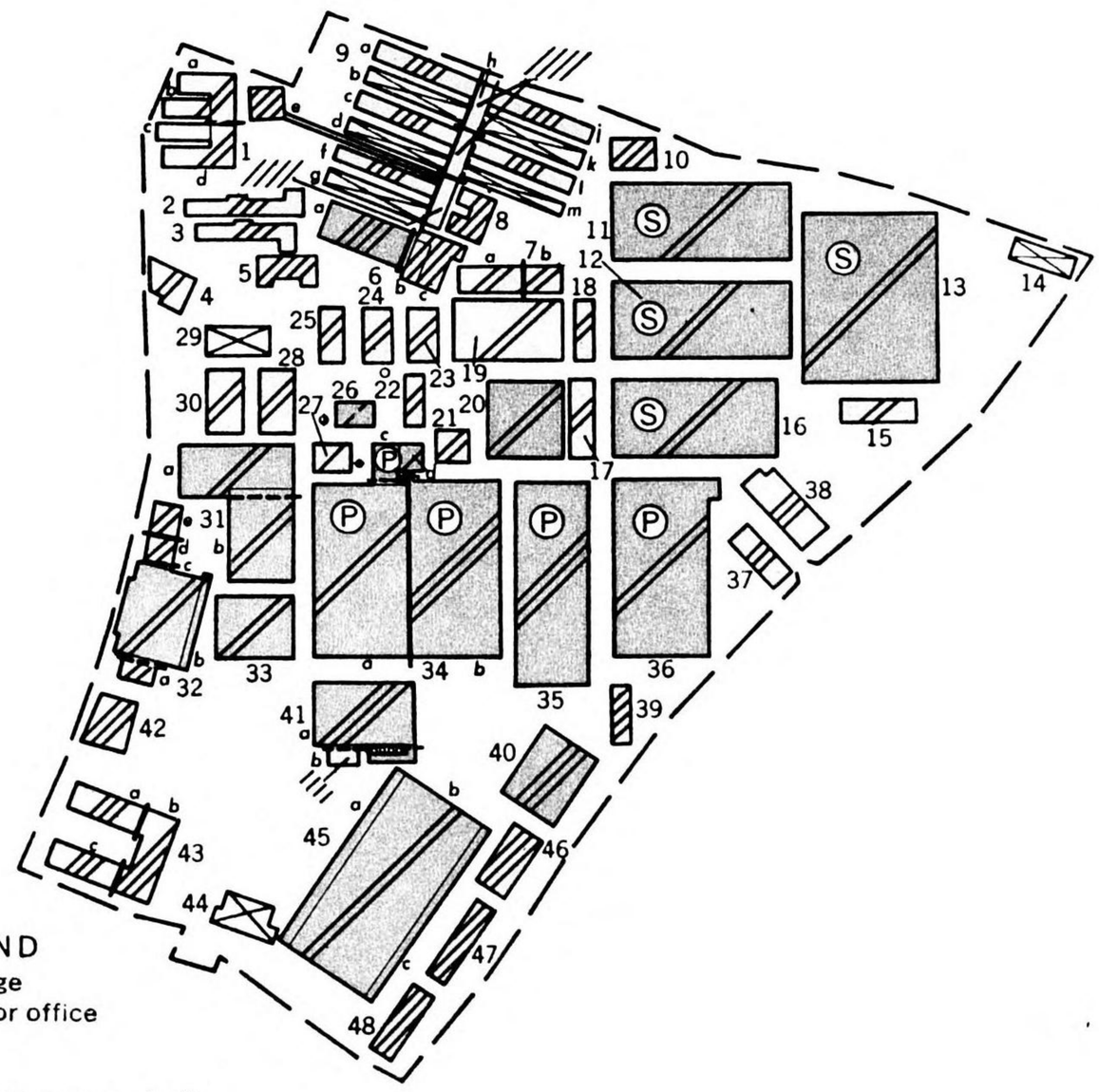
JOINT TARGET GROUP WASHINGTON D.C.

CONFIDENTIAL

KAWANISHI AIRCRAFT,
HIMEJI PLANT,
HIMEJI, JAPAN

ILLUSTRATION 90.27-2047-P5
DATE 14 May 1945
TARGET 90.27-2047
COORDINATES 34°50'N 134°43'E
PHOTOGRAPHED 20 Jan 1945 and 2 April 1945

SCALE 1:6,000
500 0 500 1000 FEET



LEGEND

1 Possible storage
2,3 Quarters and/or office
4 Unidentified
5 Office
6 Possible canteen or mess hall
7 Unidentified
8 Office
9 Workers' quarters
10 Storage
11 Metal shaping, cutting, etc.
12,13 Small parts manufacture, bench work
14 Storage
15 Unidentified
16 Small parts manufacture, bench work
17,18 Storage
19,20 Machine shop
21 Storage
22 Unidentified
23-25 Storage
26 Boiler house
27,28 Storage
29 Office
30 Storage
31a Shop
31b Machine shop
32 Warehouse
33 Shop
P 34a Sub-assembly
P 34b Major and final assembly
P 34c Unidentified
P 35 Major and final assembly
P 36 Sub-assembly
37 Garage
38 Storage
39 Office
40 Post assembly
41 Possible paint shop
42 Storage
43 Unidentified
44 Storage
45 Final and post assembly
46-48 Storage

P denotes Primary Buildings

NOTE:
⊠ Buildings Removed.
Figures below do not include those for Buildings Removed.

FIRE SUSCEPTIBILITY PLAN

PRIMARY BUILDINGS	Ⓟ	FIRE WALL, CERTAIN	
SECONDARY BUILDINGS	Ⓢ	FIRE WALL, PROBABLE	

BUILDINGS		CONTENTS	
COMBUSTIBLE		SUSCEPTIBILITY TO INCENDIARIES:	
NON-COMBUSTIBLE		NONE	
		POOR	
		FAIR	
		GOOD	
WATER TANK	Ⓦ	EXCELLENT	

AREA IN SQ. FT.	PRIMARY	SECONDARY	ALL BLDGS. SHOWN
NO. OF BUILDINGS	3	4	46
NO. OF FIRE DIVISIONS	5	4	66
PLAN AREA	216,900	209,100	913,900
TOTAL FLOOR AREA	225,000	209,100	1,040,600
SITE AREA	2,110,000		

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T A R G E T I N F O R M A T I O N S H E E T

Ref: Obj. Folder
Kure (90.30)
22 August 1944

Place: Kure
Obj. Area: 90.30
Category: Aircraft

Lat.: 34°13' N
Long: 132°37' E
Alt.: 10 feet

HIRO NAVAL AIRCRAFT FACTORY

AAF TARGET No. 90.30-660

T I S

ALL PREVIOUS SHEETS CANCELLED

NOTE: As an aid to planning, and evaluation of new reconnaissance and other intelligence, this TARGET INFORMATION SHEET is issued in advance of reconnaissance photography of the target. It is correspondingly subject to revision.

SIGNIFICANCE: This plant is a major repair and maintenance depot for land and floatplanes, but also produces a small number of planes and engines, and manufactures some components.

LOCATION: This plant is at Hiro, about 4 miles E of the Kure Naval Arsenal. It is S of the Hiro Arsenal and located on reclaimed land on the coast.

DESCRIPTION: The layout and precise location of this plant are not known, and general intelligence is very fragmentary. No photos or maps are available.

CRITICAL POINTS: (See above).

JOINT TARGET GROUP, WASHINGTON, D. C.

TARGET INFORMATION SHEET

SHEET . . . 90:33-1306—TI
DATE . . . . . 26 May 1945
PAGE 1

TARGET 90:33-1306
OBJ. AREA 90:33
OBJ. FOLDER
90:33; 90:37; 90:38
CATEGORY
End Prdt. Ind.—Aircraft

LAT. . . . . 32° 58′ N
LONG. . . . . 131° 55′ E
ALT. . . . . 15 feet

SAEKI NAVAL AIR STATION

SAEKI **JAPAN**

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-1306 material.

SIGNIFICANCE

A complete modern airbase and supply depot and a replacement shop for naval planes, with facilities for heavy seaplanes, floatplanes and medium land-based planes, now of reduced importance because of damage suffered by air attacks. Reported also engaged in navy land-based and floatplane training. Attacked by both B-29's and carrier-based planes. Photograph of 21 April shows damage or removal of 15 of the 89 buildings observed on 1 January, including all of the major hangars. The damage does not appear to be such as to interfere with the supply depot operations.

LOCATION

(Refer to Illustration No. 90:33-1306 P2.) On Saeki Bay about 10 miles W of Tsurumi Point, the easternmost tip of Kyushu. It is situated for the most part on two islands, E of the town of Saeki, separated by the Bansho, Nakaye and Nagashima Rivers. There are storage areas along the mainland bank of the Nagashima River, the westernmost of the three. The main railroad around E Kyushu skirts a hill W of the target and town and a spur runs to the main warehouse area.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90:33-1306 P4.) The easternmost island between the Bansho and Nakaye Rivers is known as Mejima and used for land based planes. An airfield occupies the N half, with four maintenance hangars (62, 64, 65, 66, all damaged by 21 April) and an operations and control tower (62) on the western edge of the field. The S half of the island is principally an aircraft dispersal area, with fairly extensive warehouse facilities near its S tip.

A seaplane base is W of the airfield on an island known as Nagashima between the Nakaye and Nagashima Rivers. Maintenance seaplane hangars (33, 34, damaged by 21 April) and a concrete apron (32) adjoin Saeki Bay. The N part of Nagashima also contains headquarters buildings (25-27), a radio station (44), and extensive storage facilities (especially 46-58). Two boat basins where over 40 lighters and other craft have from time to time been observed, are on either side of the Nagashima River mouth.

The extensive storage facilities confirm the target's use as a major supply depot. Shortage of shops, however, suggests that repairs, overhaul, and modification are not a major activity. Building 28 near the headquarters building is the only one which appears to be a machine shop.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90:33-1306 P4.) With all important hangars damaged by 21 April, the machine shop, building 28, constitutes the primary objective. Secondary targets include the concentrated storage facilities to the S of the seaplane base (buildings 46-58).

CONSTRUCTION AND VULNERABILITY

Hangars are long span, gable roofed structures, damage cover indicating heavy wood frame construction sheathed with corrugated asbestos. HE vulnerability classification is V5 (see JTG/M-3/1). Storage structures are predominantly one-story, wood frame buildings of short to medium span, HE vulnerability classification being V4. Buildings are dispersed in small to moderate sized groups over a large area.

WEAPON RECOMMENDATIONS

(Refer to Illustration No. 90:33-1306 P4.) Instructions with regard to weapons will usually be given in Field or Operational Orders, but in the absence of such instructions and to assist Planners in formulating such orders the following information is given: (Reference should also be made to General Analysis of Typical Military Targets, Part I, Airfields, published by JTG on 28 February 1945.)

Main Buildings (1-66)

An attack with a combination of incendiary and high explosive bombs is recommended, with incendiaries as the major weapon (high explosive bombs should not exceed 25 percent of the total load). A preliminary structural and occupancy analysis indicates weapons should be selected as follows:

	High Explosive	Fuzing	Incendiary
Preferred:	1000-lb GP or 2000-lb GP or 500-lb GP	0.01 N/ND T (8-15 sec T fuzes for minimum altitude attacks)	AN-M50 4-lb or AN-M69 6-lb (in aimable clusters for high altitude attack)
Alternative:	250-lb GP	0.01 N/ND T (8-15 sec T fuzes for minimum altitude attacks)	AN-M47 70-lb AN-M76 500-lb Fire bombs (Napalm filled gas tanks)

Not recommended: 100-lb GP
SAP or AP bombs
Depth bombs

Note: (a) If 0.01 N fuzes are not available, use either 0.1 or 0.025 N, and if ND T fuzes are not available, use 0.01 T. ND T fuzing is recommended as the hangars and shops have light roofs and are best destroyed by blast effects.

(b) The above recommendations are on a weight for weight basis.

(c) Fire bombs are recommended as alternative selections for low altitude attacks only.

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TARGET INFORMATION SHEET

Airfield (67)

	High Explosive	Fuzing	Incendiary
Preferred:	100-lb GP or 250-lb GP or 500-lb GP	0.1N/0.025 T and none/LD T	No incendiaries are recommended
Alternative:	1000-lb GP	0.1 N/0.025 T and none/LD T	
Not recommended:	2000-lb GP SAP or AP bombs Depth bombs		

Note: (a) The above fuzings are designed to crater and deny the enemy the use of the airfield. LD T fuzes should be set for 2-24 hour delays.

(b) Above recommendations are on a weight for weight basis.

Ammunition Dump (68) and Aircraft Dispersal Area (69)

	High Explosive	Fuzing	Incendiary
Preferred:	Strafing (minimum altitude only) 20-lb Frag	inst. N/none	AN-M50 4-lb or AN-M69 6-lb. Incendiaries are recommended against the ammunition dump only.
Alternative:	Rockets (minimum altitude only) 100-lb GP	inst. N/NDT	
Not recommended:	Other GP bombs SAP or AP bombs Depth bombs		

Note: (a) The above recommendations are on a weight for weight basis.

(b) Grounded aircraft probably will be found in most of the uncovered revetments within dispersal area.

Warehouse Area (70-89)

An attack with a combination of incendiary and high explosive bombs is recommended, with incendiaries as the major weapon (high explosive bombs should not exceed 25 percent of the total load). Weapons should be selected as follows:

	High Explosives	Fuzing	Incendiary
Preferred:	500-lb GP or 1000-lb GP	0.01 N/ND T	AN-M50 4-lb or AN-M69 6-lb (in aimable clusters for high altitude attack)
Alternative:	250-lb GP or 2000-lb GP	0.01 N/ND T	AN-M47 70-lb Fire bombs (napalm filled gas tanks)
Not recommended:	100-lb GP SAP or AP bombs Depth bombs		AN-M76 500-lb

Note: (a) If 0.01 N fuzes are not available, use either 0.1 or 0.025 N, and if ND T fuzes are not available, use 0.01 T. ND fuzing is recommended as the warehouses are best destroyed by blast effects.

(b) The above recommendations are on a weight for weight basis.

(c) Fire bombs are recommended as an alternative selection for low altitude attack only.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Photography of 1 January, 28 March and 21 April 1945 indicates no camouflage, decoys, or smoke screens.

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft after 90:33-1306 TI page 1.

JOINT
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WASHINGTON, D. C.

SAEKI NAVAL AIR STATION

SAEKI **JAPAN**

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

RESTRICTED

ILLUSTRATION	**90:33-1306 P1**
DATE	**26 May 1945**
TARGET	**90:33-1306**
COORDINATES	**32° 58'N 131° 55'E**
PHOTOGRAPHED	**1 January 1945**

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft.

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JOINT TARGET GROUP
WASHINGTON, D. C.

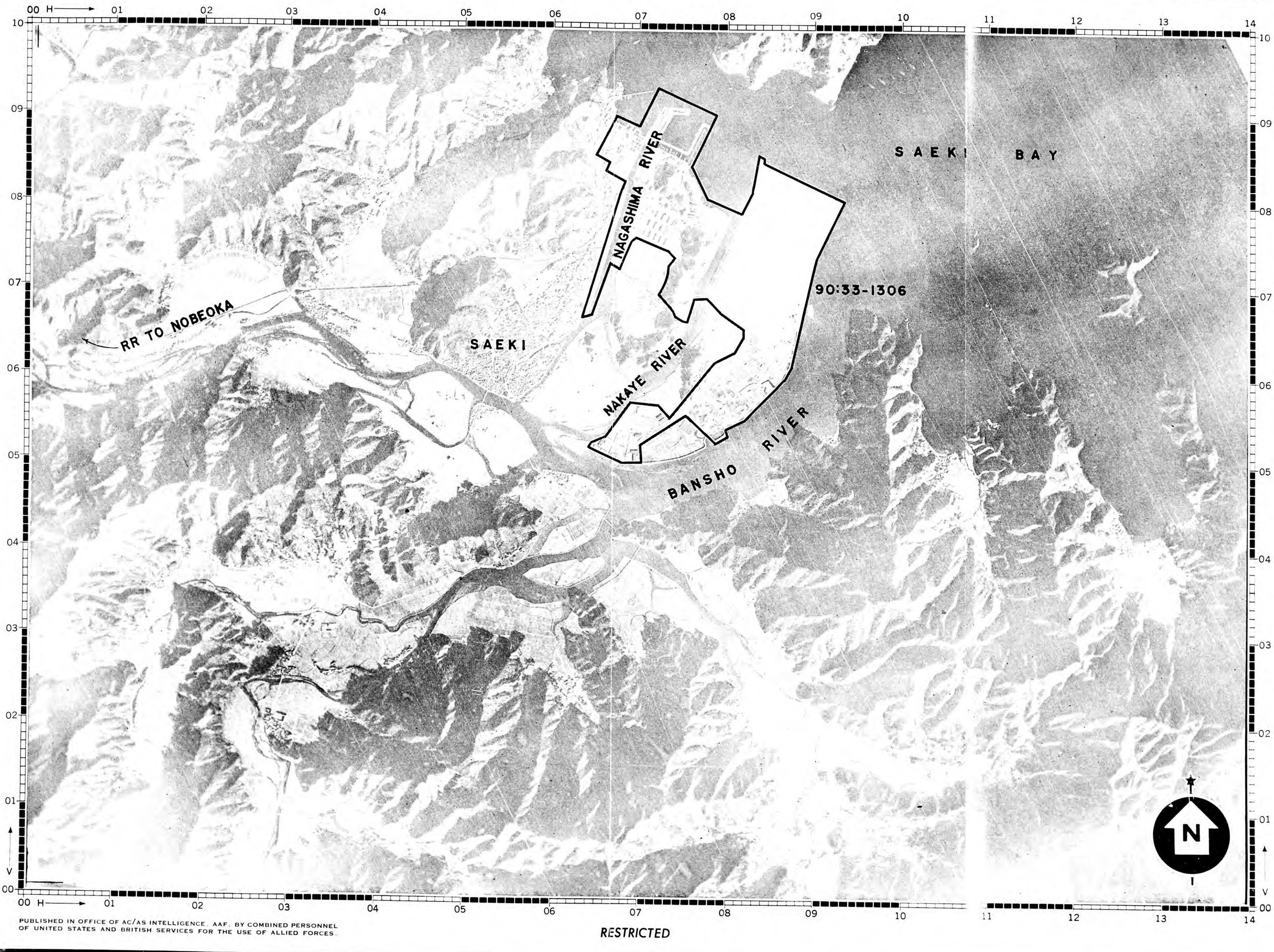
SAEKI NAVAL AIR STATION

SAEKI **JAPAN**

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

RESTRICTED

ILLUSTRATION **90:33-1306 P2**
DATE . . . . . **26 May 1945**
TARGET **90:33-1306**
COORDINATES . . . **32°58'N 131°55'E**
PHOTOGRAPHED . . . **1 January 1945**



Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft.

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JOINT TARGET GROUP
WASHINGTON, D. C.

SAEKI NAVAL AIR STATION

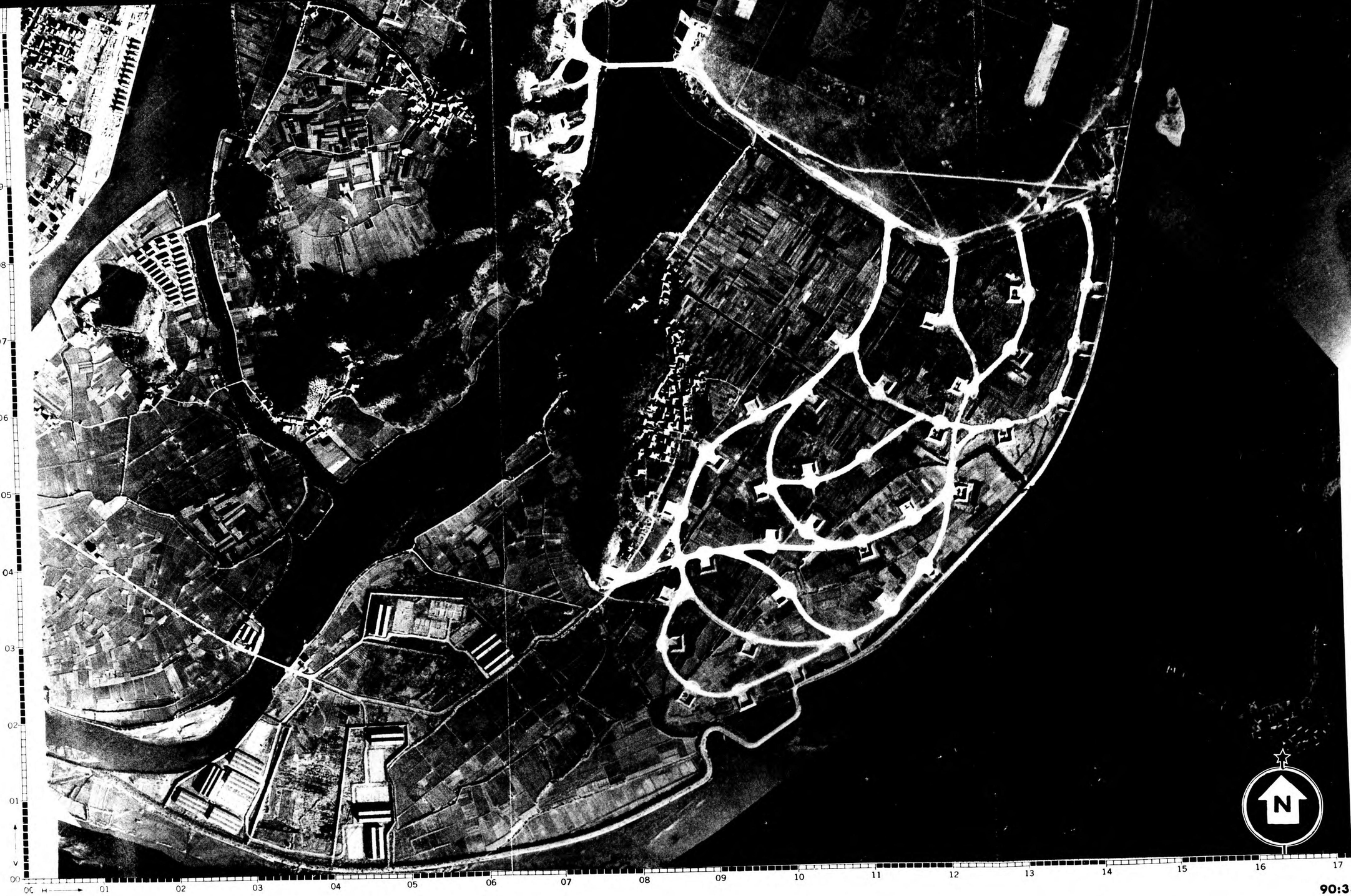
SAEKI JAPAN

0 500 1000 1500 2000 2500 3000 FEET
0 1/4 1:6000 APPROX. 1/2 MILE

RESTRICTED

ILLUSTRATION	90:33-1306 P3
DATE	26 May 1945
TARGET	90:33-1306
COORDINATES	32 58'N 131 55'E
PHOTOGRAPHED	1 January 1945

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft.



90:33-1306 P3

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CONFIDENTIAL

ILLUSTRATION	90:33-1306 P4
DATE	26 May 1945
TARGET	90:33-1306
COORDINATES	32 58'N 131 55'E
PHOTOGRAPHED	1 January 1945

SAEKI NAVAL AIR STATION

SAEKI JAPAN

0 500 1000 1500 2000 2500 3000 FEET

0 1/4 1:6000 APPROX. 1/2 MILE

LEGEND

1-13	Warehouses (buildings 3, 5, 7, 9, and 12 have been removed in 21 April 1945 coverage and their sites cleared of debris).
14	Coal Storage Yard (with shipping facilities)
15-22	Warehouses
23	Transformer Sub-Station (Removed)
24	Boiler House
25-27	Headquarters Buildings
P28	Machine Shop
29	Hangar-type Building
30	Not identified
31	Storage-type Building
32	Concrete apron (960 x 150 feet on front of seaplane hangars with slightly damaged ramp extension, 680 x 100 feet, into Saeki Bay. Large hammerhead crane at south end of ramp).
33,34	Maintenance Seaplane Hangars (roofs off)
35	Navy Garage (roof appears to be off)
36-41	Warehouses (Buildings 39 and 41 removed by 21 April 1945).
42	Possible Barracks
43	Possible Mess
44	High and medium frequency radio station (with two tripod truss-type towers).
45	Open stores (line both sides of Nagashima River).
46-58	Warehouses (with heavily revetted building 49 and 53 probably used for storage of precision instruments. Building 56 removed and debris cleared. Railway spur enters area).
59	Underground Storage Area (several small roadways lead into foot of hill).
59a-59c	Storage-type Buildings (heavily revetted).
60	Possible Ammunition and Fuel Storage Area (blast walls in front of three possible tunnel entrances).
61	Aircraft Dispersal Area (with seven 72 foot wide "U" shaped revetments.
62	Hangar (roof off)
63	Operations and Control Tower
64-66	Hangars (65 has severe roof damage over 1/2 its area; 66 has roof damage over 2/3 its area; and 64 has its roof off)
67	Airfield (one NNE SSW runway hard surfaced, 3000 x 160 feet, one NW SE hard surfaced runway 1550 x 160 feet. Landing area approximately 4800 x 1250 feet, well drained and serviceable during most weather).
68	Ammunition Dump
69	Aircraft Dispersal Area (with 34, 72 foot wide "U" shaped revetments; one under construction. Five covered fighter revetments are along the extremity of the airfield).
70-89	Warehouses (only foundations laid for buildings 71 through 74, 78, 79, 81, 83 and 87).

P—denotes primary building

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft.

AIRCRAFT DISPERSAL AREA

AIRCRAFT DISPERSAL AREA

WAREHOUSE AREA

N

90:33-1306 P4

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JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET INFORMATION SHEET

SHEET No. **90:33-1308—TI**
DATE . . . . . **May 1945**
PAGE **1**

OITA NAVAL AIR STATION

OITA **JAPAN**

TARGET No. . **90:33-1308**
OBJ. AREA **90:33**
OBJ. FOLDER No. **90:33, 37, 38**
CATEGORY . . . . **End. Prdt. Ind. Aircraft**

LAT. . . . . **33°15′N**
LONG. . . . . **131°37′E**
ALT. . . . . **13 feet**

NOTE: This Target Information Sheet is issued to show the status and importance of the target following serious damage by air attack.

SIGNIFICANCE

Prior to attack Oita Naval Air Station together with Oita Naval Air Depot, Airframe Section and Engine Section (TARGETS 90:33-2081 and 2080) constituted the headquarters of the 12th Naval Air Depot engaged in modification, repair and maintenance of naval aircraft. It was also a major combat base, training school, and replacement center.

The Air Station and both sections of the Air Depot have been attacked by both B-29's and carrier-based aircraft. Photography of 11 May shows all three targets heavily damaged and probably no longer performing significant repair or modification functions. At the Air Station 24 of the 35 buildings sustained major damage, and those remaining apparently undamaged, although including two shops and one hangar, have little target value. The airfield was probably still operational on 11 May, however, and together with extensive storage areas in the hills to the SE, may continue to have tactical importance.

For location and other details refer to Target Information Sheets and Illustrations 90:33-2080 and 90:33-2081. No illustrations will be issued for this target unless warranted by new construction.

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft.

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JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET INFORMATION SHEET

SHEET . . . 90:33-2080—TI
DATE . . . . . 18 May 1945
PAGE 1

OITA NAVAL AIR DEPOT, ENGINE SECTION

OITA **JAPAN**

TARGET 90:33-2080
OBJ. AREA 90:33
OBJ. FOLDER . . New Target
CATEGORY
End Prdt. Ind.—Aircraft

LAT. . . . . 33° 14′ N
LONG. . . . . 131° 39′ E
ALT. . . . . 13 feet

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-2080 material.

SIGNIFICANCE

This relatively new plant is probably engaged in engine repair and overhaul but could manufacture new engines on a limited scale. Many tunnel entrances in the surrounding hills may lead to underground installations making the plant more important than the visible buildings suggest. Possible damage by strikes since 28 March has not been considered.

LOCATION

(Refer to Illustration No. 90:33-2080 P2.) Situated in NE Kyushu near the S entrance to the Inland Sea, about 1 mile S from Beppu Bay on the S edge of the coastal plain between the Oita and Ono River mouths. The airframe section of the Oita Naval Air Depot (TARGET 90:33-2081) is about 1 mile W, the Oita Naval Air Station (TARGET 90:33-1308) about 6500 feet NW and Nippon Dye Works (TARGET 90:33-1317) at Tsurusaki is about 2 miles E. The plant is bounded on the N by the Nippo Mainline Railroad and on the S by a precipice.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90:33-2080 P3.) The plant site is roughly rectangular, measuring about 2500 feet along the railroad and running back 600 to 750 feet. The four principal buildings (4, 5, 7, 8) in the W part of the plant appear to be engaged in engine teardown, repair, and reassembly. Machine shops and parts shops (10, 13, 16, 18) are in a row next to the railroad in the E half. There are 12 engine test cells S of these shops. The relatively large number of engine test cells in relation to visible floor space strongly suggests that the plant is engaged in engine repair and overhaul rather than new engine manufacture. Eleven identified tunnel entrances S and E of the plant site may lead to additional underground working space.

Between 1 January 1945 and 28 March 1945, the W part of buildings 7 and 8 and six of the twelve test cells were completed. During this period some bomb damage may also have been suffered as evidenced by temporary repair roof covering on building 8, but it probably interfered only slightly with normal activity.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90:33-2080 P3.) The engine teardown and reassembly buildings (4, 5, 7, 8) and machine shops and parts shops (10, 13, 16, 18) are the primary objectives.

CONSTRUCTION AND VULNERABILITY

Process buildings are predominantly one-story, short and medium span, saw-tooth roof buildings most probably of wood frame construction sheathed, both roof and walls, with corrugated asbestos. Other buildings are of pitched roof, short-span, wood frame construction. Firewalls are visible in most of the buildings.

WEAPON RECOMMENDATIONS

Instructions with regard to weapons will usually be given in Field or Operational Orders, but in the absence of such instructions and to assist Planners in formulating such orders the following information is given:

An attack primarily with incendiary bombs, with a minimum of high explosive bombs (not to exceed 10 to 20 percent of the total load), is recommended against this target. A preliminary structural and occupancy analysis of the plant (excluding possible underground installations) indicates that weapons should be selected as follows:

	High Explosive	Fuzing	Incendiary
Preferred:	500-lb GP or 1000-lb GP or 2000-lb GP	0.01 N/ND T 0.01 N/ND T 0.01 N/ND T	AN-M50 4-lb or AN-M69 6-lb (in aimable clusters for high altitude attack)
Alternative:	250-lb GP	0.025 N/ND T	AN-M47 70-lb AN-M76 500-lb Fire bombs
Not recommended:	Other GP bombs SAP or AP bombs Depth bombs		

Notes: (a) Fire bombs (droppable gasoline tanks, napalm filled) should be used in low level attacks only.
(b) Use 0.1 N fuzes if 0.01 N or 0.025 N fuzes are not available, and 0.01 T fuzes if ND T fuzes are not available. ND tail fuzing is recommended since all buildings have light roof material and are best destroyed by blast effects.
(c) The above recommendations are on a weight for weight basis, and apply to surface installations only.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Except for the engine test cells, there is no camouflage indicated on photography of 1 January or 28 March 1945. There is no evidence of smoke screens or decoys.

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JOINT TARGET GROUP
WASHINGTON, D. C.

OITA NAVAL AIR DEPOT, ENGINE SECTION

OITA — JAPAN

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:[illegible]000 APPROX.

ILLUSTRATION 90:33-2080 P1
DATE.....18 May 1945
TARGET 90:33-2080
COORDINATES ..33°14'N 131°39'E
PHOTOGRAPHED...1 January 1945

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-2080 material.

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JOINT TARGET GROUP
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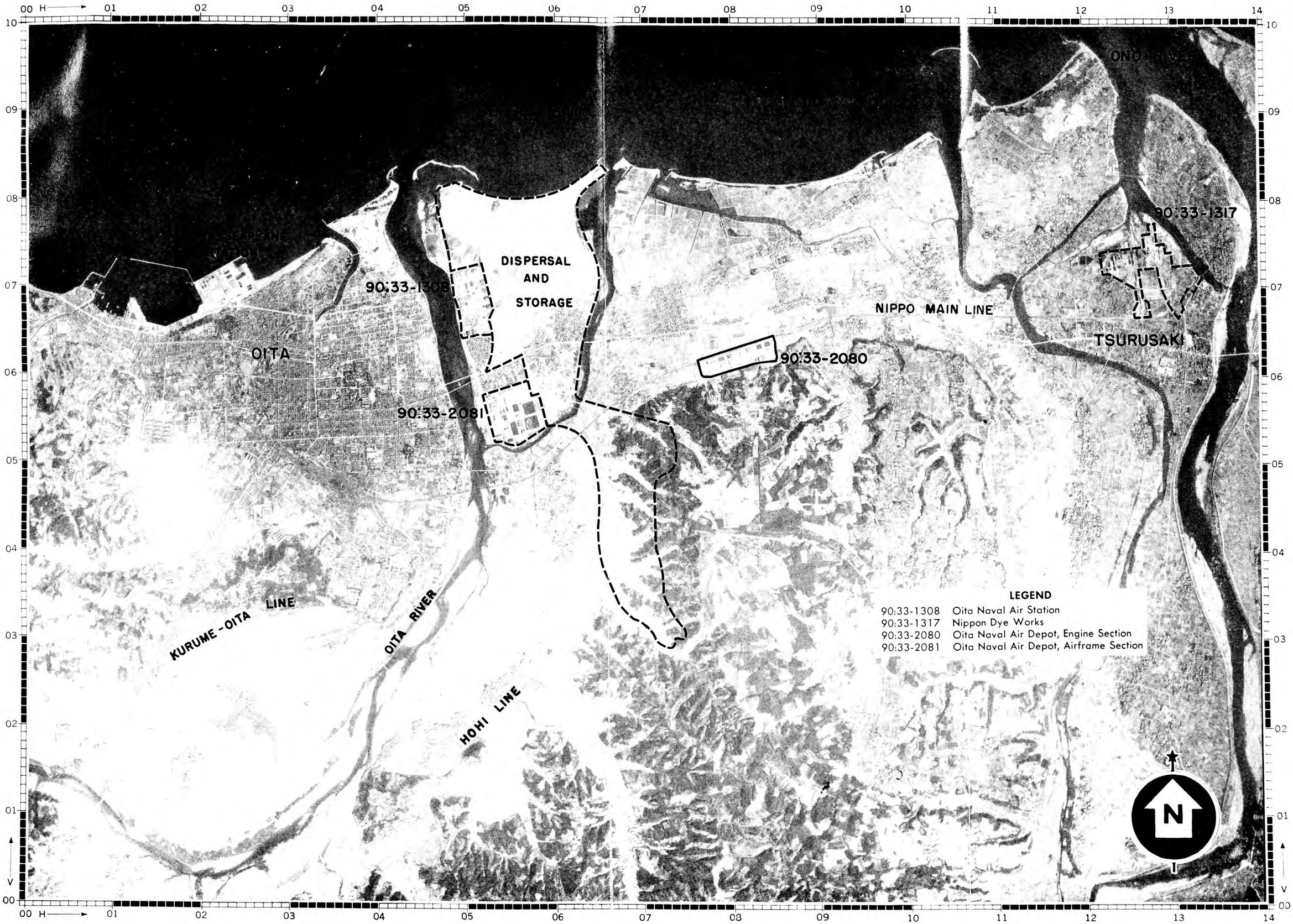
OITA NAVAL AIR DEPOT, ENGINE SECTION

OITA **JAPAN**

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

ILLUSTRATION	90:33-2080 P2
DATE	18 May 1945
TARGET	90:33-2080
COORDINATES	33°14'N 131°39'E
PHOTOGRAPHED	1 January 1945



Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-2080 material.

