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No 2

AIR TARGET SYSTEM FOLDER

JAPANESE MACHINE TOOL INDUSTRY

JOINT TARGET GROUP
WASHINGTON, D. C.

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By Authority of
The Commanding General
Army Air Forces

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GENERAL NOTE

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AIR TARGET SYSTEM FOLDERS are designed for the use of operating air units in the field and are published in a quantity to permit distribution to level of Air Force Groups (American) and Naval Aircraft Carriers.

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.

Addenda consisting of revised sheets and additional sheets will be issued from time to time. The folder is designed to permit ready substitution or addition of such material.

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Sheet No. ATSF / MTI
Date 2 Feb 1945

JAPANESE MACHINE TOOL INDUSTRY

GENERAL ANALYSIS

Joint Target Group,
Washington, D.C.

JOINT TARGET GROUP, WASHINGTON, D.C.

Sheet No. ATSF/MTI
Date 2 Feb. 1945
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GENERAL ANALYSIS

MACHINE TOOL INDUSTRY

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GENERAL ANALYSIS
MACHINE TOOL INDUSTRY

I. SUMMARY

A. PRESENT SITUATION

In 1937, the Japanese machine tool industry produced no more than 10,000 tools. Japan was heavily dependent on imports, particularly for tools of a high-precision type. By 1944, capacity in the industry was expanded sufficiently to permit a peak year production (1943-1944), of 50,000 tools. This increase in production was used principally for expansion of machining capacity in war industries, particularly aircraft, automotive, ordnance, and shipbuilding. The net increase in machine tool establishments in all industries amounted to 100,000 tools between 1940 and 1944.

Expansion in most Japanese war industries, except aircraft, slowed up or stopped by the end of 1944. This released machine tool capacity, an estimated 50% of which was converted to the production of aircraft engine components. The present production of machine tools, about 25,000 units, is sufficient to take care of normal replacement needs and the continued expansion of the aircraft industry. The demand remains highest and the production situation tightest in high-precision tools.

B. INDUSTRY ORGANIZATION AND PHYSICAL VULNERABILITY

Machine tool production is dispersed in a large number of plants. Ninety-five percent of the output is produced in nearly 150 plants, and the most important 20 to 30 plants produce less than 50% of the output. Production of high-precision tools is somewhat more concentrated.

Japan originally developed her machine tool industry in urban centers and 70% of the plants are still located in such areas, particularly Tokyo. The newer, more important plants, however, have been built outside the urban centers, and only one half of the most important plants are now located within built-up areas.

Vital equipment in machine tool plants is moderately vulnerable to air attack, but the plants are small and difficult to hit. The more important plants within the built-up areas are only moderately susceptible to fire damage resulting from area attacks.

C. MACHINE TOOLS AS A TARGET SYSTEM

Once war industry has reached its peak output, machine tool requirements are small relative to total inventory. In addition, the tools are moderately interchangeable in use so that priority users can maintain production, at least partially, by borrowing tools from other industrial users of them. The possibility of reconversion from aircraft engine part manufacture gives another element of flexibility. For these reasons, loss of production of machine tools through destruction of capacity by air attack has slight possibility of having a direct effect on the production of war materiel. The machine tool industry is unattractive as an independent target system.

A substantial impact on military strength would be obtained, however, if machine tool production, especially that of high-precision tools, is decreased as a complement to successful attacks on aero-engine or ordnance production. It is estimated that a 50% reduction in the output of the precision tools used for aero-engine production, accompanying a successful attack on engine plants, would delay full recovery of engine production by as much as four months. A considerable delay, less easily measured, could also be imposed on the recuperability of ordnance production.

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The dispersal of the machine tool industry is such, however, as to make it necessary to attack at least 20 plants, to achieve a 50% cut in precision machine tool production. Thus, the cost of attacking the machine tool industry is probably greater at the present time than alternative means of achieving the same objective of holding down aero-engine production.

Successful and widespread urban area attacks would destroy some machine tool capacity and place a heavy additional burden on the industry for tool replacement throughout industry. This might make the industry so great a bottleneck in the Japanese economy as to justify supplementary precision attacks on key machine tool plants.

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II. REQUIREMENTS & SUPPLY:
VULNERABILITY OF MILITARY STRENGTH TO LOSS OF PRODUCTION

For present purposes, machine tools may be defined as power-driven machines for metal working. Excluded from this definition are light portable power-driven tools, very heavy industrial machines such as forges and cranes, and all woodworking machinery.

A. REQUIREMENTS

Machine tools are instruments of production which are basic to manufacturing processes in all major war industries turning out end products. Some type of cutting, shaping, drilling, boring, grinding and various combinations of such metal-working are required for the finishing of all parts going into modern metal end products. Although there is an almost infinite variety of tools needed for specific uses, many of them are slight variations of general categories doing the same general type of work. Among the most important categories are the following:

	General Use
Planers	Straight line surface machining of large components.
Boring Mills and Machines	Rotary machining of large components.
Lathes	All types of turning operations.
Millers and Milling Machines	Machining by using rotary cutters.
Drilling Machines	Drilling of round holes in all types of components.
Turrets, Screw Machines, and Chucking Machines	Automatic multiple machine tools for high precision of turned components.
Gear-cutting Machines	Cutting and shaping all types of gears.
Grinders	Precision finishing of flat or curved surfaces by grinding methods.
Slotters and Shapers	Rough shaping of components by reciprocating ram-driven tools.
Metal Sawing Machines	Cutting stock for machining.

Of these categories, the most basic and most generally used are the drilling machines, lathes, and millers.1/

The principal important wartime users of machine tools are the aircraft engine, automotive (including combat vehicles), arms and munitions, and shipbuilding industries. Many of the uses to which tools are put by these manufacturers require very close tolerance work which can be performed only by high-precision machines of the best quality. Of the total inventory of tools in Japan, a comparatively small percentage can meet these requirements. It is with these high-precision tools that we are most concerned. This group includes both "general" and "special-purpose" tools. In the United States, the average length of life of a machine tool is around 20 years. However, it is useful for the highest precision work on the average for only 4-7 years. At the end of this time, it is picked up by a dealer and passed on to another user who uses tools with a lower degree of precision. This process may be repeated several times during the life of a machine.

There is some reason to believe that in Japan machine tools are maintained in their most precise uses for a somewhat longer period of time than in this country, by means of more expensive and frequent overhaul. This would raise operating costs but would be justified by shortages of tools.

1/ No study has been made of the production of abrasives, cutting tools, jigs and fixtures. Further detailed investigation of these items might be made if intelligence indicates short supply or vulnerability to air attack.

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The demand in the Japanese economy for machine tools out of current production come from two sources. One of these is new expansion of industry. There is ample evidence to show that in early 1945 the aircraft industry is still expanding. Considerable new tooling is probably currentiy being required unless some other bottleneck has halted the planned expansion. Some expansion may also still be continuing in the electronics industry. Apart from these, however, most of the demand for new tools now comes from replacement needs in existing factories. With currently available information, a rough and only highly tentative estimate can be made of what this replacement might amount to in numbers of tools. For the whole machine tool inventory, adopting the U.S. figure of an average life of 20 years, the replacement rate would be around 5%, or about 15,000 units. It must be recognized, however, that although precision tools represent a comparatively small proportion of the total inventory, the replacement rate per year may be 15-20% of the total number and that therefore a majority of all replacements will be in the precision class. Thus, there is a continuing heavy burden on the makers of the highest class tools, based on replacement needs alone.

Requirements of machine tools for expansion of the Japanese aircraft, armament, and shipbuilding industries were more important than replacement demand in 1942, 1943, and possibly 1944. The exact expansion of Japan's machine tool establishment in this period can be estimated only in the roughest way, based on known expansion of her war production and United States machine tool requirements for such production levels (See Appendix I). From 1939 to the end of 1944 it is believed that Japan's machine tool establishment increased in the neighborhood of 100,000 machine tools. This increase added to a 5% replacement demand gives a maximum annual requirement for 1943-1944 of 50,000 machine tools. Requirements are now considerably lower due to slowing up or cessation of expansion in most industries, probably in the neighborhood of 20,000 tools of which at least half are replacement requirements. Requirements for special purpose and high precision tools have undoubtedly decreased least, due to continued efforts for expansion in aircraft and the tooling up of plants for higher powered aero engines.

B. SUPPLY

In considering the available supply of machine tools, there must be taken into consideration not only production of new tools but also the entire existing inventory in all manufacturing plants and machine shops. The total inventory cannot be disregarded in calculating the effects of air attack upon either the machine tool producing industry or upon users of machine tools, because most tools are a relatively flexible production factor. Interchange of tools between uses is a common practice under normal methods of operation. It usually takes the form of movement of tools from higher to lower precision uses, but under emergency conditions the tool requirements of a high priority industry could in some cases be obtained by "borrowing" of equivalent machines from lower ranking industries, rather than out of new production. The burden could thus be made to fall where it would be felt least.

A figure for this total inventory of machines can only be arrived at indirectly through estimates of employment, production, and efficiency factors in the industries concerned.[1] Present indications are that this figure may fall between 300,000 and 350,000 machines as compared with the somewhat more than 1.5 million in the United States. There is no basis on which to break this total down according to types or degree of precision work involved.

The salient factor on the production side of the machine tool industry in Japan is the recent development of the industry on a self-sufficient basis. Up until 1937, a majority of Japan's requirements for modern high-precision machine tools had been imported - from the U.S., England, and Germany. Her domestic production for 1937 has been estimated at not over 10,000 units. 90% of these tools were produced in roughly a dozen plants by five concerns which are generally known in the industry as the orignial "Big Five:"

[1] - See Appendix I.

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Tokyo Gas & Electric (Tokyo Gasu Denki)
Niigata Iron Works (Niigata Tekkosho)
Ikegai Iron Works (Ikegai Tekkosho)
Karatsu Iron Works (Karatsu Tekkosho)
Okuma Iron Works (Okuma Tekkosho)

In addition, there were over 1,000 very small plants turning out comparatively simple machines which would meet only very low standards of precision.

In 1937, it was belatedly realized that to foster and maintain a successful war industry required development of a full-scale machine tool industry which could supply all of her needs even though all foreign imports were cut off. In order to effect this, the "Machine Tool Manufacturing Enterprise Law" was passed in 1938 to being about a rationalization and expansion of the industry. A licensing program was set up under which many of the small, inefficient manufacturers were eliminated and the leading companies in the industry were expanded with Government aid. This took the form both of expansion of old plants and construction of new ones. In addition, a number of leading engineering companies, particularly Mitsui, Mitsubishi and Hitachi, were brought into the field. Their activities have included construction of new plants and consolidation of comparatively small independent companies into larger, more efficient organizations. Where photographic cover has become available, all reports of expansion have been confirmed. Additional steps were taken in 1939 and 1940 by Government orders under this law to limit the licensed manufacturers to the production of the machines for which they were best fitted. The purposes were elimination of considerable duplication among manufacturers and a reduction in the number of models and standardization of models.

Parallel to this domestic development, up to 1941 greatly expanded purchases of key machines were made abroad, both from Europe and the United States. A total of well over 13,000 machine tools were purchased from the U.S. alone. A great many of these were put directly into war production - in the aircraft industry, in arsenals, and at other strategic points. To the extent that the machine tool industry itself received these tools, it used a certain number of them as models for planning its own production of similar tools but probably immediately installed most of them in new plants to help step up the machine tool production program.

The former belief that the Japanese are incapable of producing certain of the very difficult types of high-precision special-purpose tools has now generally been discarded as having no basis in fact. Although they may not have been able to raise their production figures on certain key machines to the levels they desire, they have been able to reproduce all the latest designs developed in this country and Europe.

The officially stated aim of the expansion program under the 1938 rationalization law was an annual productive capacity of some 50,000 machines with a market value of 200,000,000 yen, or a 500% increase in output. It is reasonably certain, considering the extent to which the aircraft and other industries have expanded, that this goal was reached during the year of peak machine tool production in 1943-44, although it probably was not by the time set for it in 1942.

This figure for maximum productive capacity is the same as that obtained independently for peak requirements. Both figures, however, are subject to such wide margins of error that the agreement establishes little beyond the general reasonableness of the estimates arrived at for requirements and productive capacity.

Since the peak year, production of machine tools has dropped off rapidly. There is considerable evidence pointing to a large-scale conversion of machine tool plants to sub-contracted work on aircraft engine parts. This program was announced in June 1944, and according to reports, was completed in October with a conversion of at least part of the facilities in nearly 70% of all plants in the industry. Present production is believed to be in the neighborhood of 25,000 units. This

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conversion would be a logical step to aid in increasing aircraft production at a time when the total demand for new machine tools declined, owing to termination of expansion in other industries which are major users of machine tools. The conversion has undoubtedly been in the smaller, less important plants, leaving the important producers of high precision tools still largely in the machine tool field.

C. PRESENT POSITION

A decrease of requirements and production from 50,000 to about 25,000 machine tools a year would appear to put the industry in a very comfortable position. The benefits of this "excess" capacity, however, are severely limited by two factors.

1. Certain types of high precision machine tools most in demand are still difficult to supply in adequate quantities. Tools such as cylindrical grinders, gear cutting machines, particularly for bevel gears, turret lathes, and certain types of milling machines are, according to American experts familiar with the Japanese industry, the most difficult for the Japanese to produce.

2. The requirements for capacity to make aircraft parts are so large and conversion has gone so far that the industry is not finding it easy to meet even the reduced machine tool requirements. If the demands for tools increase or important capacity were destroyed the industry would find it impossible to meet requirements.

D. ECONOMIC VULNERABILITY

Attack upon the machine tool industry in Japan would net the best results if it followed previous attacks on related industries which are major users of tools. Attack on machine tool production as an independent target system could have some effect on further expansion of the aircraft industry but would be in large part dispersed through all industry, and would fall largely on replacement. The effect would be greatly delayed because manufacturers would be able to defer replacements of most machines for a considerable length of time by means of more extensive repair and overhaul of their present equipment. It would not be felt at all if as is quite likely, machine tool producing capacity were restored before replacements became absolutely necessary.

However, if attack on the machine tool industry follows considerable damage inflicted on a major using industry and is carefully planned and directed against plants producing tools that are the most critical for this user, it would delay restoration of production in the related industry for a considerable period of time by cutting off the chief source of replacement for destroyed and damaged tools.

Three target systems should be considered in connection with attacks on the machine tool industry. The first two, aircraft and ordnance, have significance primarily because of the resulting qualitative requirements for high precision tools. It is believed that precision attacks on the machine tool industry following successful attack on aircraft engine plants would cause a delay in full recovery of aircraft engine production by three or four months by depriving that industry of essential high-precision tools, and considerable delay could be caused in recovery of heavy ordnance production for the same reason.[1] Corollary effects would be a complete stoppage of expansion of aircraft engine production, lowering of output in related industries from which tools would have to be borrowed by the aircraft industry, and a delay in machine tool replacement generally throughout industry.

Attacks on urban areas, the third target system, could cause a quantitative burden of replacement of all types of tools upon the machine tool industry. Of the three, area attack would place the greatest burden upon the machine tool industry, and following successful urban area attack, complementary attack on the priority machine tool plants as a precision target system would add heavily to the economic loss resulting from the area attack.[2]

If future events justify it, consideration should also be given to relating the machine tool target system to the automotive and shipbuilding industries, and possibly electrical equipment.

[1] - See Appendix II, for more detailed discussion.
[2] - See Appendix II for elaboration.

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III. VULNERABILITY OF INDUSTRY TO AIR ATTACK

A. ORGANIZATION OF THE INDUSTRY

1. Concentration by Plants

There are a large number of plants in the Japanese machine tool industry and only a moderate concentration of production in the more important plants. Out of a total of about 400 companies with an estimated 440 plants, some 60 - operating 100 plants - are believed to produce about 95% of the total output. Of these, the priority plants (Table III) probably represent 40-50% of total production. In the absence of any production statistics, these figures are estimated from the data on authorized or paid-in capital, and are therefore to be taken only as indicative of the most probable situation. In terms of precision machines, the degree of concentration in the priority plants is somewhat higher, although by no means all precision tools are manufactured by them. If these plants were neutralized, it would be extremely difficult, if not impossible, to replace their output from the production of other plants, even were their skilled mechanical and supervisory labor shifted to the smaller plants remaining.

2. Concentration in Areas

The machine tool industry has grown up around the industries which it serves. It originally developed in the Tokyo region and much of it is still concentrated there. New development since 1937 has likewise been in the old established industrial regions, although there has been a tendency to build new plants just outside the crowded urban areas. Table I shows the regions in which these concentrations now exist. For the purpose of this analysis, 143 plants - representing the bulk of the industry - have been selected.

TABLE I

Location of Machine Tool Plants by Industrial Regions

Industrial Region (including outlying districts)	Priority Targets 1/	All Plants
Tokyo	7	56
Osaka	5	26
Nagoya	3	18
Niigata-Nagaoka	2	10
Kawasaki	3	7
Yokohama	2	5
Other	5	21
	27	143

Thus nearly 40% of all plants are located in the Tokyo region alone. However, the division of priority plants among the various regions is more nearly equal, indicating that total capacity is less highly concentrated around Tokyo.

