, Germany
91 Friedrich Krupp Grusonwerke, Magdeburg, Germany

Submarine Branch

92 German Submarine Industry Report
93 Maschinenfabrik Augsburg-Nurnberg A G, Au burg, Germany
94 Blohm and Voss Shipyards, Hamburg, Germany
95 Deutschewerke A G, Kiel, Germany
96 Deutsche Schiff und Maschinenbau, Bremen, G many
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, Magdeb Germany
103 Bochumer Verein fuer Gusstahlfabrikation A Bochum, Germany
104 Henschel & Sohn, Kassel, Germany
105 Rheinmetall-Borsig, Dusseldorf, Germany
106 Hermann Goering Werke, Braunschweig, Hallen Germany
107 Hannoverische Maschinenbau, Hanover, Germa
108 Gusstahlfabrik Friedrich Krupp, Essen, German

OIL DIVISION

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

Oil Branch

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

Rubber Branch

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

Propellants Branch

80 Elektrochemischewerke, Munich, Germany
81 Schoenebeck Explosive Plant, Lignose Sprengstoff Werke G m b H, Bad Salzemen, Germany
82 Plants of Dynamit A G, Vormal, Alfred Nobel & Co, Troisdorf, Clausthal, Drummel and Duneberg, Germany
83 Deutsche Sprengchemie G m b H, Kraiburg, Germany

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1 Over-all Economic Effects Division Report
Gross National Product } Special papers which together comprise the above report
Kriegseilberichte
Herman Goering Works
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4a Industrial Sales Output and Productivity

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1b Physical Damage Division Report (ETO)
5 Villacoublay Airdrome, Paris, France
6 Railroad Repair Yards, Malines, Belgium
7 Railroad Repair Yards, Louvain, Belgium
8 Railroad Repair Yards, Hasselt, Belgium
9 Railroad Repair Yards, Namur, Belgium
0 Submarine Pens, Brest, France
1 Powder Plant, Angouleme, France
2 Powder Plant, Bergerac, France
3 Coking Plants, Montigny & Liege, Belgium
4 Fort St. Blaise Verdun Group, Metz, France
5 Gnome et Rhone, Limoges, France
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0 S. N. C. A. S. E. Aircraft Plant, Toulouse, France
1 A. I. A. Aircraft Plant, Toulouse, France
2 V Weapons in London
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6 Brauweiler Transformer & Switching Station, Brauweiler, Germany
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8 Railway and Road Bridge, Bad Munster, Germany
9 Railway Bridge, Eller, Germany
0 Gustloff-Werke Weimar, Weimar, Germany
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2 Area Survey at Pirmasens, Germany
3 Hanomag, Hanover, Germany
4 M A N Werke Augsburg, Augsburg, Germany
5 Friedrich Krupp A G, Essen, Germany
6 Erla Maschinenwerke, G m b H, Heiterblick, Germany
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8 Erla Maschinenwerke G m b H, Mockau, Germany
9 Bayerische Motorenwerke, Durrerhof, Germany
0 Mittel-Deutsche Motorenwerke G m b H, Taucha, Germany
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Ammoniawerke, Merseburg-Leuna, Germany
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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 Farbendustrie, Leverkusen, Germany
197 Chemische-Werke, Huels, Germany
198 Gremberg Marshalling Yard, Gremberg, Germany
199 Locomotive Shops and Bridges at Hamm, Germany

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*200 The Effects of Strategic Bombing on German Transportation
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

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*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

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

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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

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

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*14 The Effects of Strategic Bombing on Japanese Morale

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*15 The Japanese Aircraft Industry

*16 Mitsubishi Heavy Industries, Ltd.
Corporation Report No. I
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*17 Nakajima Aircraft Company, Ltd.
Corporation Report No. II
(Nakajima Hikoki KK)
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*18 Kawanishi Aircraft Company
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(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
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(Aichi Kokuki KK)
(Airframes & Engines)

*21 Sumitomo Metal Industries, Propeller Division
Corporation Report No. VI
(Sumitomo Kinzoku Kogyo KK, Puropera Seizosho)
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*22 Hitachi Aircraft Company
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(Hitachi Kokuki KK)
(Airframes & Engines)

*23 Japan International Air Industries, Ltd.
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(Nippon Kokusai Koku Kogyo KK)
(Airframes)

*24 Japan Musical Instrument Manufacturing Company
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(Nippon Gakki Seizo KK)
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*25 Tachikawa Aircraft Company
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(Tachikawa Hikoki KK)
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*26 Fuji Airplane Company
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(Airframes)

*27 Showa Airplane Company
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(Showa Hikoki Kogyo KK)
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*28 Ishikawajima Aircraft Industries Company, Ltd.
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*29 Nippon Airplane Company
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(Nippon Hikoki KK)
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*30 Kyushu Airplane Company
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*31 Shoda Engineering Company
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*32 Mitaka Aircraft Industries
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*33 Nissan Automobile Company
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*34 Army Air Arsenal & Navy Air Depots
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*36 Coal and Metals in Japan's War Economy

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*37 The Japanese Construction Industry
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50 Chemicals in Japan's War—Appendix
51 Oil in Japan's War
52 Oil in Japan's War—Appendix

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*53 The Effects of Strategic Bombing on Japan's V
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*54 The War Against Japanese Transportation, 19
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*55 Effects of Air Attack on Japanese Urban Econo
(Summary Report)
*56 Effects of Air Attack on Urban Complex Tok
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
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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

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73 Campaigns of the Pacific War
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75 The Allied Campaign Against Rabaul
76 The American Campaign Against Wotje, Maloelap, 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

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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)

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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*

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