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JOINT TARGET GROUP
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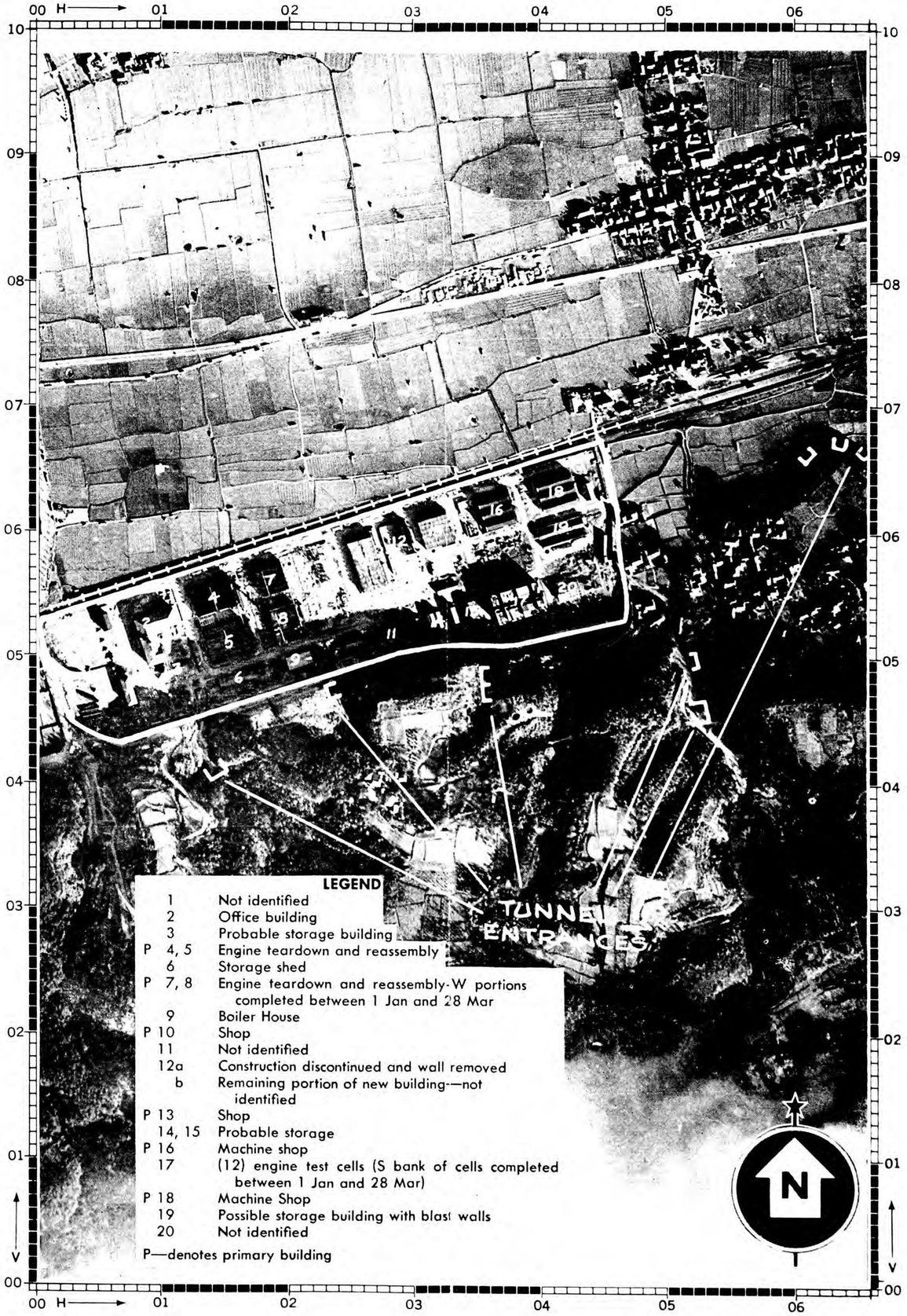
OITA NAVAL AIR DEPOT, ENGINE SECTION

OITA **JAPAN**

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

ILLUSTRATION 90:33-2080 P3
DATE.....18 May 1945
TARGET 90:33-2080
COORDINATES ..33°14'N 131°39'E
PHOTOGRAPHED...1 January 1945



LEGEND

1	Not identified
2	Office building
3	Probable storage building
P 4, 5	Engine teardown and reassembly
6	Storage shed
P 7, 8	Engine teardown and reassembly-W portions completed between 1 Jan and 28 Mar
9	Boiler House
P 10	Shop
11	Not identified
12a	Construction discontinued and wall removed
b	Remaining portion of new building-—not identified
P 13	Shop
14, 15	Probable storage
P 16	Machine shop
17	(12) engine test cells (S bank of cells completed between 1 Jan and 28 Mar)
P 18	Machine Shop
19	Possible storage building with blast walls
20	Not identified

P—denotes primary building

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-2080 material.

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JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET INFORMATION SHEET

SHEET . . . 90:33-2081—TI
DATE . . . . . 19 May 1945
PAGE 1

TARGET 90:33-2081
OBJ. AREA 90:33
OBJ. FOLDER . . New Target
CATEGORY
End Prdt. Ind.—AIRCRAFT

LAT. . . . . 33° 14′ N
LONG. . . . . 131° 38′ E
ALT. . . . . 13 feet

OITA NAVAL AIR DEPOT, AIRFRAME SECTION

OITA **JAPAN**

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:33-2081 material.

SIGNIFICANCE

The principal function of this plant is probably the repair and modification of naval aircraft. It is possible, though unlikely, that the plant may also manufacture new aircraft on a limited scale.

Some bomb damage was sustained between 1 Jan and 28 March 1945, but it probably interfered only slightly with normal activity.

LOCATION

(Refer to Illustration No. 90:33-2081 P2.) Situated in NE Kyushu near the S entrance to the Inland Sea about 1.1 miles S of Beppu Bay on the S end of an island in the mouth of the Oita River. The city of Oita lies across the river to the W, Oita Naval Air Station (TARGET 90:33-1308) is on the same island connected by a road and taxiways and the engine section of the Oita Naval Air Depot (TARGET 90:33-2080) about 1 mile E.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90:33-2081 P3.) The plant site is roughly a square measuring 1600 feet on a side. The two largest and easternmost buildings (23, 27) are the main production buildings. Two principal machine shops (20, 25) are in the center, and offices and storage buildings in the W. It seems likely that some post-assembly operations are performed at the adjoining airfield.

The presence of many different types of aircraft in the plant area indicates that this plant is probably engaged primarily in aircraft repair and modification rather than new plane manufacture.

The incompleted part of building 24, open stores between buildings 10 and 14 and the wall bordering buildings 24, 25 and 27, are shown by photography of 28 March 1945, to have been removed presumably as a result of air attacks.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90:33-2081 P3.) The main production buildings 23 and 27 are the primary objectives.

CONSTRUCTION AND VULNERABILITY

(Refer to Illustration No. 90:33-2081 P3.) Buildings 23 and 27 are one-story, long span sawtooth roofed buildings of steel frame construction with roofs and walls sheathed in corrugated asbestos, HE vulnerability (as defined in JTG/M-3/1) being V4A. Building 20 is a one-story short-span, sawtooth roofed building of similar construction. Other buildings are of wood frame construction, predominantly one-story. HE vulnerability class of these structures is predominantly V4.

WEAPON RECOMMENDATIONS

Instructions with regard to weapons will usually be given in Field or Operational Orders, but in the absence of such instructions and to assist Planners in formulating such orders the following information is given:

An attack with a combination of high explosive and incendiary bombs is recommended. A preliminary structural and occupancy analysis of the target indicates weapons should be selected as follows:

	High Explosive	Fuzing	Incendiary
Preferred:	1000-lb GP or 2000-lb GP	0.01 N/ND T	AN-M50 4-lb or AN-M69 6-lb (in aimable clusters for high altitude attack)
Alternative:	500-lb GP	0.01 N/ND T	AN-M47 70-lb AN-M76 500-lb Fire bombs (for low level attacks only)
Not recommended:	Other GP bombs SAP or AP bombs Depth bombs		

Notes: (a) Use 0.1 N or 0.025 N fuzes if 0.01 N are not available, and 0.01 T fuzes if ND T fuzes are not available. ND tail fuzing is recommended since all buildings have light roof material and are best destroyed by blast effects.

(b) The above recommendations are on a weight for weight basis.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Photography of 1 Jan. and 28 March 1945 shows no attempted camouflage. No decoys or smoke screens have been reported.

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JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET INFORMATION SHEET

SHEET No. **90.35-662-TI/1**
DATE . . . . . **8 May 1945**
PAGE **1**

WATANABE AIRCRAFT PLANT (KYUSHU AIRCRAFT)

ZASSHONOGUMA JAPAN

TARGET No.. **90.35-662**
OBJ. No. **90.35**
OBJ. FOLDER No. . . **90.35**
AIR TARGET SYSTEM **Aircraft**

LAT. . . . . **33° 32′ N**
LONG. . . . . **130° 27′ E**
ALT. . . . . **60 feet**

ALL PREVIOUS SHEETS CANCELLED

NOTE: This revision is designed to incorporate new ground intelligence although no satisfactory air cover has been received since the issuance of Target Information Sheet No. 90.35-662-TI, dated 14 September 1944.

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft in place of 90.35-662-TI, page 1.

SIGNIFICANCE

The Zasshonoguma plant, engaged in the manufacture and sub-assembly of airframe parts, is reported to be the main Watanabe Aircraft plant. There is no airfield near the plant; final assembly and flight testing of finished planes is performed elsewhere. Both the Fukuoka Seaplane Works at Najima (TARGET 90.35-2079), about 10 miles NNW, and the Tachiarai Machine Works (TARGET 90.35-1870) located on the W edge of the Tachiarai Army Air Field (TARGET 90.35-1236), about 13 miles SE, have been reported to assemble Watanabe planes. Air cover indicates plane assembly or modification and repair at both places. These plants together with the Zasshonoguma plant may now be known as Kyushu Aircraft (Kyushu Hikoki) which is reported to be the holding company for many of the aircraft plants in this area. It is also reported that Kyushu Aircraft has taken over the Omura Aircraft Factory (TARGET 90.36-1627). Recent post-attack air cover indicates that at least one of the Watanabe plane types may be assembled or repaired and modified at the Omura plant.

No important combat-type aircraft are known to be manufactured by the Watanabe Company although it has been reported that a Navy fighter is made at the Zasshonoguma plant. At one time, however, Watanabe manufactured wings for Bettys assembled by Mitsubishi and it may still be producing components for important combat type aircraft. It is also reported to manufacture engines for trainer aircraft, but no Watanabe engines have been recovered. It is not possible to determine either from air cover or ground intelligence whether this sub-contracting work and engine manufacture occurs at the Zasshonoguma plant or at another of the many Watanabe plants in the Fukuoka area.

LOCATION

(Refer to Illustration No. 90.35-662 P2). At Zasshonoguma on the S side of the Kagoshima Mainline RR, about 5 miles SE of Fukuoka City. The Mikasa River, which flows generally NW-SE is just under one mile to the NE at its closest point. The Naka River curving southward is about one mile WNW. Low hills rise directly to the S and about 1.5 miles to the N.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90.35-662 P4). The total target area is oblong in shape, measuring about 7500 feet NW-SE by 2200 feet NE-SW. Ground intelligence and air cover is not adequate to permit the identification of buildings or an analysis of the flow of production. Available photography, however, indicates that there are two distinct clusters of factory buildings separated by an open space of roughly 2,000 x 2,000 feet. The larger built-up area (Area I) lies to the NW. It is irregular in shape, consisting of approximately 480,000 square feet of closely grouped buildings. The group of buildings in the northern part of Area I has been reported to be the Watanabe Iron Works (possibly now the Kyushu Ordnance Factory) manufacturing torpedoes and depth charges for the Navy. The SE cluster (Area II) consisting of about 392,000 square feet of scattered buildings, may be an extension of the aircraft plant or a branch of the Tachiarai Army Air Depot reported to be in this area.

PRIMARY OBJECTIVES

It is not possible to determine the primary target objectives from currently available photography and ground intelligence.

CONSTRUCTION AND VULNERABILITY

Photography of 18 June 1944 indicates the buildings housing process operations to be of one-story, steel frame construction with roofs and walls of lightweight sheet materials. Sawtooth roofs of short to medium span predominate, the height to eaves of most buildings being between 20 and 30 feet. Administrative and storage buildings are probably of wood frame construction.

WEAPON RECOMMENDATIONS

Instructions with regard to weapons will usually be given in Field or Operational Orders, but in the absence of such instructions and to assist Planners in formulating such orders the following information is given:

An attack with a combination of high explosive and incendiary bombs is recommended. A preliminary structural and occupancy analysis of the plant indicates the following weapons should be selected:

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File No. **AC-776010**

	High Explosive	Fuzing	Incendiary
Preferred:	1000-lb GP or 500-lb GP or 2000-lb GP	0.01 N/ND T	AN-M50 or AN-M69 (in aimable clusters for high altitude attack)
Alternative:			AN-M47 70-lb AN-M76 500-lb
Not recommended:	Smaller GP bombs SAP or AP bombs Depth bombs		

Notes: (a) Use 0.1 N fuzes if 0.01 N fuzes are not available, and 0.01 T if ND T are not available. ND tail fuzing is recommended as most of the buildings have light roof material, and are best destroyed by blast effects.

(b) The above recommendations are on a weight for weight basis.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Photography of 18 June 1944 indicates disruptive roof painting on all buildings. There is no indication of smoke screens or decoys.

ADDITIONAL INFORMATION

Watanabe is believed to manufacture the following operational aircraft:

(1) Glen—SE Recce Float Plane (carried by submarines)
(2) Jake SE Recce Float Plane
(3) Tokai—2E Recce

A Navy fighter is also reported to be made but none have been recovered which can be definitely associated with Watanabe.

Two of the plants reported to be assembling the aircraft manufactured at Watanabe's Zasshonoguma plant, the Tachiarai Machine Works (TARGET 90.35-1870) and the Omura Aircraft Factory (TARGET 90.36-1627), have been severely damaged by air attacks during the latter part of March. However, since final assembly operations can be performed almost anywhere the destruction of these plants would not seriously interrupt Watanabe's aircraft output even if final assembly operations of Watanabe planes were performed there.

The Gannosu Airfield in the vicinity of Wajiro-mura about 10 miles NW is reported to be used for testing the wheeled airplanes manufactured at Zasshonoguma. There does not appear to be any aircraft assembly operations at this field although a field close by, the Hakata Airfield, has considerable building capacity which might be used for assembly and post-assembly.

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft in place of 90.35-662-TI, page 2.

JOINT TARGET GROUP
WASHINGTON, D. C.

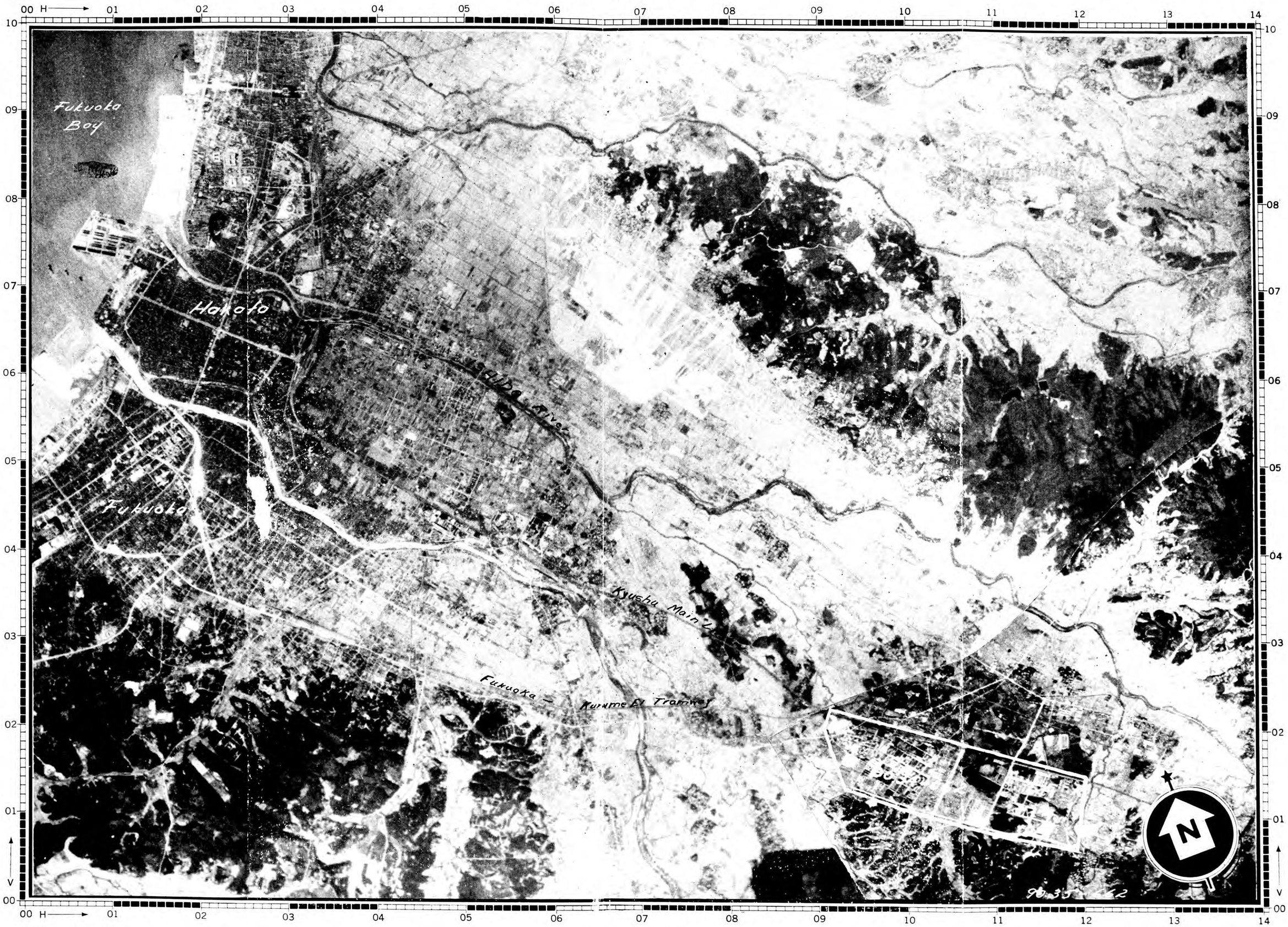
WATANABE AIRCRAFT PLANT (KYUSHU AIRCRAFT)

ZASSHONOGUMA — JAPAN

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

RESTRICTED

ILLUSTRATION No. 90.35-662 P2
DATE . . . . . 29 April 1945
TARGET No. 90.35-662
COORDINATES . . . 33°32'N 130°27'E
PHOTOGRAPHED 18 June 1944



Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90.35-662 material.

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May be taken into the air if data is trimmed off

JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET INFORMATION SHEET

SHEET . . . 90:35-2079—TI
DATE . . . . . 25 May 1945
PAGE 1

FUKUOKA SEAPLANE WORKS

FUKUOKA JAPAN

TARGET 90:35-2079
OBJ. AREA 90:35
OBJ. FOLDER . . New Target
CATEGORY
End Prdt. Ind.—AIRCRAFT

LAT. . . . . 33° 39′ N
LONG. . . . . 130° 26′ E
LAT. . . . . 10 feet

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90:35-2079 material.

SIGNIFICANCE

This small plant at one time producing Jake float planes or possible the twin engine land plane Lorna, has recently had several buildings removed, and is of relatively minor importance in the aircraft industry. It may still be producing on a reduced scale with greater dependence on outside production of parts, or may be converting to repair or modification functions.

LOCATION

(Refer to Illustration No. 90:35-2079 P2.) Situated in NW Kyushu, on reclaimed land on the NE shore of Hakata Bay, about 5 miles NNE of the center of Fukuoka and 3000 feet NE of Najima Steam Power Station (TARGET 90:35-664) at the Tatara River mouth. A main highway forms the E boundary and the Kyushu RR to Moji runs about 900 feet further inland. The Fukuoka Air Station is on a tongue of land across the bay due W.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90:35-2079 P3.) The plant occupies a narrow rectangle, measuring about 3000 feet on its main NE-SW axis and 1000 feet wide. The productive buildings were originally arranged in two rows along the main axis. Several buildings (5, 8, 15, 21) were removed between 30 December and 8 March and another (18) was in process of being dismantled. Three large buildings (12, 19, 22) and several smaller ones remained on 23 April. Sub-assembly functions, if such remain, are probably done in buildings 12 and 22, while final assembly or repair occurs in building 19. Post assembly functions are in buildings 24 and 26 at the S near the service apron and ramp.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90:35-2079 P3.) The three large productive buildings still standing (12, 19, 22) house all the remaining equipment of any consequence.

CONSTRUCTION AND VULNERABILITY

Major buildings are of noncombustible, steel frame construction with roofs and probably walls of light weight sheet materials. All except one hangar are of one-story, sawtooth roof design, long span structures (HE vulnerability class V4A; see JTG/M-3/1) predominating. Other structures which occupy a relatively small proportion of the site are mostly of one-story, wood frame construction. Because of removals the site is now sparsely built-up.

WEAPON RECOMMENDATIONS

Instructions with regard to weapons will usually be given in Field or Operational Orders, but in the absence of such instructions and to assist Planners in formulating such orders the following information is given:

An attack with high explosive bombs alone is recommended. A preliminary structural and occupancy analysis of the plant indicates that weapons should be selected as follows:

	High Explosive	Fuzing	Incendiary
Preferred:	2000-lb GP or 1000-lb GP	0.01 N/ND T 0.01 N/ND T	None
Alternative:	500-lb GP	0.01 N/ND T	None
Not recommended:	100-lb GP or 250-lb GP bombs SAP or AP bombs Depth bombs		

Notes: (a) Use 0.025 N or 0.1 N fuzes if 0.01 N fuzes are not available, and 0.01 T fuzes if ND T fuzes are not available. The use of ND tail fuzing is recommended since all of the buildings have light roof material and are best destroyed by blast effects.

(b) The above recommendations are on a weight for weight basis.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Buildings 12 and 24 have disruptive painting; the remainder are not camouflaged. There have been no indications of smoke screens or decoys.

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T A R G E T I N F O R M A T I O N S H E E T

Ref: Obj. Folder
Sasebo-Tsushima Areas (90.36,90.39)
July 18, 1944

Place: Omura, Japan
Obj. Area: 90.36
Category: Aircraft

Lat. : 32°55'N
Long.:129°56'E
Alt. : 10 ft.

OMURA AIRCRAFT FACTORY

AAF Target No. 1627

T I S

ALL PREVIOUS SHEETS ARE CANCELLED

SIGNIFICANCE: The Omura Aircraft plant, first disclosed by reconnaissance in October 1943, appears to be a major integrated engine/aircraft assembly plant. Available intelligence is inadequate for accurate appraisal of the plant's production and importance, but its large size and general layout establish it as a key unit.

LOCATION: The plant is located on the E coast of Omura Bay, just NW of the town of Omura and about 12 miles NNE of Nagasaki. The plant compound extends along the coast and adjoins the Omura Naval Air Station on the SE. Mino Island is located about one mile to the W and the Kori River lies two miles to the north.

DESCRIPTION: The main plant compound is triangular in shape, each side measuring about one mile. A group of hangar and shop-type buildings is located along the waterfront, just N of the northwestern appex of the main plant. A very extensive army barracks and training ground area is located to the E and NE. The turf-surfaced Omura Airfield is rectangular shaped, with a number of hangar, shop and administration buildings grouped in the SW corner. Dispersal revetments, small storehouses and clusters of barracks and residences extend along the three land sides of the field.

A description of individual buildings of the Omura plant is dependent upon the completion of current photographic interpretation and the availability of more complete intelligence. At the present time, the plant may tentatively be considered as comprising five principal units:

a. A group of about 23 hangar and shop-type buildings, located just N of the northwestern appex of the main plant site, appears to be the repair and maintenance depot servicing the trainers based at the adjoining naval air station. These buildings cover an area of about 2000 by 1000 square ft. and are connected to both the main plant and the airfield by a taxi-strip and a railroad spur.

b. The northwestern appex of the main triangular compound contains the original aircraft plant, reported completed in 1942. It includes final assembly buildings, ramps and seaplane cranes along the waterfront; administration and machine shop buildings to the E.

c. Two groups of engine test stands are located in the south-central portion of the main plant compound. These include 12 stands along the SE side of the original unit ("B") and a newer group of 24 completed and 12 partially completed stands just to the SE.

d. A new unit, most of it completed since October 1943, is located in the northern appex of the compound and appears to comprise the principal large parts and engine manufacturing buildings as well as sub-assembly.

e. Another recently completed unit, located in the south-eastern appex of the site, consists of one very large assembly-type structure and a number of small to large shops, assembly and storage-type buildings.

The total area of the main triangular compound is approximately 15,000,000 square ft. and contains over 75 medium to large assembly and shop-type buildings (exclusive of storage sheds, barracks, administration buildings and very small shops). These buildings have a total floor space of approximately 2,500,000 square ft. Details as construction are unavailable, but most buildings appear to be metal or asbestos sheeting over steel frame; a few are reported constructed of concrete.

CRITICAL POINTS: Accurate evaluation of the relative importance and vulnerability of the various units of this installation will depend upon detailed photographic interpretation and the availability of more complete intelligence. Available information indicates that the machinery and large assembly shops warrant first consideration.

ADDITIONAL INFORMATION: Confirming intelligence concerning the plant's production is not available, but it is reported to have assembled RUFES during May 1942, and RUFE and ZEKE types have been tentatively identified on available photo cover. However, the recent completion of additional assembly and shop units may indicate the possibility of more diversified production. An unconfirmed PW report refers to the assembly of nine RUFES per day in the original unit during May 1942 -- a rate considered excessively high in terms of estimated total Japanese production at that date. The same source refers to the installation of Mitsubishi Kinsei engines, but their place of manufacture was not established.

The plant's management is not definitely known, but it is believed to operate under the 21st (Sasebo) Naval Air Arsenal, possibly under Mitsubishi supervision. It is believed that this plant is affiliated with the small Sasebo Aircraft Factory, from which a number of the original employees were transferred.

The repair depot to the NW is reported to do third and fourth echelon repairs to KATES, VALS and BETTYS based at the naval station, (although probable PETES and DAVES have been identified in available photo cover). The Omura Airfield is a large and completely equipped naval pilot training base.

Distribution:A

TARGET NO. 90.36-1627

APPROX. COORDINATES 32° 55' N 129° 56' E

PHOTOGRAPHED 21 AUGUST 1944

OMURA AIRCRAFT FACTORY
OMURA JAPAN

0 2000 4000 6000 FEET
0 1/2 1 MILE
1:32 000 APPROX.

ILLUSTRATION NO. 90.36-1627 PI

7 SEPTEMBER 1944

CONFIDENTIAL

AC/AS. INTELLIGENCE

CONFIDENTIAL

TYPE A

RESTRICTED

JOINT TARGET GROUP
WASHINGTON, D. C.

OMURA AIRCRAFT FACTORY

OMURA JAPAN

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

ILLUSTRATION No. . . . **90.36-1627 P2**
DATE . . . . . **29 April 1945**
TARGET No. **90.36-1627**
COORDINATES . . . **32°55'N 129°56'E**
PHOTOGRAPHED . . . **21 August 1944**

Holders of Joint Target Group Folders should insert this sheet in Air Target System Folder: Japanese Aircraft with other 90.36-1627 material.

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RESTRICTED

May be taken into the air if data is trimmed off

TARGET NO. 90.36-1627

APPROX. COORDINATES 32° 55' N 129° 56' E

PHOTOGRAPHED 21 AUGUST 1944

OMURA AIRCRAFT FACTORY
OMURA JAPAN

ILLUSTRATION NO. 90.36-1627 P3A

ISSUED SEPT. 1944

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET

0 1/4 1/2 MILE

1:6000 APPROX.

AC/AS, INTELLIGENCE

CONFIDENTIAL

TYPE B

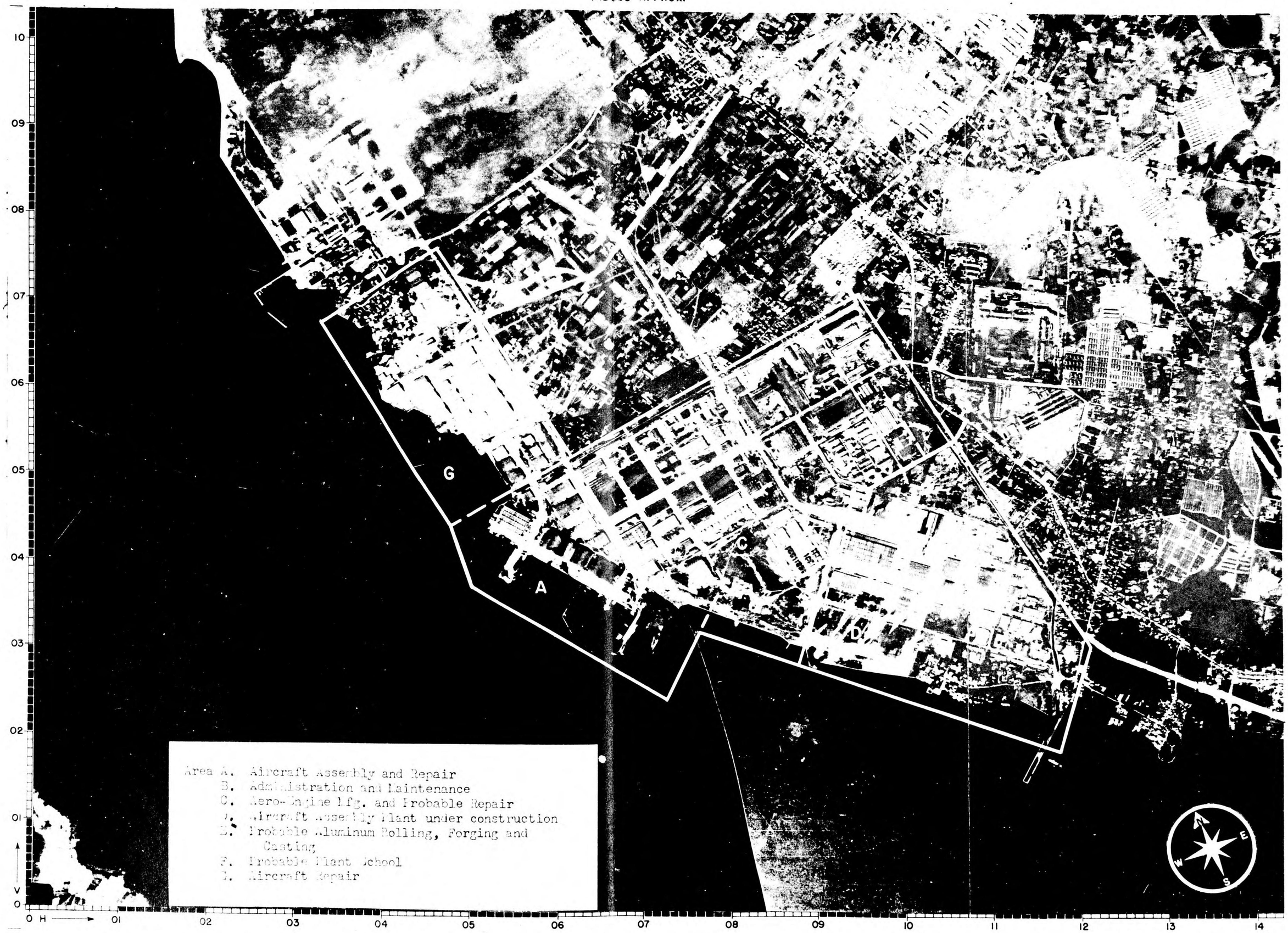
APPROX. COORDINATES 32° 55' N 129° 56' E

PHOTOGRAPHED 21 AUGUST 1944

7 SEPTEMBER 1944

CONFIDENTIAL

0 1000 2000 3000 4000 5000 6000 FEET
0 ½ 1 MILE
1:12 000 APPROX.