A breakdown of these figures showing the plants within, and outside of, the most important urban areas reveals the following:

1/ See Table III.

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TABLE II

Distribution of Machine Tool Plants Within and Outside Urban Areas 1/

Industrial Region	Priority Targets		All Plants	
	In Urban Area	Outside	In Urban Area	Outside
Tokyo	5	2	49	7
Osaka	3	3	19	7
Nagoya	2	1	11	7
Niigata-Nagaoka	2	-	8	2
Kawasaki	-	3	1	6
Yokohama	1	1	2	3
Hiroshima	-	2	-	2
	13	12	90	34

Although 90 of the 124 plants, or over 70% of the total, in these regions are within the urban areas, it is seen that one-half of the 25 priority plants located in these regions are outside. Many of the new plants were located outside built-up areas. This has been particularly true west of Kawasaki and around Osaka. Also worth noting are the two important plants outside Hiroshima.

3. Priority Plants.

In the selection of the most important plants as priority targets in the machine tool industry, primary consideration has been given to the requirements of the aircraft and ordnance industries for the products of the selected plants 2/. The most important high-precision tools used in these industries were first selected. The known major producers of each of the machines or types of machines selected were then determined from current intelligence. These are listed in Table III, together with their principal (reported) products used in these two industries. There is considerable overlapping between the two lists of plants largely owing to a lack of detailed intelligence information. Most of the available intelligence lists the products of plants by types but not by sizes. Hence, where the same general category of tools, such as milling machines, is used by both the aircraft and ordnance industries but in larger sizes by the latter, the same targets have had to be listed for both because of lack of information covering the plants making the largest sizes. Subsequent more complete information may reduce the priority target list, particularly for ordnance.

It was found that there are 23 important plants believed to produce precision machine tools for each of the industries and a total of 27 in all 3/.

This dispersion of production of the more important tools for both aero-engine and ordnance industries indicates a high cost for achieving slower recuperability of the primary industry by attacking machine tool producers. A final decision on such use of air power would rest to a considerable extent on alternative targets and available forces. Improved intelligence may later indicate a smaller group of machine tool targets whose destruction would achieve fairly decisive results.

1/ Table II omits 19 plants included in Table I under "Other", since these plants are not located in major urban areas.

2/ Analysis has yet to be made of the plants which may be important producers of machine tools for the ship-building industry.

3/ An analysis of the number of plants making each type of machine tool is contained in Appendix II.

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B. PRODUCTION PROCESS & PHYSICAL VULNERABILITY

1. Main Stages of Production and Principal Equipment

Only a comparatively small plant is needed for the manufacture of machine tools. Although part of the production may be organized on an assembly line basis, no mass production is possible in this industry for several reasons. The work must be of extremely high quality in order that the completed machines have the required close tolerances. In addition, the orders for a particular size or type of machine are never large and the pattern of production is constantly changing. Employment in a single plant will generally not run over 1,000 men, most of whom are highly skilled laborers.

Starting with high-grade steels and alloys, the manufacturer produces practically all the parts for the machine himself, including the bed and columns, the main shaft or spindle, gears, cutting tools, jigs (for guiding the work), and fixtures (for holding the work). Bearings and motors are generally obtained from other manufacturers. In this work, a comparatively small number of standard machine tools are required, but they must have a relatively high degree of precision.

The plant required for this work is contained in a compound not over 1500 ft. square as a general rule. Within this compound there are 6 to 10 main production units. The larger plants have their own foundries because of the high-quality castings required. Smaller plants may subcontract this work. Practically all plants have forging facilities. There are usually several machine shops in which the normal metal working processes, employing lathes, milling machines, grinders, gear cutters, and so forth, are carried on. A final central assembly shop is needed for building the finished tools. Much final machining is done here because of the close tolerances required of the moving parts. Almost all plants also have a small heat-treating shop, where the work must be of high quality. The administrative section of the plant contains drafting and experimental rooms in which new designs are laid out and new jigs and fixtures are planned for the special requirements of a particular order.

2. Production Time Factors

The total time required for the production of machine tools varies greatly according to the type of tool being manufactured. Estimates made by British concerns have varied from three months to over a year. Considerable stocks of raw materials and parts are maintained around the plant at all stages of production. At the start of the production process, castings must be "aged" to prevent deformation during machining. The machining of parts runs consistently ahead of the assembly schedule, in order to have an adequate supply on hand and to provide users of machine tools with spare parts as required. The assembly and final testing require considerable time and cannot be hurried because of the painstaking work involved. Minimum material on hand and machines in process would be the equivalent of three months production. There is no stocking of completed machines by manufacturers. Shipments are made immediately following testing of those who have ordered them.

3. Vital Facilities

The most critical part of a machine tool plant is the central assembly shop where all parts are brought together for final accurate machining and assembly. This shop contains the indispensable heavy cranes as well as the equipment with the closest tolerances. The various machine shops are also of major importance because of the high-precision machine tools contained in them. Foundries and forge shops are only of secondary importance because their operations are comparatively simple and the work could be subcontracted if necessary.

Damaging the buildings housing the precision processes is considerably less important than destruction of machines and equipment. Loss of tools and material in process is not the major objective but increases the production loss resulting from a successful attack.

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4. *Physical Vulnerability*	Machine tools and the facilities for manufacturing them can be seriously damaged by attack with airborne weapons. Damage to contents, the primary consideration, can be obtained effectively by directing the attack against the buildings. However, the machines are generally less vulnerable than the buildings. Thus, the number of hits which will destroy the building many not destroy the contents. Moreover, the dispersion of the targets in the target system, the difficulty in identifying the smaller targets and the portions of large plants manufacturing many items which specifically manufacture tools, and the variations in structural characteristics among the individual buildings make the industry of less than average susceptibility to attack. The discussion of weapons which follows is based upon a preliminary examination of 12 plants for which photo cover has been examined, and conclusions are subject to modification. Detailed analysis of each target is strongly recommended before attack. Reference should always be made to Target Information Sheets for weapon selection and aiming point of each plant. Fundamentally, there are two types of plants engaged in manufacturing machine tools: (a) Light engineering shops, producing precision tools and housed either in low one-story steel or wood frame buildings with saw-tooth or gable roofs, or in multi-story reinforced concrete units of massive construction. (b) Heavy engineering shops, producing large machines such as hydraulic presses, steam hammers, etc., and contained in relatively high one-story steel framed buildings with powerful overhead cranes. Against light engineering shops in low one-story buildings, the most effective weapon in damaging both machinery and the structure is a blast-producing bomb which bursts above the ground. Thus, the 4000 lb. IC bomb, fuzed instantaneously, would be the best weapon, and G.P. bombs of 500 lb. upwards, fuzed 0.1 sec. nose and 0.01 sec. tail (0.01 sec. nose, if available), alternate weapon choices. Fire also is an important means of damaging precision tools. Therefore, incendiaries should be used in combination with high explosive bombs against those plants where analysis indicates damaging fires can be obtained. Multi-story reinforced concrete structures afford great protection to precision machinery, and therefore, the attack should be directed against the building itself. This is a difficult target to damage as Japanese structures of this type are very heavy. Experience has shown that a large G.P. bomb (1000 lb. minimum, 2000 lb. preferably) fuzed 0.1 sec. nose and 0.025 sec. tail will produce maximum damage to the structure and contents. The structural characteristics of these buildings generally exclude the use of incendiaries, but again, their use depends on a complete target analysis. The 2000 lb. G.P., fuzed 0.1 sec. nose and tail, is the most effective weapon for attacking heavy engineering shops as it has best chance of causing maximum damage to the structure as well as the contents. Structural damage extending to the cranes is particularly important in this case since cranes are essential to production and other facilities cannot be substituted. The 0.1 sec. fuzing will produce maximum craters, which are necessary to undermine heavy columns in the high buildings. Undermining two or more adjacent columns, possible with the 40 to 45 foot crater made by the 2000 lb. bomb, gives best expectancy of primary collapse and thus, serious damage to the overhead cranes. The use of incendiary bombs is not advised, unless the contents contain considerable oil and other inflammables.
5. *Vulnerability in Area Attacks*	The large number and small size of machine tool plants makes them unpromising as a target system for precision attacks. It is possible, however, that considerable machine tool capacity might be destroyed as a result of area attack. The work of fire-zoning Japanese cities on the basis of available photographic cover is not

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complete and for this reason a final estimate cannot be made of the vulnerability of the industry to this type of attack. It should be noted, however, (See Section III-A-2) that while 70% of all machine tool plants are inside urban areas, only one-half of priority plants are so located. Previous study based on former fire zones also showed that a significant part of the plants inside the urban areas were probably not very vulnerable. Thus, area attacks cannot be counted on to destroy so much capacity in the machine tool industry as to affect seriously any critical end product such as aircraft. This point, however, must be considered tentative until the present analysis of vulnerability is completed. It should also be pointed out that this analysis does not make allowance for the added burden of replacement which successful area attacks might put on the machine tool industry. (This question is discussed in the Target System Folder on Urban Areas).

C. *DURATION OF PRODUCTION LOSS*

1. *Unused Capacity*

Between mid-1944 and early 1945 a considerable part of the capacity of the Japanese machine tool industry was converted to the manufacture of aircraft parts. If operating capacity in the industry were destroyed by air attack a certain amount of reconversion would be possible which would cushion the effect of the attack. The extent of the reconversion would depend on the current priorities for the items being produced by the converted plants. Some cushion also exists because only a part of the industry is operating on two full shifts (as of late 1944). Loss of capacity would cause relatively early reduction in production if plants making special purpose tools with a high degree of precision were destroyed.

2 *Recuperability*

The chief bottleneck to restoration of production following successful attack would be replacement of machine tools doing the work, rather than of the plant buildings themselves. If only one or several machine tool plants were damaged, they could obtain new tools comparatively quickly from other plants in the industry. If, however, a majority of the leading plants were attacked, considerable difficulty would be experienced in replacing machines. Some could be obtained by "borrowing" from end products industries, but only at the expense of loss of production in those industries. Furthermore, comparatively few of the tools which could be made available in this fashion would have the requisite degree of precision, making necessary a further period of delay for overhaul of these borrowed machines in previously reconstructed shop buildings. Probably the greatest difficulty would be experienced with the heaviest models.

In Britain, the greatest loss of production time has occurred from damage to heavy machine shops. It has been estimated that a total of 12 months is necessary for replacement of essential equipment in these shops, entailing an estimated loss of production of about 8 months. The difference is accounted for by a certain amount of subcontracting in the interim period. With damage to light machine shops, on the other hand, 6 months has been required for replacement of productive facilities, whereas only an estimated one-month's loss of production resulted. In Britain, the light machine shop work can be extensively subcontracted, but not sufficient facilities are available elsewhere to perform any great proportion of the heavy work. British statistics for the assembly and packing department are 8 months for replacement and a 2 months production loss. If considerable stocks of materials are lost, the production time loss will be several months longer.

It is believed that Japanese experience would show a similar time period for restoration of production facilities but that the total time of production loss would be somewhat greater owing to less opportunity for subcontracting. It is doubted that a proportionate machine shop capacity doing precision work would be available in Japan.

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3. *Dispersal Possibilities*

A certain amount of dispersal of production of the leading plants could take place through employment of floor space in a large number of small machine shops located mostly in the big urban areas. There are, however, severe limitations on such a process. The prime requisite would be supplying the required high-precision machine tools. Since the primary bottleneck in restoring production is procurement of the machines rather than of shop space, no great advantage could accrue from this course. Furthermore, this would be in the nature of subcontracting, because a central shop, equipped with large cranes, would still be necessary for the final assembly work.

D. *CONCLUSIONS AS TO VULNERABILITY OF INDUSTRY TO AIR ATTACK*

The machine tool industry has less than average vulnerability to air attack due to the large number of plants and their small size. The concentration of production of the more critical tools is greater than that for tools in general, but as many as 25 plants might have to be attacked to decrease production of critical tools by 50%. This makes it difficult to attack the industry as a complement to attacks on aero-engines or ordnance, despite the possibility of prolonging recuperability of aero-engine production by as much as 4 months if 50% of critical machine tool capacity could be destroyed. Improvement in intelligence may make a more selective attack profitable.

Vulnerability of the industry to area attack is considerably less for the more important plants than for the older, smaller establishments. A final judgment on this point must await further incendiary zone analysis.

The disadvantage of the industry as a target system as judged by the usual standards should not preclude attempts to find inexpensive methods of attacking it (especially if aero-engines and ordnance were prime objectives). It should be given especial consideration in choice of secondary objectives and industrial clusters for radar bombing.

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APPENDIX I

THE MACHINE TOOL REQUIREMENTS OF JAPANESE INDUSTRY

Several techniques were used to ascertain the machine tool requirements of the Japanese metal-working industries 1939 to 1944. These techniques depended on the knowledge of output, capacity, or employment in various branches of the metal-working industry. Whenever information on one or a combination of these was available, factors derived from American and European experience on the number of tools required were applied. These factors were modified by information on the differences between Japanese and western practice. The results provide a fairly reliable estimate of general size of the machine-tool establishment in the Japanese metal-working industries and the changes in the establishment as the various branches have developed and expanded.

A. *SUMMARY*

Between 1939-40 and 1943-44, the establishment of machine tools in the Japanese metal-working industries increased by approximately 100,000 units. Of this figure, it is estimated that the following percentages went into the following industries:

Industry	Per Cent
Aircraft	43
Shipbuilding	15
General	42

To achieve this expansion, in addition to a yearly requirement of 15,000 units for normal replacement on the old establishment, an expansion of machine tool output to 50,000 units in the peak year 1943-44 was required. This was the figure set by the Japanese in 1937 as their goal. In view of the recent conversion of the machine tool industry to production of aircraft components with the virtual end of expansion in other industries, present output probably has dropped to a level of 20-30,000 units per year. The methods by which these conclusions were reached are summed up below.

B. *AMERICAN EXPERIENCE*

While the United States and Britain entered the war period with an old, well established metal-working industry, the demands of war materiel industries have been such that the use-pattern of the whole machine tool establishment has changed radically. In 1940 the United States had an establishment of 7-800,000 units, at least 30 per cent of which fell within a general metal fabrication category. Roughly 70 per cent of this establishment was over 10 years old. Between 1940 and mid-1943, the requirements of expansion led to a greater than 50 per cent expansion of the establishment, of which roughly half went into the aircraft industry. During the same period, tools were shifted by conversion from the old peacetime categories, such as metal fabrication, into war end-product categories. The aircraft requirements and universal need for high precision led to a number of changes in machining practice, necessitating large numbers of grinders and millers, and certain special purpose tools and fixtures. The old establishment, because of its age and the requirements for more precise tolerances, required extensive rebuilding and retooling.

Knowledge of these features of American practice, which have been typical also of tooling-up programs in England and Germany, has been applied to the known facts about Japanese industry. These facts fall within four categories:

1. Output or capacity in certain industries producing war materiel.

2. Employment in certain industries as drived from Factory Statistics 1/ and other sources.

3. Ranges of output of machine tools, inferred from data on individual plants, known expansion, and yen values of overall output.

1/ Modified to allow for plants employing fewer than 5 workers.

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4. The density of tools in a certain industry and the ratio per shift of workers to tools in that industry. These help to relate establishment to both employment and output. Changes in this ratio in the five years 1939-40 to 1943-44 reflect changes in efficiency.

C. ESTABLISHMENTS IN AIRCRAFT, SHIPBUILDING, AUTOMOTIVE

The machine tool establishment of three industries engaged almost completely in production of war materiel was calculated for 1939-40 and again for 1943-44 from output or capacity estimates. They are:

	1939-40		1943-44	
	Tool Establishment	Employment	Tool Establishment	Employment
Aircraft	7,000	60,000	50,000	700,000
Shipbuilding	35,000	200,000	50,000	500,000
Automotive	20,000	75,000	20,000	125,000

In the case of aircraft, the rate of growth and absolute size are not very well known before 1941. Checks were made against employment figures running through 1938 to ascertain from what level the large expansion 1939-44 took place.

Lower Japanese efficiency in the metal-working industries seems to be reflected in the number of workers they require per tool rather than the number of tools required to achieve a given rate of output. This conclusion is reached from pre-war studies, experience of American engineers with Japanese industry, and recent PU reports. As output has increased there seems to be a greater fluctuation in the number of workers per tool than in the output per tool. Most of the increase in the ratio of workers to tools reflects the partial addition of second shifts.

In certain categories American efficiency is such that a drastic modification of coefficients is necessary, placing them more in line with European experience. In the automotive field before the war, this country turned out annually nearly 4 million units with roughly 500,000 workers and 180,000 tools. Estimated Japanese output by comparison, was 90-100,000 units, based on an employment of 75,000 workers and 20,000 tools.

D. TEXTILE MACHINERY ESTABLISHMENT

The category of textile machinery is included separately because of the outstanding importance of this industry in the total Japanese machine tool establishment before the war. Estimates of the machine tool inventory of this industry are based on the employment of the industry, checked against what data is available on exports of textile machinery. A further check was made against that part of the 1930-1940 growth of new machinery in place in the textile industry which can be attributed to domestic production. Conversion of the industry is calculated from the possibilities evident in the American conversion 1941-1943.