TARGET NO. 90.36-1627

OMURA AIRCRAFT FACTORY
OMURA JAPAN

ILLUSTRATION NO. 90.36-1627 P4A

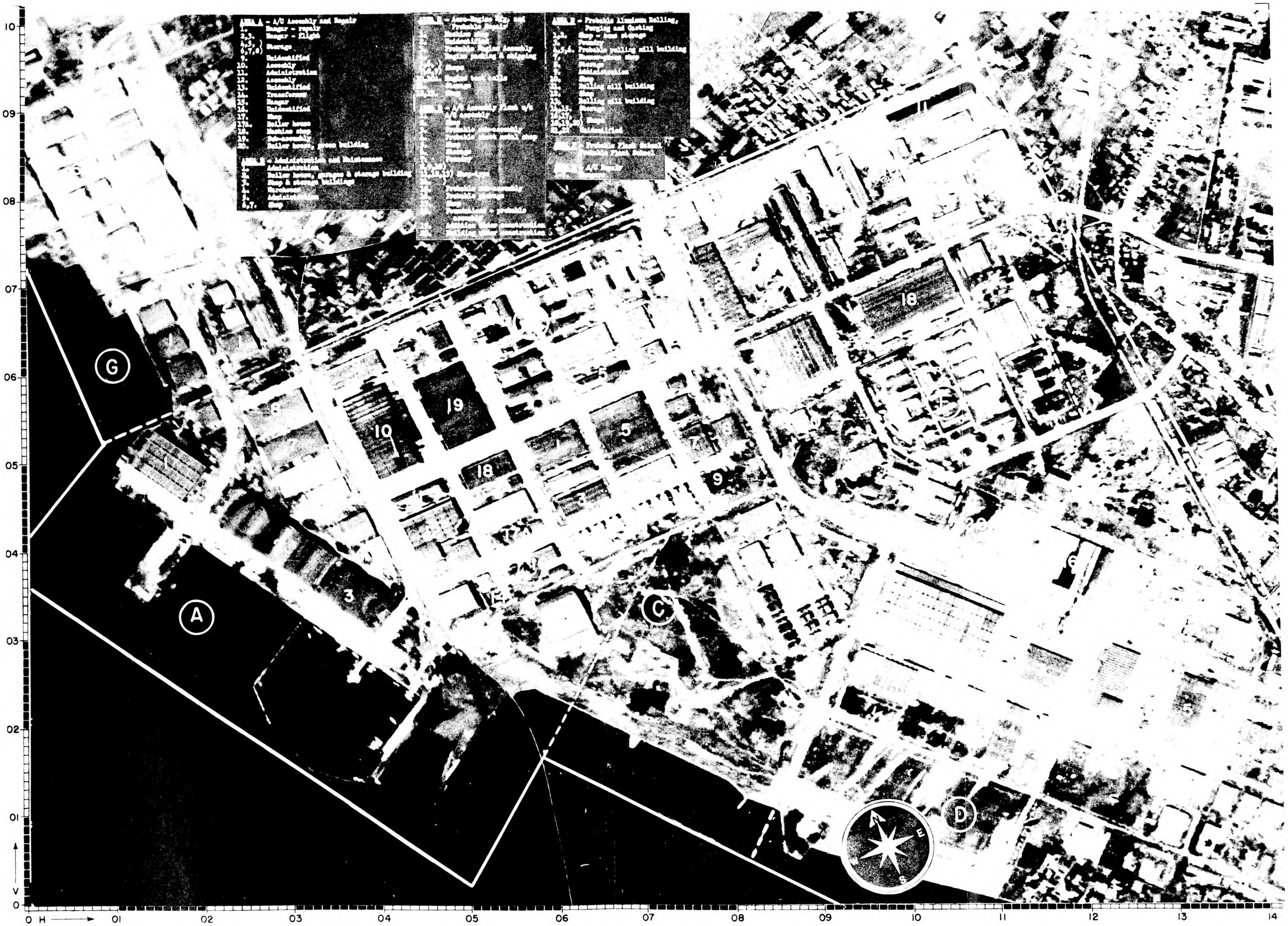
APPROX. COORDINATES 32° 55' N 129° 56' E

ISSUED SEPT. 1944

PHOTOGRAPHED 21 AUGUST 1944

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET
0 1/4 1/2 MILE
1:6000 APPROX.



AC/AS, INTELLIGENCE

CONFIDENTIAL

TYPE B

TARGET NO. 90.36 - 1627
90.36 - 849

APPROX. COORDINATES 32°55′ NORTH
129°56′ EAST

PHOTOGRAPHED 20 AUGUST 1944

JOINT TARGET GROUP-WASHINGTON, D. C.

OMURA FACTORY AND NAVAL AIR STATION

OMURA, KYUSHU

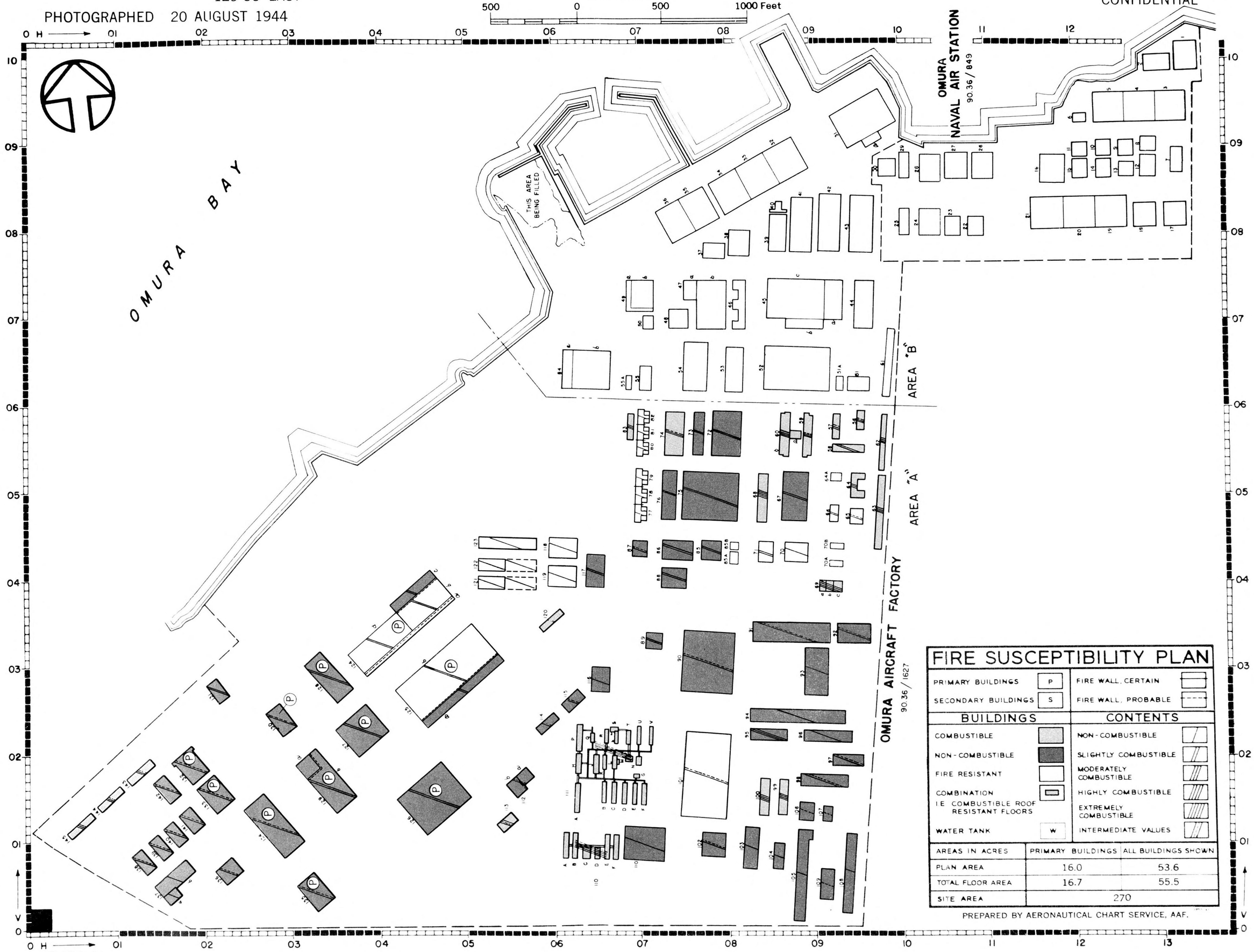
SCALE 1:6000

500 0 500 1000 Feet

ILLUSTRATION NO. 90.36 - 1627 - P5
90.36 - 849

ISSUED 11 DECEMBER 1944

CONFIDENTIAL



FIRE SUSCEPTIBILITY PLAN

PRIMARY BUILDINGS	P	FIRE WALL, CERTAIN	
SECONDARY BUILDINGS	S	FIRE WALL, PROBABLE	
BUILDINGS		**CONTENTS**	
COMBUSTIBLE		NON-COMBUSTIBLE	
NON-COMBUSTIBLE		SLIGHTLY COMBUSTIBLE	
FIRE RESISTANT		MODERATELY COMBUSTIBLE	
COMBINATION IE COMBUSTIBLE ROOF RESISTANT FLOORS		HIGHLY COMBUSTIBLE	
		EXTREMELY COMBUSTIBLE	
WATER TANK	W	INTERMEDIATE VALUES	

AREAS IN ACRES	PRIMARY BUILDINGS	ALL BUILDINGS SHOWN
PLAN AREA	16.0	53.6
TOTAL FLOOR AREA	16.7	55.5
SITE AREA	270	

PREPARED BY AERONAUTICAL CHART SERVICE, AAF.

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Combined personnel of U.S. and British
Services for the use of Allied Forces

NOT TO BE TAKEN INTO THE AIR

T A R G E T I N F O R M A T I O N S H E E T

Ref: Formosa, Interim Report February 1944

Place: Okayama, Formosa
Objective Area: 91.6
Category: Aircraft

Lat. : 22°48'N
Long.: 120°16'E
Alt. : 30 feet

OKAYAMA AIRCRAFT PLANT

AAF Target No. 166

T I S

ALL PREVIOUS SHEETS ARE CANCELLED

SIGNIFICANCE: The Okayama Aircraft Plant is believed to be one of the principal aircraft repair/maintenance/modification plants outside of Japan Proper, and possibly a secondary assembly plant as well. It is a strategically located plant (see ADDITIONAL INFORMATION below).

LOCATION: The plant is situated in southwestern Formosa, three miles in from the W coast and between the Okayama Airport and the town of Okayama. It is located on an open coastal plain, marked by extensive sugar cane fields to the N and S and by the Takao-Keelung Railway Line which runs N/S along the E side of the town. Two isolated hills rise about four miles to the NNE; one very small hill is located midway between the plant and the coast.

DESCRIPTION: The plant adjoins a group of hangar and administration buildings at the SE side of the airport. (See accompanying reconnaissance photography). A workers' housing development is situated just to the E and several groups of storehouses are located to the N.

The plant compound is roughly rectangular and measures approximately 2900 ft. E-W by 1400 ft. N-S. It comprises some 50 assembly and shop-type buildings which have a total floor space of about 1,200,000 square feet. While the operations in individual buildings have not been identified with certainty in most cases, the plant may be broken up into four general functional units:

a. The southeasternmost group of buildings appear to be the parts and sub-assembly units (possibly also engine manufacturing) with tubing, benchwork, etc., shops. This group also contains the administration buildings. Four engine test blocks are located at the NW edge of this unit, near the center of the plant compound.

b. The material preparation unit is located near the SW corner of the compound, and includes heat treating and hardening shops; probable dye making, cutting, stamping, and testing buildings.

c. The modification, repair and/or assembly buildings are located along the northern and northwestern sides of the compound. Taxi strips lead W and N to the airfield and dispersal sites.

d. Receiving and storage sheds are located in the southwesternmost section.

TARGET INFORMATION SHEET (Cont'd.)

The predominant construction appears to be sheet metal (or possibly asbestos sheeting) over steel frames.

CRITICAL POINTS: Accurate evaluation of the character and relative importance of the various units of this plant is dependent upon a more detailed intelligence as to type and volume of production, location of key equipment, etc.

ADDITIONAL INFORMATION: Okayama is part of an aircraft staging, supply and pilot training complex which includes Formosa and several surrounding theaters. The plant is believed to operate under the control of the 61st Naval Air Arsenal and at least part of its function probably includes servicing and maintenance of intermediate and advanced trainers based at Okayama and other Formosan airfields. There has been no consistent line-up of planes near the assembly or modification buildings, but the predominant types appear to be Nakajima 95 (DAVES) with ground gears instead of floats, and probable BETTYS and NELLS -- all reported used as trainers at the field.

The Okayama Airport is a large and completely equipped intermediate and advanced bomber training field. It has two large groups of hangar and storage buildings, four surfaced runways and extensive dispersal revetments.

A large, underground storage depot is located at the base of a 400 ft. hill, four miles NNE of the field. A 75 ft. wide taxiway and a railroad spur connect this depot with the airport and the aircraft plant. It has not been possible to determine the function of this depot, but it is presumed to be a storage for materiel and possibly also for dismantled or partially finished aircraft. A large radar installation has been identified on a hill just to the N of this depot.

Distribution:A

TARGET NO. 91.6-166

APPROX. COORDINATES 22° 48' N 120° 16' E

PHOTOGRAPHED 12 JANUARY 1944

OKAYAMA AIRCRAFT PLANT

OKAYAMA, FORMOSA

0 2000 4000 6000 FEET

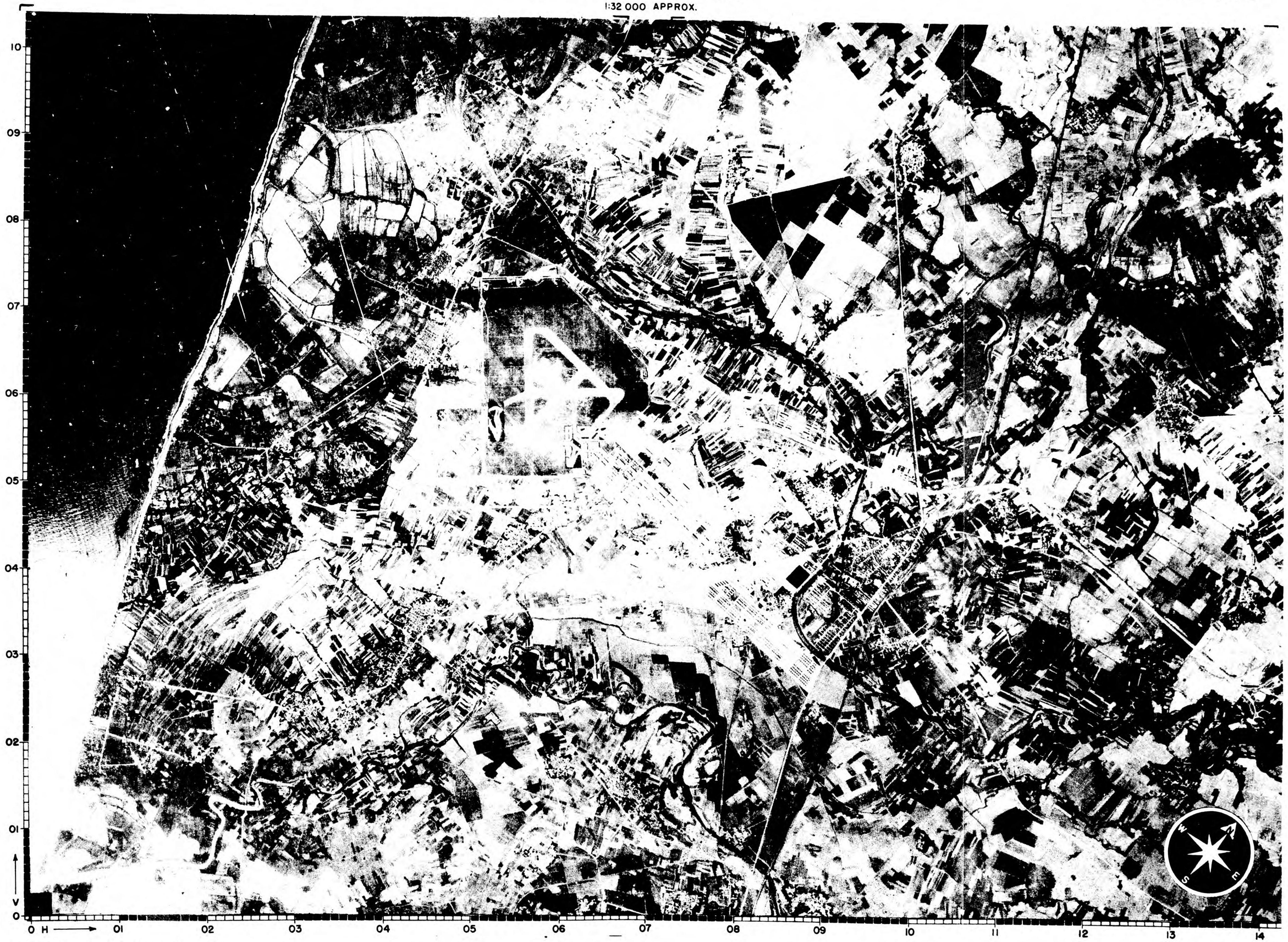
0 1/2 1 MILE

1:32 000 APPROX.

ILLUSTRATION NO. 91.6-166 P1

7 SEPTEMBER 1944

CONFIDENTIAL



AC/AS. INTELLIGENCE

CONFIDENTIAL

TYPE A

TARGET NO. 91.4-166

APPROX. COORDINATES 22° 48' N 120° 16' E

PHOTOGRAPHED 12 JANUARY 1944

OKAYAMA AIRCRAFT PLANT

OKAYAMA, FORMOSA

0 2000 4000 6000 FEET

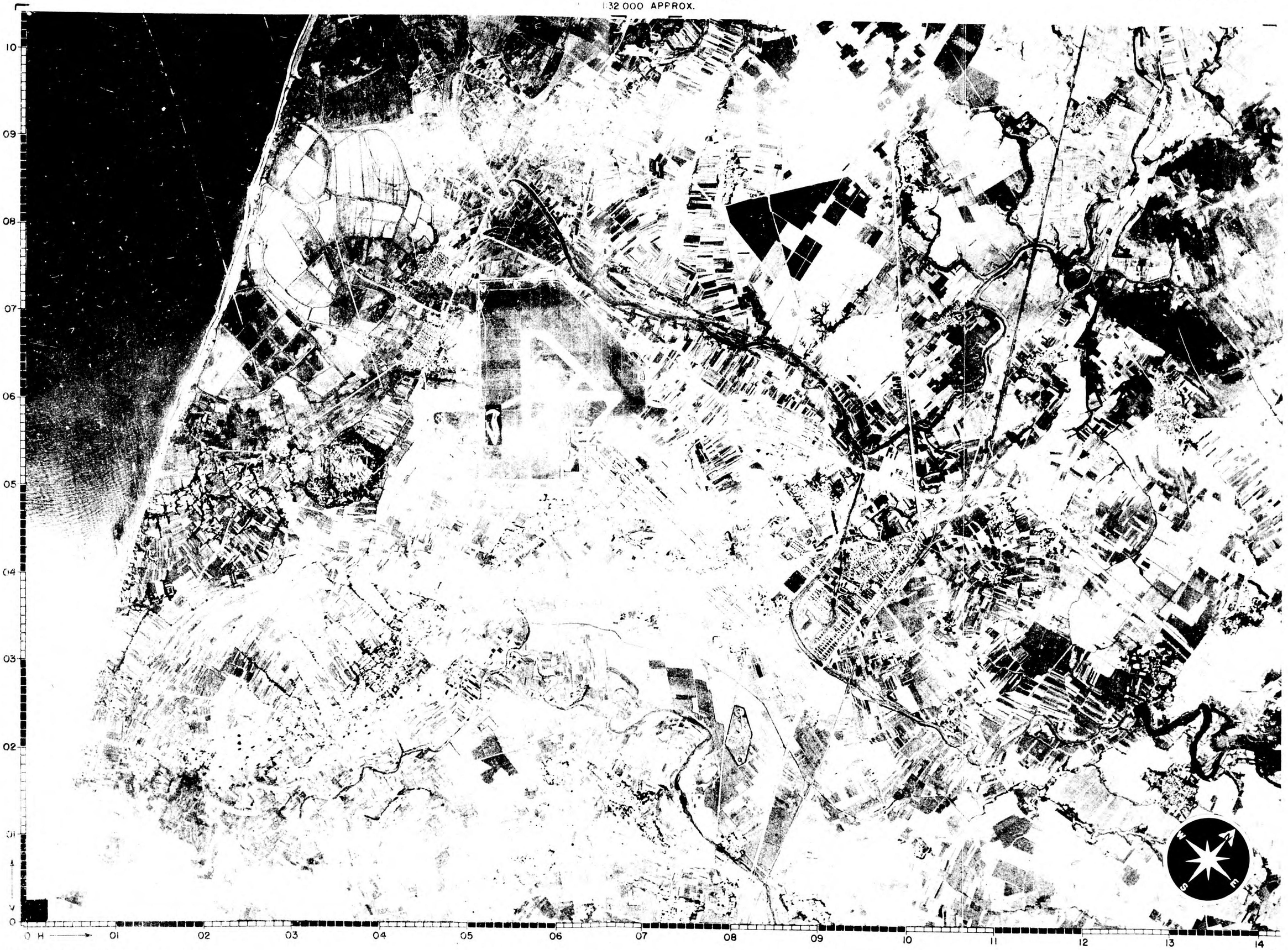
0 1/2 1 MILE

1:32 000 APPROX.

ILLUSTRATION NO. 91.6-166 P2

7 SEPTEMBER 1944

CONFIDENTIAL



AC/AS. INTELLIGENCE

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TYPE A

TARGET NO. 91.4-166

OKAYAMA AIRCRAFT PLANT
OKAYAMA, FORMOSA

ILLUSTRATION NO. 91.6-166 P3

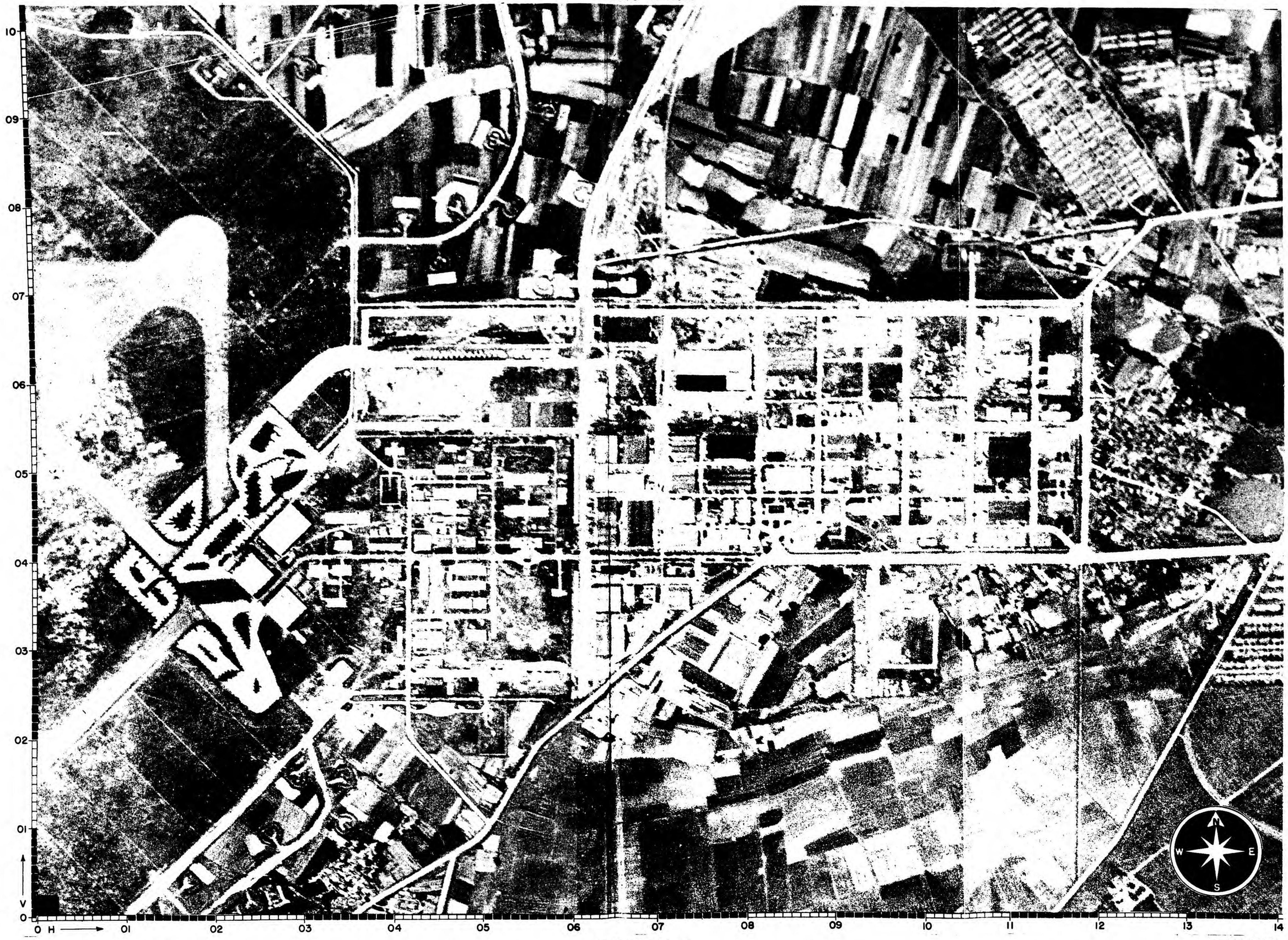
APPROX. COORDINATES 22° 48'N 120° 16' E

PHOTOGRAPHED 29 JUNE 1944

15 SEPTEMBER 1944

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET
0 1/4 1/2 MILE
1:6000 APPROX.



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TYPE B

TARGET NO. 91.6-166

APPROX. COORDINATES 22° 48' N 120° 16' E

PHOTOGRAPHED 25 AUGUST 1944

OKAYAMA AIRCRAFT PLANT
OKAYAMA, FORMOSA

ILLUSTRATION NO. 91.6-166 P4

ISSUED 10 OCT. 1944

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET
0 1/4 1/2 MILE
1:6000 APPROX.

1,14.	Repair hangars	18,30,36,) 39,40,41.)	Building, use not established	34.	Garages (probable)
2.	Repair shops	19,26,27,) 28,29,33.)	Administration & offices	35.	Vehicle shops (probable)
3,5,13,15.	Assembly hangars	21,23,32.	Building storage	42.	Walled-in area, not determined
4,6,16,20.	Sub-assembly shops	22,25,29.	Engine Shop (probable)	43.	Transformers
7,8,9,10.	Shipping & receiving (probable)	24.	Engine test cells (4)		
11,12,17,) 37,38.)	Shops - general	24A.	Engine test sheds probable)		
17,31.	Boiler house				

V 0 01 02 03 04 05 06 07 08 09 10 11 12 13 14 H

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JOINT TARGET GROUP, WASHINGTON, D.C.
TARGET INFORMATION SHEET

Sheet No.93.3-45-TI
Date 30 Dec. 1944
Page No. 1 (6 pages)

Obj. Folder 93.1-5
Obj. Area 93.3
AAF Target No. 93.3-45

Place Mukden
Category Aircraft

Lat.: 41°52'N
Long: 123°26'E
Alt.: 106 feet

NAME OF TARGET MANCHURIA AIRPLANE MFG. CO., PLANT NO. 2

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE

This plant is not believed to be producing either combat aircraft or engines. It is of little significance to the Japanese aircraft industry. The layout and construction of buildings suggests that the facilities here are devoted to repair and overhaul of aircraft, and possibly to some experimental work.

LOCATION:

On the W side of the N Mukden airfield. It is immediately N of the Peiling Tombs and about 4.5 miles N of the old walled city of Mukden. It is bounded on the E by the airfield and on the W by a main roadway running N from Mukden.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 93.3-45 P5). The target area is roughly triangular, extending 5200 feet N-S and 2600 feet at the widest E-W point. The plant is divided into two well separated groups of buildings, and has been broken down into Target A and Target B. Target A contains the fabrication and repair facilities, as well as the administration section and workers' huts. Target B consists of flight and testing hangars and related buildings. Buildings 13 and 3, hangar-type construction, are the largest units, having plan areas of 78,600 and 64,000 square feet. Construction is continuing at the site.

CONSTRUCTION & VULNERABILITY

(Refer to Illustration No. 93.3-45 P5).

General: Buildings 3, 12, 13, 22-26 (Hangar-type construction) have steel trusses supported on masonry or reinforced concrete walls. Roofing is probably corrugated iron. Buildings 4 and 11 probably have steel trusses supporting saw-tooth roofs with masonry external walls. Section B of building 11 probably has a combustible roof supported by wood trusses. Building 6 has a wood trussed roof, supported upon masonry bearing walls. Remainder of the buildings are of wood frame construction.

Floors: Floors are concrete or compacted earth.

Number of Stories: Approximately 85 per cent of the entire target is composed of single story buildings.

Number of Fire Divisions: Target A: 27 fire divisions in 17 buildings.
Target B: 8 fire divisions in 7 buildings.

(Buildings 20, 21, 29, 30, 31, 32, 34 are not considered in the fire analysis as they are workers' huts, living quarters, and probably a school).

The Fire Susceptibility Plan shows the vulnerability to fire of each building and its contents. Contents are of low to moderate combustibility. It is estimated that 40 per cent of Target A and 50 per cent of Target B can be destroyed by fire. The target is a good choice for combined high explosive-incendiary attack.

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PRIMARY OBJECTIVES

(Refer to Illustration No. 93.3-45 P5). Target A: Buildings 3, 4, 10, 11, 12, 13, and 18, housing the fabrication and repair facilities. All buildings in this group fall well within a circle of 1000-foot radius centering on building 12. The aiming point for Target A should be building 12.

Target B: The service and repair hangars, buildings 23, 24, 25, 26. Building 24 should be the aiming point. (Selection of aiming points is for a high level attack.)

WEAPON RECOMMENDATIONS

The most effective weapons for high level attack against Targets A and B are the AN-M50 4-lb incendiary bomb (in M17 clusters) and the AN-M65 1000-lb G.P. Maximum damage to structures and contents will result if the high explosive bombs are fuzed 0.1 sec. nose and 0.01 sec. tail.

The AN-M50 I.B. is slightly more effective against this target than the AN-M47 because of the wide dispersal of combustible material in the primary objectives, which require multiple hits for a high level of damage. This same factor makes the use of the AN-M76 500-lb incendiary unprofitable. Because buildings are fairly well spaced, each fire division must be ignited. This, plus the presence of fire walls, tends to prevent fire spread.

The 1000-lb G. P. is selected as the best high explosive weapon because it is equal in effectiveness to the AN-M66 2000-lb G.P. on the buildings in Target A, and 15 per cent more effective than the 2000-lb bomb on Target B structures. The AN-M64 500-lb G.P. is only 86 per cent as effective against buildings in Target A as the 1000-lb bomb, and only 77 per cent as effective against Target B structures. Considerable damage to contents as well as structures will result with the 1000-lb bomb exploding 6 to 10 feet beneath the roof due to 0.01 sec. tail fuzing.

The following loading tables show, for different choices of weapons, the best combinations of H.E. and I.B. for different weights of attack and for different assumptions regarding the number of bombs dispatched falling within 1000 feet of the aiming point to obtain maximum damage for a given weight of bombs. They also show the fraction of structural damage to the buildings in Targets A and B which can be expected for each weight of attack and assumption of bombs dispatched falling within 1000 feet of aiming point.

Table I is computed for the best combination of weapons, namely, 2000-lb G.P. and AN-M50 incendiary. If conditions of supply or other factors indicate choice of weapons other than those recommended in Table I, the reduced effectiveness of the alternate weapons is shown in Table II, which is made up for the 1000-lb G.P. and the AN-M47 incendiary.

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Table I

LOADING TABLE - MOST EFFECTIVE WEAPONS

H.E. : AN-M65 1000-lb G.P. (1)
I.B. : AN-M50 4-lb.

Manchuria Airplane Manufacturing Co., Plant No. 2

----Target A-----

Total Load in Tons (4)	Per cent of bombs dispatched expected to fall within 1000 feet of aiming point (2)											
	10%			15%			20%			30%		
	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)
50	35	15	.08	25	25	.14	20	30	.18	15	35	.25
75	35	40	.14	25	50	.20	20	55	.25	15	60	.31
100	35	65	.18	25	75	.25	20	80	.29	25	75	.35
125	35	90	.22	25	100	.28	20	.05	.33	50	75	.38
150	35	115	.25	25	125	.31	40	110	.35	75	75	.42
175	35	140	.27	25	150	.33	65	110	.37	100	75	.45
200	35	165	.29	50	150	.35	90	110	.40	125	75	.48
250	55	215	.33	100	150	.39	140	110	.44	175	75	.53
300	80	220	.35	150	150	.42	190	110	.48	225	75	.58
400	180	220	.40	250	150	.48	290	110	.54	325	75	.66
500	280	220	.44	350	150	.53	390	110	.61	425	75	.72

-----Target B-----

Total Load in Tons (4)	Per cent of bombs dispatched expected to fall within 1000 feet of aiming point (2)											
	10%			15%			20%			30%		
	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)
50	35	15	.16	25	25	.25	20	30	.30	15	35	.37
75	35	40	.25	25	50	.33	20	55	.37	15	60	.42
100	35	65	.30	25	75	.37	20	80	.41	30	70	.46
125	35	90	.34	25	100	.40	25	100	.45	55	70	.51
150	35	115	.37	25	125	.41	50	100	.47	80	70	.55
175	35	140	.39	40	135	.44	75	100	.49	105	70	.58
200	35	165	.41	65	135	.46	100	100	.52	130	70	.61
250	50	200	.45	115	135	.51	150	100	.57	180	70	.67
300	100	200	.46	165	135	.54	200	100	.61	230	70	.72
400	200	200	.52	265	135	.61	300	100	.69	330	70	.80
500	300	200	.57	365	135	.67	400	100	.75	430	70	.86

NOTES:
(1) The table for Target A also is valid for the 2000-lb G.P. Because of the difference in effectiveness, there will be a small error if the table for Target B is used for the 2000-lb G.P.
(2) In the examples following this table this quantity is called the "Index of Mission Efficiency".
(3) Expected fraction (per cent) of structural damage to buildings within Targets A and B.
(4) Load is given in tons of actual (not nominal) weight of bombs.

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Table II

LOADING TABLE - ALTERNATE WEAPONS

H.E.: AN M65 1000-lb G. P.(1)
I.B.: AN M47 70-lb I.B.

Manchuria Airplane Manufacturing Company, Plant No. 2

-----Target A-----

Total Load in Tons (4)	Per cent of bombs dispatched expected to fall within 1000 feet of aiming point (2)											
	10%			15%			20%			30%		
	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)
50	35	15	.06	25	25	.12	20	30	.16	15	35	.22
75	35	40	.12	25	50	.17	20	55	.22	15	60	.29
100	35	65	.16	25	75	.22	20	80	.28	15	85	.34
125	35	90	.19	25	100	.26	20	105	.31	15	105	.37
150	35	115	.22	25	125	.29	20	130	.34	45	105	.41
175	35	140	.25	25	150	.32	20	155	.36	70	105	.44
200	35	165	.28	25	175	.34	45	155	.38	95	105	.47
250	35	215	.31	45	205	.37	95	155	.43	145	105	.52
300	35	265	.34	95	205	.41	145	155	.47	195	105	.57
400	95	305	.38	195	205	.47	245	155	.54	295	105	.65
500	195	305	.43	295	205	.52	345	155	.60	395	105	.72

----Target B-----

Total Load in Tons (4)	Per cent of bombs dispatched expected to fall within 1000 feet of aiming point (2)											
	10%			15%			20%			30%		
	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)	H.E. Tons (4)	I.B. Tons (4)	F(3)
50	35	15	.08	25	25	.16	25	25	.21	25	25	.29
75	35	40	.16	25	50	.23	25	50	.29	25	50	.38
100	35	65	.21	25	75	.29	25	75	.36	25	75	.44
125	35	90	.26	25	100	.35	25	100	.41	40	85	.48
150	35	115	.29	25	125	.38	25	125	.44	65	85	.52
175	35	140	.33	25	150	.42	45	130	.47	90	85	.57
200	35	165	.36	35	165	.44	70	130	.50	115	85	.59
250	35	215	.41	80	170	.48	120	130	.55	165	85	.65
300	45	255	.44	130	170	.52	170	130	.59	215	85	.70
400	145	255	.50	230	170	.59	270	130	.67	315	85	.79
500	245	255	.55	330	170	.65	370	130	.74	415	85	.85

NOTES: (1) The table for Target A also is valid for the 2000-lb G.P. Because of the difference in effectiveness, there will be a small error if the table for Target B is used for the 2000-lb G.P.

(2) In the examples following this table this quantity is called the "Index of Mission Efficiency".

(3) Expected fraction (per cent) of structural damage to buildings within Targets A and B.

(4) Load is given in tons of actual (not nominal) weight of bombs.

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Method of Use:

1. Determine index of mission efficiency:
   (a) Estimate per cent of dispatched planes bombing primary target.
   (b) Estimate per cent of bombs over target expected to fall within 1000 feet of aiming point.
   (c) Multiply (a) by (b) and round off to nearest percentage figure in table.

2. Read under computed index of mission efficiency and opposite the total load dispatched the recommended H.E. - I.B. loading and the expected fraction of damage.

Examples Illustrating Use of Loading Table: (based on Table I- Target A)

1. To find best H.E. - I.B. combination and resulting per cent of damage for a given force:
   Given: Planes expected to bomb primary target, 70% of mission.
   Per cent of bombs over target expected to fall within 1000 feet of aiming point, 30%.
   Mission of 100 planes with total load 300 tons.

   Solution: 70% x 30% = 21%; i.e., 20% is index of mission efficiency.
   Opposite 300 tons in 20% column find loading:
   H.E. 190 tons -- 63 plane loads at 3 tons per plane.
   I.B. 110 tons -- 37 plane loads at 3 tons per plane.
   F= 48%

   Hence, for optimum loading, 63 planes will carry H.E. and 37 planes I.B., but if groups of 12 are to carry only one kind of bomb per group, this may be revised to 5 groups with H.E.'s and 3 groups with I.B.'s.

2. To find force required to achieve a recommended level of damage:
   Given: Recommended level of damage, 40%.
   Same index of mission efficiency as in example 1.
   Individual A/C bomb load, 4 tons.

   Solution: In 20% index of mission efficiency column, take:
   F = 40% and find loading H.E. 90 tons
   I.B. 110 tons
   Total 200 tons
   requiring a total force of 50 aircraft or 4 groups of 12 aircraft.

LEVEL OF DAMAGE

Loss due to less than 15 per cent structural damage probably can be repaired rather quickly. It is not likely that much critical equipment would be hit at this level, and repairs would be confined to the walls and roof. While replacement time depends to a considerable degree on whether the scattered bombs hit some especially important spot, loss caused by destruction of material and aircraft in process and repair is not likely to result in more than 10 to 14 days output.

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Experience indicates that damage of 30 to 40 per cent is much more serious, as a high percentage of the material in process and repair would be destroyed. It would be more economical to move the plant to new buildings than to attempt to repair the buildings damaged 30 to 40 per cent. The loss in airframe fabrication and repair probably would be two to three months, spread over four or five months. Damage greater than 40 per cent is not profitable because of increased force requirements necessary against this small plant.

CAMOUFLAGE, DECOYS AND SMOKE SCREENS

Photography of 19 June 1944 shows no attempt at camouflage or decoys. Use of smoke screens has not been reported.

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TARGET NO. 93.3 – 45

MANCHURIA AIRPLANE MFG. CO., PLANT 2
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3 – 45 P I

APPROX. COORDINATES 41° 51' N 123° 26' E

PHOTOGRAPHED 19 JUNE 1944

11 SEPTEMBER 1944

CONFIDENTIAL

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

AC/AS. INTELLIGENCE

CONFIDENTIAL

TYPE A

TARGET NO. 93.3-45

APPROX. COORDINATES 41° 51' N 123° 26' E

PHOTOGRAPHED 19 JUNE 1944.

MANCHURIA AIRPLANE MFG. CO., PLANT 2
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-45 P2

11 SEPTEMBER 1944

CONFIDENTIAL

0 2000 4000 6000 FEET
0 ½ 1 MILE
1:32 000 APPROX.

AC/AS, INTELLIGENCE

CONFIDENTIAL

TYPE B

TARGET NO. 93.3-45

MANCHURIA AIRPLANE MFG. CO., PLANT 2
MUKDEN, MANCHURIA.

ILLUSTRATION NO. 93.3-45 P3

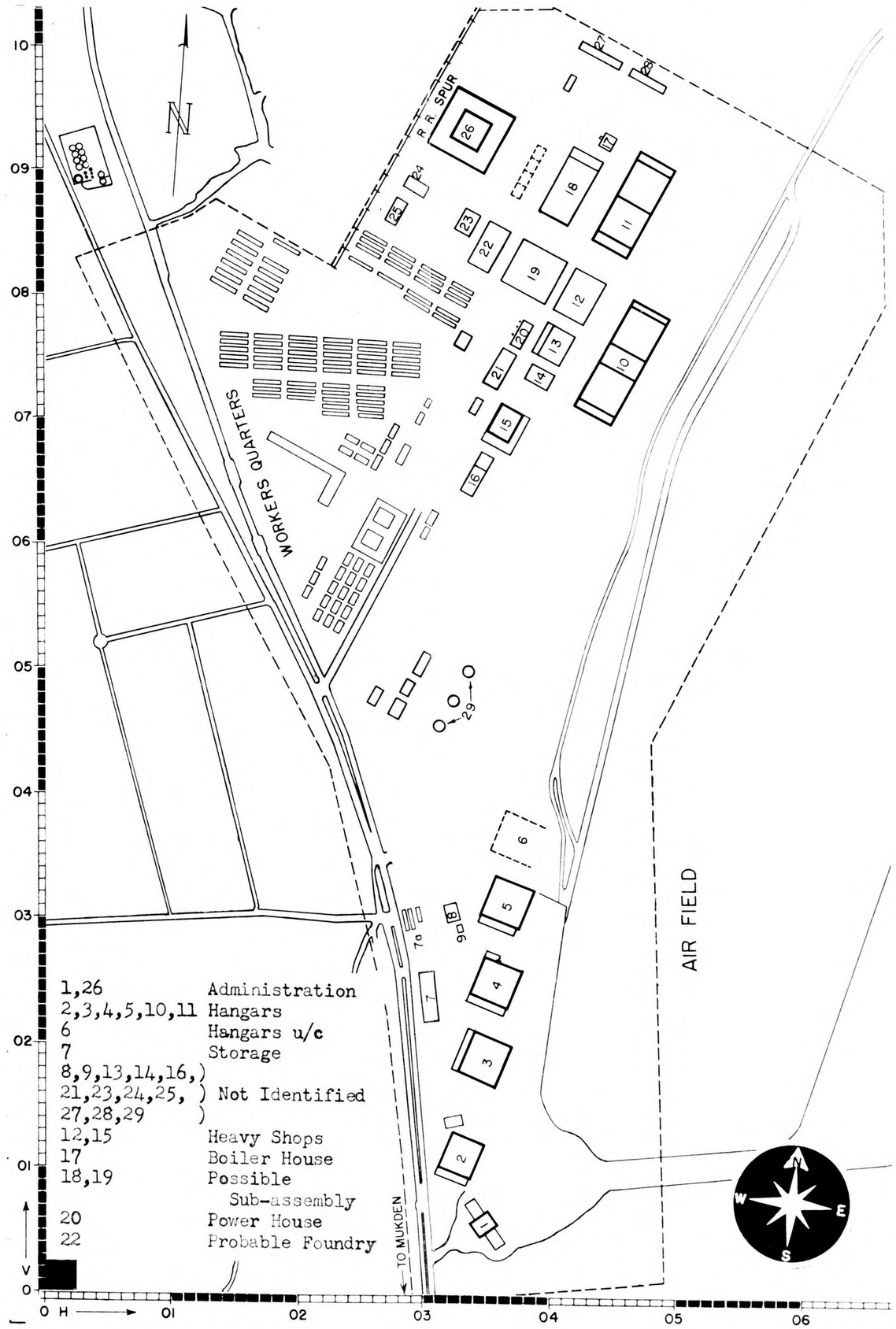
APPROX. COORDINATES 41° 51' N 123° 26' E

PHOTOGRAPHED 19 JUNE 1944

11 SEPTEMBER 1944

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET
0 1/4 1/2 MILE
1:6000 APPROX.



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TYPE B

NOT TO BE TAKEN INTO AIR

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Sheet No. 93.3-177TI/1
Date 16 Dec. 1944
Page No. 1 (7 pages)

JOINT TARGET GROUP, WASHINGTON, D.C.
TARGET INFORMATION SHEET

Obj. Folder 93.1-5
Obj. Area 93.3
AAF Target No. 93.3-177

Place **Mukden (Manchuria)**
Category **Aircraft**

Lat.: 41°48' N
Long: 123°30' E
Alt.: 160'

NAME OF TARGET **MANCHURIA AIRPLANE MFG. CO., PLANT #1**
(Manshu Hikoki Seizo KK)

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE:

The plant is probably now being used for the production of advanced single engine trainers. Study of aerial cover indicates that it is the only plant in Mukden engaged in aircraft fabrication. Target No. 93.3-45 (Manchuria Airplane Manufacturing Co., Plant No. 2), located on the W side of the N Mukden Airfield (41°52' N, 123°26' E) consists mainly of hangar type structures and is believed to be a repair and modification center.

Despite the frequent references to the importance of Manchuria as a producer of aircraft, the only aircraft and aero-engine nameplates recovered to date show that the obsolete fighter Nate and its engine (type 97650) were made at this plant in November, 1942. One intelligence source states that the Tachikawa firm set up a plant for the production of single engined trainers at Mukden in 1939, and it is not improbable that this is the present product. It is unlikely that either operational aircraft or engines are made here.

Output figures are not available. The size of the plant believed devoted to airframe (over 600,000 sq. ft.) and the large number of aircraft seen in and adjacent to the factory grounds suggest an output of at least 200 planes per month. While the existence of test beds in the extreme northern portion of the plant suggests engine production, there is no knowledge at present of the location or quantity of engine output by this company.

LOCATION:

This plant is part of a target complex which includes the Mukden Arsenal (Target No. 93.3-46) and its subsidiary Manchuria Machine Tool Co. (Target No. 93.3-164) and Manchuria Iron Works (Target No. 93.3-166). It is situated in the eastern suburbs of Mukden approximately 2½ miles E of the old walled city. The Hun River flowing generally NE-SW lies to the S and E with its nearest point about 4,500 feet SE. A RR spur runs W through the target and the adjacent Mukden Arsenal, and then NW to the Mukden-Kirin line. The compound is bounded on the W by the Mukden Arsenal, on the NE by a tributary of the Hun River, and on the S by the Old East Mukden Airfield. The Airfield is used for testing and flying off completed planes. The target area is adjacent to open country on the S and N and a sparsely built-up area on the E.

DESCRIPTION AND LAYOUT:

(Identity numbers quoted in this section refer to Illustration No. 93.3-177/P5, Fire Susceptibility Plan.) The plant occupies a triangular area 2,500 x 2,000 feet totalling 5,590,000 sq. ft. The major producing facilities occupy a compact square 1,200 feet on a side 45% built up, containing Buildings 5a and b, 12, 16, 19-21, and 30. This area contains the sub and final assembly facilities and possibly most of the metal processing and bench work as well. A minor producing area centers around Buildings 22 and 25 and those lying N of the railroad (Buildings 40-57). This area is probably used for basic airframe machining and stores if the plant makes only airframes and is functionally related to assembly in Building 6; or for engine compon-

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ent manufacture, if engines are made. It is not considered of primary importance even if the plant is engaged in engine manufacture since it is probable that a high percentage of engine components is produced in the arsenal itself.

The southwestern portion of the plant (Buildings 6 and 7) is presumably devoted to assembly and/or repair and/or experimental work.

Further details of building identifications are given in the attached functional analysis, Sheet No. 93.3-177/P6, which is keyed to the fire plan.

CONSTRUCTION AND VULNERABILITY:

(Identity numbers refer to Illustration No. 93.3-177/P5, Fire Plan.)

Walls: The majority of the buildings are steel framed; some smaller buildings are timber framed. Wall panels may be either masonry or corrugated iron.

Roofs: The bulk of the roofs are non-combustible, probably of corrugated iron or asbestos.

Floors: Concrete floors probably used in most buildings, particularly the hangar-like structures. Floors in multi-story units are reinforced concrete.

Number of Stories: 91% of the whole target and 96% of primary objectives consist of single story buildings.

Number of Fire Divisions: 63 in 57 buildings.

The Fire Plan shows the vulnerability to fire of each building and its contents. Contents are of low to moderate combustibility. It is estimated that 46% of the whole target and 38% of the primary objectives can be destroyed by fire. The target is therefore a reasonably good choice for combined HE -IB attack.

PRIMARY OBJECTIVES:

(Identity numbers refer to Illustration No. 93.3-177/P5, Fire Plan.) Whether or not engine parts are made at this plant, the primary objectives are the principal buildings associated with airframe production (machine shops, detail, sub-assembly and assembly). These are numbered as 5a and b, 12, 16, 19, 20a and b, 21 and 30.

These buildings are all within the 1,200-foot square mentioned in Section 4 above. All buildings within this area fall within a circle of 1,000 foot radius centering on Building 20. A large proportion of all airframe or engine machining buildings lie in this circle.

The selection of a single aiming point on Building 20 is therefore recommended for high level attack.

WEAPON RECOMMENDATIONS:

The most effective weapons for high level attack against the primary objectives in this target are the AN-M50 4 lb. incendiary in (M17 clusters) and the 2000 G.P. (AN-M66). Maximum damage to structures and contents will result if the HE bombs are fuzed 0.1 sec. nose and 0.01 sec. tail.

The AN-M50 IB (in M17 clusters) is much more effective than the AN-M47 against this target because of the wide dispersal of combustible material in the primary objectives, which requires multiple hits

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for a high level of damage. This same factor makes the use of the AN-M76 500 lb. incendiary very unprofitable. It is necessary to ignite each fire division, because the buildings are fairly well spaced and this, plus the presence of fire walls, tends to prevent fire spread.

The 2000 lb. G.P. is more effective than smaller G.P. bombs because it gives the best expectancy of causing spreading collapse to the long spanned and high roofed assembly buildings, particularly when it explodes 6 to 10 feet beneath the roof as a result of 0.01 sec. tail fuzing. The building area destroyed by a ton of either of the 500 lb. G.P. or the 1000 lb. G.P. is estimated to be about 90% of that destroyed by the 2000 lb. G.P.

The following loading tables show, for different choices of weapons, the best combinations of HE and IB for different weights of attack and for different assumptions regarding the number of bombs dispatched falling within 1,000 feet of the aiming point to obtain maximum damage for a given weight of bombs. They also show the fraction of structural damage to primary objectives which can be expected for each weight of attack and assumption of bombs dispatched falling within 1,000 feet of aiming point.

Table I is computed for the best combination of weapons, namely 2000 lb. G.P. and AN-M50 incendiary. If conditions of supply or other factors indicate choice of weapons other than those recommended in table I, the reduced effectiveness of the alternate weapons is shown in table II, which is made up for the 2000 lb. G.P. and the AN-M47 incendiary.

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Table I

LOADING TABLE - MOST EFFECTIVE WEAPONS

HE:AN-M66, 2000 lb. G.P. (1)
IB:AN-M50, 4 lb.

Manchuria Airplane Manufacturing Company, Plant No. 1

Total Load in Tons (4)	Percent of bombs dispatched expected to fall within 1,000 ft. of aiming point (2)							
	10%		15%		20%		30%	
	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)
50					20-30	19%	15-35	27%
75	35-40	16%	25-50	22%	20-55	28	15-60	34
100	35-65	20	25-75	28	20-80	32	25-75	37
125	35-90	24	25-100	31	20-105	35	50-75	40
150	35-115	28	25-125	34	40-110	37	75-75	43
175	35-140	30	25-150	36	65-110	39	100-75	46
200	35-165	32	50-150	37	90-110	41	125-75	48
250	35-215	35	100-150	40	140-110	45	175-75	53
300	80-220	37	150-150	43	190-110	48	225-75	57
400	180-220	41	250-150	48	290-110	54	325-75	64
500	280-220	45	350-150	53	390-110	60	425-75	70

Notes: - (1) Because of the small difference in effectiveness of the various G.P. bombs, there will be only a small error if this table is used for the 1000 and 500 lb. G.P. bombs.

(2) In the examples following this table this quantity is called the "Index of Mission Efficiency".

(3) Expected fraction (percent) of structural damage to vital parts in target.

(4) Load is given in tons of actual (not nominal) weight of bombs.

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Table II

LOADING TABLE - ALTERNATE WEAPONS

HE: AN-M66, 2000 lb. G.P. (1)
IB: AN-M47, 70 lb.

Manchuria Airplane Manufacturing Company, Plant No. 1

Total Load in Tons (4)	Percent of bombs dispatched expected to fall within 1,000 ft. of aiming point (2)							
	10%		15%		20%		30%	
	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)	HE - IB Tons (4)	F(3)
50					20-30	9%	15-35	13%
75	35-40	7%	25-50	10%	20-55	13%	15-60	19
100	35-65	10	25-75	13	20-80	17	15-85	24
125	35-90	12	25-100	16	20-105	21	35-90	28
150	35-115	13	25-125	19	20-130	24	60-90	31
175	35-140	15	25-150	21	45-130	26	85-90	34
200	35-165	17	25-175	24	70-130	29	110-90	37
250	35-215	22	75-175	28	120-130	33	140-90	43
300	45-255	24	125-175	31	170-130	37	210-90	48
400	145-255	29	225-175	37	270-130	45	310-90	58
500	245-255	33	325-175	42	370-130	53	410-90	66

Notes: - (1) Because of the small difference in effectiveness of the various G.P. bombs, there will be only a small error if this table is used for the 1000 and 500 lb. G. P. bombs.

(2) In the examples following this table this quantity is called the "Index of Mission Efficiency".

(3) Expected fraction (percent) of structural damage to vital parts in target.

(4) Load is given in tons of actual (not nominal) weight of bombs.

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Method of Use:

1. Determine index of mission efficiency:
   (a) Estimate percent of dispatched planes bombing primary target.
   (b) Estimate percent of bombs over target expected to fall within 1,000 feet of aiming point.
   (c) Multiply (a) by (b) and round off to nearest percentage figure in table.
2. Read under computed index of mission efficiency and opposite the total load dispatched the recommended HE - IB loading and the expected percent of damage.

Examples Illustrating Use of Loading Table: (Based on Table I)

1. To find best HE - IB combination and resulting percent of damage for a given force:

   Given: Planes expected to bomb primary target, 70% of mission.
   Percent of bombs over target expected to fall within 1,000 feet of aiming point, 30%.
   Mission of 100 planes with total load 300 tons.

   Solution: 70% x 30% = 21%; i.e., 20% is index of mission efficiency.
   Opposite 300 tons in 20% column find loading:
   HE 190 tons = 63 plane loads at 3 tons per plane.
   IB 110 tons = 37 plane loads at 3 tons per plane.
   F 48%
   Hence, for optimum loading 63 planes will carry HE and 37 planes IB, but if groups of 12 are to carry only one kind of bomb per group, this may be revised to 5 groups with HE's and 3 groups with IB's.

2. To find force required to achieve a recommended level of damage.

   Given: Recommended level of damage, 40%. Same index of mission efficiency as in example 1.
   Individual A/C bomb load, 4 tons.

   Solution: In 20% of mission efficiency column take:
   F = 41% and find loading HE 90 tons
   IB 110 tons
   Total 200 tons
   requiring a total force of 50 A/C or
   4 groups of 12 A/C.

LEVEL OF DAMAGE:

Any damage amounting to less than 15% structural damage to either the airframe or engine section of the plant will probably be repaired rather quickly. If the damage is in the airframe assembly section, it is not likely that much critical equipment will be hit and the only repairs necessary will be to walls and roof. This degree of damage in the engine section is likely to injure some tools, but increased use of similar equipment already in the plant and other temporary expedients are likely to put the plant back in full operation in a relatively short time. While repair time depends to a considerable degree on whether the scattered bombs hit some especially important spot, loss caused by destruction of material in process and by decrease in production of either airframes or engines is not likely to be more than 10 days to two weeks output.

Damage of 30 to 40% is much more serious. While there is no experience upon which to base Japanese reaction to this degree of damage,

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TARGET INFORMATION SHEET *(Contd.)*

European experience indicates that at this level a high percentage of material in production is destroyed and it is more economical to move the plant to new buildings than to attempt to repair the damaged buildings. Loss in airframes should be on the order of two to three months production, spread over four or five months; loss of engine production in this small plant should amount to about four months output spread over six or seven months. In this small plant higher damage than 40% is not likely to yield appreciably greater results.

CAMOUFLAGE:

Roofs of several buildings have disruptive painting, but many of the buildings show no attempt at camouflage.

ADDITIONAL INFORMATION:

This sheet cancels previous sheet 93.3-177TI, dated 28 August 1944.

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TARGET NO. 93.3-177

MANCHURIA AIRPLANE MFG. CO., PLANT 1
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-177 P1

APPROX. COORDINATES 41°-48' N 123° 30' E

28 AUGUST 1944

PHOTOGRAPHED 19 JUNE 1944.

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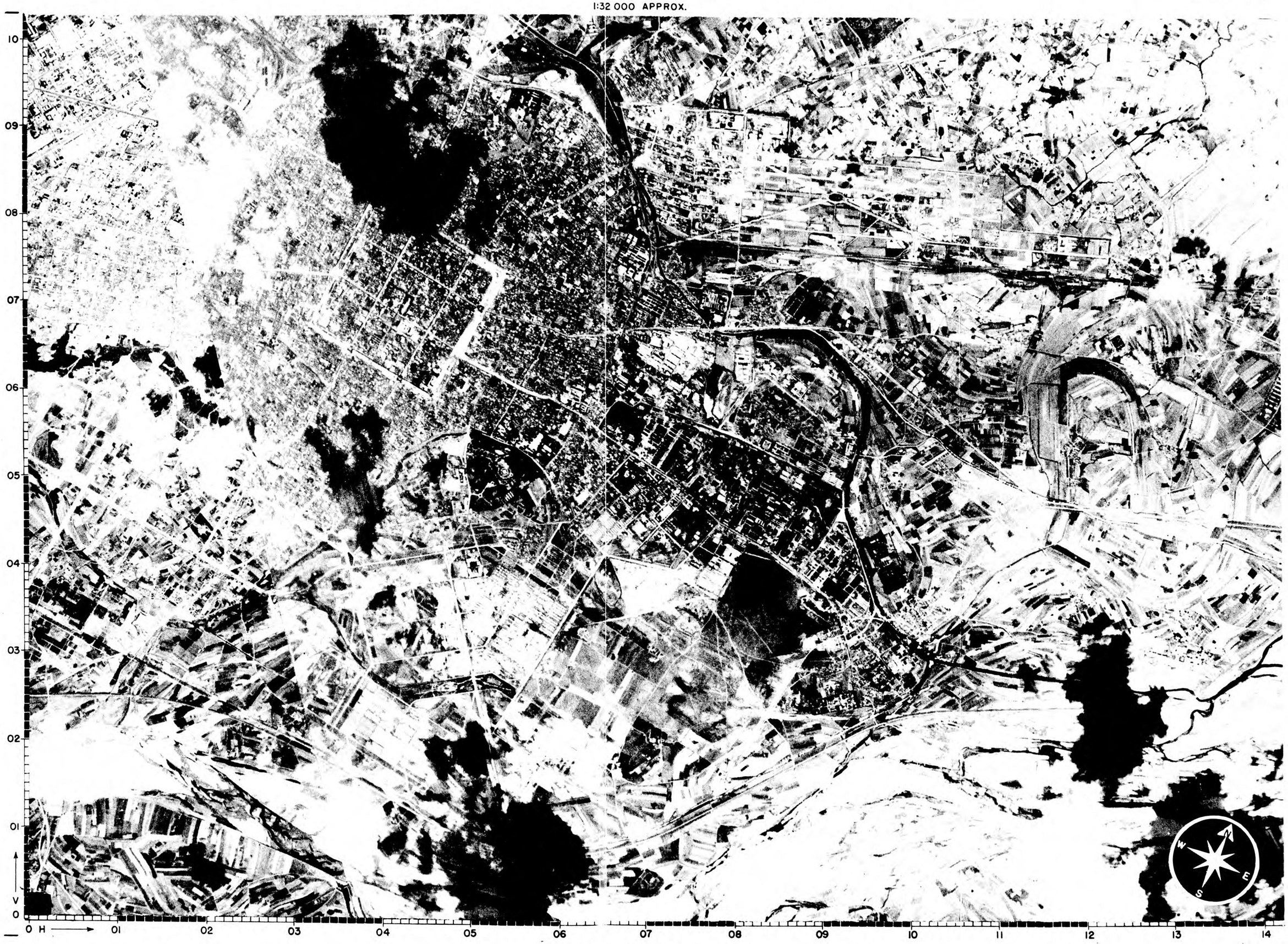
0 2000 4000 6000 FEET
0 1/2 1 MILE
1:32 000 APPROX.



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TYPE A

TARGET NO. 93.3-177

MANCHURIA AIRPLANE MFG. CO., PLANT 1
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-177 P2

APPROX. COORDINATES 41° 48' N 123° 30' E

28 AUGUST 1944

PHOTOGRAPHED 19 JUNE 1944

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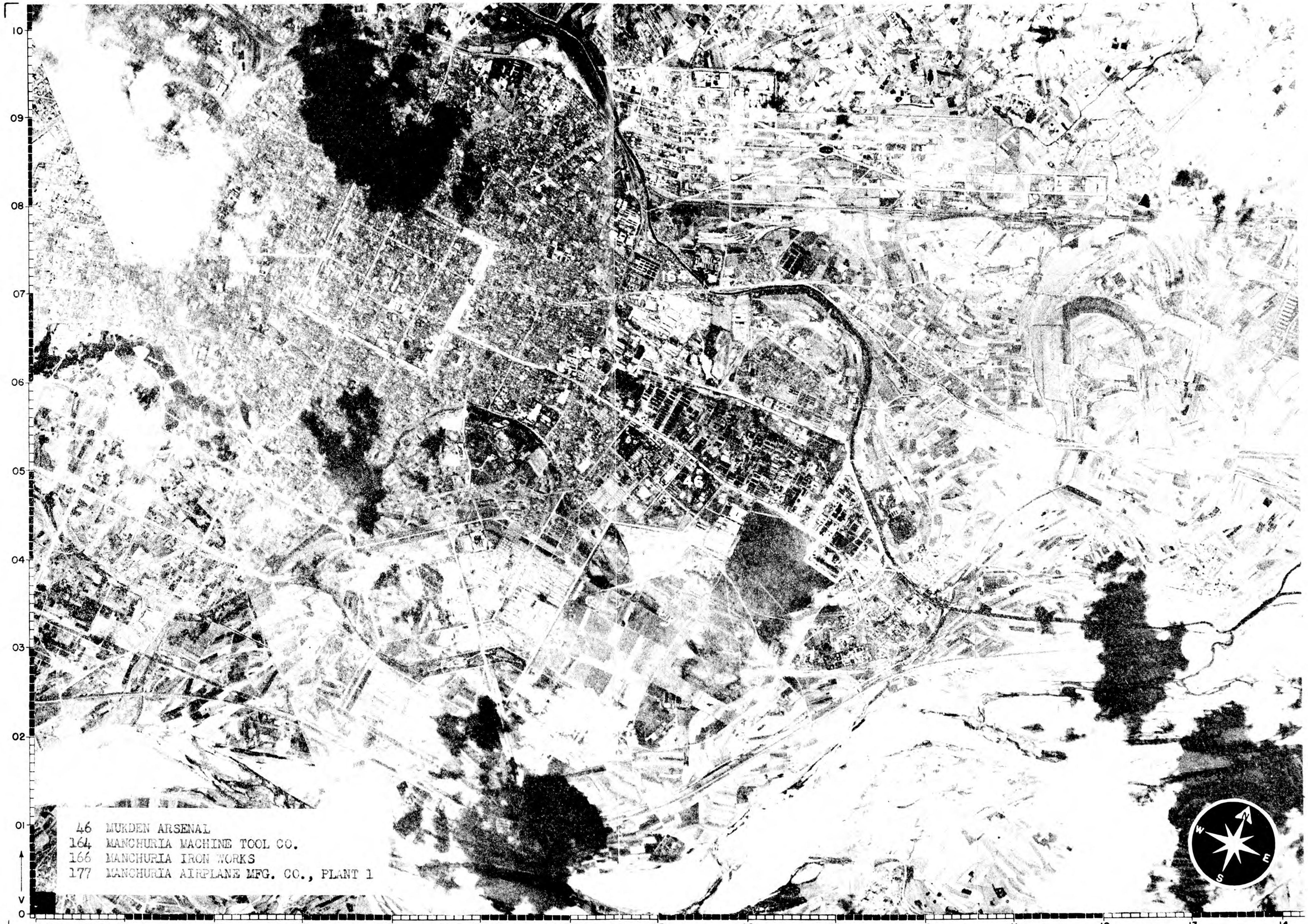
1:32 000 APPROX.



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TYPE A

TARGET NO. 93.3-177

MANCHURIA AIRPLANE MFG. CO., PLANT 1
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-177 P3

APPROX. COORDINATES 41° 48' N 123° 30' E

28 AUGUST 1944

PHOTOGRAPHED 19 JUNE 1944

CONFIDENTIAL

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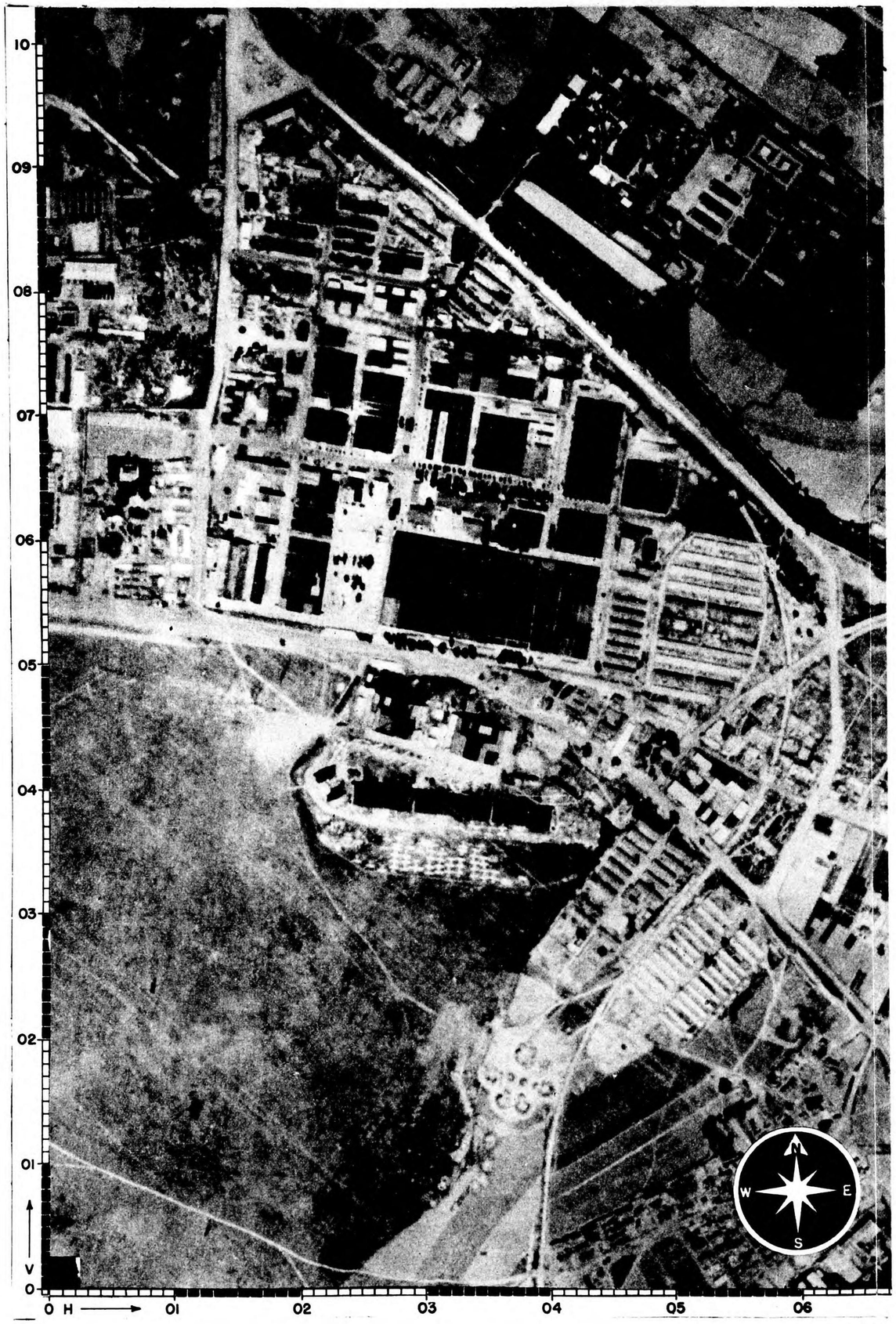
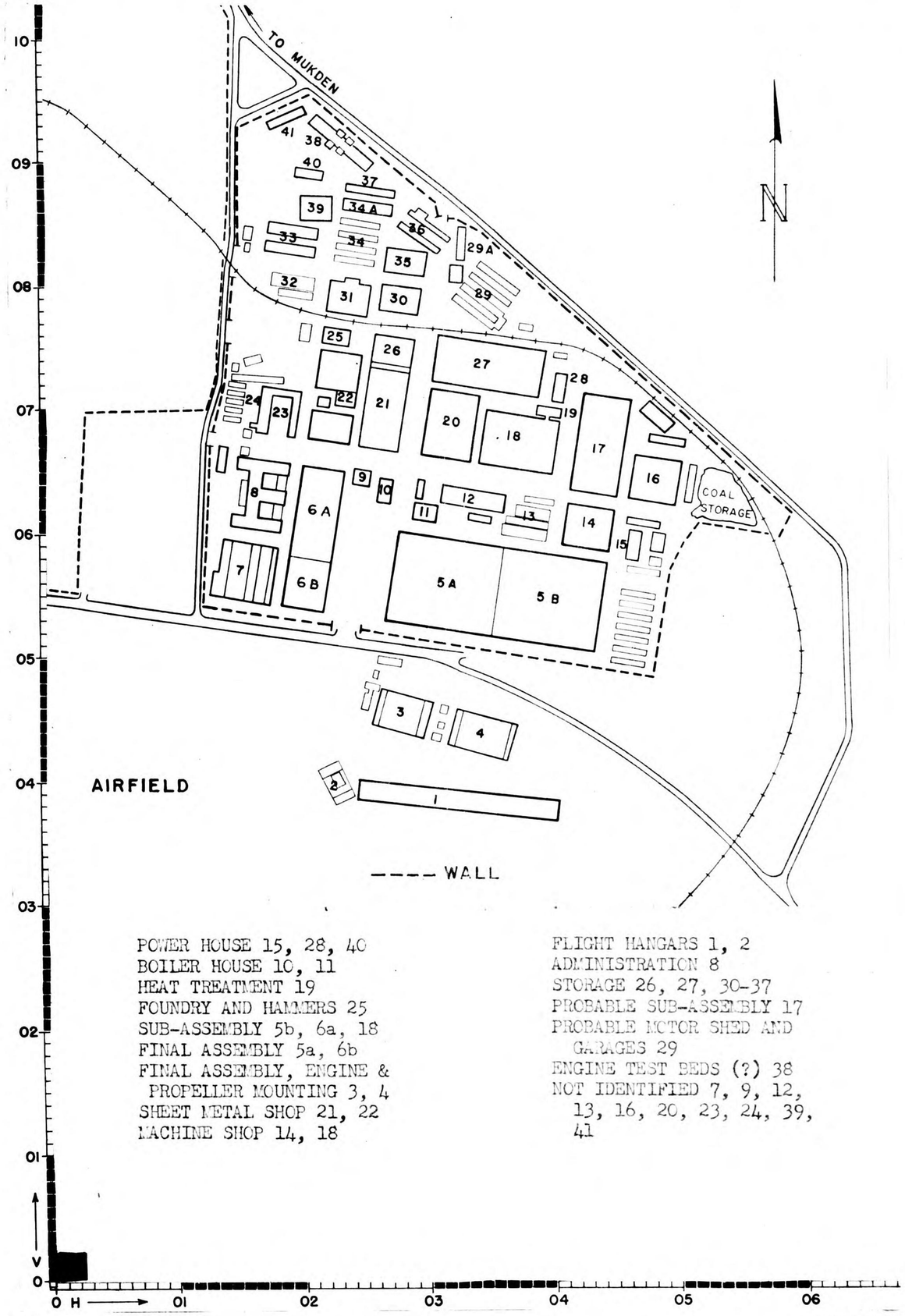
0 1/4 1/2 MILE
1:6000 APPROX.