	1939-40		1943-44	
	Establishment	Employment	Establishment	Employment
Textile Machinery	15,000	65,000	2,000	15,000

E. GENERAL METAL-WORKING ESTABLISHMENT

The above four branches of industry permit a fairly detailed analysis based upon our knowledge of either output or employment, or both. Prior to 1939, the remaining categories of the Japanese metal-working industry are so amorphous and certain branches, as communications equipment, are so lacking in development that we have no method of breakdown. One approach to this general engineering category is through the Japanese figures of employment for the rough category of "Machinery and Tools". This category included about 1.1-1.2 million workers in 1939-40, covering the employment in the four categories above. Since the machine tool establishment in the remaining categories (fabricated metal products, industrial equipment, communications and electrical equipment, precision mechanisms, ordnance, and heavy and transportation equipment) is, with the exception of the last

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category, fairly homogeneous, it is safe to derive a range of establishment in 1939-40 from the residual employment of 700,000 workers in this category.

To ascertain how far this general machining or engineering category expanded 1940-1944 is practically impossible. What establishment there was under this heading in 1940 had been converted and expanded, certain lines in 1944 far outweighing others. As in the United States, England and Germany, Japanese ordnance production, for example, has developed in numerous industrial locations, utilizing to a large extent converted tools from a large number of industries. Since the order of expansion in the main consuming industries is known, the maximum expansion which could have taken place can be inferred. Rough notions of the increase in this category (which is relatively small owing to the degree to which establishment can be shifted and considering that the Japanese have operated only with an average of 1.3 shifts) were checked against the expansion of the industrial labor force, power consumption, and changing efficiency. It is estimated that the establishment in this category expanded by 30 per cent 1939-40 to 1943-44 (13,000 units coming from the textile machinery industry).

	1939-40		1943-44	
	Establishment	Employment	Establishment	Employment
General Metal Fabrication	140,000	700,000	195,000	1,600,000

It should be emphasized that much weight is given to the failure of the Japanese to add second shifts to priority industry. It can be assumed that more complete utilization of tools is a preliminary to an expansion of existing establishment. The spotty record of second shifts, whether due to material or power shortages, has complicated the estimates of expansion. Where a comparison is made between Japanese establishment and American and German establishments, this fact should be kept in mind, since the operation of additional shifts provide the last two countries with a degree of utilization of existing establishment not to be found in Japan. The net effect is to create an excess of machining capacity, which, despite its smallness by comparison with that of the western powers, is a cushion against the effects of both area and precision attacks.

Estimates Of The Size Of The Japanese Machine Tool Establishment

	1939-40			1943-44		
	Establ.	No. Shifts	Employment	Establ.	No. Shifts	Employment
Total	217,000		1,100,000	317,000		2,940,000
Aircraft	7,000	1	60,000	50,000	1.8	700,000
Shipbuilding	35,000	1	200,000	50,000	1.5	500,000
Automotive	20,000	1	75,000	20,000	1	125,000
General Metal Fabrication	140,000	1	700,000	195,000	1.3	1,600,000
Textile Machinery	15,000	1	65,000	2,000		15,000

F. TOTAL REQUIREMENTS

In view of the possibilities of error, the above estimates should not be viewed as attempts at precise statement of the size of the Japanese machine tool establishment. The totals show an increase of 100,000 units between 1939-40 and 1943-44. Requirements for 5 per cent replacement of the tools in place 1939-40 probably totalled 50,000 over this five year period. No allowance is made for depreciation on the new items going in place in this period.

How the requirement of 150,000 units is pro-rated by years from 1939-1944 depends on two factors:

1. The levels of output of machine tools from which the original expansion was begun.

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2. The existence of a peak production year, from the levels of output of which production has now declined.

Since production in 1937 is generally estimated at 5-10,000 units and the results of expansion were only beginning to be evident in 1939, output at the beginning of rapid expansion in 1939-40 can be estimated at 10-15,000 units. The Japanese program envisioned expansion at constantly accelerating rate.

From intelligence on Japanese industrial expansion and the recent conversion of part of the machine tool industry to aircraft components, it is now evident that the peak year in the expansion of industry and in the output of machine tools ended in mid-1944. With an accelerating output from the 1937 base and the original production goal of 50,000 units a year to be attained in 1942, a safe inference can be drawn that production in 1943-44 actually equalled the estimated requirement of 50,000 units. In short, after 1939-40, production probably increased on an accelerating basis from 10-15,000 units per year to 45-50,000 units in the peak year. This would account for the requirement of 150,000 units in the five years. Even at this level, it would still have been less than half German peak production and between one-fifth and one-fourth American peak production.

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APPENDIX II
ATTACK ON THE MACHINE TOOL INDUSTRY AS A
SUPPLEMENT TO ATTACKS ON OTHER TARGET SYSTEMS

A. AIRCRAFT

As stated in the text, it is believed that attack on the priority machine tool targets listed in Section III following successful damaging of the aircraft engine industry would delay full recovery of engine production by as much as four months. The following explains the derivation of this estimate.

There are a half dozen aircraft engine plants in Japan producing most of the 4,500 or so engines per month being turned out at present. A rough estimate of the number of machine tools in these plants, including the machine shops for maintenance and repair of the producing machines, places them at between 25,000 and 30,000. This calculation is based upon a total floor space for these plants of about 12 million square feet, with roughly 40% of the space given over to machine shop activities, and with an estimated 200 square feet allowed for each machine tool. An independent calculation based on machine tools required per unit of engines produced per month in the U. S. checks fairly closely. If 10,000-15,000 of these tools were destroyed or seriously damaged during, say, a four-months attack on the aircraft industry, the present monthly production of about 2,000 new machine tools would be sufficient to take care of most of the necessary re-tooling. The aircraft industry would prefer to replace damaged machines with new ones, rather than salvaging the old ones, as it would be quicker and would produce better results. Since it is the moving parts of machines tools that are the most vulnerable, rather than the bases and stationary parts, a certain number of tools could be salvaged comparatively easily and almost immediately by use of replacement parts, which would either be in stock or could be obtained from machine tool manufacturers. The only effect would be delay to plants in other industries that had ordered machine tools for replacement purposes.

If, however, through successful attack on priority machine tool plants a significant proportion of the capacity for production of important high-precision machine tools should be neutralized immediately following attacks on the aircraft industry, the re-tooling problem would be much more difficult. Partial restoration of production could be effected in two ways.

1. Some damaged machines could be repaired either by cannibalizing or by acquisition of new parts, which would be easier to obtain than new machines - from plants specializing in cutting tools, bearings, shafts, etc., and from inventories.

2. Tools would be "borrowed" to some extent from other machine tool users, particularly the automotive industry which is the chief user of the same types and sizes required by aircraft engine plants. It should be remembered, however, that many of the tools required are special-purpose machines which could not be obtained in this way. Of those tools which were so obtained, many would have to be reconditioned to raise their precision to the standards required for production of aircraft engines. This would necessitate tearing the tools down in machine shops and rebuilding them with new parts.

It should be noted that both of these methods of restoring machining capacity would be rendered much more difficult if, in the initial attacks on the aircraft industry, the machine shops of the engine plants - where machine maintenance and repair are conducted - are destroyed or damaged.

By these means, partial restoration of aircraft engine production could be effected in a comparatively short time by replacement of possibly 5,000-7,000 machine tools, or one-half of those originally destroyed or damaged. The remaining half of the tools, which would be special-purpose precision types, would, however, have to be obtained from the machine tool industry out of new production. Present production of precision tools probably represents from one-half to three-quarters of total monthly output, or between 1,000 and 1,500 units because, with the current cutback

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in machine tool production, the plants making the highest quality tools have been left in the field. Successful attack on machine tool priority targets could reasonably be expected to reduce production of precision tools by one-half, or to 500-750 per month. With present production of 1,000-1,500 precision tools, the aircraft replacement requirement for 5,000-7,000 tools could be met in possibly five months. With reduced production following attack on the machine tool priority plants, however, the period would be extended to nearly nine months. On the basis of this analysis, it is believed that full recovery of aircraft engine production would be delayed three to four months.

B. ORDNANCE MANUFACTURE

It is not possible to develop as precise a relationship between the machine tool and ordnance industries as with aircraft. However, it is possible to point out some general relationships which may act as a guide in gauging the effect of a related attack. Heavy weapons only have been selected as an example in this analysis, and a determination has been made of the types of machine tools required for the manufacture of heavy AA guns (75 mm and over), since these are of particular interest at the present time. In the manufacture of the tubes, breech-rings, and breech-blocks of the guns, very heavy and specialized machine tools must be employed, such as turning and boring lathes, turret lathes, broaches, milling machines, and slotters. Such parts as the bearings, mounts, carriages, and recoil mechanisms are generally made in separate shops and are therefore not considered here. To make 150 guns per month (with standard spares, including 200 spare tubes) would require - on the basis of American practice - not over 250 of these heavy specialized tools. Since this estimate is on the basis of production in one plant, and there are a half dozen producers of heavy AA guns in Japan, the number of tools having to be replaced following successful attack upon them would be considerably greater, probably by three or four times. Even with this consideration, the replacement problem, on the basis of numbers alone, would not appear to be a great one. However, these are specialized tools which could not be obtained by borrowing from any other industry. Even in the manufacture of other types of guns, such as heavy howitzers, other types and sizes of tools are required. Consequently, all replacement would have to come from manufacturers of machine tools, comparatively few of whom are equipped to make the large sizes and special types required, and these only in small numbers. Neutralization of these plants would, then, result in loss of production of heavy ordnance, except to the extent it could be restored from cannibalized machines, for the full length of time required to rebuild the machine tool plants and restore production in them.

A considerable number of smaller general purpose tools are required for the production of parts going into gun manufacture, but these are not of particular interest since in most of them a high degree of precision is not required, and they could be obtained easily from the existing inventory of tools as well as from a large number of machine tool manufacturers.

C. NUMBERS OF PLANTS WHICH MUST BE ATTACKED

The feasibility of prolonging the loss of aero-engine production (or ordnance production) by supplementary attack on machine tools rests largely on the number of plants which must be attacked. A study of the priority plants shows that the number of plants producing the important and critical high-precision tools needed for aero-engines, are as follows:

Type of Machine Tool	No. of Known Principal [1] Producers
Grinders (Cylinderical, internal, thread, surface, centerless)	15 [2]
Millers and milling machines (vertical and horizontal)	12
Turret lathes (horizontal and vertical, hand and automatic)	7
Gear-cutting machines (shapers, hobbers, grinders, generators)	6
Hones and lapping machines	6
Broaches and broaching machines	3

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Type of Machine Tool	No. of Known Principal[1] Producers
Jig borers	2
Screw machines (hand and multiple automatic)	1
Total number of plants producing these items	23

A similar list of machine tools containing those most important in the manufacture of heavy AA guns has been selected, based only on the production of the tubes, breech-rings and breech-blocks, and including only the heavy special-purpose tools, and the corresponding number of known principal producers is as follows:

Type of Machine Tool	No. of Known Principal Producers
Milling machines (including thread millers)	10
Thread grinders and internal thread generators	9
Slotters	7
Turret lathes	7
Vertical boring mills	6
Hones	4
Broaches	3
Turning and boring, gun lathes	2
Total number of plants producing these items	23

[1] All plants do not produce all the types listed. See Table III.
[2] Only 8 of these plants are so far identified with production of the critical internal grinder.

These tables show clearly the dispersion of production of the machine tool industry, particularly in the most important and critical types, such as grinders and milling machines. As a means of delaying recuperability of aircraft engine or ordnance production, attack on machine tools would be costlier in terms of bombing effort than repeat attacks on aircraft or ordnance until such time as dispersion had increased the number of plants in these industries to 20 or more, nearly a quadrupling of the present number.

D. URBAN AREAS

Projected incendiary attacks upon the major Japanese cities would have an effect upon the machine tool industry relative both to direct damage to machine tool plants and to the burden of repair and replacement of the metal-working industries as a whole. Irrespective of the direct damage done to the machine tool industries by such attack, the burden of replacement of tools in general would be sufficient to greatly enhance the value of attacks directed against the remaining priority machine tool plants as a related target system. More complete data on this point is developed in the Air Target System Folder on the Urban Areas.

Area attacks upon the major western German cities in the 10 months from March through December 1943 resulted in a loss of 55 per cent of 10 months production in the machine tool industry. Direct damage to machine tool industry accounted for 8 per cent, replacement demands for all industry, including the machine tool industry, accounted for 47 per cent of the 55 per cent. It can be seen from these figures that replacement was roughly 6 times as important as direct damage to machine tool industry by area attack. A general ratio of this sort has been found to be applicable in the attacks upon Britain, and may in fact be on the low side for Japan.

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TABLE III. AIR TARGET SYSTEM
Major Japanese Machine Tool Plants

JOINT TARGET GROUP-WASHINGTON, D. C.

Sheet No. ATSF/MTI/T3
Date 2. Feb. 1945

TARGET NUMBER	NAME OF PLANT	LOCATION	PRINCIPAL PRODUCTS (REPORTED)											Products used in mfr. of		REMARKS
			Boring Mills (Vertical)	Broaching Machines and Broaches	Gear Cutting Machines	Grinders	Hones and Lapping Machines	Jig Borers	Gun Turning and Boring Lathes 1/	Millers and Milling Machines	Screw Machines 2/	Slotters	Turret Lathes	Aircraft Engines	Ordnance	
90.9 - 998	Niigata Iron Works, Plant No. 1 (Niigata Tekkosho KK)	Niigata	x	x		x	x			x		x		x	x	
90.9 -1656	Tsugami-Atagi Mfg. Co. (Tsugami-Atagi Seisakusho)	Nagaoka				x		x						x	x	Thread and screw grinders.
90.11- 941	Fujikoshi Steel Products, Toyama Plants (Fujikoshi Kozai Kogyo KK)	Toyama		x										x	x	
90.17- 133	Shibaura Engineering Works, Ltd. (Shibaura Seisakusho)	Yokohama	x	x								x		x	x	Heavy duty machine tools.
90.17- 331	Tokyo Gas and Electric Engineering Co. (Tokyo Gasu Denki)	Tokyo, Omori				x	x			x		x		x	x	A Hitachi concern. Most types of grinders; possibly the most important Japanese producer of milling machines.
90.17- 882	Ikegai Machine Foundry (Ikegai Tekkosho)	Tokyo, Shiba				x			x	x			x	x	x	Surface grinders; heavy-duty millers.
90.17- 898	Japan Military Goods Co., Shonan Plant (Dai Nippon Heiki KK)	Yokohama				x				x				x	x	
90.17-1357	Oriental Precision Machinery Co. (Tokyo Seiki KK)	Tokyo, Kamata			x	x	x	x						x	x	Thread grinders.
90.17-1686	Hitachi Engineering Works, Kameari Plant (Hitachi Seiki KK)	Tokyo Adachi				x				x	x		x	x	x	Hand-operated screw machines; reported to specialize in turret lathes.
90.17-1687	Mitsui Machine Tool Co., Okegawa Plant (Mitsui Kosaku Kikai KK)	Okegawa				x								x	x	Recently built with Norton help for production of Norton-type grinders.
90.17-1688	Hitachi Machine Tool Co. (Hitachi Seiki KK)	Kawasaki					x			x				x	x	
90.17-2026	Ebara Mfg. Co., Kamata Plant (Ebara Seisakusho KK)	Kokyo, Kamata	x												x	Large size boring and turning mills.
90.17-2027	Ebara Mfg. Co., Kawasaki Plant (Ebara Seisakusho KK)	Kawasaki	x												x	Large size boring and turning mills.
90.17-2028	Ikegai Iron Works, Mizonoguchi Plant (Ikegai Tekkosho KK)	Kawasaki			x	x								x		
90.17-2029	Okamoto Machine Tool Co., Kamata Plant (Okamoto Kosaku Kikai KK)	Tokyo, Kamata			x									x		Gear grinders, Gleason gear generators.
90.20- 254	Mitsubishi Electric Mfg. Co. (Mitsubishi Denki KK)	Nagoya				x				x			x	x	x	Surface grinders; special milling machines; planned '40 to make Warner & Swazey or Gisholt turret lathe.
90.20-1146	Okuma Iron Works, Hagino Plant (Okuma Tekkosho KK)	Nagoya	x			x				x			x	x	x	
90.20-1799	Hokoku Machinery Co., Kasadera Plant (Hokoku Kikai KK)	Nagoya										x			x	
90.25-1634	Mizaguchi Gear Works (Osaka Seisa Zoki KK)	Osaka			x									x		Gear cutters, Sunderland-type hobbers, Gleason generators, shapers.
90.25-1773	Osaka Chain and Machinery Works (Osaka Seisa Zoki KK)	Ibaragi				x						x		x	x	Cylindrical and internal grinders; heavy-duty slotters.
90.25-1780	Osaka Machinery Co. (Osaka Kiko KK)	Itami								x		x		x	x	
90.25-1784	Osaka Wakayama Iron Works (Osaka Wakayama Tekkosho KK)	Fukuizumi				x				x			x	x	x	Now called Japan Machine Tool Co. (Dai Nippon Koki KK) Internal grinders; German Pitler-type turret lathes.
90.25-2030	Osaka Chain and Machinery Works, Maegawa Plant (Osaka Seisa Zoki KK)	Osaka			x									x		Reported production of 20 Fellows gear shapers per month, hobbers, Gleason generators.
90.30-1885	Mitsubishi Electric Mfg. Co. (Mitsubishi Kosaku Kikai KK)	Hiroshima								x			x	x	x	Formerly Toyo Kikai KK. Van Norman-type millers.
90.30-1890	Toyo Industry (Toyo Kogyo KK)	Hiroshima				x								x	x	Internal and Heald automatic grinders.
90.36- 833	Karatsu Iron Works (Karatsu Tekkosho KK)	Karatsu	x		x	x			x	x		x	x	x	x	Gear shapers and hobbers; most types of grinders; gun boring lathes.
93.3 - 164	Manchuria Machine Tool Co. (Manshu Kosaku Kikai KK)	Mukden	x		x	x				x					x	Important because adjacent to the Mukden Arsenal (Target 46) which it undoubtedly serves.