POWER HOUSE 15, 28, 40
BOILER HOUSE 10, 11
HEAT TREATMENT 19
FOUNDRY AND HAMMERS 25
SUB-ASSEMBLY 5b, 6a, 18
FINAL ASSEMBLY 5a, 6b
FINAL ASSEMBLY, ENGINE & PROPELLER MOUNTING 3, 4
SHEET METAL SHOP 21, 22
MACHINE SHOP 14, 18

FLIGHT HANGARS 1, 2
ADMINISTRATION 8
STORAGE 26, 27, 30-37
PROBABLE SUB-ASSEMBLY 17
PROBABLE MOTOR SHED AND GARAGES 29
ENGINE TEST BEDS (?) 38
NOT IDENTIFIED 7, 9, 12, 13, 16, 20, 23, 24, 39, 41

JOINT TARGET GROUP-WASHINGTON, D. C.

TARGET NO. 93.3-177

MANCHURIA AIRPLANE MFG CO
PLANT NO. 1
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-177-P5

APPROX. COORDINATES 41°48′ NORTH
123°30′ EAST

PHOTOGRAPHED 19 JUNE 1944

ISSUED 11 DECEMBER 1944

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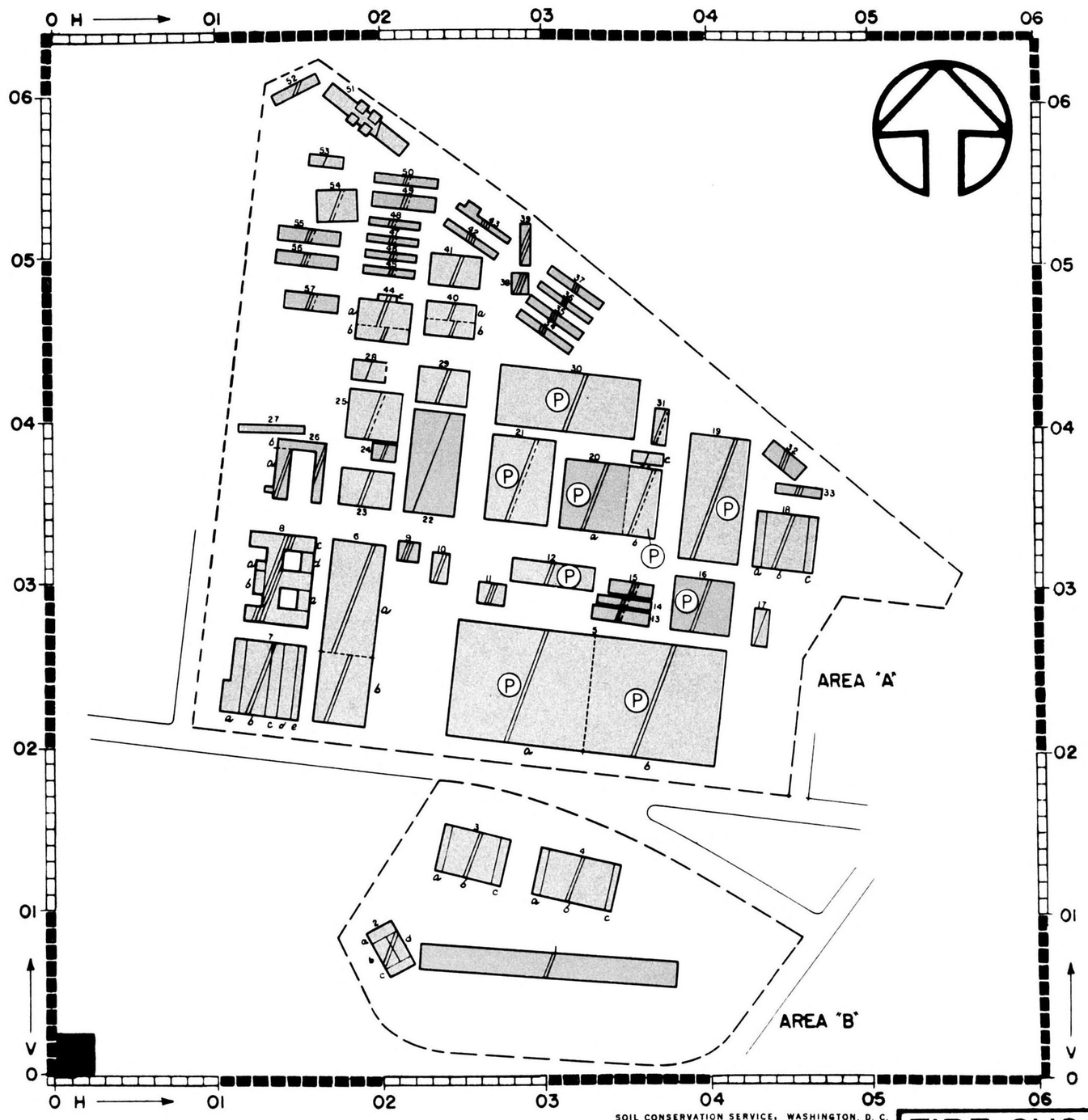

SOIL CONSERVATION SERVICE, WASHINGTON, D. C.
JANUARY 1945

FIRE SUSCEPTIBILITY PLAN

PRIMARY BUILDINGS	P	FIRE WALL, CERTAIN	
SECONDARY BUILDINGS	S	FIRE WALL, PROBABLE	
BUILDINGS		**CONTENTS**	
COMBUSTIBLE		NON-COMBUSTIBLE	
NON-COMBUSTIBLE		SLIGHTLY COMBUSTIBLE	
FIRE RESISTANT		MODERATELY COMBUSTIBLE	
COMBINATION I.E. COMBUSTIBLE ROOF RESISTANT FLOORS		HIGHLY COMBUSTIBLE	
		EXTREMELY COMBUSTIBLE	
WATER TANK	W	INTERMEDIATE VALUES	

AREAS IN ACRES	PRIMARY BUILDINGS	ALL BUILDINGS SHOWN
PLAN AREA	13.7	29.2
TOTAL FLOOR AREA	14.1	30.9
SITE AREA	128.0	

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JOINT TARGET GROUP, WASHINGTON, D.C.
FUNCTIONAL IDENTIFICATION SHEET

Sheet No. 93.3-177-P6
Date 16 Dec. 1944
Page No. 1 (1 pages)

Obj. Folder 93.1-5
Obj. Area 93.3
AAF Target No. 93.3-177

Place MUKDEN (Manchuria)
Category Aircraft

Lat.: 41°48' N
Long: 123°30' E
Alt.: 160'

NAME OF TARGET MANCHURIA AIRPLANE MFG. CO,, PLANT NO. 1
(Manshu Hikoki Seizo KK)

ALL PREVIOUS SHEETS CANCELLED

F U N C T I O N A L I D E N T I F I C A T I O N

(to be read in conjunction with Illustration 93.33-177/P5, Fire Plan)

Bldg. No.	Function of Building
1.	Flight hangar
2.	Hangars-control tower
3-4.	Hangars-post assembly and propeller mount-/ing
5a.	Final assembly
5b.	Sub-assembly
6a.	Sub-assembly
6b.	Final assembly
7.	Possible experimental and repair
8.	Administration
9.	Unidentified
10.	Boilerhouse
11.	Boilerhouse
12-15.	Unidentified
16.	Sub-assembly
17.	Power house
18.	Hangar type — possible sub-assembly
19.	Sub-assembly
20.	Metal shaping and detail and heat treating
21.	Metal fabrication
22.	Metal shaping, possible detail
23.	Sub-assembly
24-25.	Metal fabrication
26-27.	Unidentified
28.	Die foundry and hammers
29.	Storage
30.	torage and possible metal shaping
31.	Power house
32-33.	Unidentified
34-39.	Motor sheds and garages
40-44.	Storage
45-50.	Probable storage
51.	Engine test cells
52.	Unidentified
53.	Power house
54.	Unidentified
55-56.	Storage
57.	Unidentified
Area "A"	Main Plant Area
Area "B"	Post Assembly Area

(Based on Functional Analysis Report No. F/A-9 dated 11 Dec. 1944)

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JOINT TARGET GROUP-WASHINGTON, D. C.

TARGET NO. 93.3-177

MANCHURIA AIRPLANE MFG CO
PLANT NO. 1
MUKDEN, MANCHURIA

ILLUSTRATION NO. 93.3-177-DP 2

APPROX. COORDINATES 41°48′ NORTH
123°30′ EAST

PHOTOGRAPHED 13&26 DEC. 1944

ISSUED FEBRUARY 1945

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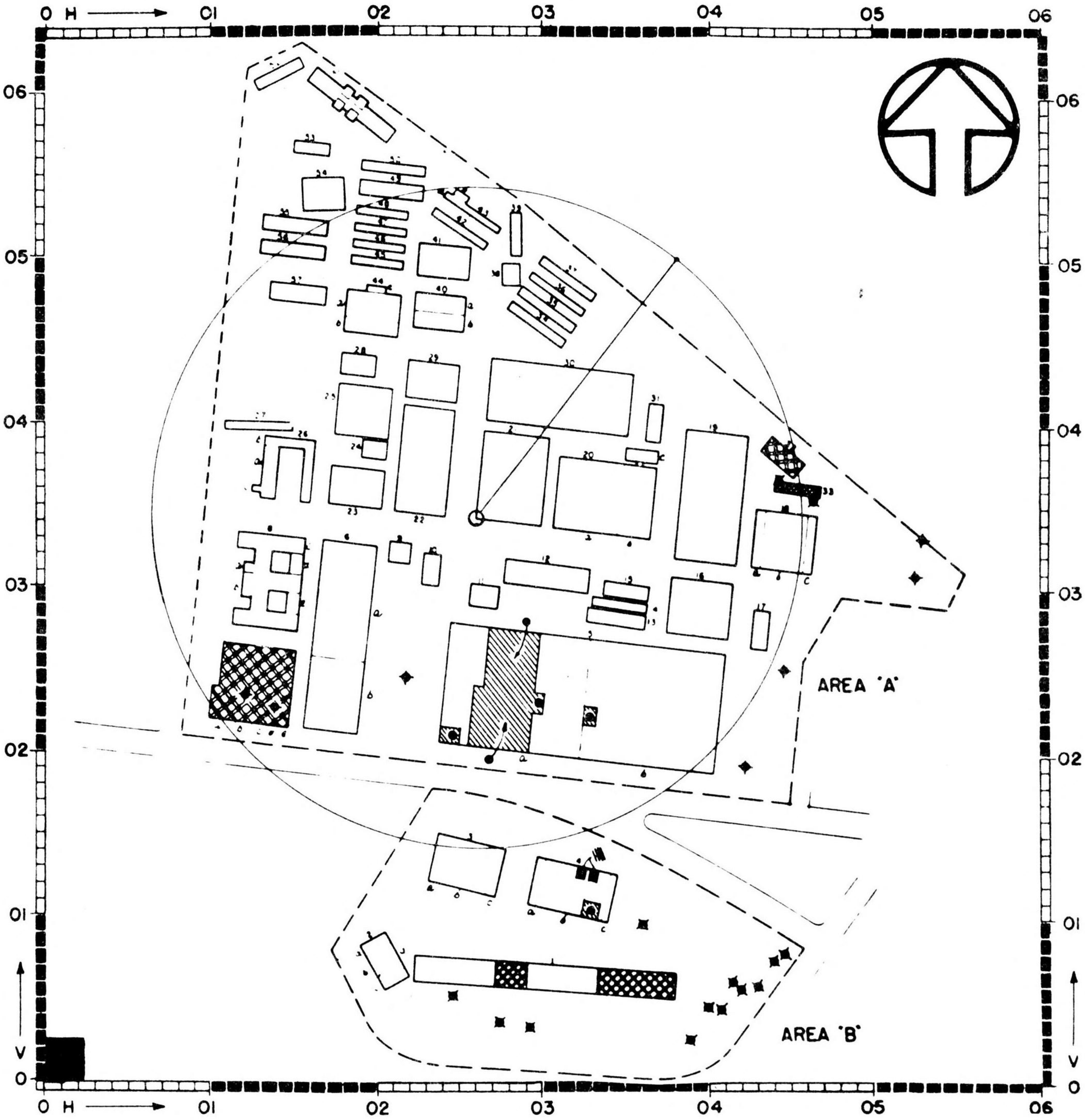

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JAPANESE AIRCRAFT

With corresponding material

ATTACK OF 7 DEC. '44

INDUSTRIAL DAMAGE PLAN

AREAS OF VISIBLE DAMAGE

STRUCTURAL	CAUSE	SUPERFICIAL
	H E	
	FIRE	
	H E + FIRE	
	CAUSE NOT ASSIGNED	

PRIOR DAMAGE NOT COMPLETELY REPAIRED

HIGH EXPLOSIVE BOMBS

- SINGLE BOMB CERTAIN WITH CRATER
- SINGLE BOMB CERTAIN WITHOUT CRATER
- SINGLE BOMB PROBABLE WITHOUT CRATER
- ONE OR MORE BOMBS CERTAIN IN GENERAL VICINITY OF ARROWHEAD
- ONE OR MORE BOMBS PROBABLE IN GENERAL VICINITY OF ARROWHEAD

NOT TO BE TAKEN INTO THE AIR

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ECONOMIC DAMAGE ASSESSMENT

Sheet No. 93.3–177–DA
Date 17 February 1945
Page No. 1

Obj. Folder 93.1–5
Obj. Area 93.3
AAF Target No. 93.3–177
Air Target System—Aircraft

Lat.: 41°48′N
Long.: 123°30′E
Alt.: 160′

MANCHURIA AIRPLANE MFG. CO.. PLANT NO. 1 (Manshu Hikoki Seizo KK) MUKDEN . . . . . MANCHURIA

ALL PREVIOUS SHEETS CANCELLED

THIS SHEET IN AIR TARGET SYSTEM FOLDER—JAPANESE AIRCRAFT—WITH CORRESPONDING MATERIAL IN OTHER AIR TARGET SYSTEM FOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET

PARTICULARS OF ATTACK

On 7 December 1944, this plant was attacked by 80 B–29's of the XX Bomber Command; 259 tons of explosives (184 tons of 500-pound G. P. and 75 tons of 500-pound I. B. bombs) were dropped from heights ranging between 19,300 and 23,800 feet. The plant was reattacked on 21 December by 19 B–29's. On this raid, 83 tons of bombs (41 tons of 500-pound G. P.'s and 42 tons of 500-pound I. B.'s) were dropped from roughly the same altitudes as were used during the first attack.

PREVIOUS REPORTS

None.

SUMMARY OF CONCLUSIONS

1. Damage to the part of the plant producing airframes was nearly entirely confined to final assembly which received about 40 percent superficial damage.
2. This is estimated to have caused about 2 weeks' loss in output of trainers, divided equally between loss in process and replacement time.
3. Other damage to post assembly and possibly repair functions, while severe, will scarcely be reflected in an appreciable loss of aircraft.
4. Little or no repair clearance is observed nearly 3 weeks after the attacks, suggesting dispersal of the damaged functions.

PHYSICAL DAMAGE

Of the plant's 1,269,000 square feet, 80,000 square feet or 6 percent of the total area suffered structural damage while 65,000 square feet or 5 percent of the total area received superficial damage from the first attack. The second attack did not add to this damage. The superficial damage was nearly entirely concentrated on the known productive parts of this factory (principally final assembly) while the structural damage was confined to post assembly functions and to unidentified buildings. This damage is summarized in the attached schedule.

Building No. 1, believed engaged in propeller mounting, was about 40 percent structurally damaged and a nearby hangar (Building No. 4) was slightly damaged. Post raid cover was obtained 6 days after the attack and it is difficult to estimate the number of planes destroyed in or around these buildings. At the outside, this should only amount to a few days' output.

Building No. 7, unidentified, was destroyed. It is believed that this building might have been engaged in repair work. At the most this damage might result in 1 month's loss of planes and components—type unknown—under repair, but the small size of this building suggests that this function was relatively unimportant.

ECONOMIC ASSESSMENT

As the productive portion of this plant received only superficial damage to its final assembly building (40 percent of this function being damaged) the net loss to trainer aircraft under construction is light. It is believed that this loss will not exceed 1 week's output. An additional week's output will probably be lost while this production is set up elsewhere—possibly at the No. 2 plant in northern Mukden (Target 93.3–45). The damage to the rest of the productive part of this plant was negligible and can be disregarded.

REPAIR ACTIVITY

There is evidence of some clearance to Building No. 7 noted on the cover of 25 December 1944, taken 18 days after the first attack. Lack of repair to Building No. 5a strongly suggests that final assembly functions will be dispersed.

Study of the strike and post attack cover shows that a large portion of Building No. 5b (subassembly) had been removed between the time of the first cover of this plant and the time of the first attack. Presumably a fire not caused by air attack caused the damage which necessitated abandoning this part of the plant. Building No. 30, once believed to be an incoming storage building, has had north light roofing substituted for its previous flat roof. It is thus possible that this building now houses the subassembly function once carried out in the destroyed portion of Building No. 5a.

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133–T

JOINT TARGET GROUP, WASHINGTON, D. C.
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Date **March 1945**

Issue No. **3**

AIR TARGET INDEX—JAPANESE WAR AND AIR TARGET SYSTEM FOLDERS

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ComFifth Fleet	5	237–241
ComSeventh Fleet	1	242
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ComSecond Carrier Task Force, Pac	1	244
ComFltAir, West Coast (OinC)	1	245
ComFltAir, Alameda (OinC)	1	246
ComFltAir, Seattle (OinC)	1	247
Commander, Navy No. 169	2	248–249
Commander, Navy No. 3233	2	250–251
ComForward Area, CenPac	2	252–253
Commander, Navy No. 3254	2	254–255
ComPhilippine SeaFron	2	256–257
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Nº 1

AIR TARGET SYSTEM FOLDER

JAPANESE NONFERROUS METALS

JOINT TARGET GROUP
WASHINGTON, D. C.

SECRET

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JOINT TARGET GROUP • WASHINGTON, D. C.
15 January 1945

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The material in this folder is divided into three parts as follows:

GENERAL ANALYSIS

This gives an over-all appreciation of the target system so that the importance of individual targets within the system can be readily evaluated. It also lists the essential details of the main targets in the system.

LOCATION MAP

This shows the location of the principal targets.

DATA ON INDIVIDUAL TARGETS

This is to contain Target Information Sheets and Illustrations and Economic Damage Assessment Reports as issued for individual targets in the system.

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Japanese Non-ferrous Metals

GENERAL ANALYSIS

SECRET
By Authority of
The Commanding General
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FOREWORD

The Japanese Non-Ferrous Metals Industry may be broken down into six main parts as follows:

Part I	Alumina-Aluminum
Part II	Copper
Part III	Zinc
Part IV	Magnesium
Part V	Nickel
Part VI	Lead

A report on Part I Alumina-Aluminum is submitted herewith. Reports on other parts will be prepared later and will be issued as addenda for insertion in this folder.

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JAPANESE NON-FERROUS METALS, PART I - ALUMINA-ALUMINUM, GENERAL ANALYSIS

INDEX

Page No.

SUMMARY

I. CHARACTERISTICS OF THE INDUSTRY 1

II. JAPAN'S PRESENT POSITION 1
A. ALUMINA PRODUCTION 1
B. ALUMINUM PRODUCTION 1

III. VULNERABILITY OF INDUSTRY TO AIR ATTACK 1
A. ALUMINA 2
B. ALUMINUM 2
C. ALUMINA VS. ALUMINUM 2
D. ALUMINUM VS. AIRCRAFT 2

ALUMINA INDUSTRY

1. EFFECT OF LOSS OF ALUMINA PRODUCTION ON MILITARY STRENGTH 3
A. USE PATTERN 3
B. EXISTING STOCKS 3
C. EXPENDITURE RATES 3

II. VULNERABILITY OF PRODUCTION TO AIR ATTACK 4
A. INDUSTRIAL PATTERN 4
1. Shift from Bayer Process 4
2. Capacity, Production and Geographic Distribution 4
3. Concentration 5
4. Extent of Integration 5
5. Trends 6
B. PRODUCTION PROCESS AND PHYSICAL VULNERABILITY 7
1. Production Processes 7
(A) Bayer Process 7
(B) Modified Pedersen Process 7
(C) Soda-Lime-Sinter Process 8
2. Physical Vulnerability and Weapon Recommendations 8
C. DURATION OF PRODUCTION LOSS 9
1. Recuperability of Alumina Plants by Process 9
2. Use of Cement Plants 9
3. Summary of Duration of Production Loss 9
D. CONCLUSIONS AS TO VULNERABILITY OF ALUMINA PRODUCTION 9

ALUMINUM REDUCTION INDUSTRY

I. EFFECT OF LOSS OF ALUMINUM PRODUCTION ON MILITARY STRENGTH 11
A. USE PATTERN: REQUIREMENTS 11
B. PRODUCTION AND STOCKS 12
C. TIMING OF EFFECT ON FRONT LINE STRENGTH 12
D. CONCLUSIONS AS TO VULNERABILITY 12

II. VULNERABILITY OF PRODUCTION TO AIR ATTACK 13
A. INDUSTRIAL PATTERN 13
1. Capacity; Geographic Location 13
2. Concentration 13
3. Extent of Integration 14
4. History and Possible Future Changes 14

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INDEX (Cont'd.)

	Page No.
B. PRODUCTION PROCESS AND PHYSICAL VULNERABILITY	15
1. Process	15
2. Layout	15
(A) Pot Rooms	15
(B) Rectifier Buildings	16
(C) Transformer Yards	16
3. Production Time Factor	16
4. Vital Facilities	16
5. Physical Vulnerability of Vital Installations	17
6. Physical Vulnerability of an Aluminum Plant as a Whole	18
7. Weapon Recommendations	18
C. DURATION OF PRODUCTION LOSS	19
1. Unused Capacity Available	19
2. Time Required to Repair or Replace Damaged Facilities	19
3. Available Substitutes & Dispersal Possibilities	20
D. CONCLUSIONS AS TO VULNERABILITY	20

TABLES

/T1 Estimated Current Annual Capacity and Production of Japanese Aluminum and Alumina Plants as of January, 1945.

APPENDIX NO. 1

PROCESSES IN USE IN THE JAPANESE ALUMINA-ALUMINUM INDUSTRY

Description	1
/FC1 - Flow Chart No. 1 - Soderberg Process for Aluminum Reduction	1
/FC2 - Flow Chart No. 2 - Bayer Process	1
/FC3 - Flow Chart No. 3 - Modified Pedersen Process	1
/FC4 - Flow Chart No. 4 - Soda-Lime-Sinter Process	1

DIAGRAMS

/D1 Diagram Showing Principal Details of Construction of Siemens-Schuckert Mercury Arc Rectifier
/D2 Relative Capacities of Japanese Aluminum and Alumina Plants

ILLUSTRATIONS

/P1 Ground Plan of Typical Japanese Aluminum Plant
/P2 Illustrations of Mercury Arc Rectifiers in Kambara Plant
/P3 Installation of Brown Boveri Type Rectifiers in a Japanese Aluminum Plant.
/P4 American Rectifier Transformer Interior Assembly

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JAPANESE NON-FERROUS METALS

PART I

ALUMINA-ALUMINUM

GENERAL ANALYSIS

SUMMARY

I. CHARACTERISTICS OF THE INDUSTRY

The Japanese aluminum industry consists of three stages, which are considered as separate target systems: alumina production, aluminum reduction, and aluminum and aluminum alloy fabrication. Alumina or aluminum oxide is the product of all alumina plants and is the raw material for the aluminum reduction plants which produce aluminum in ingot form. Fabrication is the production of aluminum and aluminum alloy sheet, forgings, castings and extrusions from aluminum ingot. The fabrication industry is least susceptible to air attack. It will be discussed in a supplement to this study.

The principal importance of the aluminum industry results from the fact that an estimated 82 percent of its output is used in aircraft production. For this reason, it is considered here not as an independent target system but primarily as an alternative method of reducing Japanese air strength.

II. JAPAN'S PRESENT POSITION

A. ALUMINA PRODUCTION

Japan's alumina industry is in a state of transition from the Bayer process, which requires bauxite as a raw material, to other processes which use other types of raw material. Bauxite is available only in the N.E.I.; other materials in the Inner Zone. Shortages due to the shipping stringency have already reduced operations of Bayer process alumina plants to less than 30 percent of capacity. Capacity in non-Bayer alumina plants alone is apparently not yet adequate to meet total requirements, but expansion now under way should correct this deficiency shortly.

B. ALUMINUM PRODUCTION

Japanese annual requirements for aluminum for all purposes are estimated at 208,000 metric tons[1] based on the 1945 Japanese aircraft program. A decline in Japanese aircraft production will, of course, reduce requirements. Even holding production to present levels will bring requirements below 208,000 tons since working inventories can be cut and no further expansion of inventories is required. Current production is believed to be adequate to meet requirements but stocks are probably not greater than necessary operating inventories. Annual capacity exceeds requirements and production by at least 24,000 tons.

III. VULNERABILITY OF INDUSTRY TO AIR ATTACK

A. ALUMINA

Present estimates of capacity indicate that as much as 64 percent of the crucial non-Bayer capacity may be located in five plants in Manchuria, Korea, and Honshu. Since new capacity has been developed rapidly and there may be new plants about which no intelligence is yet available, this degree of concentration may not exist now or will probably decline in the near future. Alumina plants are moderately susceptible to damage by air attack but recuperability time is relatively short so that frequent attack would be required to hold down production. It is believed possible, in addition, to replace or add to capacity by a conversion of cement plants, which would take about five months.

[1] Based largely on analysis of United States experience. This estimate is in process of revision and is believed to be on the high side.

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B. ALUMINUM	Aluminum capacity is spread through a number of plants. Twenty plants have been located. Fourteen contain 92 percent of capacity, ten contain 80 percent. A number of plants are difficult to attack: six are located in Manchuria and Korea; as many as seven of the twenty, involving 28 percent of total capacity, are on the Japan Sea and may be beyond the range of carrier-based aircraft, and very difficult for B-29's to attack from present bases. The production of aluminum in any aluminum reduction plant can be stopped by air attack. If the vital installations, the rectifiers and rectifier transformers, are destroyed, the plant cannot operate until they are replaced--a minimum period of six months, if several installations were destroyed. If a large number of plants were attacked successfully in a short period of time, there is good reason to believe that the recovery period might be at least twice as long. In view of the small area of the vital installations, aluminum plants are especially suitable for low level attack.
C. ALUMINA VS. ALUMINUM	According to present knowledge of non-Bayer alumina plants, production of alumina is concentrated in fewer plants than is production of aluminum. This situation, however, may be due to a lack of recent intelligence regarding new non-Bayer alumina plants. Aluminum reduction plants are more easily immobilized by aerial bombing than alumina plants, and they are slower to recover. If a number of aluminum plants are attacked within a short period, the recuperability time is markedly lengthened. Until the total number and location of non-Bayer alumina plants is more definitely known, aluminum reduction is the more promising point of attack.
D. ALUMINUM VS. AIRCRAFT	Attacking aluminum as an alternative to attacking aircraft manufacture directly has the disadvantages of, (1) less concentration in production, (2) the location of a number of plants beyond the range either of land-based bombers from our present bases or of carrier-based aircraft, and (3) a lag of five months between loss of aluminum production and reduced front-line aircraft strength. It has the advantages that dispersal is much more difficult, and that recovery time for the aluminum industry, especially if the attack is concerted, is considerably longer. The start of attacks on aircraft manufacturing raises the issue of what its effect will be on a choice of aluminum as a target system. If attacks on aircraft manufacture are successful, a resulting excess of aluminum capacity will permit the Japanese to stock-pile aluminum and become relatively invulnerable to later attack. Such a stock-piling, however, is not at all certain. In the first place, attacks on aircraft manufacture may not cut sharply aircraft production for as long as a year. Shipping and power shortages will make Japan reluctant to produce more aluminum than is necessary for current requirements. Once aircraft has become so dispersed as to be an unrewarding target, aluminum might be the best available alternative method of getting at aircraft.

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ALUMINA INDUSTRY

I. EFFECT OF LOSS OF ALUMINA PRODUCTION ON MILITARY STRENGTH.

A. USE PATTERN

The only use of alumina which is vital to the enemy war economy is as raw material for the aluminum reduction industry. It is also used--probably in relatively small quantities by the Japanese--in abrasives, in ceramics for certain types of fire brick and furnace linings, in chemicals and as a water softnener; but satisfactory substitutes are available for all of these uses. Therefore the effec of loss of alumina production on military strength would be the same as for aluminum, except for the additional time lag of one month, and this subject will be discussed under the *Aluminum Reduction Industry*.

It is estimated that approximately 93 percent of Japanese current annual aluminum production, 194,000 metric tons, is for direct military use. 388,000 metric tons of alumina, or about 91 percent of current annual production, is required to produce this amount of aluminum. Nearly all of the balance of 9 percent is required to produce aluminum for indirect military and industrial use, which is considered necessary to the enemy war economy.

B. EXISTING STOCKS

There is no definite information available on the quantity of alumina in stock. It is believed, however, due to the serious problem the Japanese have had to face in converting their alumina industry to handle low grade raw materials, that stocks, if any, are limited to average working stocks at aluminum plants. These are estimated as one month's supply or a total of 35,000 metric tons.

C. EXPENDITURE RATES

Alumina is needed at the aluminum plants at the rate of about 35,000 metric tons per month. Expenditure rates for the other uses mentioned above is in the realm of pure speculation and relatively unimportant.

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ALUMINA INDUSTRY

II. VULNERABILITY OF PRODUCTION TO AIR ATTACK.

A. *INDUSTRIAL PATTERN*

1. *Shift From Bayer Process*

The Japanese aluminum industry, which was initiated in 1934, was built around the Bayer alumina process which is dependent on high grade bauxite of low silica content. Bauxite suitable for this process is now available to the Japanese only from Bintan Island and Malaya. There is evidence as early as 1937, when the development of the Pedersen process was initiated in the plant at Fushun, Manchuria (Target 93.3-32), and later in January, 1941, when an article was published in Tokyo by Dr. Yagi[1], a Japanese scientist, that the Japanese realized this weakness in their position and began making plans to overcome the weakness. Recently there is considerable evidence that these plans have gradually developed into an intensive effort to convert their alumina industry to handle the low grade aluminous raw materials of which they have an adequate supply in Manchuria and North China. There is further evidence that these efforts have been reasonably successful and their alumina industry, if not now fully self-sufficient within their Inner Zone, is rapidly approaching that status.

It is further believed that the Japanese are accomplishing their aim of self-sufficiency in alumina to such an extent that they may be in the process of writing most of the Bayer plants off as losses.[2] The above in addition to the other evidence mentioned herein is supported by the continued increase in Japanese aircraft production.

2. *Capacity, Production and Geographic Distribution*

Total current alumina capacity is estimated at 571,000 metric tons per annum, of which 232,000 metric tons is in seven Bayer process plants. Total current alumina production is estimated at 424,000 metric tons. The production of the Bayer plants, with the exception of the plant at Takao, has been estimated at no more than 30 percent of capacity because of shortages of bauxite.

The geographic distribution of alumina plants is as follows:

	Number of Plants	Estimated Capacity in Metric Tons
Manchuria	2	72,000
Korea	4	68,000
Honshu	10	311,000
Shikoku	1	20,000
Kyushu	2	60,000
Formosa	1	40,000
	20	571,000

The breakdown of types of production (processes) is as follows:

	Number of Plants	Estimated Capacity in Metric Tons	
Using Bauxite			
Bayer Process			
Honshu	4	132,000	
Kyushu	2	60,000	
Formosa	1	40,000	
Total Bayer	7		232,000

1- *"Concerning the Aluminum Industry in Manchukuo and Chosen," Dr. Yagi, Toyo Keisai Shimpo, Tokyo, 25 January 1941, pp. 36-37.*

2- *See under 'Production Processes - Bayer Process. (Sec. II.B.1.(A)*

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Using Shale and Other Low Grade Raw Materials					
Pedersen Process					
Manchuria	1		48,000		
Lime-Sinter Process					
Honshu	2		120,000		
Other plants using low grade raw materials.*					
Manchuria	1		24,000		
Korea	4		68,000		
Honshu	4		59,000		
Shikoku	1		20,000		
		10		171,000	
Total Non-Bayer		13			339,000
Total All Plants		20			571,000

*NOTE: *Process used in these plants is not definitely known. Three or four plants in Manchuria and Korea may be using the Pedersen process. Others may have installed large rotary kilns and be using the lime-sinter process.*

For further details as to capacity, production and location of the individual plants see Map 1, Diagram 2, and Table 1.

3. *Concentration*

The 10 largest plants include 76.5 percent of capacity; the 14 largest plants, 90.5 percent of capacity. Because of the doubtful value of the Bayer process plants either to the Japanese or as targets the following are considered the five most important plants:

Target Number	Location	Estimated Capacity in Metric Tons	Estimated Production in Metric Tons
90.32- 822	Onoda, Honshu	70,000	70,000
90.29-1690	Itozaki, Honshu	50,000	50,000
93.3 - 32	Fushun, Manchuria	48,000	48,000
84.2 - 1	Konan, Korea	24,000	24,000
93.2 - 200	Antung, Manchuria	24,000	24,000
		216,000	216,000
Percent of Total Non-Bayer Plants		63.7 percent	64.4 percent

4. *Extent of Integration*

Elevan of the plants are integrated with aluminum plants and share the same plant compound. These plants would undoubtedly suffer incidental damage as a result of a concerted attack on the aluminum industry. The eleven integrated plants are as follows:

Target Number	Location	Estimated Capacity in Metric Tons	Estimated Production in Metric Tons
	Manchuria		
90.3 - 32	Fushun	48,000	48,000
93.2 -200	Antung	24,000	24,000
	Korea		
84.2 - 1	Konan	24,000	24,000
84.3 - 67	Chinnampo	20,000	20,000
93.2 -201	Yoshi	21,000	17,000
84.4 -208	Genzan	3,000	3,000

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		Honshu		
90.12-1100		Omachi	* 8,000	2,400
90.11- 861		Higashi Iwase	20,000	20,000
90.11- 866		Takaoka	* 14,000	4,200
90.5 -1557		Hachinohe	* 10,000	3,000
		Formosa		
91.6 - 3		Takao	* 40,000	32,000
			232,000	197,600
		Percent of Total	40.6	46.5

*Bayer process plants, their integration is of questionable duration.

5. *Trends.*

The major trend in the alumina industry is the continued increase in non-Bayer in non-Bayer capacity. Current aluminum production requires 416,000 metric tons of alumina. Non-Bayer plants produce only 335,000 tons. The intelligence indicating an early correction of this apparent unbalance together with decline in the production of alumina in Bayer plants is noted below.

June 1944 photography of the plant at Fusbun, Manchuria (Target 93.3-32) shows a very large increase in the alumina plant under construction which may now be completed and in operation. If this is so, alumina production at Fushun is probably very much larger than reported.

Similar expansion of the plant at Antung, Manchuria (Target 93.2-200), is reported.

The two cement plants at Onoda and Itozaki, Honshu (Targets 90.32-822, 90.29-1690), are reliably reported to have been converted to the production of alumina, using the lime-sinter process. These plants are believed to be producing alumina at the annual rate of 70,000 and 50,000 metric tons respectively.

An alumina plant is reported to have been built at Changtien, Shantung Province, China. Rotary kilns, reported as having been moved here from a former cement plant, indicate the lime-sinter process.

The several air photo coverages of the Bayer plant at Takao, Formosa (Target 91.6-3), during the past year show this plant to be receiving bauxite on a hand-to-mouth basis and indicate that this plant is producing at considerably below capacity.

Recent air photography of the three other Bayer plants where NEI bauxite is most likely to be shipped and used--those at Shimizu, Honshu (Target 90.18-1176), and at Kurosaki and Omuta, Kyushu (Targets 90.34-1108 and 90.35-1877)--show little or no activity at these plants with little or no bauxite on hand, and no effort being made to convert them to handle low grade raw materials.

Future changes will work toward increasing or completing Japan's self-sufficiency in alumina. Illustrative of this trend, reports of the following probable future changes have been received:

(a) Increase in the capacity of the Onoda and Itozaki plants (Targets 90.32-822 and 90.29-1690) to a possible 100,000 and 64,000 metric tons respectively by April 1945.

(b) Material increase in the capacity of the Fushun Plant (Target 93.3-32).

(c) Completion of conversion of Yokohama plant (Target 90.17-521) by April, 1945 and the increase of its capacity to 40,000 metric tons.

(d) Increase in the capacity of the plants at Konan and Chinnampo, Korea (Targets 84.2-1 and 84.3-67), and at Higashi Iwase, Honshu (Target 90.11-861).

(e) It is possible that more cement plants may be found to have been converted to alumina manufacture.

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B. PRODUCTION PROCESSES AND PHYSICAL VULNERABILITY

1. Production Processes

The three processes known to be used by the enemy - Bayer Process, Modified Pedersen Process and Soda-Lime-Sinter Process - are graphically described in flow charts Nos. 2,3, and 4 and the notes accompanying same, which will be found in Appendix No. 1.

In each case the primary objective (critical point) has been selected to meet the following requirements:

(a) A point in the process whose destruction or immobilization will stop production in the entire plant.

(b) The point in the process whose equipment will require the longest period to repair or replace.

(c) With due consideration to (a) and (b) above, a point that is readily susceptible to damage or destruction by bombing.

(A) *Bayer Process.* The most important steps or equipment in the Bayer process plant, in the order of their importance, are as follows: digesters, rotary kilns, blowoff tanks and filter presses, precipitators and steam plant. The digesters, filterpresses and precipitators are housed in various types of buildings, the two last requiring relatively large buildings. The blowoff tanks can be outside. The rotary kilns may be partly exposed.

The primary objective in any Bayer process alumina plant is the digester equipment which consists of a number of steel pressure tanks or autoclaves, operating under steam pressure of from 100 to 200 lbs. and a number of pumps usually operated by steam. In addition there is a considerable network of piping connecting the several tanks and pumps with the other plant installations, and a considerable number of valves (some of which are difficult to replace) for the purpose of controlling pressures and the flow of materials. This equipment normally occupies about 80 percent of the floor space of the digester building. The size of the individual digester tanks is variable and not important to the process.

Serious damage to the digester building would stop production in the entire plant.

(B) *Modified Pedersen Process.* The most important steps or equipment in the Pedersen process plant, in the order of their importance, are as follows: electric furnaces, rotary kilns, solution tanks, refining troughs and precipitators, and steam plant.

Only one plant, that at Fushun, Manchuria (Target 93.3-32), is known to be equipped for the Pedersen Process. It is possible, however, that subsequent intelligence may disclose that this process is in use in the plants at Konan, Korea (Target 84.2-1); Antung, Manchuria (Target 93.2-200); and Yoshi, Korea (Target 93.2-201).

The electric furnaces at the Fushun Plant are installed in buildings believed to be reinforced concrete including roofs (Bldgs 30 and 35) If electric furnaces are found at other plants they also will probably be housed in similar substantially constructed buildings. The types of buildings housing the rotary kilns, solution tanks, refining troughs and precipitators, and steam plant are not important to the process and various types may be found. The solution tanks, refining troughs and precipitators require relatively large buildings. The rotary kilns may be partly exposed.

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The primary objectives in a Pedersen process plant are the electric furnaces, which, in the Fushun plant, are in batteries of 8 and 12, in single rows in buildings about 240 ft. and 385 ft. in length respectively. The individual furnaces are necessarily large in order to handle the large bulk of raw materials, which, in this plant, is estimated at 24,000 metric tons per month.

Large furnaces are usually spaced about 15 ft. apart. Based on this spacing and the air photography of the Fushun plant the outside dimensions of the furnaces are about 16 by 20 ft. Their height is not known but is probably about 18 ft. overall. Such furnaces are built of fire brick on a steel frame and have a lining which must be resistant chemically to the materials with which the furnace is to be charged. The total thickness of the furnace walls is estimated at about 16 in. For the purpose used the furnaces would operate at a temperature of about 2500°F.

Partial damage to or destruction of the furnace buildings would not stop production in the entire plant as it is believed that undamaged furnaces could continue to operate at a proportionately reduced rate. Total destruction of the transformers would stop production in the furnaces and in the entire plant but it is believed that the Japanese could replace the stepdown transformers fairly quickly.

(C) *Soda-Lime-Sinter Process.* No photo cover is available of any Japanese Lime-Sinter or Soda-Lime-Sinter process plant, and, therefore, intelligence is less definite than for the other two processes. The most important steps or equipment in a Lime-Sinter process plant are the rotary kilns and then in their probable order of importance: the hoppers, conveyors, etc. for handling raw materials; the leaching, filtering and clarifying tanks; the precipitators; and the boiler plant.

The rotary kilns are usually housed in a large building with a ventilated, non-combustible roof supported on a light steel frame, but may be partly exposed. Stacks may be present, but are not always visible, at one end of the kilns. The other equipment in a lime-sinter process plant can be housed in almost any type of building. Those housing the leaching and filtering tanks and precipitators are relatively large.

The primary objectives in a lime-sinter process plant are the rotary kilns. These are large, heavy equipment, usually larger than the kilns used in a Bayer process plant. The individual kilns vary from 6 to 11 ft. in diameter and from 60 to 500 ft. in length--average length about 300 feet. They are constructed of steel boiler plate about 3/4 in. thick and are lined with fire brick. They are equipped with 2 to 6 steel tires, the number depending on the length of the kiln. The thickness of the steel at and near the points where the tires are attacked is built up to about 2 inches.

2. *Physical Vulnerability and Weapon Recommendations*

Most buildings are light and only act as cover. Damage to machinery is therefore the criterion for weapon and fuze selection.

The machinery is moderately vulnerable to H.E. effect. Blast is not very effective and damage will mostly result from direct hits or shock and fragmentation from very near misses. Neither contents, equipment, nor structures are readily combustible and the *use of incendiaries is not recommended.*

The primary objectives differ in the various processes ranging from electric furnaces in the Pedersen process, to digesters (autoclaves) and rotary kilns in the Bayer process, and to rotary kilns in the lime-sinter process. They all have the same degree of vulnerability, however, and will best be damaged by direct hits of meduim size HE bombs. The same size of bombs will also be efficient in creating damage to mechanical conveyors on which the movement of bulky materials depends.

The 250 lbs. G.P. bomb or the 500 lbs. G.P. bomb as alternate will be the most effective weapon and should be fuzed .1 sec. nose and .01 tail.

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It must be understood that the above recommendation is general in character and that individual targets may possibly differ from normal. Therefore reference should always be made to the Target Information Sheets for weapon selection and amining points.

C. *DURATION OF PRODUCTION LOSS*

1. *Recuperability of Alumina Plants by Process.*

(A) *Bayer Process plants.* Replacement time for digester equipment is about 3 months. All other equipment in the plant except possibly the rotary kilns could be more quickly replaced or repaired. In the event of serious damage to the rotary kilns, production could be continued pending replacement or repairs by shipping the aluminum trihydrate to another plant or to a cement plant for calcination. The boiler plant could be replaced temporarily by a portable contractor's boiler pending repairs.

(B) *Pedersen Process plants.* In the Pedersen process, replacement time for the electric furnaces is about six months. All other equipment in this type of plant could be more quickly replaced or repaired. In the event of serious damage to the rotary kilns, production could be continued pending replacement or repairs by shipping the aluminum trihydrate to another plant or to a cement plant for calcination. The boiler plant could be replaced temporarily by a portable contractor's boiler pending repairs.

(C) *Sida-Lime-Sinter process.* The replacement time for rotary kilns is about three months. This is based on the time required to transport the kiln or kilns from another location and set them up. It is known that the Japanese had a considerable excess of cement plants and rotary kilns before the war. If they had to build new kilns from scratch, the replacement time would be longer--4 to 5 months.

Partial production could probably be continued in a lime-sinter plant, in the event of a successful attack, if one or more kilns remained useable.

Of secondary importance in a lime-sinter plant are the hoppers, conveyors, etc., for the handling of raw materials. The bulk of shale and lime required is such that it could not be handled temporarily by manual labor if this equipment were damaged. Damage to or destruction of this equipment would delay production until repairs or replacement could be made.

2. *Use of Cement Plants*

There is believed to be little, if any, existing unused capacity of alumina to which the Japanese could resort, because of the lack of bauxite and the difficulty of converting the Japanese Bayer process plants (see Note on Bayer process, Appendix I). New capacity could be created, however, and may already have been created by the conversion of cement plants to the Lime-Sinter process.

3. *Summary of Duration of Production Loss*

The duration of production loss is determined, first, by the replacement time of critical equipment (i.e. 3 months for digester equipment, 6 months for electric furnaces, 3 months for rotary kilns), and, second, by the conversion time of cement plants (which is estimated at about five months).

D. *CONCLUSIONS AS TO VULNERABILITY OF ALUMINA PRODUCTION*

The various alumina processes are moderately susceptible to bomb damage. Recovery time, however, is fairly short, and frequent attack would be required to hold down production. Cement plants can be converted to the Lime-Sinter process but only after a time lag of five months.

The alumina industry is most vulnerable during early 1945 when bauxite for the Bayer process is no longer available and the capacity of non-Bayer plants is apparently not yet adequate to maintain current aluminum output. Concentration of production in five plants in Honshu, Korea, and Manchuria is thought to be high (63%). However, the uncertainty of information about the changing alumina industry,

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e.g., the report of two new plants in North China, reduces somewhat the significance of the apparent shortage of capacity and the concentration of capacity in a few plants.

As the Japanese complete their conversion to non-Bayer process plants the increase in capacity and decrease in concentration will make the alumina industry less vulnerable. The desirability of attacking aluminum production by destroying alumina capacity at some later date will depend on the capacity, concentration and location of production at that time.

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ALUMINUM REDUCTION INDUSTRY

I. EFFECT OF LOSS OF ALUMINUM PRODUCTION ON MILITARY STRENGTH.

A. *USE PATTERN: REQUIREMENTS*

Based on the best available estimates of Japanese aluminum requirements, the uses of aluminum can be broken down as follows:

	Percent of total primary aluminum	
Direct Military Uses		93.0
For aircraft production	82.0	
Other Army uses	5.0	
" Navy uses	6.0	
Indirect Military and Industrial Uses		7.0
		100.0

Current use of aluminum by the Japanese in aircraft production, including engines, propellers and spare parts, can be estimated roughly by applying the United States ratio for aircraft output to aluminum input to estimates of Japanese aircraft production. This method yields an estimate of 175,000 metric tons required for the current year, a figure which may be somewhat high. Following is a description of the method:

(1) The ratio of total United States shipments of aluminum fabricated shapes to total empty weight of United States planes was figured for the years 1941-1944.

(2) A study of these ratios revealed that certain allowances would have to be made for difference between United States and Japanese practice, relative size of planes and for the fact that the Japanese aircraft expansion program is about two years later than our own. With these considerations a comparable Japanese ratio was selected and applied to total empty weight of Japanese planes for 1944 to produce total weight of Japanese fabricated shapes for the year.

(3) Secondary aluminum was estimated at 10 percent.

(4) Total Japanese primary aluminum required was figured from total Japanese fabricated shapes minus secondary.

(5) This method produced a figure of 162,000 metric tons of primary aluminum required for aircraft production for 1944. As this was based on an estimated production by Japan of 17,500 combat planes during 1944 it was necessary to revise the estimate of aluminum requirements to make it applicable to the current estimated production of 2000 combat planes per month.

It should be noted that the estimates for Army, Navy, and indirect military and industrial uses are not direct estimates of the Japanese use pattern but are based almost entirely on experience in the United States with the following assumptions:

(1) That the Japanese needs for and uses of aluminum under wartime conditions are essentially the same and proportional to those in the United States.

(2) That the amount of steel available to Japanese consumers of aluminum outside the aircraft industry is the limiting factor in production of arms, munitions, etc., other than aircraft, and that since aluminum exists in a fairly fixed ratio to steel in these products, their production will govern aluminum requirements. Therefore, by multiplying the United States consumption in each of these categories (i.e. Army, Navy, and indirect military and industrial) of aluminum fabricated shapes by the figure representing the percentage that Japanese total steel production is of United States steel production, one arrives at reasonable extimates of requirements of the Japanese Army, Navy, etc.

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By this method, the estimated 1944 requriement of aluminum by the Japanese Army in vehicles, ammunition, electronic equipment, artillery, etc., is 10,120 metic tons. The 1944 Japanese Navy requirement of aluminum in ammunition, ship construction, electronic equipment, etc., is 12,155 tons. Indirect military and industrial 1944 uses for de-oxidizing of steel, equipment parts, power transmission lines, etc., are estimated at 16,015 metric tons.

Future requirements will vary with aircraft production. If Japan achieves her planned aircraft production increase in 1945, the rise in aluminum requirements will be substantial, but the rate of increase of aluminum requirements will be less than proportional to the increase in aircraft. If aircraft production is held down or cut because of attacks on aero-engine or aircraft plants, aluminum requirements will decrease, particularly since a stationary aircraft production no longer needs new aluminum for increased working inventories.

B. PRODUCTION AND STOCKS

No independent estimate of production is available. Since there is no evidence than any shortage of aluminum has limited Japanese aircratt production and since capacity is adequate (see Section II), it is believed that production is approximately equal to requirements.

On the other hand, the scarcity of raw materials, shortages of shipping, pressure on electric power supply, and the recent rate of growth forced on the industry has probably prevented any accumulation of a stock pile other than that normally required for operating inventories.

C. TIMING OF EFFECT ON FRONT LINE STRENGTH

Inasmuch as 82 percent of Japanese aluminum is used for aircraft production and very little is known regarding the time factor in connection with the other Japanese uses of aluminum, the discussion here will be limited to the effect on front line aircraft strength.

The 14 largest enemy aluminum reduction plants comprise 92 percent of production capacity. If any comparable percentage of aluminum production capacity is immobilized by bombing, the effect will be felt by a material reduction in replacements at front line units within a 5 months period which may be broken down as follows:

In stock at aluminum reduction plants and in transit to rolling mills	15 days
From aluminum ingot delivered at rolling mills to finished sheet delivered at aircraft plants	45 days
From sheet delivered at aircraft assembly plants to completed and tested aircraft	60 days
From factory airfield to delivery at the front line	30 days
	150 days

The production and fabrication of sheet has been selected as the limiting factor in the above computation because it has the shortest time factor of the 4 main branches of the so called "pipe line" from aluminum ingot to completed planes. These are, in the order of the time required, sheet, sand castings, extrusions and forgings.

The above estimate is based on American practice and is subject to correction as further intelligence becomes available.

D. CONCLUSIONS AS TO VULNERABILITY

There is no question but that a substantial loss of aluminum production can reduce the aircraft output and hence affect military strength. It is also clear, however, that since the only important, large-scale use of aluminum is in aircraft, an attack on aluminum must be considered only as an alternative to other methods of attacking aircraft. As such an alternative, the aluminum industry, with its advantages and disadvantages, is discussed under Section II D.

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ALUMINUM REDUCTION INDUSTRY

II. VULNERABILITY OF PRODUCTION TO AIR ATTACK

A. *INDUSTRIAL PATTERN*

1. *Capcity; Geographic Location*

Total current aluminum production capacity is estimated at 232,000 metric tons per annum. Production is estimated to be 208,000 metric tons per annum.

Aluminum is produced by the enemy in 20 plants which are broken down by areas as follows:

	Number of Plants	Estimated Capacity in Metric Tons
Manchuria	2	36,000
Korea	4	36,500
Honshu	11	109,500
Shikoku	1	10,000
Formosa	2	40,000
	20	232,000

Because aluminum reduction requires large quantities of electric energy, plants have been built in areas where electric power is most plentiful, such as Formosa, northern Korea, and southern Manchuria, and, as far as Japan Proper is concerned, in the Tokyo electric supply area. Aluminum plants (like alumina plants) are generally located on the coast.

Five of the Honshu plants plus two of those in Korea, accounting for 20% of total capacity, are on or near the shore of the Japan Sea. It is probable, therefore, that they will be beyond the reach of carrier-based bombers for some time.

All Japanese aluminum plants use the same process - electrolytic reduction of alumina with Soderberg electrodes.

Estimates of the capacity of Japanese aluminum plants have been based on the best ground intelligence available and, for four of the largest plants, on interpretation of adequate air photography.

Photography has shown the capacity of two plants to have been substantially underestimated on the basis of ground intelligence (these were recent installations). It is possible that as further photo coverage is available individual and total capacity estimates will undergo considerable adjustment.

For further details as to capacity, production and location of the individual plants see Map 1, Diagram 2, and Table 1.

2. *Concentration*

The 14 largest plants include 92 percent of capacity. These, with the cumulative percent of total Japanese capacity, are as follows:

Target No.	Location	Capacity in Metric Tons	Percent of Total Japanese Capacity	Cumulative Percent of Total Japanese Capacity
90.18-1177.	Kambara, Honshu	40,000	17.2	17.2
91.6 - 3	Takao, Formosa	20,000	8.6	25.8
91.5 - 61	Karenko, Formosa	20,000	8.6	34.4
93.3 - 32	Fushun, Manchuria	18,000	7.8	42.2
90.9 -1003	Niigata, Honshu	18,000	7.8	50.0
93.2 - 200	Antung, Manchuria	18,000	7.8	57.8
93.2 - 201	Yoshi, Korea	18,000	7.8	65.6

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Target No.	Location	Capacity in Metic Tons	Percent of Total Japanese Capacity	Cumulative Percent of Total Japanese Capacity
90.12-1100	Omachi, Honshu	12,000	5.2	70.8
84.2 - 1	Konan, Korea	12,000	5.2	76.0
90.29- 924	Niihama, Shikoku	10,000	4.3	80.3
90.11- 861	Higashi Iwase, Honshu	8,000	3.4	83.7
90.11- 866	Takaoka, Honshu	8,000	3.4	87.1
90.11-1689	Sasazu, Honshu	6,000	2.6	89.7
90.20-1822	Ogaki, Honshu	6,000	2.6	92.3

3. *Extent of Integration*

Eleven of the aluminum plants are integrated with alumina plants and share the same plant compound, as follows:

Target No.	Manchuria	Estimated Capacity in Metric Tons	Production in Metric Tons
93.3 - 32	Fushun	18,000	18,000
93.2 - 200	Antung	18,000	10,000
	Korea		
84.2 - 1	Konan	12,000	12,000
84.3 - 67	Chinnampo	5,000	5,000
93.2 - 201	Yoshi	18,000	18,000
84.4 - 208	Genzan	1,500	1,500
	Honshu		
90.12-1100	Omachi	12,000	12,000
90.11- 861	Higashi Iwase	8,000	8,000
90.11- 866	Takaoka	8,000	8,000
90.5 -1557	Hachinohe	4,000	4,000
	Formosa		
91.6 - 3	Takao	20,000	14,000
		124,500	110,500
	percent of Total	54	53

4. *History and Possible Future Changes*

Production of aluminum by the Japanese was initiated in 1934. Prior to that the Japanese aluminum industry consisted solely of the manufacture of a relatively small amount of aluminum goods from imported ingots, and experimental work. Production of aluminum from 1934 is as follows:

		Metric Tons
1934	-	700
1935	-	4,700
1936	-	7,500
1937	-	10,500
1938	-	17,000
1939	-	23,000 (Approx.)
1940	-	45,000 (Estimated)
1941	-	70,000 (")
1942	-	100,000 (")
1943	-	150,000 (")
1944	-	208,000 (")

The industry was developed around the Bayer process and, as a consequence, was until recently largely dependent on imported bauxite. However, there is evidence even in the earlier years of experimental work in an effort to produce alumina from native low-grade aluminous raw materials. A pilot plant which resulted in the development of the Modified Pedersen process is known to have been in operation at Fushun, Manchuria (Target 93.3-32), prior to 1937. No evidence is available

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regarding the date of initial development of the soda-lime-sinter process but it was probably between 1939 and 1941. The Soderberg process for aluminum reduction was evidently adopted from the beginning and is used exclusively in Japanese plants.

Definite evidence regarding the construction of individual plants is available for only four plants which are, however, among the largest -- those at Takao, Formosa (Target 91.6-3); Fushun, Manchuria (Target 93.3-32); and at Kamabara and Niigata, Honshu (Targets 90.18-1177 and 90.9-1003).

The original plant at Takao, centering around the two older pot rooms, was begun in 1936 and finished late in 1937. The original plant at Fushun, centering around the two larger pot rooms, was begun about January 1938 and completed late in 1939. The plant at Kambara was begun about March, 1940 and by July, 1941 the first two pot rooms were completed and a third under construction. The plant at Niigata, originally planned for 2 pot rooms, was under construction at the same time as the Kambara plant. It is known that a contract was let to build the plant at Antung, Manchuria, but as of July, 1941 construction was still held up because the Japanese had not been able to furnish the necessary electric equipment.

B. *PRODUCTION PROCESS AND PHYSICAL VULNERABILITY*

1. *Process.*

Only one process is in use for the production of aluminum - electrolytic reduction of alumina with Soderberg electrodes. Electroytic reduction is the only process that has been developed successfully for commerical use anywhere. The process as used by the Japanese - spoken of as the Soderberg process - differs from the older electrolytic process only in the type of electrodes used. The process is graphically described in Flow Chart No. 1 and notes accompanying same in Appendix No. 1.

The process consists of dissolving the alumina in a molten bath of synthetic cryolite in the electrolytic pot and electrolyzing it with direct current at 32,000 amperes and about 4.75 volts per pot, the current passing from the Soderberg anode to the carbon lining of the pot which serves as the cathode. The molten aluminum is drawn or syphoned off periodically from the bottom. In the larger Japanese plants the pots are connected in series in "lines" of 132 pots and the direct current is fed to the line at 32,000 amperes, 700 volts. The heat generated by the high amperage current supplied by the mercury-arc rectifiers keeps the elctrolyte molten.

The primary or most essential buildings and equipment in an aluminum reduction plant are the pot rooms, housing the electrolytic pots, the rectifier building, housing the mercury-arc rectifiers and (in Japanese practice) the rectifier transformers, and the open transformer yard, which includes the stepdown transformers, circuit breakers and usually a skeleton steel framework to support the wires, cables and bus bars.

These primary buildings in every aluminum plant will be found in the same arrangement (See accompanying sketch of *Typical Japanese Aluminum Plant Ground Plan* - Illustration No. P1). The rectifier building, which is the primary objective in all aluminum plants, will be found at one end of the long parallel and easily recognized pot rooms, between the pot rooms and the open transformer yard as illustrated in sketch. This should make it possible to locate the primary objective from the air in plants that may not be covered by air photography. In certain of the larger plants this entire installation may be duplicated (See air photography of plants at Fushun, Manchuria, and Takao, Formosa).

2. *Layout*

(A) *Pot Rooms.* The pot rooms invariably are large, long, one-story buildings from 70 to 180 ft. in width and from 475 to 600 ft. long, usually built on a steel frame and with monitor or saw-toothed roofs for the necessary ventilation (See Illustration P2). Usually there are two but there may be 3 or 4 pot rooms in a

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group (See air photography of the plants at Kambara, Honshu, and at Takao and Karenko, Formosa). They are always built parallel to each other within the group and from 50 to 60 ft. apart.

(B) *Rectifier Buildings*. Rectifier buildings are long and narrow, averaging 65 to 70 ft. in width. Their length approximates the total overall width of the pot rooms which they serve, and will probably average about 300 ft. (at the plant at Kambara, Honshu, there are 2 rectifier buildings approximately in line serving the 4 parallel pot rooms). All Japanese rectifier buildings will probably prove to be two-story buildings. Those more recently built are probably of reinforced concrete construction including the roof. Rectifier buildings in the older plants do not necessarily have concrete roofs (See older rectifier building at Takao, Formosa (Target 91.6-3)), but even these will probably have a reinforced concrete second floor because of the weight that must be carried thereon. The distance between the rectifier building and the pot rooms ("a" in sketch of typical plant, Illustration P1) is necessarily short. It varies from adjoining to a maximum of about 25 ft. Thus an attack on either part of the installation may be expected to damage the other. One or at most two rectifier buildings will be found at each aluminum plant.

(C) *Transformer Yard*. The distance between the rectifier building and the open transformer yard ("b" in sketch of typical plant, Illustration P1) varies from adjacent to a maximum of about 50 ft. The transformer yard is easily recognizable by the large step-down transformers and circuit breaking equipment, usually be a large skeleton steel structure for supporting wires, cables and bus bars, and by the power line leading thereto.

3. *Production Time Factor*

The average time required by the enemy to produce aluminum ingot from alumina, including shipment to the fabricating plant is estimated at about one month.

4. *Vital Facilities*

The vital facilities in any aluminum plant are the mercury-arc rectifiers and the rectifier transformers housed in the rectifier building. Both of these types of equipment are essential to the production of aluminum. Production in any plant would cease immediately if 60 percent or more of the installed units of either type ceased to function. Both types of equipment are easily damaged and both require a long period to replace. This period would increase progressively in the event of a concerted attack as the number of required replacements increased.

The mercury-arc rectifiers are in a single row on the second floor of the two-story rectifier buildings. They are large but delicately adjusted units of industrial electronic equipment whose purpose in the aluminum plant is to convert multi-phase alternating current into a smooth flow of direct current at high amperage. The operating weight of each unit, including water, is from 8 to 15 tons. Mercury-arc rectifiers have no moving parts except the accessory vacuum and water pumps. Their operation is based on the fact that mercury vapor conducts electricity only in one direction between the graphite anodes and the mercury-pool cathode.

A mercury-arc rectifier, of the type known to be in use in the Japanese aluminum industry, consists essentially of a large cylindrical steel tank, from 6 to 8 ft. in diameter and from 4 to 6 ft. in height, in which are inserted from 12 to 18 graphite anodes and a single mercury pool cathode, and in which is maintained an atmosphere of mercury vapor in a very high vacuum. The side walls of the inner (vacuum) tank are of rolled boiler plate from 0.25 to 0.315 in. thick. The side walls of the outer tank (water jacket) are of rolled boiler plate from 0.2 to 0.25 in. thick. The openings in the inner (vacuum) tank where the anodes, excitation anodes, starting anode, and cathode are inserted must be insulated, usually with ceramic bushings, and must be sealed perfectly against the vacuum. These are critical points for damage to the rectifier. Rectifiers are insulated from the floor and are either mounted on ceramic insulators which may be lightly bolted to the floor, or on wheels, as in the Siemens-Schuckert type, which may be of phenolic plastic and serve as insulators.

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The largest mercury-arc rectifiers known to be in use in the Japanese Aluminum industry (See the photo of installation in Kambara Plant-Target 90.18-1177 in Illustration P2 and the diagram D1, and also Illustration P3) are exact copies of the German Siemens-Schuckert type and are believed to be exact copies of Siemens-Schuckert model VD100 10, on which detailed Siemens-Schuckert construction drawings are available.

The following pertinent facts and specifications are for this model:

Capacity -	8,000 amperes or 5,600 K.W.
Anodes -	18
Overall height	10.4 ft
Outside diameter	8.9 ft
Operating weight, including water for cooling -	14.88 short tons
Weight without water	12.12 " "
Mounted on 10 inch solid wheels	
(Possibly phenolic plastic for insulation)	
Inner (vacuum) tank	
diameter	8 ft. 3 in.
height	6 ft.
capacity	307.6 cu. ft.
side walls, rolled steel plate,	0.315 in.
Outer tank (water jacket)	
side walls, rolled steel plate	0.2 in.

The multi-phase rectifier transformers are in a single row on the ground floor of the two-story rectifier buildings. They are large units with complex windings (See Illustration P4) whose purpose in the aluminum plant is to furnish alternating current to the rectifiers at the proper voltage (in Japanese practice usually 700 volts) and in the proper number of phases (normally 6). In Japanese practice each transformer furnishes the power to a single rectifier.

Specifications of Japanese rectifier transformers are not available but pertinent specifications of a comparable American transformer are as follows:

Output rating - 6 phase, 8,000 amperes, 700 volts
For operation from: 13,200 Volts, 3 phase, 60 cycle power
Tanks made from boiler plate, 7/16" thick.
Weights per transformer:

Core and coils -	25,000 lbs
Tank and fittings -	27,000 "
Oil -	24,000 "
Total Weight -	76,000 "

5. *Physical Vulnerability of Vital Installations*

The mercury-arc rectifiers and rectifier transformers are both easily damaged by H.E.'s. The rectifiers are large but delicately adjusted industrial electronic units. Any shock which damaged one or more of the numerous insulated vacuum seals would cause a rectifier to cease to function. Any damage which resulted in warping or bending the side wall of the inner (vacuum) tank could probably not be repaired because it would then be very difficult to restore the vacuum seal between the main body of the tank and the anode plate.

In the United States rectifier transformers are installed in a row outside of the rectifier building, presumably because of our fire regulations. Although it is possible that they may be found in this position in some Japanese plants, it is known that they are installed inside, on the ground floor of the two-story rectifier buildings at the five largest enemy aluminum plants: those at Kambara and Niigata, Honshu; Takao and Karenko, Formosa; and at Funshun, Manchuria. This leads to the belief that the inside installation is typical of Japanese practice and that, in all probability, all rectifier transformers will be found inside.