1/ - The plant of the Nomura Mfg. Co. (Nomura Seisakusho KK) in Osaka is reported as a manufacturer of vertical boring and turning mills, gun boring lathes and turret lathes. However, there is insufficient information on this plant to list it as a target.

2/ - Only one plant is listed as making screw machines, and none the multiple automatic variety, but there are undoubtedly others making this important item.

Location Map

NOT TO BE TAKEN INTO THE AIR

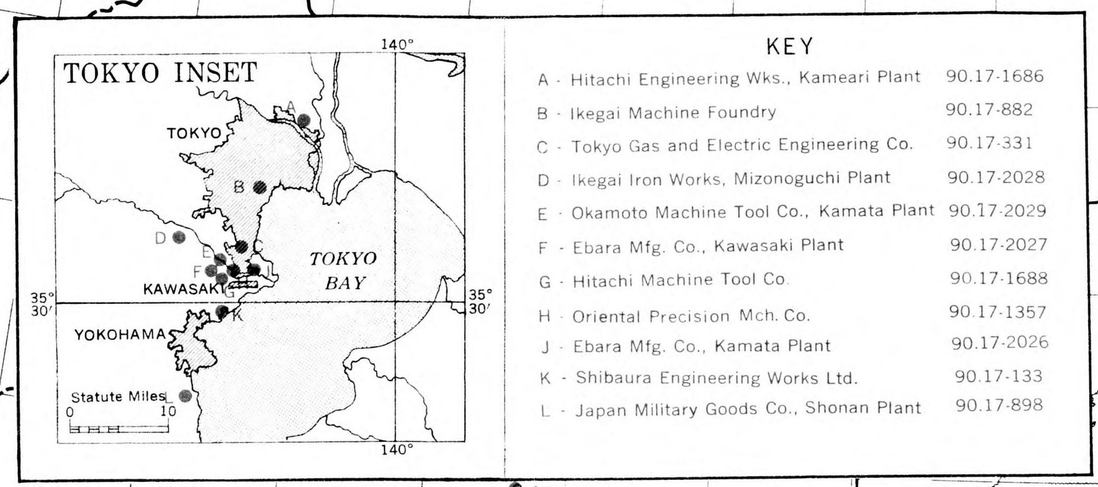
SECRET

JOINT TARGET GROUP - WASHINGTON, D.C.

SHEET NO. ATSF/MTI/MI
DATE 2 FEB 1945
PAGE NO. 1 (1 PAGE)

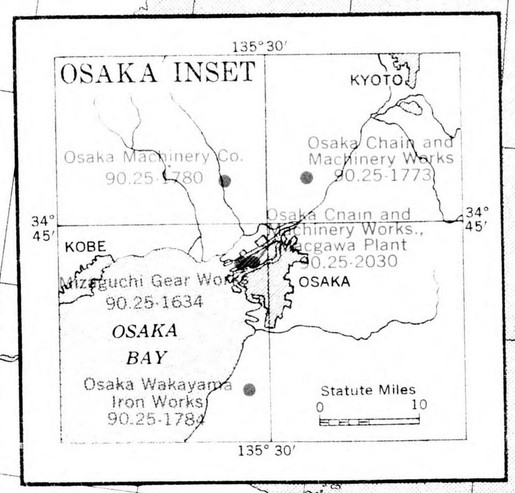
AIR TARGET SYSTEM FOLDER - JAPANESE MACHINE TOOL INDUSTRY

GENERAL LOCATION MAP



KEY

A	Hitachi Engineering Wks., Kameari Plant	90.17-1686
B	Ikegai Machine Foundry	90.17-882
C	Tokyo Gas and Electric Engineering Co.	90.17-331
D	Ikegai Iron Works, Mizonoguchi Plant	90.17-2028
E	Okamoto Machine Tool Co., Kamata Plant	90.17-2029
F	Ebara Mfg. Co., Kawasaki Plant	90.17-2027
G	Hitachi Machine Tool Co.	90.17-1688
H	Oriental Precision Mch. Co.	90.17-1357
J	Ebara Mfg. Co., Kamata Plant	90.17-2026
K	Shibaura Engineering Works Ltd.	90.17-133
L	Japan Military Goods Co., Shonan Plant	90.17-898



MUKDEN
Manchuria Machine Tool Co.
93.3-164

Niigata Iron Works, Plant No. 1
90.9-998

Tsugami Atagi Mfg. Co., Nagaoka
90.9-1656

Fujikoshi Steel Products, Toyama Plants
90.11-941

Okuma Iron Works, Hagino Plant
90.20-1146

Mitsubishi Electric Mfg. Co.
90.20-254

Hokoku Machinery Co., Kasadera Plant
90.20-1799

Mitsubishi Electric Mfg. Co.
90.30-1885

Tokyo Industry
90.30-1890

Karatsu Iron Works
90.36-833

Mitsui Machine Tool Co., Okegawa Plant
90.17-1687

See Tokyo Inset Map
See Osaka Inset Map

U S S R
KURILE ISLANDS
HOKKAIDO
OTARU
SAPPORO
HAKODATE
SEA OF JAPAN
CHOSEN
CHINA
YELLOW SEA
HONSHU
SENDAI
NIIGATA
TOKYO
YOKOHAMA
YOKOSUKA
KYOTO
NAGOYA
KOBE
OSAKA
OKAYAMA
KURE
SHIKOKU
KOCHI
FUKUOKA
KYUSHU
NAGASAKI
KAGOSHIMA
NORTH PACIFIC OCEAN

Statute Miles
100 0 100 200

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for the use of Allied Forces.

SECRET

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.
February 1945

Target Material

JOINT TARGET GROUP, WASHINGTON, D. C.
AIR TARGET INDEX—JAPANESE WAR
PART I—SYSTEM INDEX

Sheet **ATI/1/MTI/2**
Date **5 April, 1945**
Page **No. 1** (**1 page**)

MACHINE TOOL INDUSTRY

ALL PREVIOUS SHEETS CANCELLED

TARGET NAME	PLACE NAME	TARGET NUMBER
Ebara Mfg. Co., Kamata Plant	Tokyo (Japan)	90.17-2026
Ebara Mfg. Co., Kawasaki Plant	Kawasaki (Japan)	90.17-2027
Fujikoshi Steel Products, Toyama Plants	Toyama (Japan)	90.11-941
Hitachi Engineering Wks., Kameari Plant (1)	Tokyo (Japan)	90.17-1686
Hitachi Machine Tool Co.	Kawasaki (Japan)	90.17-1688
Hokoku Machinery Co., Kasedera Plant	Nagoya (Japan)	90.20-1799
Ikegai Iron Works, Mizonoguchi Plant	Kawasaki (Japan)	90.17-2028
Ikegai Machine Foundry	Tokyo (Japan)	90.17-882
Japan Military Goods Co., Shonan Plant	Yokohama (Japan)	90.17-898
Karatsu Iron Works	Karatsu (Japan)	90.36-833
Manchuria Machine Tool Co.	Mukden (Manchuria)	93.3-164
Mitsubishi Electric Mfg. Co. (2)	Nagoya (Japan)	90.20-254
Mitsubishi Electric Mfg. Co.	Hiroshima (Japan)	90.30-1885
Mitsui Machine Tool Co., Okegawa Plant	Okegawa (Japan)	90.17-1687
Mizaguchi Gear Works	Osaka (Japan)	90.25-1634
Niigata Iron Works, Plant No. 1	Niigata (Japan)	90.9-998
Okamoto Machine Tool Co., Kamata Plant	Tokyo (Japan)	90.17-2029
Okuma Iron Works, Hagino Plant	Nagoya (Japan)	90.20-1146
Oriental Precision Machinery Co.	Tokyo (Japan)	90.17-1357
Osaka Chain and Machinery Works	Ibaragi (Japan)	90.25-1773
Osaka Chain and Machinery Works, Maegawa Plant	Osaka (Japan)	90.25-2030
Osaka Machinery Co.	Itami (Japan)	90.25-1780
Osaka Wakayama Iron Works	Fukuizumi (Japan)	90.25-1784
Shibaura Engineering Works, Ltd. (3)	Yokohama (Japan)	90.17-133
Tokyo Gas & Electric Engineering Co.	Tokyo (Japan)	90.17-331
Toyo Industry	Hiroshima (Japan)	90.30-1890
Tsugami-Atagi Mfg. Co.	Nagaoka (Japan)	90.9-1656

(1) See "Armament"
(2) See "Electrical Equipment Industry" and "Aircraft"
(3) See "Electrical Equipment Industry"

Holders of Joint Target Group folders should insert this sheet in Air Target System Folder—Air Target Index—Japanese War in place of Sheet No. ATI/1/MTI/1.

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JOINT TARGET GROUP • WASHINGTON, D. C.

NIHON STEEL CO.

Muroran, Japan

TARGET No. 90.3-378

COORDINATES 42°19'N 141°00'E

ILLUSTRATION No. 90.3-378 PX2

ISSUED 6 MARCH, 1945

CONFIDENTIAL

0 1000 2000 FEET

SCALE 1:5550 APPROX

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER: JAPANESE COKE, IRON & STEEL AND ARMAMENT

GOVERNMENT COALING PIER

MURORAN HARBOR

100 TON WHARF CRANE

STEEL CO. PIER

Stream

Drain

LOCOMOTIVE SHED

CHYS.

Stream

CHATSU

1 Machine Shop
2 Heat Treating & Shrinking Shop
3 Power House
4 Forging Shop
5 Foundry
6 Crane Gantry (covered)
7 Pattern Shop
8 Main Store

Steel Building
Brick Building
Wooden Building
RAILROADS

←TO COALING PIER
←TO MURORAN

GOVERNMENT RAILWAY

DATE OF PLAN—1935

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

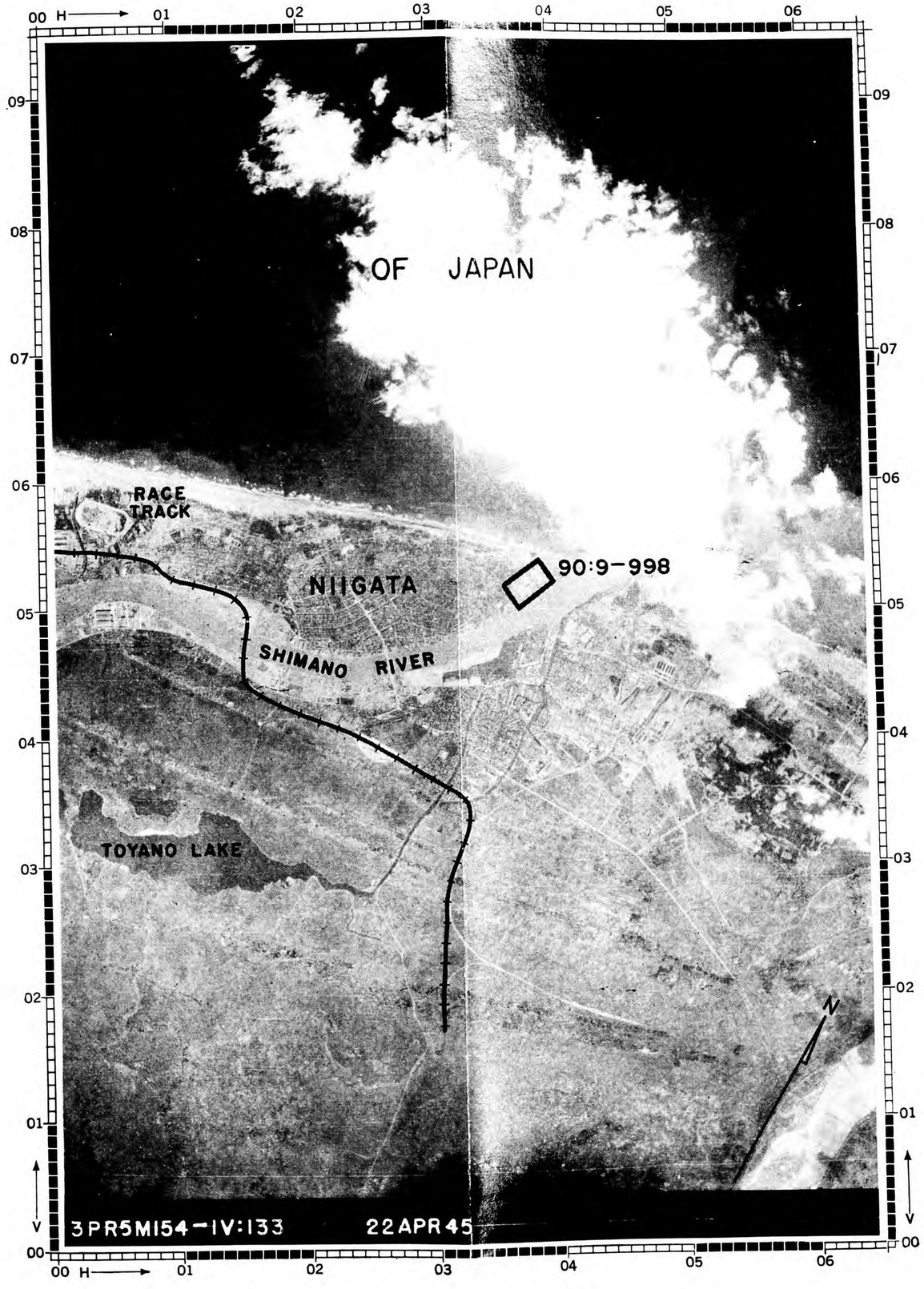
NIIGATA IRON WORKS, PLANT N
NIIGATA JAP

SHEET . . . . . 90:9-998—TL
DATE . . . . . 31 May 1945
CATEGORY . . . . . Bsc. Eqpt. Ind.—MACHY. & MACH. TOOLS
COORDINATES . . . . . 37°56'N 139°04'E
ALTITUDE . . . . . 30 feet

SIGNIFICANCE:

This company manufactures a complete line of high-precision machine tools, particularly lathes, broaches, milling and boring machines, slotters and grinders. This plant is believed making some or all of these and also rolling stock, Diesel engines and general machinery.

LARGE SCALE ILLUSTRATION—SCALE APPROX.: 1:19,950



SMALL SCALE ILLUSTRATION—SCALE APPROX.: 1:65,000

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File No. 461,998.1

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Sheet No.90.17-133-TI
Date 6 Jan. 1945
Page No. 1 (2 pages)

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

Obj. Folder 90.17
Obj. Area 90.17
AAF Target No.90.17-133

Place Yokohama
Category Electrical Equipment/ Machine Tools

Lat.: 35° 29'N
Long:139° 42'E
Alt.: 10 feet

NAME OF TARGET SHIBAURA ENGINEERING WORKS

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE

One of the three largest Japanese producers of heavy electrical equipment. Output estimated roughly at 30 per cent of Japanese total. 1941 products known to include heavy generators, turbines, electric locomotives, electric motors (except very small sizes), transformers, converters, condensers, mercury arc rectifiers, electric furnaces, and many other items for both land and ship use.

This plant is also an important producer of heavy high-precision machine tools. With the Tokyo plant of Shibaura Machine Tool Co (TARGET 90.17-354) it was required by the Government in 1940 to specialize in the production of lathes, long planers, horizontal and vertical boring mills, slotters and large broaching machines.

It is the only known manufacturer in Japan of heavy steel rolling mill equipment, with special emphasis on rollers capable of withstanding heavy stress.

LOCATION

In the center of an industrial development on reclaimed land extending from Yokohama Harbor NE along the Tsurumi and Kawasaki waterfront. It is about 4 miles NE of the westernmost point of Yokohama Harbor, 5½ miles SW of the mouth of the Tama River, and one mile NE of the mouth of Tsurumi Creek. It is located on a nearly rectangular area of reclaimed land surrounded by water except for a 750 feet wide strip at the NE corner connecting with the mainland. The area is bounded on the E by a ship canal separating it from the Petroleum Center (TARGET 90.17-128), and on the W and S by the waters of Kawasaki Harbor.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90.17-133 P3). The main target area is about 2250 x 1425 feet, roughly rectangular in shape with its major axis lying in a NE-SW direction. The area is divided functionally into four main sections. Section A, outside the main target area and measuring about 650 x 600 feet, is devoted to administration and storage. At the SW corner there is a small standby power plant.