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Rectifier transformers are encased in a tank of boiler plate, 7/16 in. thick. The transformer coils operate in a bath of highly refined transformer oil of high insulating quality and dielectric strength, which must be kept free from water, air and oxygen. The temperature of the oil in a transformer operating at full load is normally about 55°C above room temperature. The transformer oil is similar to a light household lubricating oil such as "3 in 1." Because of its temperature in operation it can be considered highly inflammable. The transformers, therefore, when installed within the rectifier building, may present a serious fire-hazard.

There are three different types of rectifier transformers as regards the method of cooling used. The differences are of interest because they may affect the vulnerability of the equipment. It is not as yet known which of these types exists in the enemy plants.

In the United States, where the transformers are installed outside, the common practice is to equip them with large cooling radiators outside the tank in which the oil circulates by gravity. The oil-cooled transformer, when installed outside, is highly vulnerable to fragmentation bombs. This type of transformer can be installed inside with forced air circulation but it is more logical that one of the other two types will be found.

The other two types have no radiators. In the one, spoken of as water-cooled, cool water is circulated through a coil of pipe within the oil bath inside the transformer tank. However, the water-cooled type may not be in use as it is subject to short circuiting -- the slightest leak in the water pipes and connections within the tank will cause a short circuit sooner or later and the trouble is not apparent until the short circuit occurs.

The third type, known as forced-oil-cooled, has openings at the top and bottom of the transformer tank to which pipes are fitted, which lead to a heat exchanger. Here the oil is cooled by pumping it continuously to and from the heat exchanger. Where this type of transformer is found the oil can be spilled by breaking the pipes leading to the heat exchanger.

The amount of oil in the latter two types is somewhat less than in the self-cooled type but in any case a considerable tonnage of oil would be involved. Once spilled and ignited, a major fire hazard would be created.

6. *Physical Vulnerability of an Aluminum Plant as a Whole*

All other equipment in aluminum plants is less vulnerable than the rectifying equipment. Electrolytic pots consist of strong rectangular or round tanks made of steel 1 to 2 in. thick. The tank is usually lined with fire brick and then with a tamped and baked carbon lining 6 to 10 in. thick. They are not easily damaged and those that are damaged can be shorted out of the pot line so that production can be continued in the undamaged pots while repairs are being made to damaged pots and to the building. There are from 250 to 528 pots in a single plant.

The step-down transformers in the open transformer yards are also considered less attractive as a target. They are standard equipment and replacements could probable be made without protracted delay.

Damage to the synthetic cryolite and carbon paste plants would not necessarily stop production of aluminum because the cryolite and carbon paste could be shipped in from another plant pending repairs.

7. *Weapon Recommendations*

The reinforced concrete building housing the mercury-arc rectifiers and the multi-phase transformers is the primary objective in attacks on Japanese aluminum plants. Since these buildings are usually of fire resistant construction, attack with high explosive weapons alone is recommended.

A preliminary analysis indicates that the AN-M64-500 lb. G.P. bomb will be the most effective weapon on a weight for weight basis in damaging the rectifiers and

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transformers. The use of 0.1 sec. nose/.025 sec. tail fuzing is recommended to obtain penetration which is necessary for maximum damage, in two-story installations. When primary objectives are located in one-story buildings the use of 0.1 sec. nose/0.01 sec. tail fuzing will be more effective.

The extent of damage will be greatly increased if firing of the transformer oil occurs. The high explosive weapon selected is capable of both rupturing the oil radiators and igniting the released contents. The 500 lbs. G.P., fuzed either .01 tail or .025 tail is also the most effective weapon to cause general damage to equipment other than the primary objectives.

It must be understood that the above recommendation is general in character and that individual targets may possibly differ from normal. Therefore, reference should always be made to the Target Information Sheets for weapon selection and aiming points.

C. *DURATION OF PRODUCTION LOSS*

1. *Unused Capacity Available.*

According to the estimates used in this study, the difference between total capacity and production is 24,000 metric tons. This is probably an underestimate of unused capacity. Some technical over-capacity in aluminum may exist in certain plants to allow them to operate wholly on hydro-electric power. If aircraft production is held to its present levels, requirements for aluminum will decrease, as already noted. Excess capacity in aluminum would then be substantially increased.

2. *Time Required to Repair or Replace Damaged Facilities*

In the event of an attack on a single plant resulting in serious damage to 60 percent or more of either the rectifiers or rectifier transformers (in each rectifier building if there are 2), the immediate results would be as follows:

(a) Direct current power to the pot lines would be cut off.

(b) Assuming the damage was severe enough so that the D.C. power could not be restored within 4 hours, the electrolyte in all the pots would cool and solidify. This would necessitate chipping the electrolyte out of all the 250 to 528 pots and relining them with carbon. This is all hand labor with the assistance of compressed air tools if available. This work would require at least 3 months and full production could not be resumed in less time even though D.C. power were restored earlier. If a sufficient number of rectifiers and rectifier transformers were undamaged, partial production could be resumed in about two months.

The above, however, applies only to the potroom phase of restoring production facilities. Actually full production could not be resumed until the destroyed or seriously damaged rectifying equipment had been replaced and this would require a minimum of six months.

In the event of a concerted attack on the rectifying equipment in enemy aluminum plants, the time required to repair or replace would be greater and would increase progressively with the number of units destroyed. It is reliably estimated that a minimum of 150 mercury-arc rectifiers and 150 rectifier transformers, including installed spares, are in use in the enemy aluminum reduction industry. The time required by the enemy to replace any large number of units of this equipment is not known as it involves the time required to construct the equipment by the Japanese heavy electric industry. Rectifying equipment, especially in the large sizes required for the aluminum industry is highly specialized and is all made to order even in the United States.

The companies which produce about 80% of the mercury-arc rectifiers in the United States estimate that under emergency conditions it would require 29 weeks working at full capacity to produce 150-3600 KW rectifiers and 18 weeks to produce 150 rectifier transformers of comparable size. It is reasonable to believe that the Japanese, with a much smaller heavy electric industry, might require at least double this time. If an attack on the industry were only moderately successful,

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the recuperability problem would not be nearly as severe, since the Japanese heavy electric industry already produces some rectifiers for expansion purposes. In such a case, overall loss of production might be six months.

3. Available Substitutes & Dispersal Possibilities

It is possible to use wood, magnesium and steel or combinations thereof as substitutes for aluminum in aircraft production. Any major effort to use these materials as substitutes for aluminum in aircraft would involve complete redesign of the aircraft, retooling of aircraft plants and would require a minimum of from 1 to 1½ years before finished planes could be produced in significant quantities. The extent of Japanese research and development along this line is not known. To date little, if any, enemy material has been captured which would indicate such an effort with operational planes.

It is not possible to sub-contract parts of the aluminum process. Dispersal would involve the construction of new plants.

D. CONCLUSIONS AS TO VULNERABILITY

The essential factor in the evaluation of aluminum as a target system is that it is a method of getting at aircraft production and should be considered as an alternative to attacking the aircraft industry directly. As such an alternative, the aluminum reduction industry has several disadvantages.

(a) Production is less concentrated.
(b) A number of plants are out of range of present bases and some are probably not within range of carrier-based aircraft.
(c) There is a lag (although not excessively long) between loss of aluminum capacity and reduced aircraft production.

On the other hand, aluminum has two important advantages.

(a) It cannot be dispersed nearly as effectively as aircraft.
(b) If a concentrated attack could be mounted on a large part of the industry and succeed in destroying vital installations, recovery would be considerably longer delayed than for aero-engine or airframe manufacture (this applies to attack on aluminum reduction, not alumina).

While there is a case for initially attacking aluminum as the primary raw material of aircraft, other factors have led to a decision to attack aircraft manufacture. The question then becomes how will the attack that has been and is being made on the aircraft industry affect evaluation of the aluminum industry as a target system? It is possible that with a cut in aircraft production aluminum might be stockpiled so as to make it invulnerable to later attack. Such a stockpiling, however, is not at all certain. In the first place, even a successful attack on aero-engines will leave large remaining aircraft production. Shipping and power shortages will make Japan reluctant to produce more aluminim than is necessary.

Once aircraft has become so dispersed as to be an unrewarding target, aluminum might be a good alternative method of getting at aircraft.

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Sheet No. ATSF/NFM/ T1
Date 7 February 1945
Page No. 1 (1 pages)

TABLE I

JAPANESE NON FERROUS METALS

ESTIMATED CURRENT ANNUAL CAPACITY AND PRODUCTION OF JAPANESE ALUMINUM AND ALUMINA PLANTS AS OF JANUARY 1945
ARRANGED ACCORDING TO ALUMINUM CAPACITY
IN METRIC TONS

Target No.	Company	Location	Coordinates North	Coordinates East	Aluminum Capacity	Percent of Total	Aluminum Production	Percent of Total	Alumina Capacity	Percent of Total	Alumina Production	Percent of Total
90.18-1177	Japan Light Metals Aluminum Plant	Kambara, Honshu	35°07'	138°37'	40,000	17.24	40,000	19.23				
91.6 - 3	Nippon Aluminum Co.	Takao, Formosa	22°37'	120°17'	20,000	8.62	14,000	6.73	B- 40,000	7.01	32,000	7.54
91.5- 61	Japan Aluminum Co.	Karenko, Formosa	24°01'	121°38'	20,000	8.62	10,000	4.81				
93.3 - 32	Manchuria Light Metals (Aluminum)Mfr. Co.	Fushun, Manchuria	41°50'	123°47'	18,000	7.76	18,000	8.65	48,000	8.41	48,000	11.30
90.9 -1003	Japan Light Metals Co.	Niigata, Honshu	37°54'	139°03'	18,000	7.76	18,000	8.65				
93.2 - 200	*Manchuria Light Metals Co.	Antung, Manchuria	40°07'	124°23'	18,000	7.76	10,000	4.81	24,000	4.20	24,000	5.65
93.2 - 201	*Oriental Light Metals Co.	Yoshi, Korea (Shingishu or Gishu)	39°59'	124°28'	18,000	7.76	18,000	8.65	21,000	3.68	17,000	4.00
90.12-1100	Showa Denko Aluminum, Omachi	Omachi, Honshu	36°29'	137°51'	12,000	5.17	12,000	5.77	B- 8,000	1.40	2,400	0.56
84.2 - 1	Chosen Nitrogen Fertilizer Co.	Konan, Korea	39°50'	127°38'	12,000	5.17	12,000	5.77	24,000	4.20	24,000	5.65
90.29- 924	Sumitomo Aluminum Reduction Plant	Niihama, Shikoku	33°58'	133°17'	10,000	4.31	10,000	4.81				
90.11- 861	Nichiman Aluminum Co.	Higashi Iwase, Honshu	36°45'	137°14'	8,000	3.45	8,000	3.85	20,000	3.50	20,000	4.71
90.11- 866	Nippon Soda Co., Aluminum Plant	Takaoka, Honshu	36°46'	137°01	8,000	3.45	8,000	3.85	B- 14,000	2.45	4,200	0.99
90.11-1689	Kokusan Light Metals Co,Sasazu Plt	Sasazu, Honshu	36°34'	137°13'	6,000	2.59	6,000	2.88				
90.20-1822	*Ibigawa Electro-Chemical Co,Kido/ Plt	Ogaki, Honshu	35°22'	136°37'	6,000	2.59	6,000	2.88				
84.3 - 67	Chosen Riken Metals Co.	Chinnampo, Korea	38°43'	125°23'	5,000	2.16	5,000	2.40	20,000	3.50	20,000	4.71
90.5 -1557	Nitto Chemical Co.	Hachinohe, Honshu	40°32'	141°31'	4,000	1.72	4,000	1.92	B- 10,000	1.75	3,000	0.71
90.10-1658	Northeast Aluminum Plant (Nichiman Aluminum Co.)	Koriyama, Honshu	37°24'	140°24'	4,000	1.72	4,000	1.92				
90.25-1726	Osaka Ceramic Industry Cement Co.	Osaka, Honshu	34°38'	135°28'	2,000	0.86	2,000	0.96				
90.17-2034	*Nasu Aluminum Co.	Tokyo, Honshu	35°42'	139°45'	1,500	0.65	1,500	0.72				
84.4 - 208	*Nichiman Aluminum Co.	Genzan, Korea	39°10'	127°26'	1,500	0.65	1,500	0.72	3,000	0.53	3,000	0.71
90.18-1176	Japan Light Metals Alumina Plant	Shimizu, Honshu	35°00'	138°31'					B-100,000	17.51	30,000	7.06
90.32- 822	Onoda Cement Co.	Onoda, Honshu	33°58'	131°10'					70,000	12.26	70,000	16.49
90.29-1690	Asano Cement Co.	Itozaki, Honshu	34°23'	133°07'					50,000	8.76	50,000	11.78
90.35-1877	Toyo Aluminum Co.	Omuta, Kyushu	33°03'	130°27'					B- 36,000	6.30	10,800	2.54
90.34-1108	Japan Aluminum Co.	Kurosaki, Kyushu	33°52'	130°45'					B- 24,000	4.20	7,200	1.70
90.29-1657	Sumitomo Alumina Plant	Niihama, Shikoku	33°58'	133°16'					20,000	3.50	20,000	4.71
90.7 -1759	Kokusan Light Metals	Kurosawajiri, Honshu	39°17'	141°07'					20,000	3.50	20,000	4.71
90.17- 521	Showa Electro-Chemical Co.	Yokohama, Honshu	35°29'	139°40'					16,000	2.80	16,000	3.77
90.27-1648	Asada Alumina Plants	Shikama, Honshu	34°48'	134°41'					3,000	0.53	3,000	0.71
	TOTALS				232,000	100.01	208,000	99.98	571,000	99.99	424,600	100.00
	Percentage of total capacity or production of ten largest plants					80.17		77.88		76.53		79.60
	Percentage of total capacity or production of fourteen largest plants					92.25		91.34		90.53		94.62
	From Bauxite in Bayer Plants								232,000	40.6	89,600	21.10
	From Shales and other low grade aluminous raw materials								339,000	59.4	335,000	78.90

* - The exact locations of these plants are not known. Coordinates are for the towns.
B - Bayer Process Plants

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JAPANESE NON-FERROUS METALS, PART I, ALUMINA-ALUMINUM - GENERAL ANALYSIS

APPENDIX NO. I

PROCESSES IN USE IN THE JAPANESE ALUMINA-ALUMINUM INDUSTRY

	DESCRIPTION
	The four (4) processes in use in the Japanese alumina-aluminum industry are graphically described in the four (4) flow charts at the end of this appendix.
FLOW CHART NO. 1. SODERBERG PROCESS FOR ALUMINUM REDUCTION	Only the one (1) process is in use in the Japanese aluminum industry. For convenience the manufacture of **synthetic** cryolite is usually associated with the manufacture of alumina. In actual practice fluorspar (CaF_2) is treated with sulphuric acid (H_2SO_4) to produce hydrofluoric acid (HF). Sodium aluminate liquor ($NaAlO_2$) is then drawn from the alumina plant and treated with the hydrofluoric acid to produce synthetic cryolite (Na_3AlF_6) thus eliminating the direct use of alumina and soda ash in this part of the process.
FLOW CHART NO. 2. BAYER PROCESS	This is the standard process for the manufacture of alumina where high grade bauxite of low silica content is available. It cannot be used for lower grade aluminous raw materials or those with a high silica content. Due to the Japanese shipping situation and to the fact that no bauxite of a suitable grade for the Bayer process is available to the Japanese nearer than the Netherlands East Indies, the value of the Bayer process plants to the Japanese war effort and their importance as targets is open to serious question. The Japanese may well be in the process of writing them off, so far as their war effort is concerned, in anticipation of the complete loss of their supplies of bauxite from the NEI. This becomes understandable when considering the fact that, facing the necessity of producing alumina from low grade materials, it is far simpler and easier to convert cement plants, of which Japan had a considerable surplus before the war, to the Lime-Sinter process than it is to convert a Bayer plant to handle low grade materials. Also the conversion of a Bayer plant would require considerable additional plant space because of the necessity of handling a greatly increased bulk of raw materials and it would be very difficult for the enemy to find room for the necessary expansion and rearrangement at some of the compact Bayer plants. It is true that experimental work in an effort to convert the Bayer plants, including a pilot plant at one location, has been reported but, in view of the above, it is believed that the effort will not be carried very far and it is very doubtful whether it will produce satisfactory results.
FLOW CHART NO. 3. MODIFIED PEDERSEN PROCESS	This modification of the Pedersen process was developed by the Japanese for use at the alumina plant at Fushun, Manchuria, for processing native aluminous shale. The use of this process, requiring 10,000 KWH of electric power per ton of alumina, approximately doubles the power required per ton of aluminum. Dr. Yagi[1] states that the total power requirements per ton of aluminum at Fushun are over 50,000 KWH. For this reason the process is suitable only in areas where hydro-power is relatively abundant during the entire year, such as Southern Manchuria and Northern Korea. At present it is definitely known to be in use at the Fushun plant only but may be found in two or three (2 or 3) other plants in the area named. It very probably will not be found in use in the main Japanese Islands.
FLOW CHART NO. 4. THE SODA-LIME-SINTER PROCESS	The soda-lime-sinter process offers the only logical explanation of the reliably reported fact that the two (2) large cement plants at Onoda and Itozaki have been converted to alumina production and are using low grade aluminous raw Material.

1 "Concerning the Aluminum Industry in Manchukuo and Chosen," by Dr. Yagi In Toyo Keizai Shimpo, 25 Jan. 1941, pp 36-37, translated by MID, NY, Report No. 14206, 19 May 1944.

The essential features of the process have been known to the chemical world for years and there is no reason for assuming that it is not known to the Japanese. In fact it was reported in August 1943 as having been studied by several companies and research institutes in Japan since the outbreak of the war. A cement plant can readily be converted to its use without any large drain on strategic materials in about five (5) months. No other known process would be suitable for use in a converted cement plant.

A modification of this process has been used commercially in Norway and Sweden and will shortly be in use in this country. The Process undoubtedly would have been used more and earlier but for the fact there was no need for it. As long as there was an adequate supply of high grade bauxite the Bayer process was preferred.

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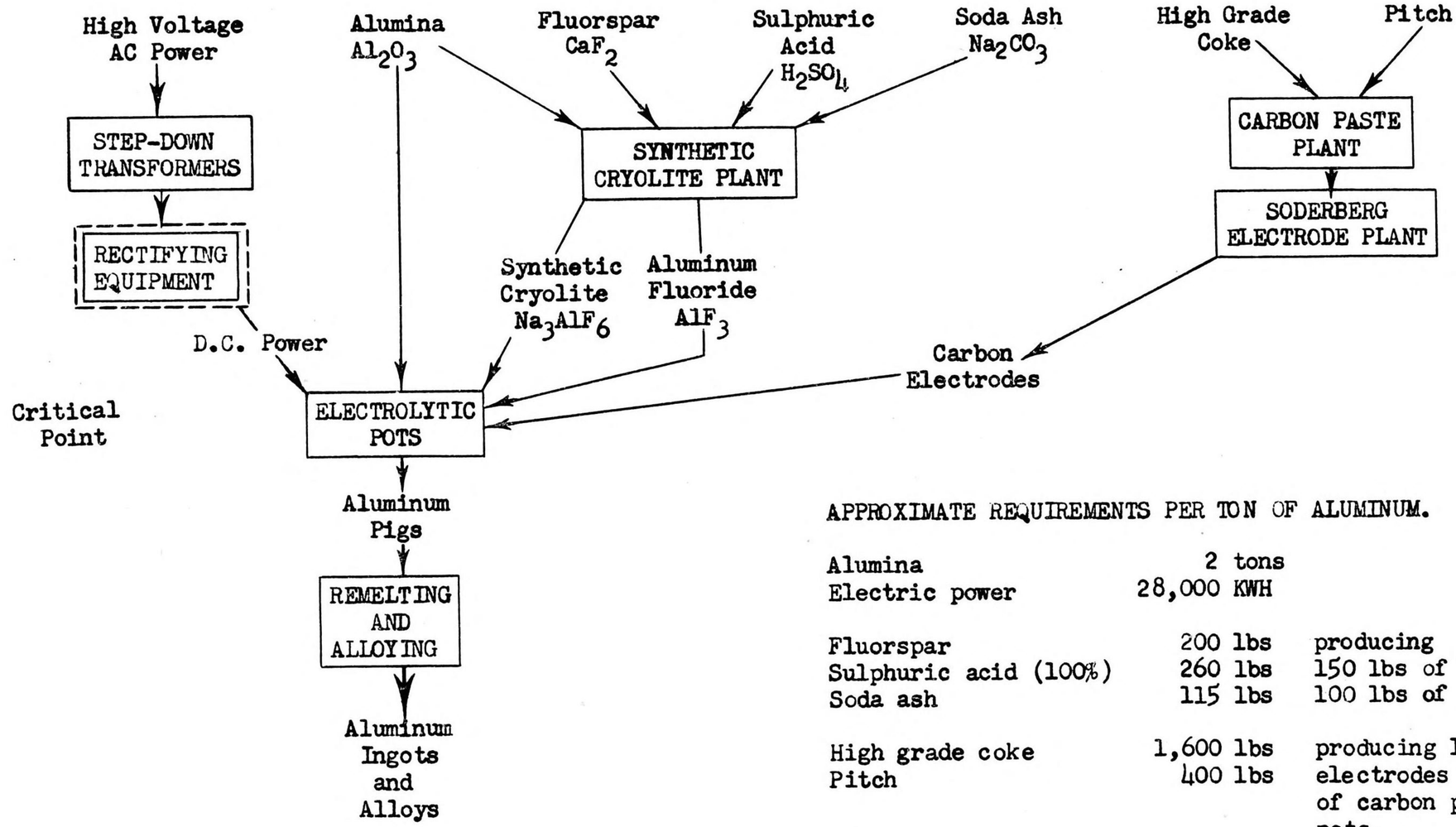
SODERBERG PROCESS IN USE IN ALL JAPANESE ALUMINUM REDUCTION PLANTS, INCLUDING MANUFACTURE OF SYNTHETIC CRYOLITE AND CARBON ELECTRODES.



APPROXIMATE REQUIREMENTS PER TON OF ALUMINUM.

Alumina	2 tons	
Electric power	28,000 KWH	
Fluorspar	200 lbs	producing
Sulphuric acid (100%)	260 lbs	150 lbs of cryolite and
Soda ash	115 lbs	100 lbs of aluminum fluroide
High grade coke	1,600 lbs	producing 1200 lbs of carbon
Pitch	400 lbs	electrodes plus small amount of carbon paste for relining pots.

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FLOW CHART NO. 1 - SODERBERG PROCESS

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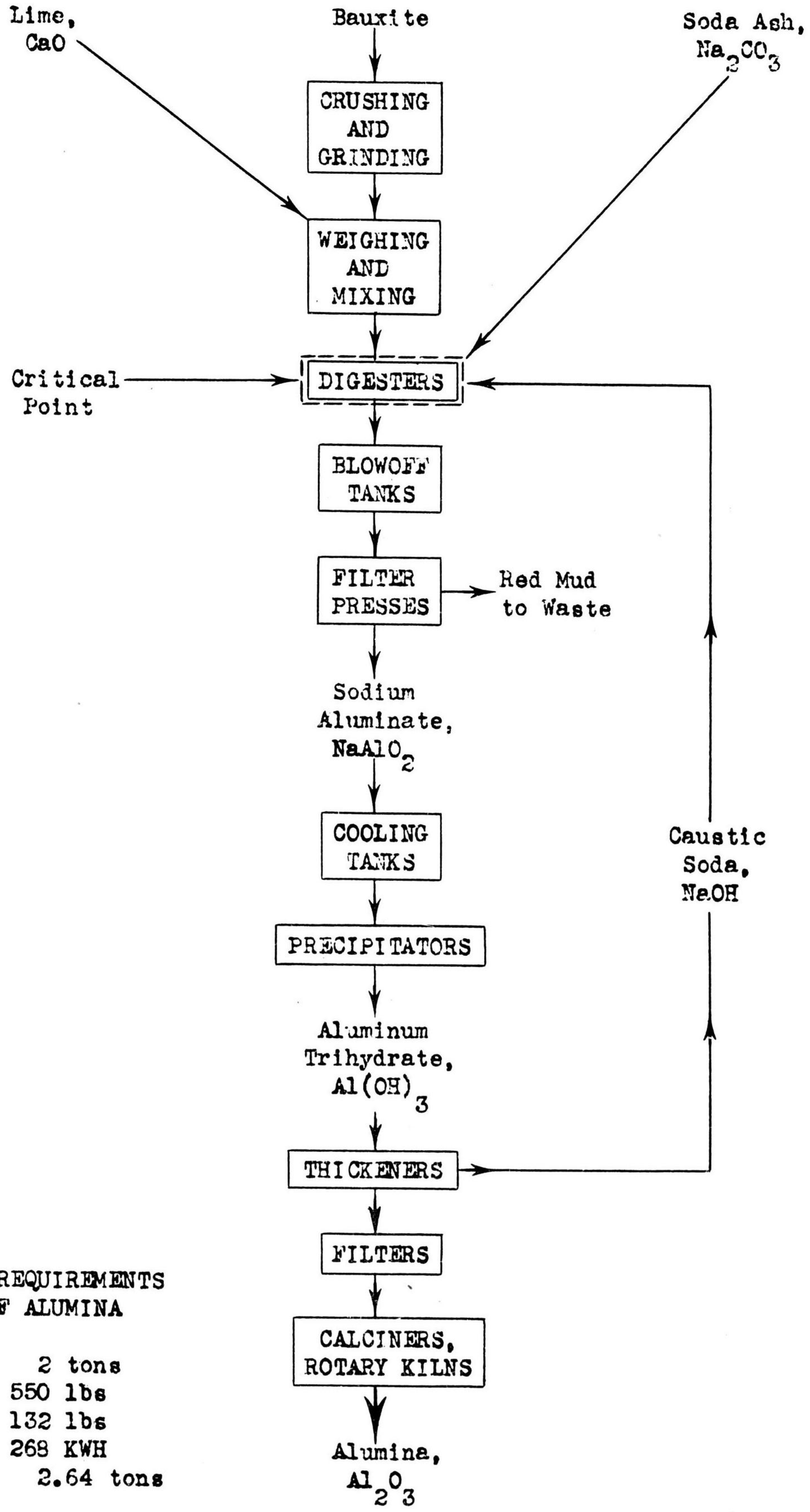
FLOW CHART NO. 2 - BAYER PROCESS

BAYER PROCESS IN USE IN JAPANESE ALUMINA PLANTS AT SHIMIZU, TAKAO, OMUTA, KUROSAKI, TAKAOKA, HACHINOHE AND OMACHI.



APPROXIMATE REQUIREMENTS PER TON OF ALUMINA

Bauxite	2 tons
Lime	550 lbs
Soda Ash	132 lbs
Elec. Power	268 KWH
Bit. Coal	2.64 tons

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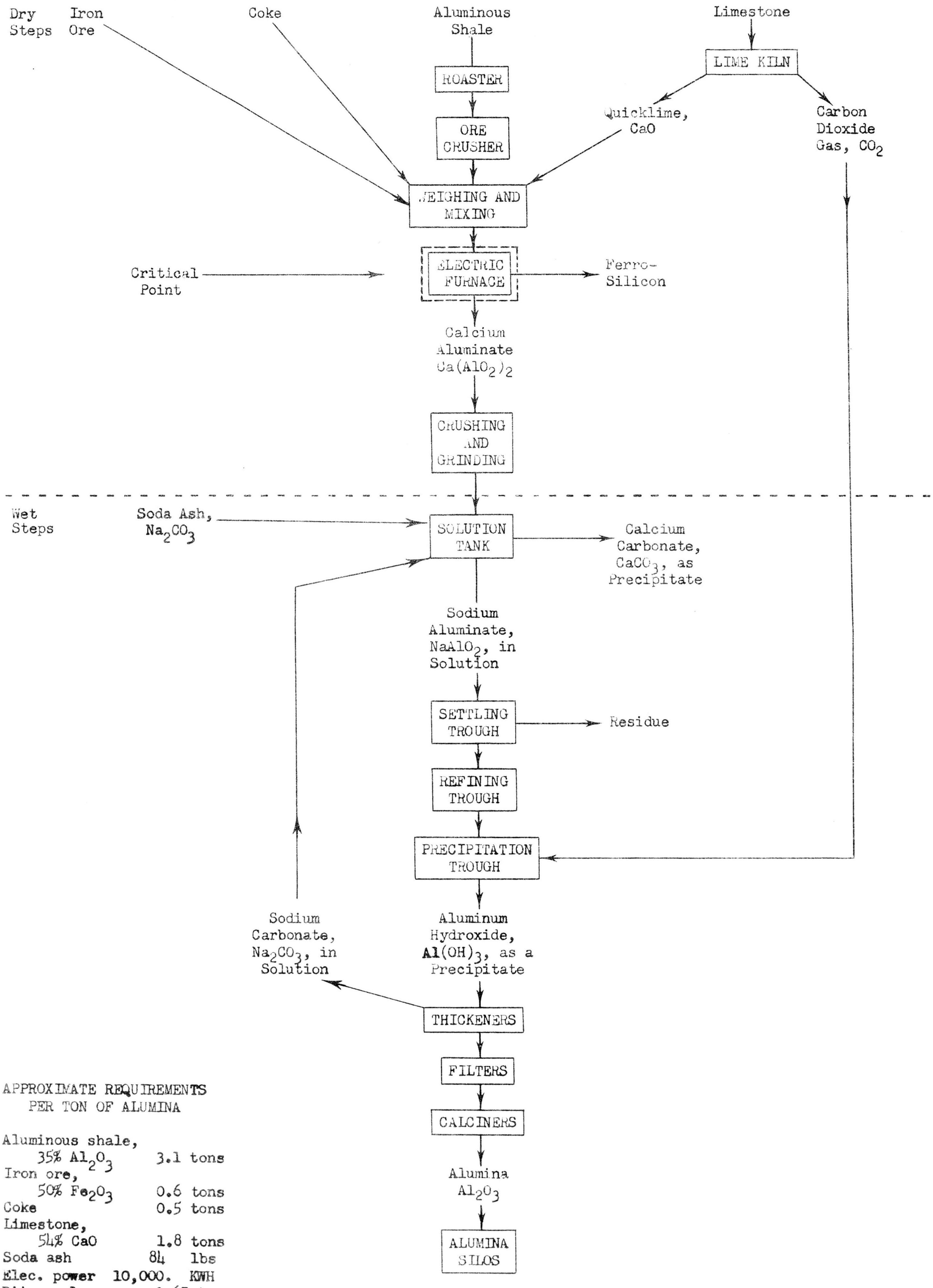
MODIFIED PEDERSEN PROCESS IN USE AT THE ALUNIMA PLANT OF MANCHURIA LIGHTS METALS CO., FUSHUN, MANCHURIA



APPROXIMATE REQUIREMENTS
PER TON OF ALUMINA

Aluminous shale,	
35% Al_2O_3	3.1 tons
Iron ore,	
50% Fe_2O_3	0.6 tons
Coke	0.5 tons
Limestone,	
54% CaO	1.8 tons
Soda ash	84 lbs
Elec. power	10,000. KWH
Bit. coal	0.67 tons

Adapted from a translation of an article by Dr. Yagi published in Tōyō Keizai Shimpō (The Oriental Economist), Tokyo, 25 January 1941.