Section B, containing the two largest shop buildings in the compound, is used for the production of heavy electrical equipment.

Section C is the rolling mill manufacturing section. Buildings 35 and 38 are known to be the main machine shops for this purpose. Although building 44 appears on the photographs to be connected with this part of the plant, it has been tentatively identified from old ground plans as a punch press shop.

Section D is the most likely location of the machine tool manufacturing operations. Equipment includes forge shops, foundries, machine shops and heat treatment shops.

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CONSTRUCTION & VULNERABILITY

(Refer to Illustration No. 90.17-133 P3). All major buildings are of modern earthquake-resistant construction. The large shop buildings 20, 24, 38 and 44 are heavily framed in steel, single story but ranging in clear interior height up to 49 feet, with normal to long spans and with traveling cranes of capacities up to 110 tons. Side and end walls are of reinforced concrete probably encasing the framework, and with tremendous glass areas; roofs are believed to be reinforced concrete slabs, but their trusses, and all interior columns, are open steel work unfireproofed. Buildings 29, 55 and 63 are presumably similar. Some of the smaller buildings such as No. 42 are two and three-story structures of full reinforced concrete framing, floors and roofs, with short spans and normal story heights.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90.17-133 P3). The most important shops functionally are as follows: in the electrical equipment section, buildings 20 and 24; in the rolling mill section, building 38; and in the machine tool section, buildings 55 and 63.

WEAPON RECOMMENDATIONS

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

The most effective weapon for high level attack against this target is the AN-M66 2000 lb G.P. bomb. Maximum damage to the heavy structures and contents will result if the bombs are fuzed 0.1 sec. nose and 0.1 sec. tail.

Heavy buildings and machinery of the type found in this target are vulnerable to cratering effects and relatively invulnerable to blast and/or fragmentation. It is necessary to undermine at least two main adjoining columns in order to cause primary collapse and therefore serious damage to these buildings. The 2000 lb G.P. causes an average crater of 40 to 45 feet in diameter, giving much better structural collapse expectancy than smaller G. P. bombs.

The average height of the buildings in this target is such as to necessitate 0.1 sec. fuzing for best results.

The use of incendiary bombs in combination with the 2000 lb G. P. is not recommended as the main structures are non-combustible and fire resistant, and their contents are of low combustibility.

LEVEL OF DAMAGE

CAMOUFLAGE DECOYS AND SMOKE SCREENS

Photography of 1 November 1944 shows little attempt at camouflage and no use of decoys. No use of smoke screens has been reported.

ADDITIONAL INFORMATION

(Refer to Illustration No. 90.17-133 P3). The shop buildings just N of Section A, formerly part of the Shibaura compound, are an automobile plant listed as Ishikawajima Motor Co. (Target 90.17-1343)

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JOINT TARGET GROUP • WASHINGTON, D. C.

SHIBAURA ENGINEERING WORKS
YOKOHAMA, JAPAN

TARGET No. 90.17–133

COORDINATES 35°29′ N 139°42′ E

PHOTOGRAPHED 1 NOVEMBER 1944

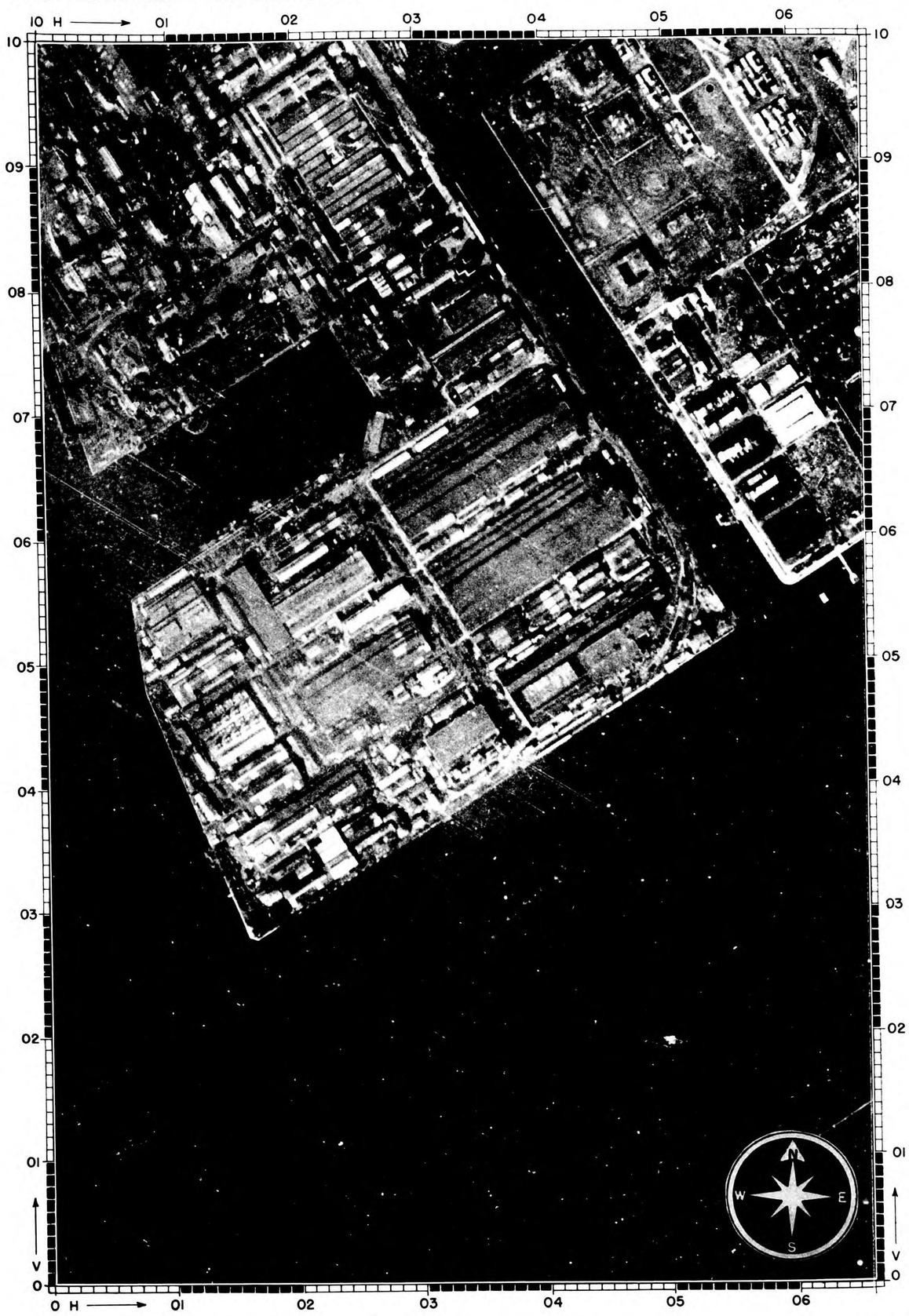
ILLUSTRATION No. 90.17–133 P3

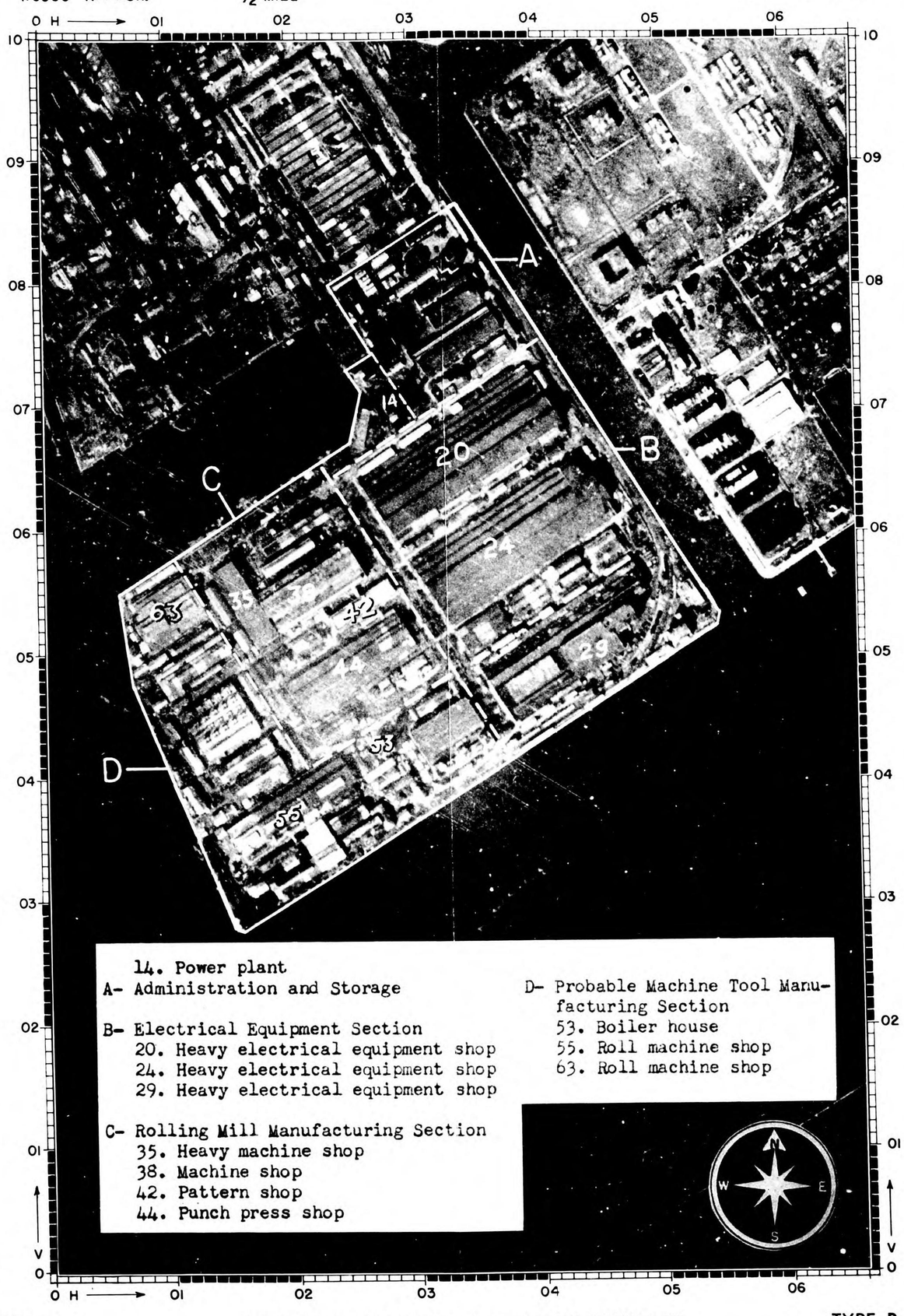
ISSUED 14 JANUARY 1945

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET

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





14. Power plant

A– Administration and Storage

B– Electrical Equipment Section
- 20. Heavy electrical equipment shop
- 24. Heavy electrical equipment shop
- 29. Heavy electrical equipment shop

C– Rolling Mill Manufacturing Section
- 35. Heavy machine shop
- 38. Machine shop
- 42. Pattern shop
- 44. Punch press shop

D– Probable Machine Tool Manufacturing Section
- 53. Boiler house
- 55. Roll machine shop
- 63. Roll machine shop

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TYPE B

TOKYO GAS AND ELECTRIC ENGINEERING CO.

(Tokyo Gasu Denki)

TOKYO . . . . . JAPAN

CONFIDENTIAL

Sheet No. 90.17-331-TI
Date 16 February 1945
Page No. 1

Obj. Folder 90.17
Obj. Area 90.17
AAF Target No. 90.17-331
Air Target System:
Machine Tool Industry

Lat.: 35°35'N
Long.: 139°44'E
Alt.: 15'

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE

One of the leading Japanese machine tool producers, and was one of the original "Big Five." Production also includes ordnance, airplane and engine parts, and possibly complete aero-engines. Plant is now owned by Hitachi Engineering.

Machine tool production includes milling machines, grinders, boring machines, shapers, slotters, honing and lapping machines, and special machines for rolling stock construction. Possibly the most important Japanese producer of milling machines. Ordnance production known to include 6.5-mm. LMG's and 7.7-mm. HMG's and reportedly 20-mm. air cannon. Aircraft components production reported to include such parts as gauges, carburetors and pumps. Various types of commercial and trainer planes were formerly produced, but present activity in this line is believed limited to small engines for trainers.

LOCATION

(Refer to Illustration No. 90.17-331 P2.) In SE Tokyo on the border of the Omori and Shinagawa districts near the shore of Tokyo Bay, about 6.5 miles SSE of the Imperial Palace and about 4.2 miles NNW of the mouth of the Tama River. A ship canal between the shore and filled land is about 700 feet from the E edge of the compound, with a highway running N-S between. The Tokaido Mainline Railroad running generally N-S is about 500 feet W of the nearest edge of the compound. The southern end of the Shinagawa Railroad Yards (TARGET 90.17-364) on this line is about 2.5 miles to the N. A prominent "clover-leaf" traffic intersection is about 6,000 feet to the WNW. The plant is served by highway transport and by a spur from the Keihin Electric Railroad which forms part of the E border of the compound. The target is in a densely built-up industrial area but is surrounded by a wide firebreak closely following its irregular outline.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90.17-331 P3.) The target area is irregular in shape measuring about 1,350 feet across its widest part at the N end, and a maximum of about 2,100 feet NW-SE. It is divided into two sections by an E-W street. The SE part of the area (buildings 1–3) is devoted to administration and storage. The foundry (buildings 15–17) is located at the N end of the southern section, and forging (building 31) is probably done at the N end of the northern section. The principal assembly shops are buildings 13 and 22. It is impossible to assign all buildings to the manufacture of particular products known to be made. Buildings 12 and 13 and the shops near them were formerly used for aircraft production. They probably now manufacture machine tools and aircraft parts, and possibly engines. Building 24 is used for arms production. Buildings 22 and 23, formerly motor car assembly and machine shops respectively, now probably house machine tool or arms manufacture.

PRIMARY OBJECTIVES

In the southern compound, machine and assembly buildings 12 and 13, followed by machine shops 6–9. In the northern compound, shops 22–25.

CONSTRUCTION AND VULNERABILITY

(Refer to Illustration No. 90.17-331 P3.) Most of the buildings, including practically all those listed as primary objectives, are rather old one-story sawtooth-roofed structures of short span and normal eave height. They are reported to be framed in wood, with corrugated galvanized steel roofing and with walls also of corrugated steel, or in some cases of brick. Newer buildings, such as Nos. 19, 20, and 29–32, are probably steel framed and surfaced with corrugated steel or asbestos. Building 25, also probably fairly new, appears to be a multistory, framed reinforced concrete structure with flat roof.

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

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target indicates the following weapons would be most effective:

AN–M64 500-lb. G. P., fuzed 0.01 sec. nose/0.01 sec. tail (if 0.01 sec. nose fuzes unavailable, 0.1 sec. nose fuzes should be used).
AN–M50 4-lb. or AN–M69 6-lb. incendiaries (in aimable clusters for high level attack).

The 500-pound bomb has been found the most effective against one-story buildings of short span and normal height. The 0.01 sec. fuzing gives the best expectancy of causing maximum damage to the contents as well as the structure.

Fire has been an important factor in damaging precision tools in plants where buildings are largely combustible. Either the AN–M50 or AN–M69 incendiary is recommended as the roofs are light, and both produce multiple hits. Additional fire damage may result from the effects of high explosive bombs. The presence of the wide firebreak surrounding the plant makes the spread of fire from adjacent residential areas unlikely.

LEVEL OF DAMAGE—CAMOUFLAGE, DECOYS AND SMOKE SCREENS

Photography of 26 November and 13 December 1944 shows no camouflage or use of decoys. No use of smoke screens has been reported in this area.

ADDITIONAL INFORMATION

This plant formerly manufactured automobiles but the equipment was moved in 1941 to the new Diesel Automotive Co. plant at Hino (west of Tokyo).

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—JAPANESE MACHINE TOOL INDUSTRY

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JOINT TARGET GROUP • WASHINGTON, D. C.

TARGET No. 90.17–331

COORDINATES 35° 35′ N 139° 44′ E

PHOTOGRAPHED 26 NOVEMBER 1944

TOKYO GAS AND ELECTRIC ENGINEERING CO.
TOKYO, JAPAN

0 2000 4000 6000 FEET

0 ½ 1 MILE

1:32 000 APPROX.

ILLUSTRATION No. 90.17–331 P1

ISSUED 7 MARCH 1945

RESTRICTED

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER: JAPANESE MACHINE TOOL INDUSTRY

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JOINT TARGET GROUP • WASHINGTON, D. C.

TOKYO GAS AND ELECTRIC ENGINEERING CO.
TOKYO, JAPAN

TARGET No. 90.17–331

COORDINATES 35° 35′ N 139° 44′ E

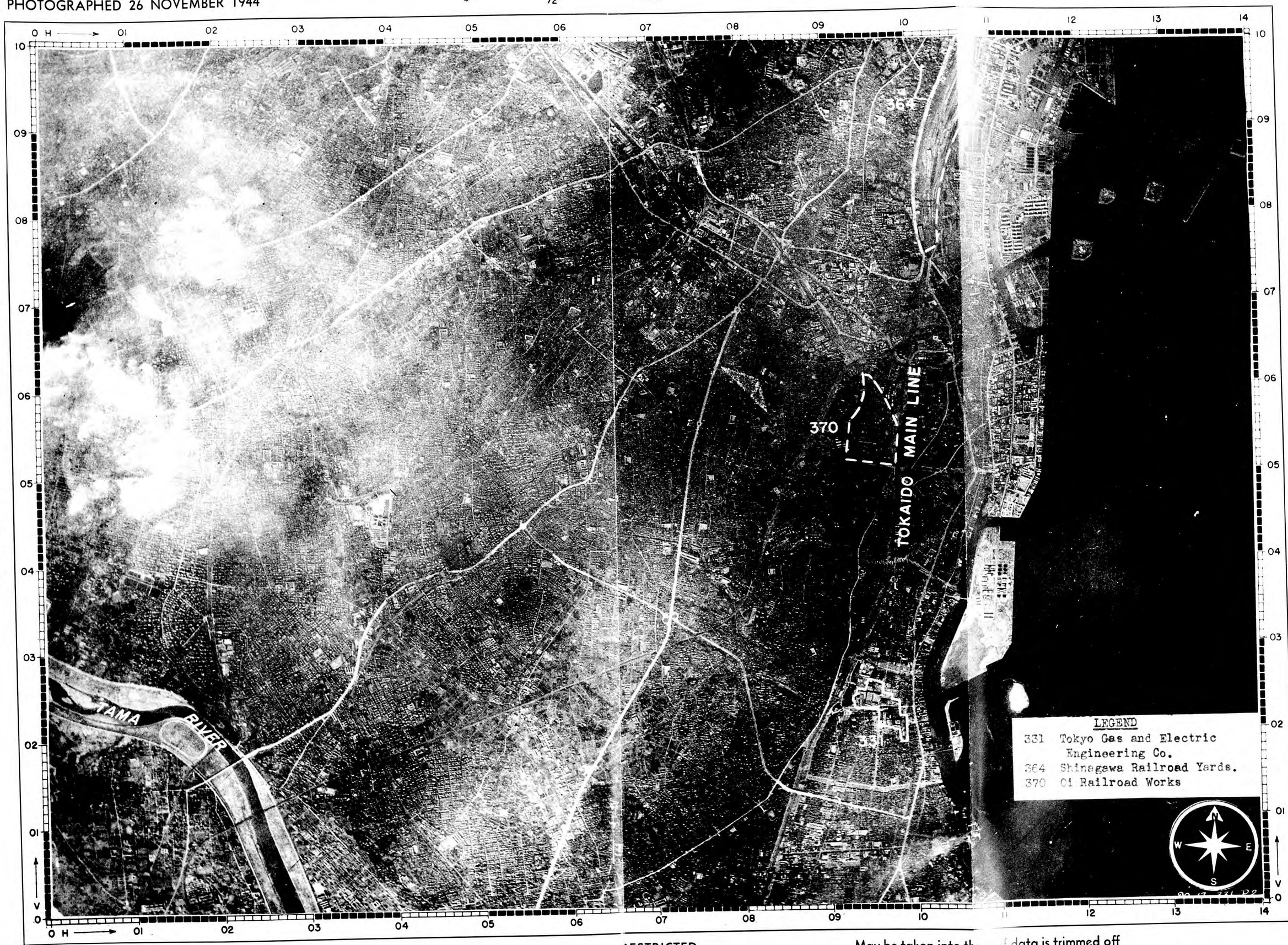
PHOTOGRAPHED 26 NOVEMBER 1944

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

ILLUSTRATION No. 90.17–331 P2

ISSUED 7 MARCH 1945

RESTRICTED



HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER: JAPANESE MACHINE TOOL INDUSTRY

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JOINT TARGET GROUP • WASHINGTON, D. C.

TOKYO GAS AND ELECTRIC ENGINEERING CO. TOKYO, JAPAN

TARGET No. 90.17–331

COORDINATES 35° 35′ N 139° 44′ E

PHOTOGRAPHED 26 NOVEMBER 1944

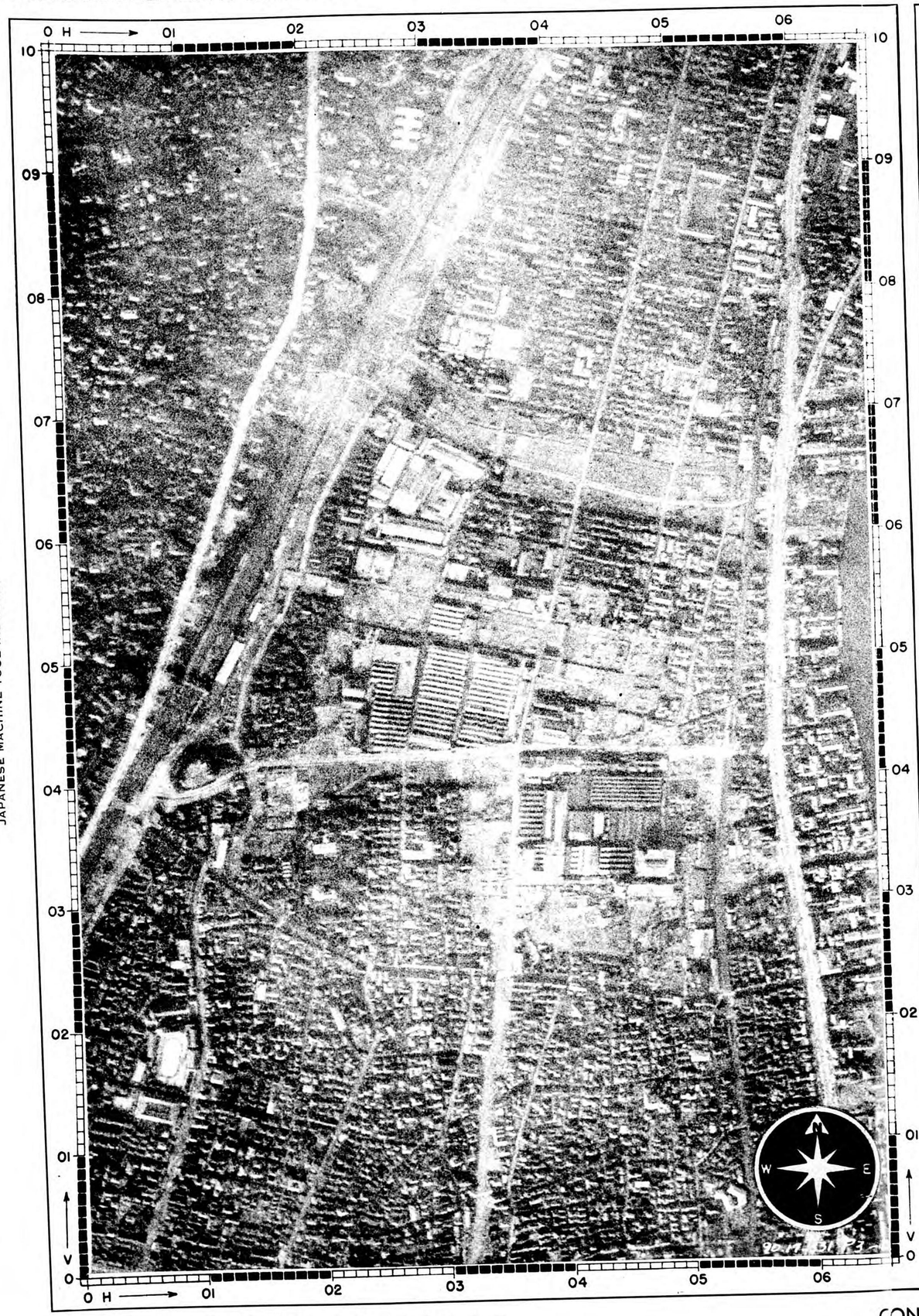
ILLUSTRATION No. 90.17–331 P3

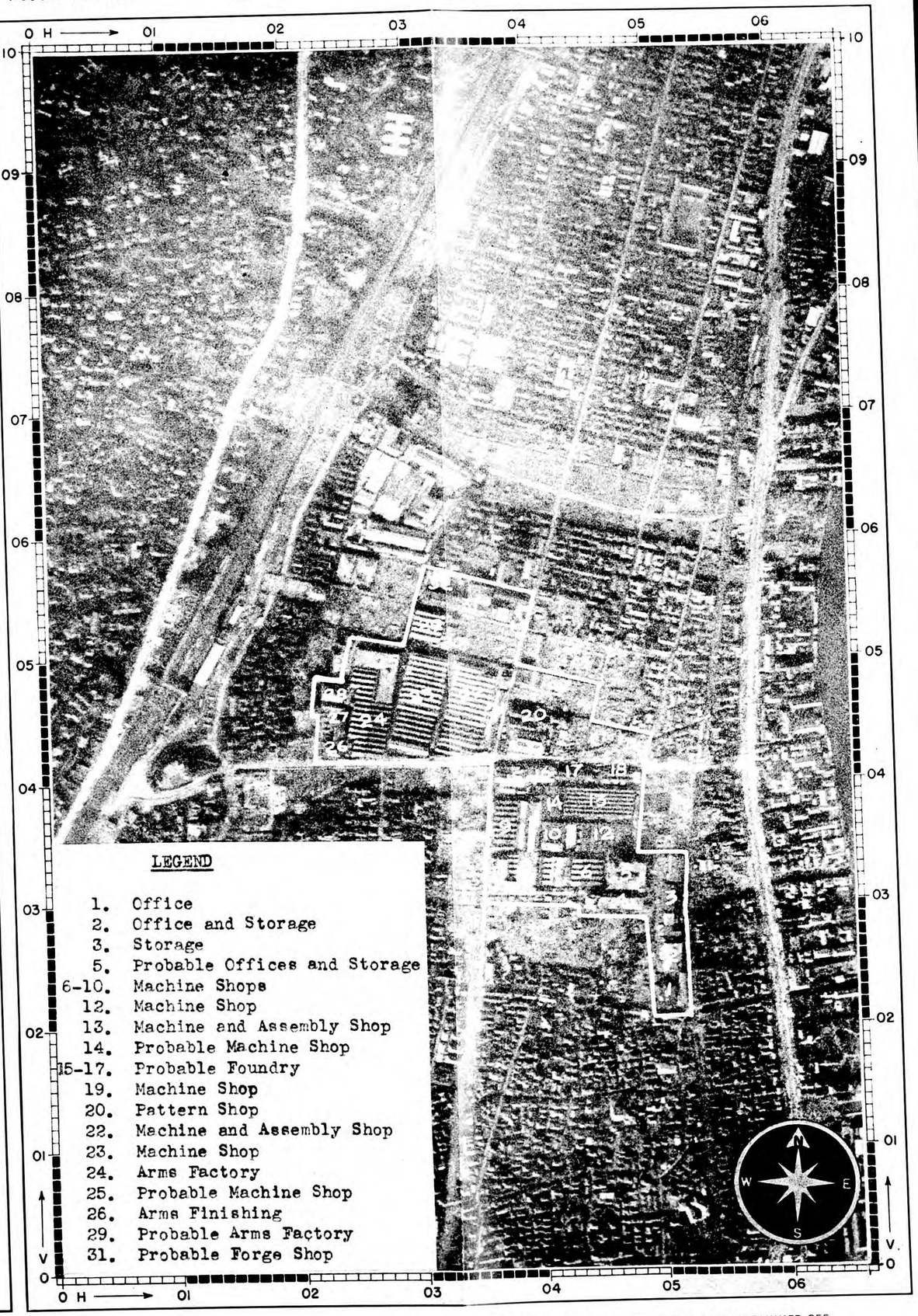
ISSUED 7 MARCH 1945

CONFIDENTIAL

0 500 1000 1500 2000 2500 3000 FEET

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





LEGEND

1. Office
2. Office and Storage
3. Storage
5. Probable Offices and Storage
6-10. Machine Shops
12. Machine Shop
13. Machine and Assembly Shop
14. Probable Machine Shop
15-17. Probable Foundry
19. Machine Shop
20. Pattern Shop
22. Machine and Assembly Shop
23. Machine Shop
24. Arms Factory
25. Probable Machine Shop
26. Arms Finishing
29. Probable Arms Factory
31. Probable Forge Shop

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER JAPANESE MACHINE TOOL INDUSTRY

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JOINT TARGET GROUP, WASHINGTON, D. C.

TARGET INFORMATION SHEET

Sheet No.	90.17-899-TI
Date	30 March 1945
Page	1
Target No.	90.17-899
Obj. Area	90.17
Obj. Folder No.	90.17
Air Target System—Armament/ Machine Tool Industry	
Lat.	35°21′N
Long.	139°38′E
Alt.	Not known

JAPAN MILITARY GOODS CO. TOMIOKA PLANT (Dai Nippon Heiki KK)

YOKOHAMA . . . . . JAPAN

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE

The Japan Military Goods Co. is a leading private producer of automatic weapons and ammunition, and of high-precision machine tools.

The Tomioka Plant, one of four identified factories of the company, is known to produce the 7.7 mm. fixed MG, and fixed and flexible type 20 mm. machine cannon for aircraft, mostly Navy. It has a reported capacity of from 200–500 air cannon per month. The plant was constructed with the aid of Oerlikon engineers, and the guns are Oerlikon types. Ammunition for these guns is also prepared here, as evidenced by the presence of storage and loading facilities for propellants, initiators, and percussion elements. Production is reported as greater than 100,000 rounds per day.

The machine tool production of the company is believed located in this plant. The company was licensed by the government to produce milling machines and grinders. They are of the highest quality.

LOCATION

(Refer to Illustration 90.17–899 P2.) In the Horiguchi section of Yokohama just S of the small town of Tomioka. Honmoku Point in Yokohama is about 4.5 miles to the NNE. The target is bordered on the E by the Shonan Electric RR and the coastal highway. Tokyo Bay lies about 2,640 feet SE of its eastern edge. Japan Steel Co., Yokohama Plant (TARGET 90.17–2042) is about 1.25 miles to the SSW and Oppama Naval Air Station (TARGET 90.17–298) about 2 miles to the SSE. Ishikawajima Engine Plant (TARGET 90.17–1391) and Tomioka Seaplane Base (TARGET 90.17–1403) are on Tokyo Bay about 1.5 miles to the N. The plant is in hilly, open country.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90.17–899 P3.) The target area is irregular in shape, measuring a maximum of about 2,900 feet E-W and from 1,000 to 2,700 feet N-S. The shop facilities for manufacture of guns and machine tools are all located along the eastern side of the area in a space about 2,300 x 600 feet. The largest machine shop (No. 61) measures about 375 x 375 feet. Extensive grading was necessary during construction of the plant and the buildings have been placed at different levels. The remainder of the target area is devoted to the loading and storage of ammunition: at the W end, the loading of initiators and percussion elements in the revetted buildings 1–11; and on the S side of the area, the loading of propellants in 15–23 and their storage in 24–28. There is further activity in revetted buildings in the hills to the W of the target areas. (See illustration No. 9017–899 P2.) The center of the target is served by highway and by rail transport, with a probable shipping station in buildings 54 and 55.

CONSTRUCTION AND VULNERABILITY

(Refer to Illustration No. 90.17–899 P3.) Principal manufacturing buildings along the E side of the target area are generally rather large one-story steel-framed structures of short span, mostly with sawtooth roofs surfaced with lightweight noncombustible sheet material. Remaining buildings are small, one-story, and probably combustible, buildings 1–11 in particular being extremely small and widely dispersed. Buildings 1–11 and 15–23 are protected by earth revetments.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90.17–899 P3.) For the manufacture of MG's and machine tools, machine shops 40a, 43a, 51, 52, 61c, and machine and assembly building 61a. For ammunition production, 1–11 and 15–23.

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 pre-

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liminary structural and occupancy analysis of the plant indicates the weapons should be selected as follows:

	High explosives	Fuzing	Incendiary
Preferred	1,000-lb. G. P	.01 N/ND T	AN-M50 4-lb. (in aimable clusters for high level attack).
Alternate	500-lb. G. P 2,000-lb. G. P	.01 N/ND T .01 N/ND T	AN-M69 6-lb. (in aimable clusters for high level attack). AN-M47 70-lb. AN-M76 500-lb.
Not recommended	Smaller GP bombs SAP, 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.

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

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Photography of 13 December 1944 shows camouflage in the form of rectangular or irregular black and white painting on buildings 37, 40a and 61b only. No decoys are noted. No use of smoke screens is reported in this area.

ADDITIONAL INFORMATION

A. Addresses of the other known Japan Military Goods Co. plants are:

1. 1, 1-Gaido, Muro-aza, Hanada-cho, Toyohashi.

This is a new MG plant, working for the Navy.

2. 1, Motobayashi-aza, Hishi Ike-oaza, Kodamura, Nukata-gun, Aichi-ken.

3. 1, 3-Chome west, Azuma-cho, Mukojima-ku, Tokyo.

This plant, a converted spinning mill, was completely destroyed in the attack of 10 March 1945. Its function is unknown, but it was probably making ordnance.