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JAPANESE NON FERROUS METALS

FLOW CHART NO. 3 - MODIFIED PEDERSEN PROCESS

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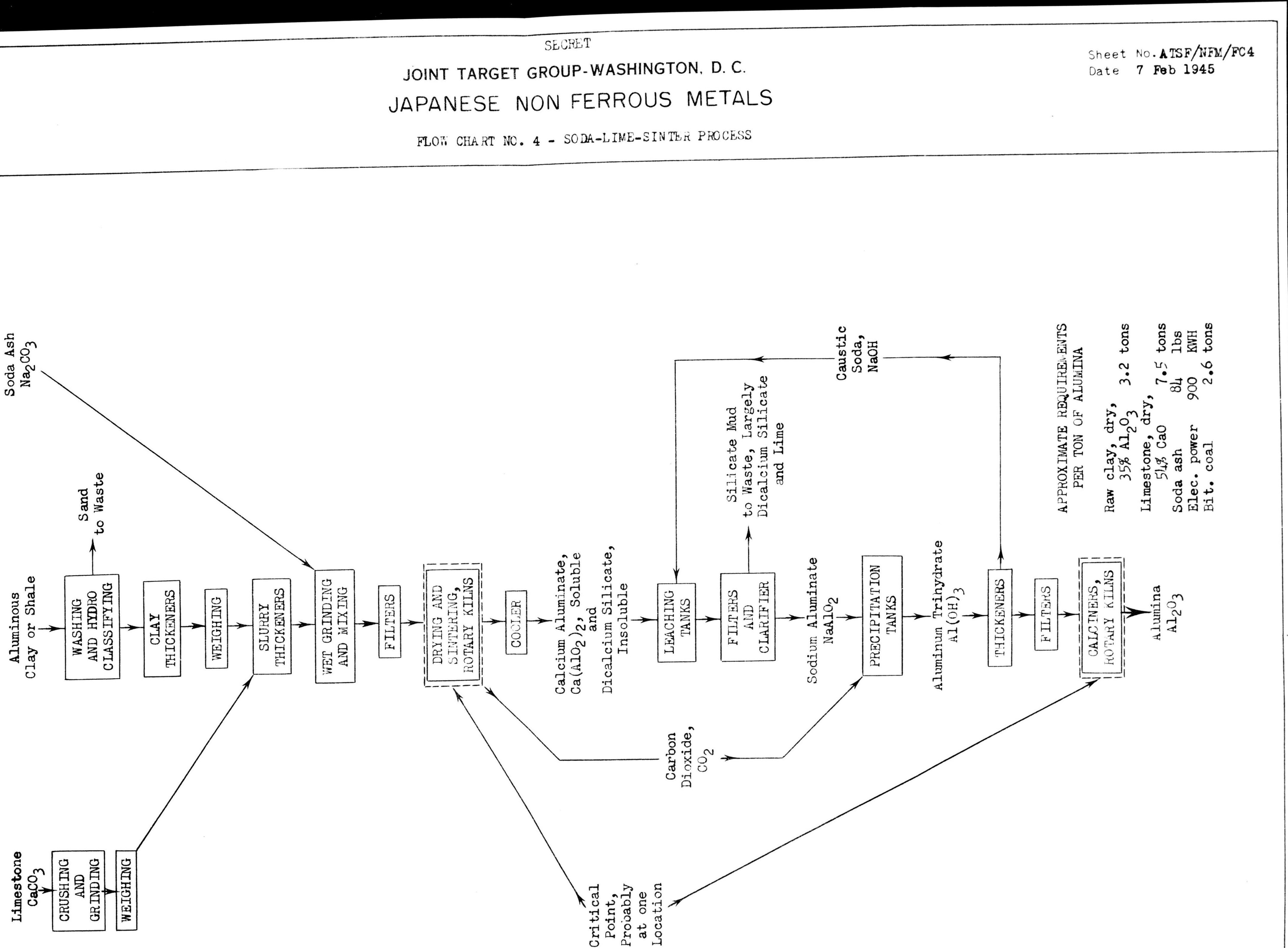
JAPANESE NON FERROUS METALS

FLOW CHART NO. 4 - SODA-LIME-SINTER PROCESS



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Date: 7 February 1945

JAPANESE NON FERROUS METALS

DIAGRAM SHOWING PRINCIPAL DETAILS OF CONSTRUCTION OF SIEMENS SCHUCKERT MERCURY ARC RECTIFIER (MODEL VD 10010)

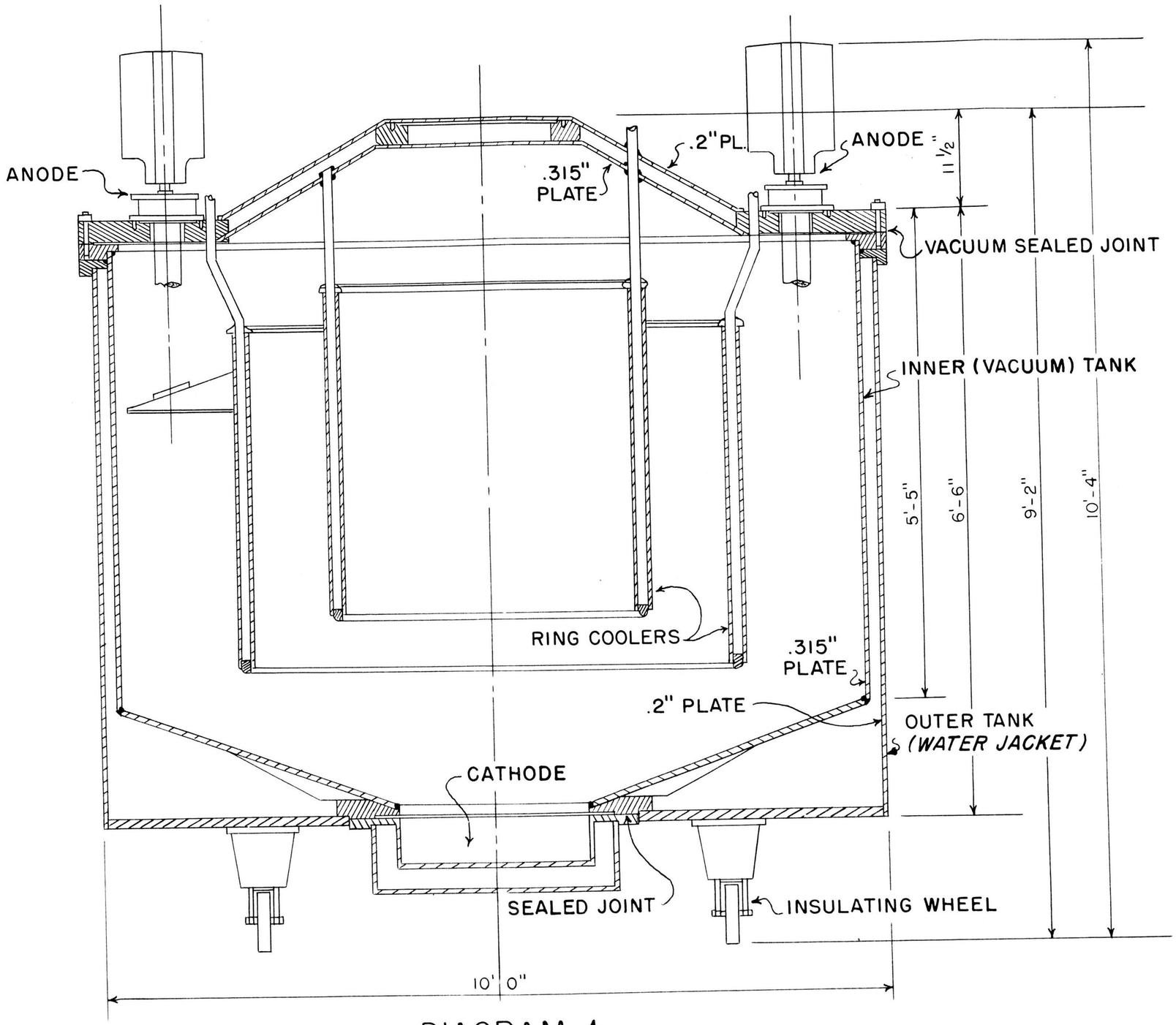

DIAGRAM 1

Drawn from German Siemens-Schuckert construction blue prints of their model VD10010, 18 anode, 5,600 KW rectifier -- belived to be essentially the same model as the rectifiers installed in the plant at Kambara, Honshu, 90.18-1177 (See Illustration No. 2)

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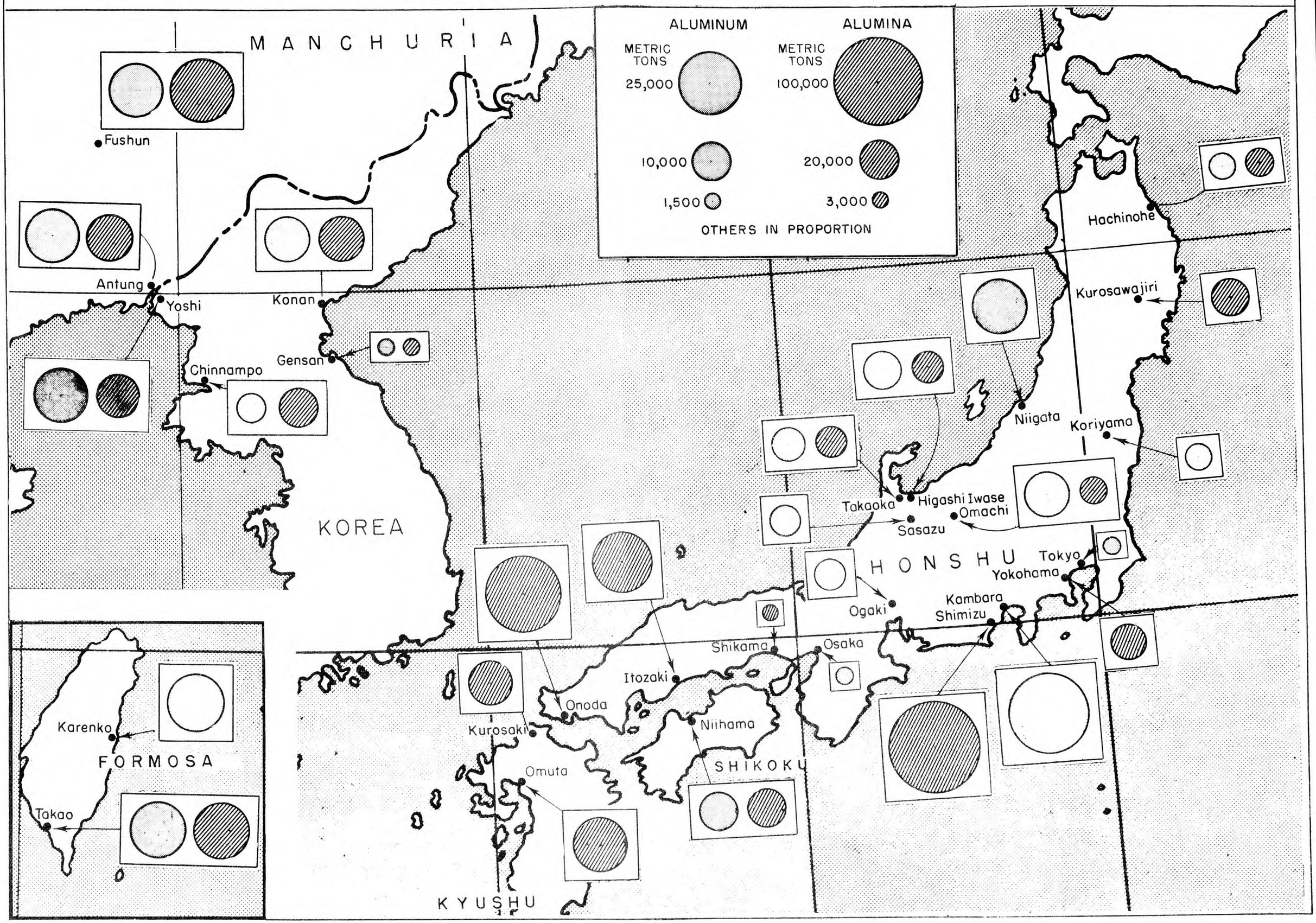
Date 7 Feb. 1945

JAPANESE NON FERROUS METALS

RELATIVE CAPACITIES OF JAPANESE ALUMINUM AND ALUMINA PLANTS



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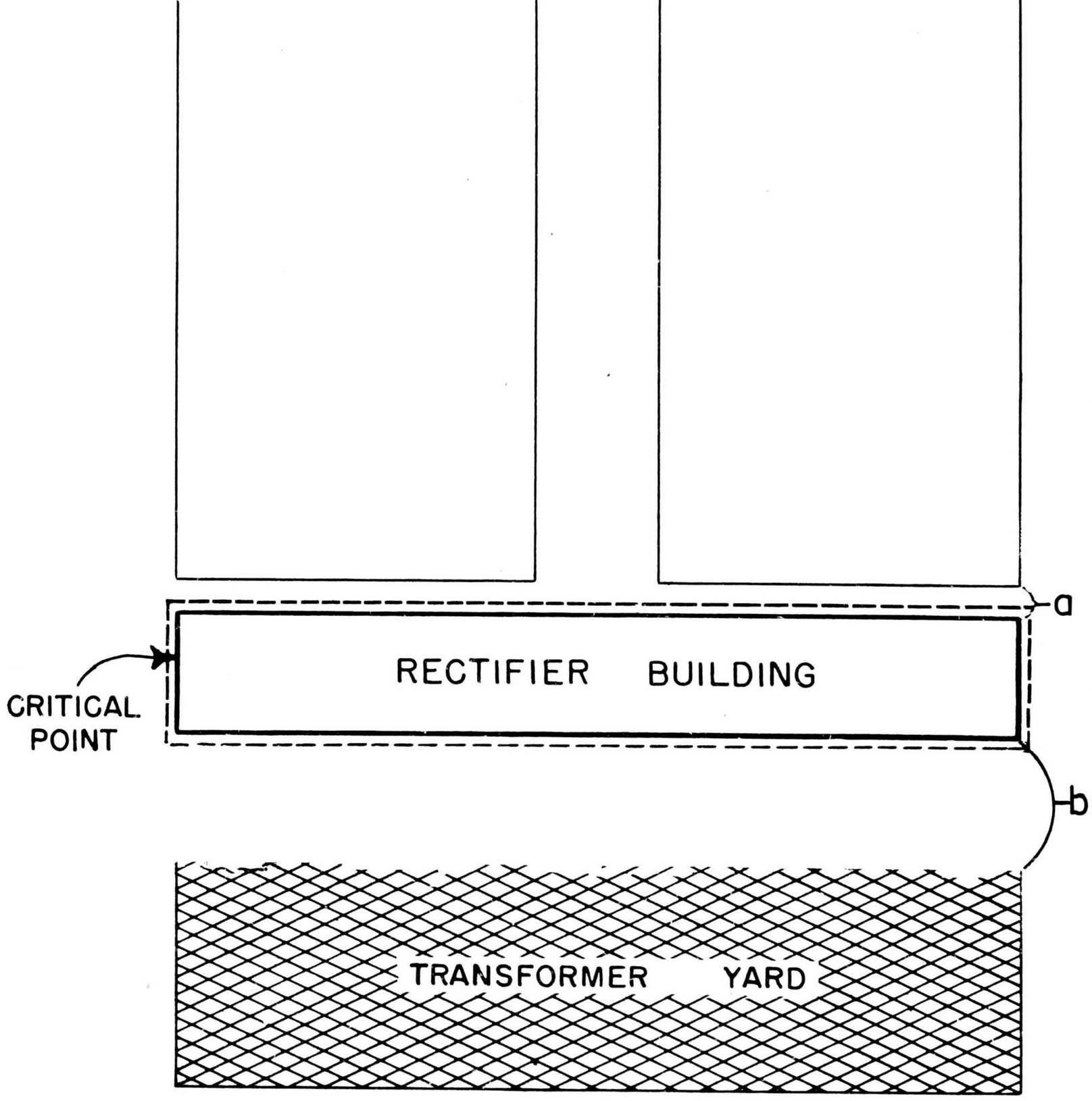
JAPANESE NON FERROUS METALS

GROUND PLAN OF TYPICAL JAPANESE ALUMINUM PLANT



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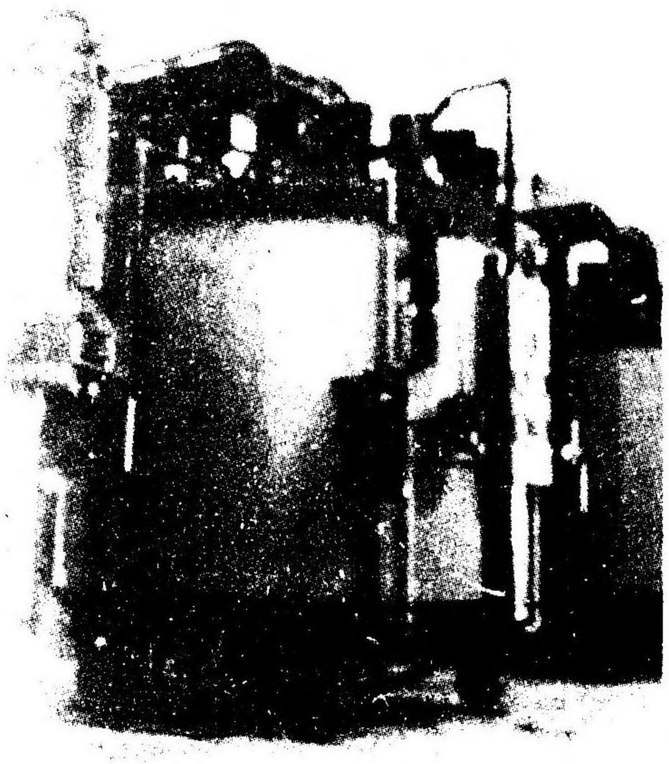
JAPANESE NON FERROUS METALS
MERCURY ARC RECTIFIERS IN KAMBARA PLANT

Target 90.18-1177 - Aluminum Reduction Plant



8,000 ampere Mercury Arc Rectifier, one of 17 in Kambara plant in 1941. Made in Japan - copied exactly after German Siemens Schuckert type. Overall height, 10 to 11 feet.

Interior view of pot room in Kambara Plant showing construction of building.

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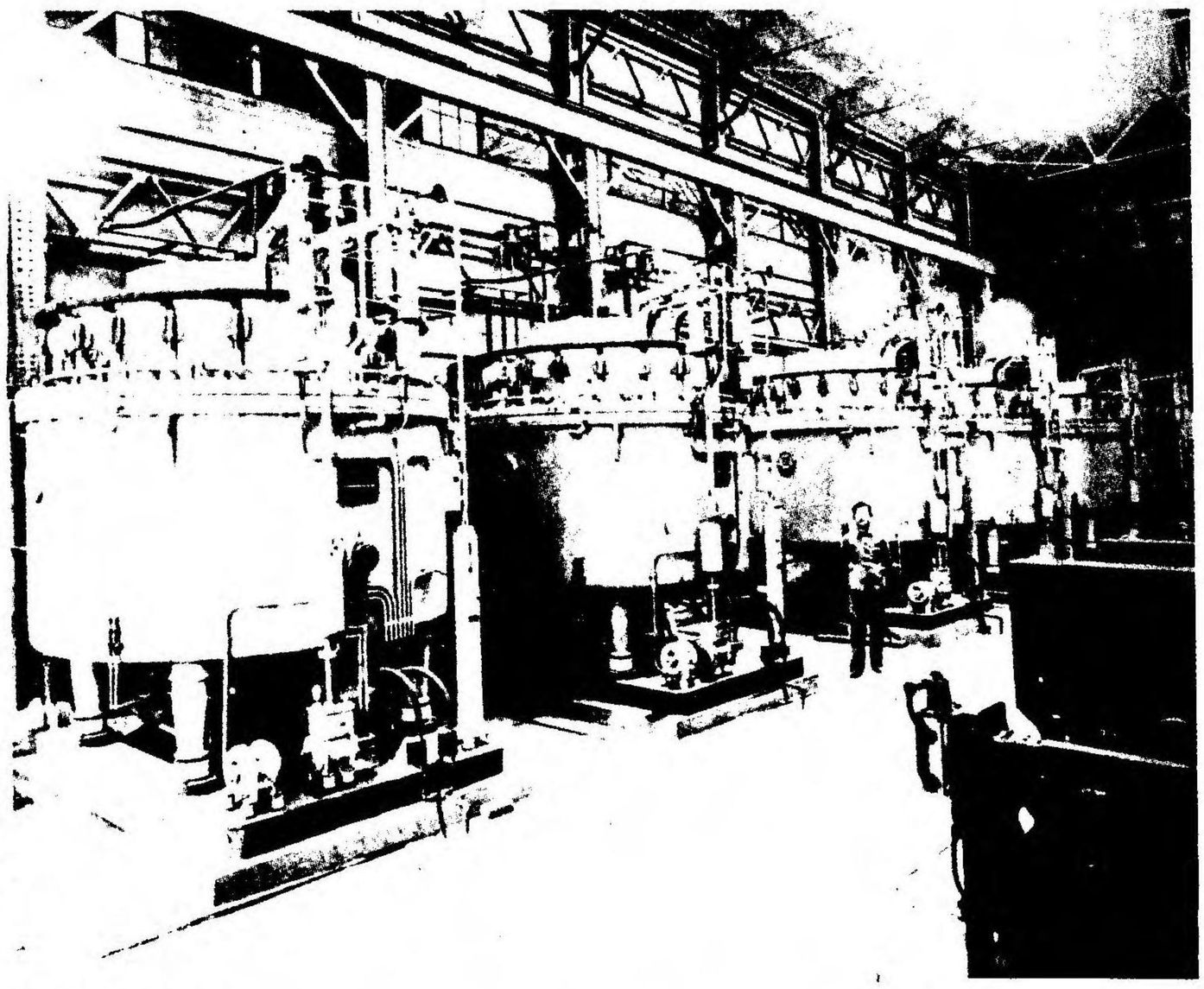
JAPANESE NON FERROUS METALS

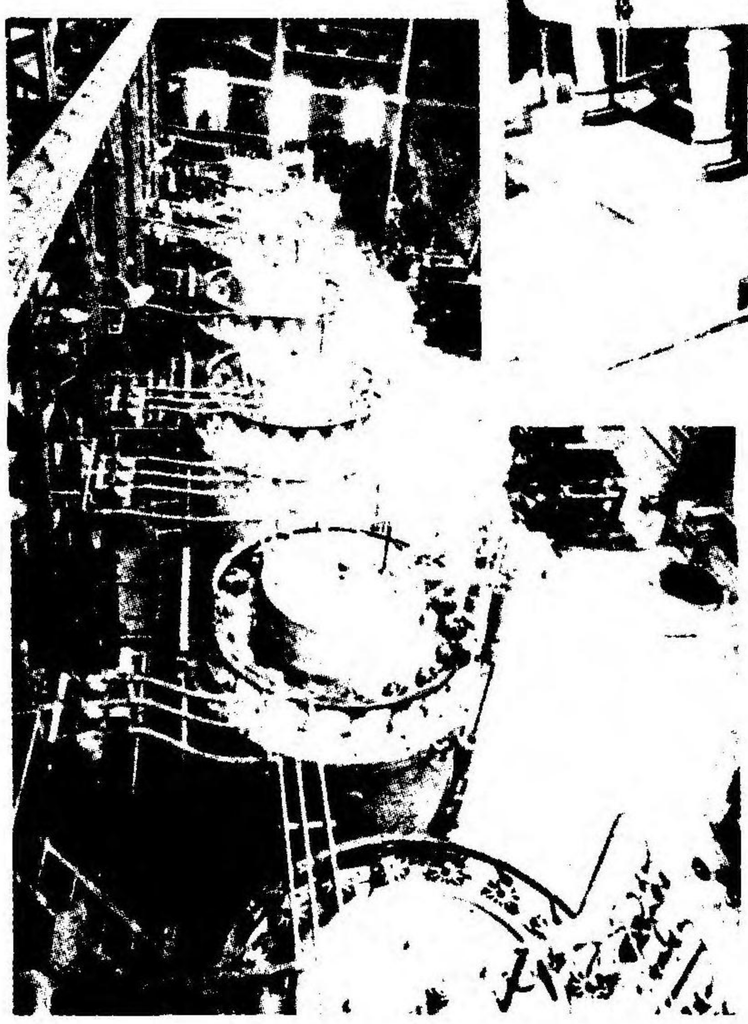
INSTALLATION OF BROWN BOVERI TYPE RECTIFIERS IN JAPANESE ALUMINUM PLANT

30,000--Ampere Rectifier Plant

Photographs show a row of 6 heavy-current mercury-arc rectifiers installed for aluminum industry - output of each unit is 3,000 KW. These rectifiers are provided with controlling grids to make constant-current operation as well as short-circuit protection. The equipment of this plant has been manufactured by Shibaura Engineering Works, Ltd., Tokyo, and more than 70 units of similar large-power mercury-arc rectifiers for use in chemical industry are now being constructed at the same works.

Photographs show actual installation of 30,000-A mercury-arc rectifiers for an aluminum plant in Japan





Total capacity of installation	18,000 kW
Total ampere of installation	30,000 A
Number of sets	3
Kilowatt per set	6,000 kW
D. C. Voltage	0 to 600 V
Rating of transformer	6,940 kVA ; 3,330 V
Number of rectifiers	6
Ampere per rectifier	5,000 A
Number of anodes per rectifier	18
Number of phases	6
Frequency	60 cycles per second
Type of anode insulation	Mycalex seal
Operation	full automatic

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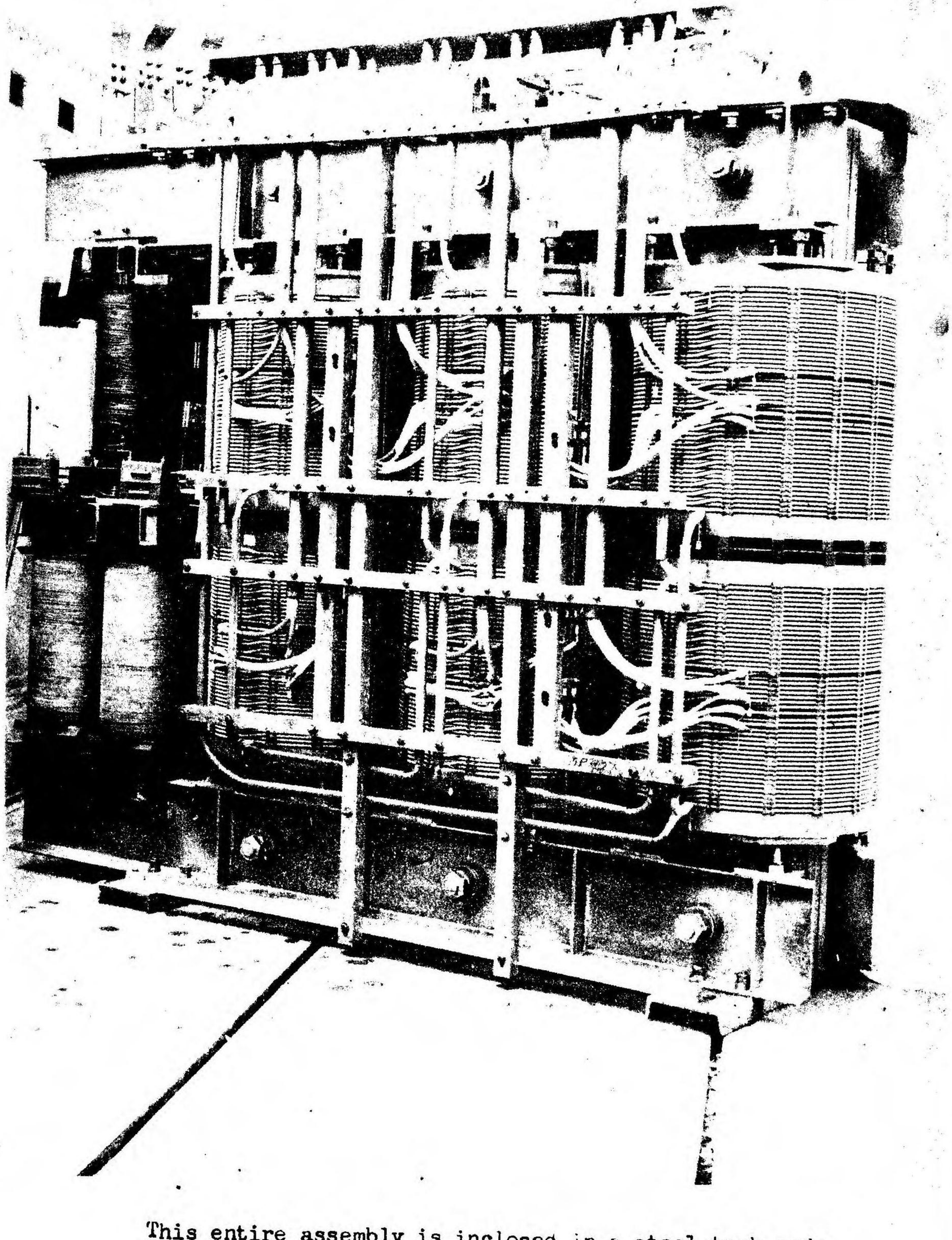
JAPANESE NON FERROUS METALS

AMERICAN RECTIFIER TRANSFORMER INTERIOR ASSEMBLY



This entire assembly is inclosed in a steel tank made from 7/16" boiler plate and operates in a bath of transformer oil.

Weights -	Core and coils	25,000 lbs.
	Tank and fittings	27,000 lbs.
	Oil	24,000 lbs.
	Total Wt.	76,000 lbs.

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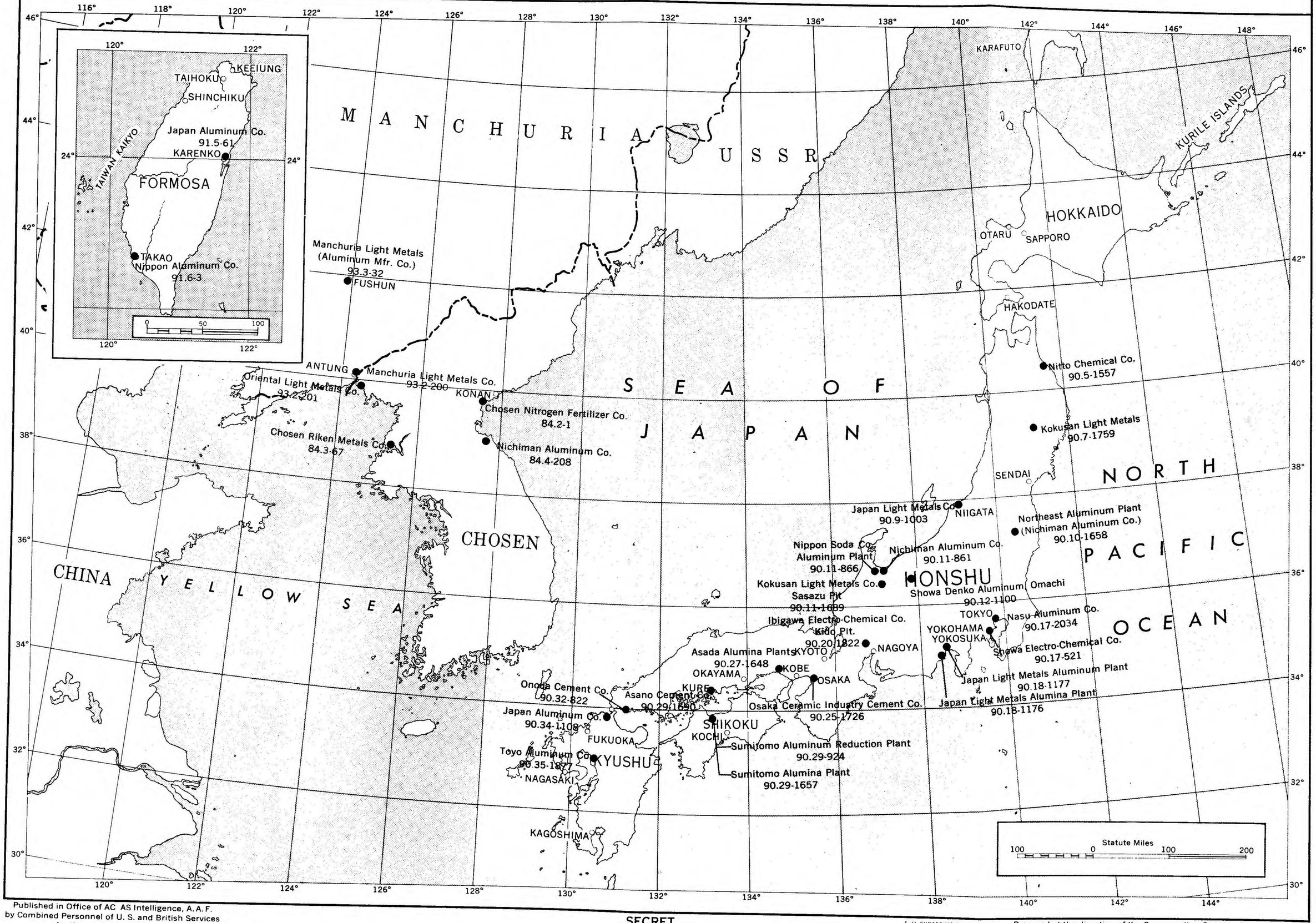
JOINT TARGET GROUP - WASHINGTON, D. C.

AIR TARGET SYSTEM FOLDER - JAPANESE NON-FERROUS METALS

GENERAL LOCATION MAP

SHEET NO. ATSF/NFM/MI
DATE 7 FEB 1945
PAGE NO. 1 (1 PAGES)



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for the use of Allied Forces.

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Prepared at the direction of the Commanding General, Army Air Forces,
Aeronautical Chart Service, by the U. S. Coast and Geodetic Survey,
Washington, D.C. for AC AS Intelligence.
January 1945

Joint Target Group, Washington, D. C.

AIR TARGET INDEX — JAPANESE WAR
PART I — SYSTEM INDEX

NON-FERROUS METALS

Target Name	Place Name	Target Number
Asahi Electro-Chemical Co.	Tokyo (Japan)	90.17-212
Asano Cement Co., Itozaki Plant	Itozaki (Japan)	90.29-1690
Chosen Nitrogen Fertilizer Co. (1)	Konan (Korea)	84.2-1
Chosen Riken Metals Co.	Chinnampo (Korea)	84.3-67
Furukawa Copper Refinery	Kiyotaki (Japan)	90.13-811
Furukawa Copper Smelter	Honzan (Japan)	90.13-810B
Hulutao Lead & Zinc Smelter	Hulutao (Manchuria)	93.3-187
Japan Mining Co. Smelter	Chinnampo (Korea)	84.3-68
Japan Light Metals Co.	Niigata (Japan)	90.9-1003
Japan (Showa) Electro-Chemical Co.	Yokohama (Japan)	90.17-521
Japan Light Metals, Alumina	Shimizu (Japan)	90.18-1176
Japan Light Metals, Aluminum	Kambara (Japan)	90.18-1177
Japan Aluminum Co.	Karenko (Formosa)	91.5-61
Korea Refining Co.	Choko (Korea)	84.6-116
Kokusan Light Metals Co.	Sasazu (Japan)	90.11-1689
Manchuria Light Metals Co., Fushun Plt	Fushun (Manchuria)	93.3-32
Manchuria Magnesium Industry	Yingkou (Manchuria)	93.3-34
Mitsubishi Copper Refinery	Osaka (Japan)	90.25-697
Mitsui Electrolytic Zinc Refinery	Omuta (Japan)	90.35-1261
Mitsui Zinc Distillery	Omuta (Japan)	90.35-1260
Mitsui Zinc Smelter	Hikoshima (Japan)	90.34-1847
Nichiman Aluminum Co.	Higashi-Iwase (Japan)	90.11-861
Niihama Copper Concentrating Mill	Niihama (Japan)	90.29-925
Nippon Aluminum Co.	Takao (Formosa)	91.6-3
Nippon Aluminum Co.	Kurosaki (Japan)	90.34-1108
Nippon Soda, Odera Refinery	Odera (Japan)	90.10-1666
Nippon Soda Co., Aluminum Plant	Takaoka (Japan)	90.11-866
Onoda Cement Co.	Onoda (Japan)	90.32-822
Riken Metal Co., Ube Plant	Ube (Japan)	90.32-922
Saganoseki Copper Works	Saganoseki (Japan)	90.33-1328
Showa Denko Aluminum, Omachi	Omachi (Japan)	90.12-1100
Sumitomo Alumina Plant	Niihama (Japan)	90.29-1657
Sumitemo Aluminum Reduction Plant	Niihama (Japan)	90.29-924
Toyo Aluminum Co.	Omuta (Japan)	90.35-1877

(1) See "Chemical Industry".

CONFIDENTIAL

83:11-174-TL

83:11-174

xxxxxxxxxxxxxxx CATEGORY:
Bsc Proc Ind-Non-Ferrous Metals

36° 46' N
118° 01' E
180 ft.

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LOCATION

NORTH CHINA LIGHT METALS Co.,

CHANGTIEN PLANT

Changtien, Shantung, China

SIGNIFICANCE

Large alumina plant under construction. Work of construction progressing slowly between 1 January '45 and 7 March '45. Believed designed for Pedersen process. Raw materials, abundant deposits of aluminous shale and limestone, nearby. Planned as one of the largest alumina plants under Japanese control.