B. The machine tool plant of the company (TARGET 90.17–898, Japan Military Goods Co., Shonan Plant) is now believed to be at the same location as the Tomioka Plant, rather than as formerly spotted on the point of land about 1.5 miles to the N. The plant facilities at the latter location are believed entirely occupied by TARGET 90.17-1391, Ishikawajima Engine Plant. The identical location of the Shonan and Tomioka plants is confirmed by Japanese industrial index addresses. TARGET 90.17–898 is cancelled and both plants are included in TARGET 90.17–899.

JOINT TARGET [illegible]OUP • WASHINGTON, D. C.

TARGET No. 90.17–1686

HITACHI ENGINEE[illegible]NG WORKS, KAMEARI PLANT

T[illegible]KYO, JAPAN

ILLUSTRATION No. 90.17–1686 P1

COORDINATES 35° 47′ N 139° 51′ E

PHOTOGRAPHED 26 NOVEMBER 1944

0 2000 6000 FEET

0 ½ 1 MILE

1:32 000 APPROX.

ISSUED 27 MARCH 1945

RESTRICTED

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER: JAPANESE MACHINE TOOL INDUSTRY—JAPANESE ARMAMENT.

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JOINT TARGET GROUP • WASHINGTON, D. C.

HITACHI ENGINEERING WORKS, KAMEARI PLANT

TOKYO, JAPAN

TARGET No. 90.17–1686

COORDINATES 35° 47′ N 139° 51′ E

PHOTOGRAPHED 26 NOVEMBER 1944

0 2000 4000 6000 FEET

0 ½ 1 MILE

1:32 000 APPROX.

ILLUSTRATION No. 90.17–1686 P2

ISSUED 27 MARCH 1945

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JOINT TARGET GROUP • WASHINGTON, D. C.

HITACHI ENGINEERING WORKS, KAMEARI PLANT
TOKYO, JAPAN

TARGET No. 90.17–1686

COORDINATES 35° 47′ N 139° 51′ E

PHOTOGRAPHED 26 NOVEMBER 1944

0 500 1000 1500 2000 2500 3000 FEET

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

ILLUSTRATION No. 90.17–1686 P3

ISSUED 27 MARCH 1945

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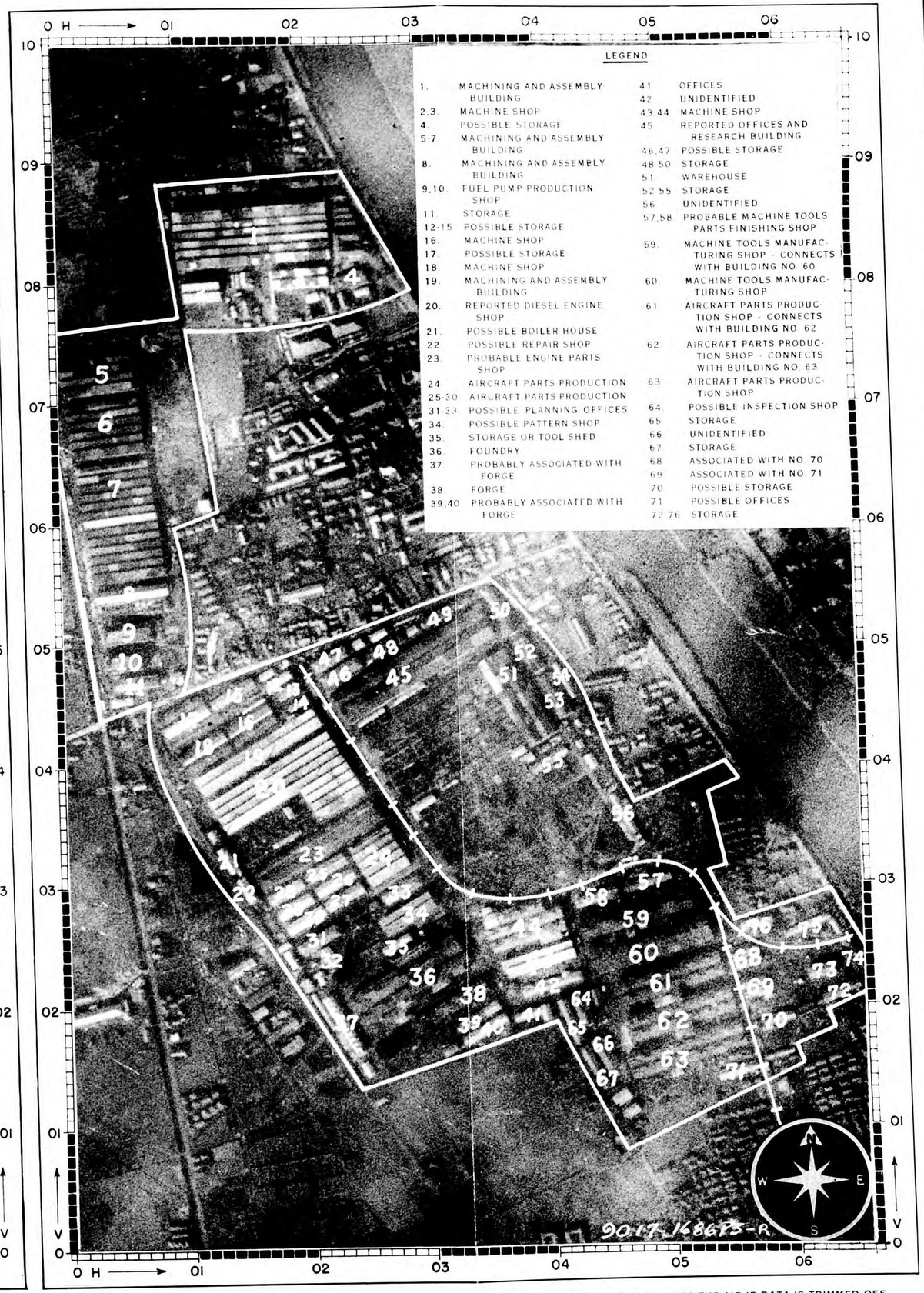

LEGEND

1.	MACHINING AND ASSEMBLY BUILDING
2,3.	MACHINE SHOP
4.	POSSIBLE STORAGE
5-7.	MACHINING AND ASSEMBLY BUILDING
8.	MACHINING AND ASSEMBLY BUILDING
9,10.	FUEL PUMP PRODUCTION SHOP
11.	STORAGE
12-15.	POSSIBLE STORAGE
16.	MACHINE SHOP
17.	POSSIBLE STORAGE
18.	MACHINE SHOP
19.	MACHINING AND ASSEMBLY BUILDING
20.	REPORTED DIESEL ENGINE SHOP
21.	POSSIBLE BOILER HOUSE
22.	POSSIBLE REPAIR SHOP
23.	PROBABLE ENGINE PARTS SHOP
24.	AIRCRAFT PARTS PRODUCTION
25-30.	AIRCRAFT PARTS PRODUCTION
31-33.	POSSIBLE PLANNING OFFICES
34.	POSSIBLE PATTERN SHOP
35.	STORAGE OR TOOL SHED
36.	FOUNDRY
37.	PROBABLY ASSOCIATED WITH FORGE
38.	FORGE
39,40.	PROBABLY ASSOCIATED WITH FORGE
41.	OFFICES
42.	UNIDENTIFIED
43,44.	MACHINE SHOP
45.	REPORTED OFFICES AND RESEARCH BUILDING
46,47.	POSSIBLE STORAGE
48-50.	STORAGE
51.	WAREHOUSE
52-55.	STORAGE
56.	UNIDENTIFIED
57,58.	PROBABLE MACHINE TOOLS PARTS FINISHING SHOP
59.	MACHINE TOOLS MANUFACTURING SHOP - CONNECTS WITH BUILDING NO. 60
60.	MACHINE TOOLS MANUFACTURING SHOP
61.	AIRCRAFT PARTS PRODUCTION SHOP - CONNECTS WITH BUILDING NO. 62
62.	AIRCRAFT PARTS PRODUCTION SHOP - CONNECTS WITH BUILDING NO. 63
63.	AIRCRAFT PARTS PRODUCTION SHOP
64.	POSSIBLE INSPECTION SHOP
65.	STORAGE
66.	UNIDENTIFIED
67.	STORAGE
68.	ASSOCIATED WITH NO. 70
69.	ASSOCIATED WITH NO. 71
70.	POSSIBLE STORAGE
71.	POSSIBLE OFFICES
72-76.	STORAGE

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Sheet No. 90.20-254-TI
Date 3 Jan. 1945
Page No. 1 (2 pages)

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

Obj. Folder 90.20
Obj. Area 90.20
AAF Target No. 90.20-254

Place Nagoya
Category Machine Tools/ Electrical Equipment

Lat.: 35° 11'N
Long: 136° 57'E
Alt.: 40 feet

NAME OF TARGET MITSUBISHI ELECTRIC MFG. CO.

ALL PREVIOUS SHEETS CANCELLED

SIGNIFICANCE

One of leading Japanese producers of light electrical equipment and a key components producer for Nagoya's aircraft and munitions industries. Production is known to include electric motors up to 100 HP, ground radios, and items of aircraft equipment including small motors, lights, switches, voltammeters, fuel pumps, switch boxes, junction boxes, fuse boxes, and rheostats.

Since 1937 this plant has gone increasingly into the production of machine tools. It specializes in turret lathes and horizontal grinders by government order.

LOCATION

In the NE part of Nagoya city about 1.75 miles E of Nagoya Castle and 6 miles N by E of Nagoya Harbor piers (TARGET 90.20-251). The Mitsubishi Aircraft Engine Works (TARGET 90.20-193) is about 1000 feet to the E: the Chigusa Factory, Nagoya Arsenal (TARGET 90.20-196) is about 1800 feet to the S. The Shonai River, making its northern loop around the city, is about 2600 feet NNE at its nearest point. The compound is bounded on the W by a small yard of the Chuo RR line, and on the N and E by a wide main roadway. The target is in a densely built-up area.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 90.20-254 P3). The total target area is about 2200 x 1600 feet, roughly rectangular in shape with the major axis lying in a N-S direction. The area is compactly built. Manufacturing activities are in the central and eastern section of the compound. A central assembly point is believed housed in the large 600 x 275 foot building 3 at the SE corner. Storage and shipment facilities are in the NW section, N of building 30. RR spurs enter the compound from the Chuo line on the W.

CONSTRUCTION & VULNERABILITY

(Refer to Illustration No. 90.20-254 P3). The plant consists almost entirely of large one-story buildings, steel framed, 20 feet (or less) high to eaves, with exterior walls more than half glass, and with short-span saw-tooth roofs probably surfaced with corrugated steel or asbestos. Principal exceptions: roof of building 3 has normal to long spans (indicated by exposed-chord trusses); and two-thirds of roof of building 6 is flat, probably reinforced concrete, though known to be supported on open steel trusses and columns.

PRIMARY OBJECTIVES

(Refer to Illustration No. 90.20-254 P3). Building 3, believed to be the central assembly point. Following this, the 7 machine shops are all of about equal importance.

WEAPON RECOMMENDATIONS

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

A combined attack with high explosive and incendiary weapons is recommended, with H.E. as the major bomb. A preliminary structural

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and occupancy analysis of the plant indicates that the following weapons will be most effective:

AN-M64 500-lb G.P. bomb, fuzed 0.1 sec. nose/0.01 sec. tail*.
AN-M50 4-lb (in M17 clusters) or AN-M47 70-lb incendiary bomb.

*(If M 139 nose fuzes, 0.01 sec. delay, are available, they should be used in place of the AN-M103, set for 0.1 sec. delay.)

Weight for weight, the 500-lb G.P. bomb will be the most effective against this target, as most of the principal buildings are one-story, short to normal span and not subject to spreading collapse. The 0.01 sec. fuzing will cause the bomb to burst 6 to 10 feet beneath the roof, thus damaging the machines as well as the structures.

The buildings are in a compact group, and the numerous fire divisions are reasonably large. Thus, multiple hits will be obtained in each fire division with the 4 or 70-lb incendiaries.

LEVEL OF DAMAGE

CAMOUFLAGE, DECOYS AND SMOKE SCREENS

Photography of 23 November 1944 shows some attempted camouflage in the form of white rectangles painted on darker surfaces. Dazzle painting has been used on a few small buildings. There is no evidence of decoys and no use of smoke screens has been reported.

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JOINT TARGET GROUP • WASHINGTON, D. C.

TARGET No. 90.20–254

MITSUBISHI ELECTRIC MFG. CO.
NAGOYA, JAPAN

ILLUSTRATION No. 90.20–254 P1

COORDINATES 35° 11′ N 136° 57′ E

PHOTOGRAPHED 23 NOVEMBER 1944

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

ISSUED 18 JANUARY 1945

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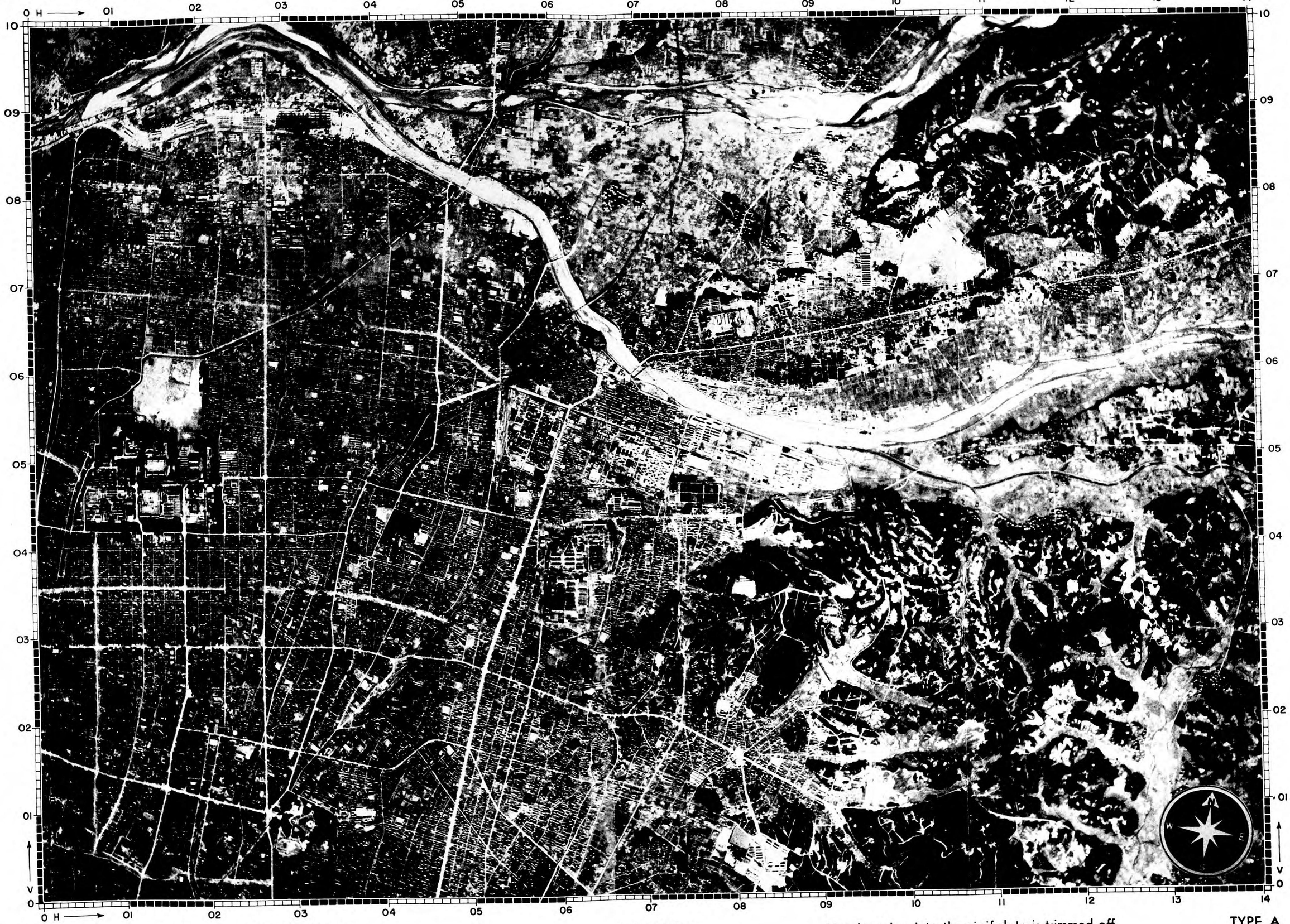

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TYPE A

JOINT TARGET GROUP • WASHINGTON, D. C.

TARGET No. 90.20–254

COORDINATES 35° 11′ N 136° 57′ E

PHOTOGRAPHED 23 NOVEMBER 1944

MITSUBISHI ELECTRIC MFG. CO.
NAGOYA, JAPAN

0 2000 4000 6000 FEET

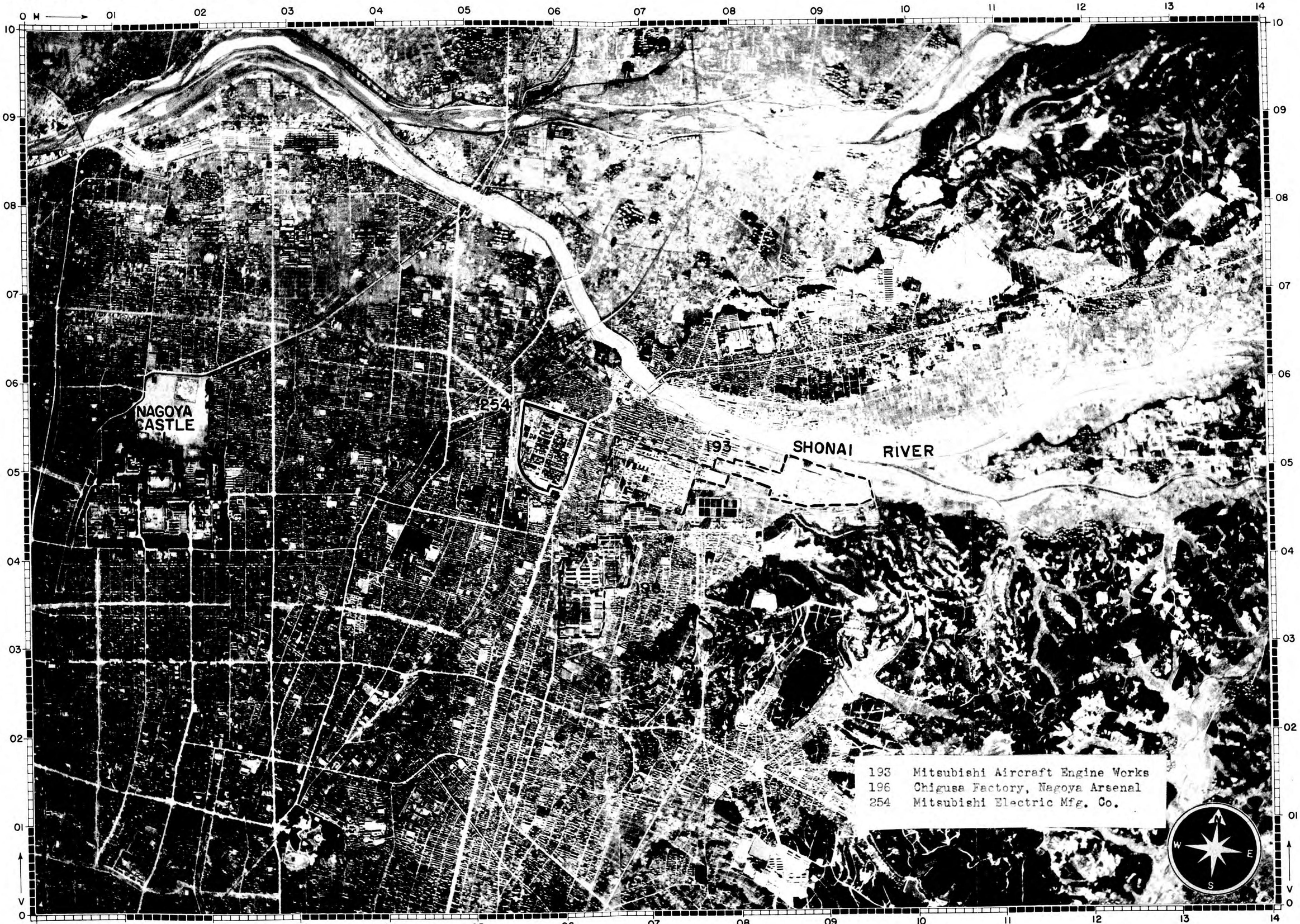
0 ½ 1 MILE

1:32 000 APPROX.

ILLUSTRATION No. 90.20–254 P2

ISSUED 18 JANUARY 1945

RESTRICTED



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TYPE A

JOINT TARGET GROUP • WASHINGTON, D. C.

TARGET No. 90.20–254

COORDINATES 35° 11′ N 136° 57′ E

PHOTOGRAPHED 23 NOVEMBER 1944

MITSUBISHI ELECTRIC MFG. CO.
NAGOYA, JAPAN

ILLUSTRATION No. 90.20–254 P3

ISSUED 18 JANUARY 1945

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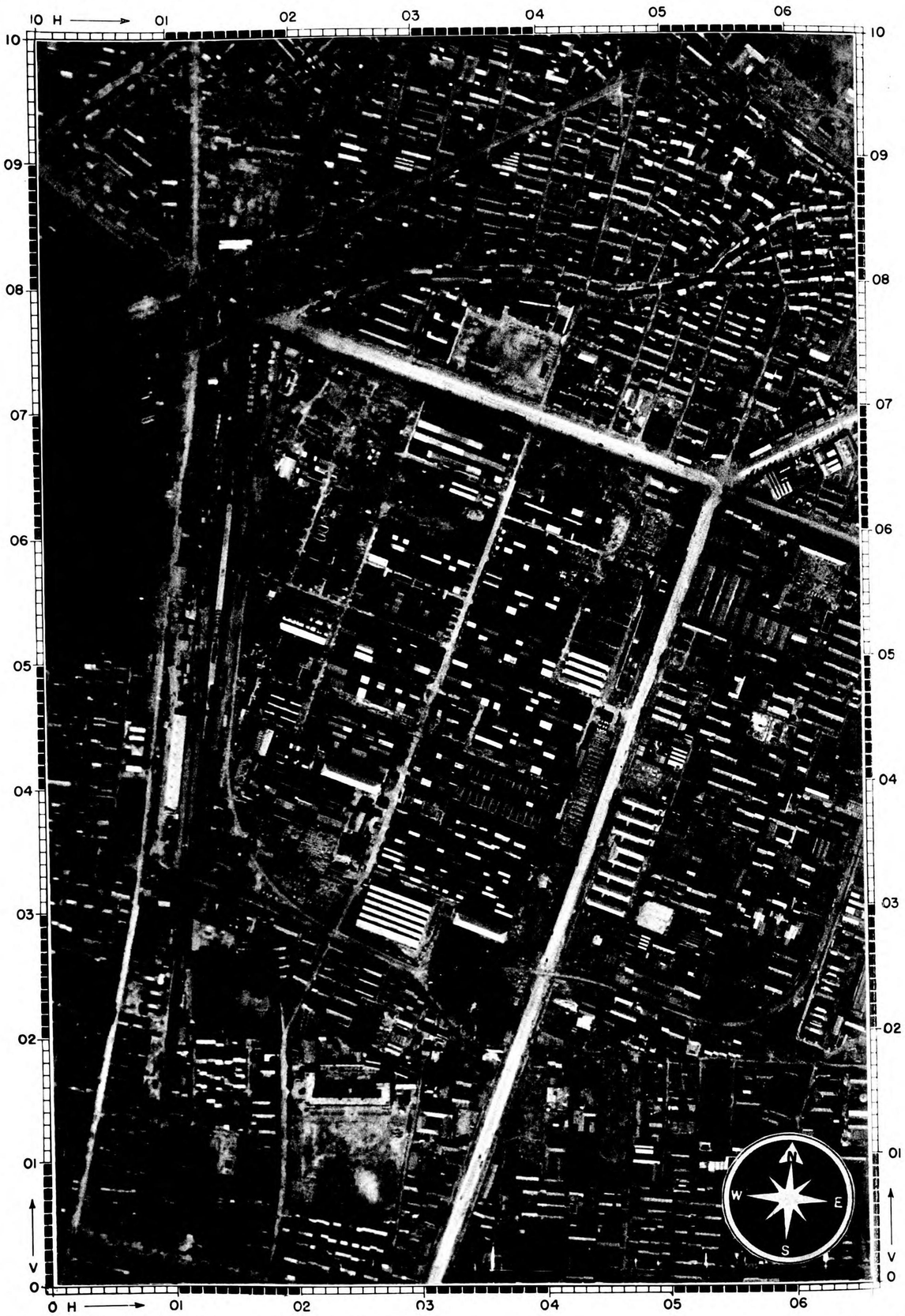
0 500 1000 1500 2000 2500 3000 FEET

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



LEGEND

3. Assembly Shop
6. Machine Shop
8. Probable Machine Shop
9. Boiler House
10. Probable Machine Shop
12. Probable Machine Shop
13. Machine Shop
15. Foundry
18. Machine Shop
22. Machine Shop
26. Foundry Building
30. Boiler House

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TYPE B

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

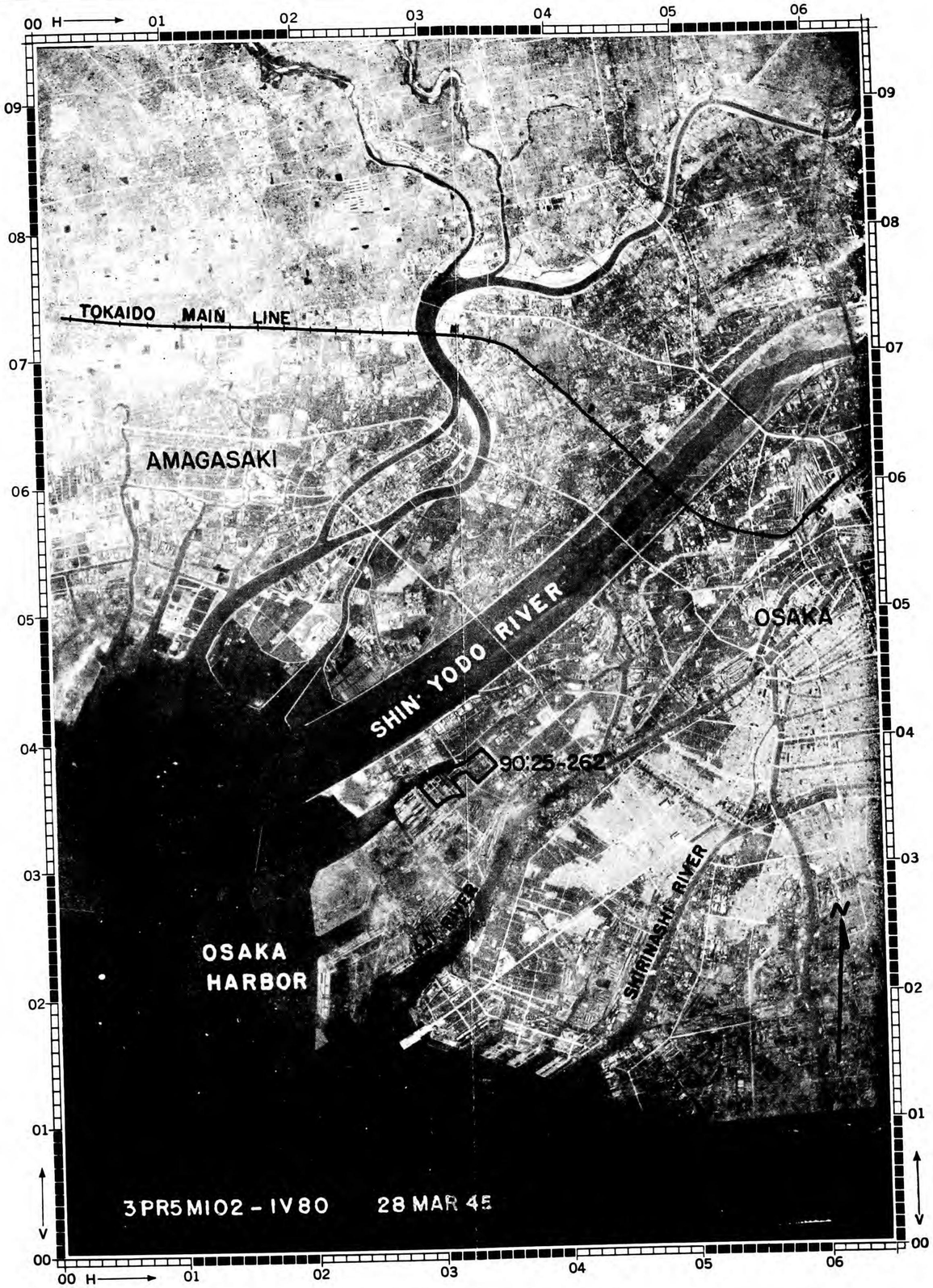
SUMITOMO ELECTRIC INDUSTRIES CO.
OSAKA JAPAN

SHEET No. .....90.25-262—TL
DATE.....22 May 1945
TARGET No. 90.25-262
CATEGORY.....Bsc. Eqpt. Ind.—Machy. and Mach. Tools
COORDINATES ....34°40'N 135°26'E
ALTITUDE .....20 feet

SIGNIFICANCE:

The leading producer of electric wire and cable. Its pre-war production of insulated wire and cable is estimated at 25% of the Japanese total. Area "B" is a recent expansion believed to be making electrical equipment.

LARGE SCALE ILLUSTRATION—SCALE APPROX.: 1:9,300



SMALL SCALE ILLUSTRATION—SCALE APPROX.: 1:64,000

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

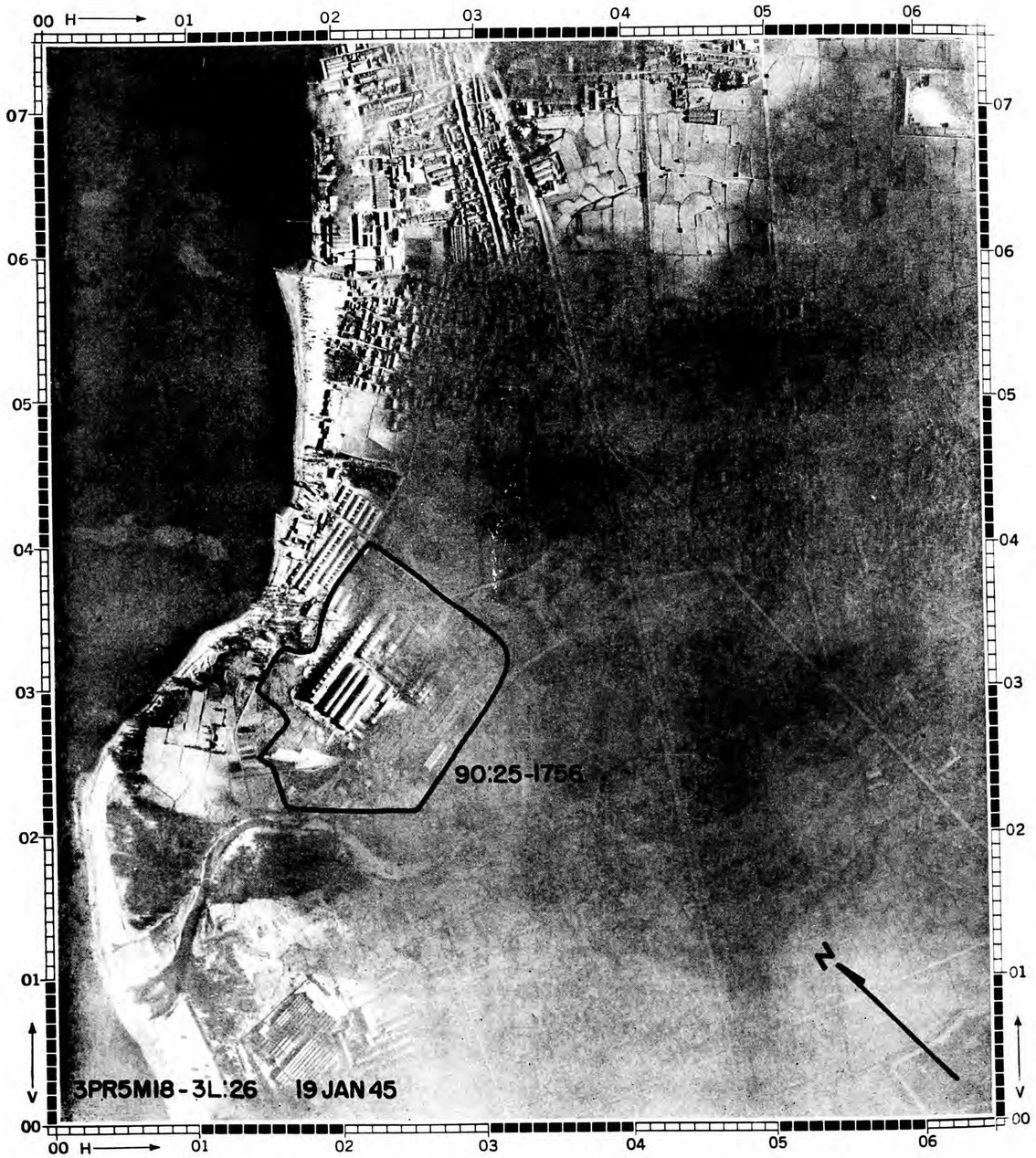
ORIENTAL CABLE CO.

KA , HONSHU JAPAN

SHEET No. .....90.25-1756—TL
DATE.....23 May 1945
TARGET No. 90.25-1756
CATEGORY.....Bsc. Eqpt. Ind.—Machy. and Mach. Tools
COORDINATES ....34°26'N 135°21'E
ALTITUDE .....30 feet

SIGNIFICANCE:

A producer of all kinds of wire and cable. Believed to be of medium importance.



LARGE SCALE ILLUSTRATION—SCALE APPROX.: 1:9,300

SMALL SCALE ILLUSTRATION—SCALE APPROX.: 1:62,000

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

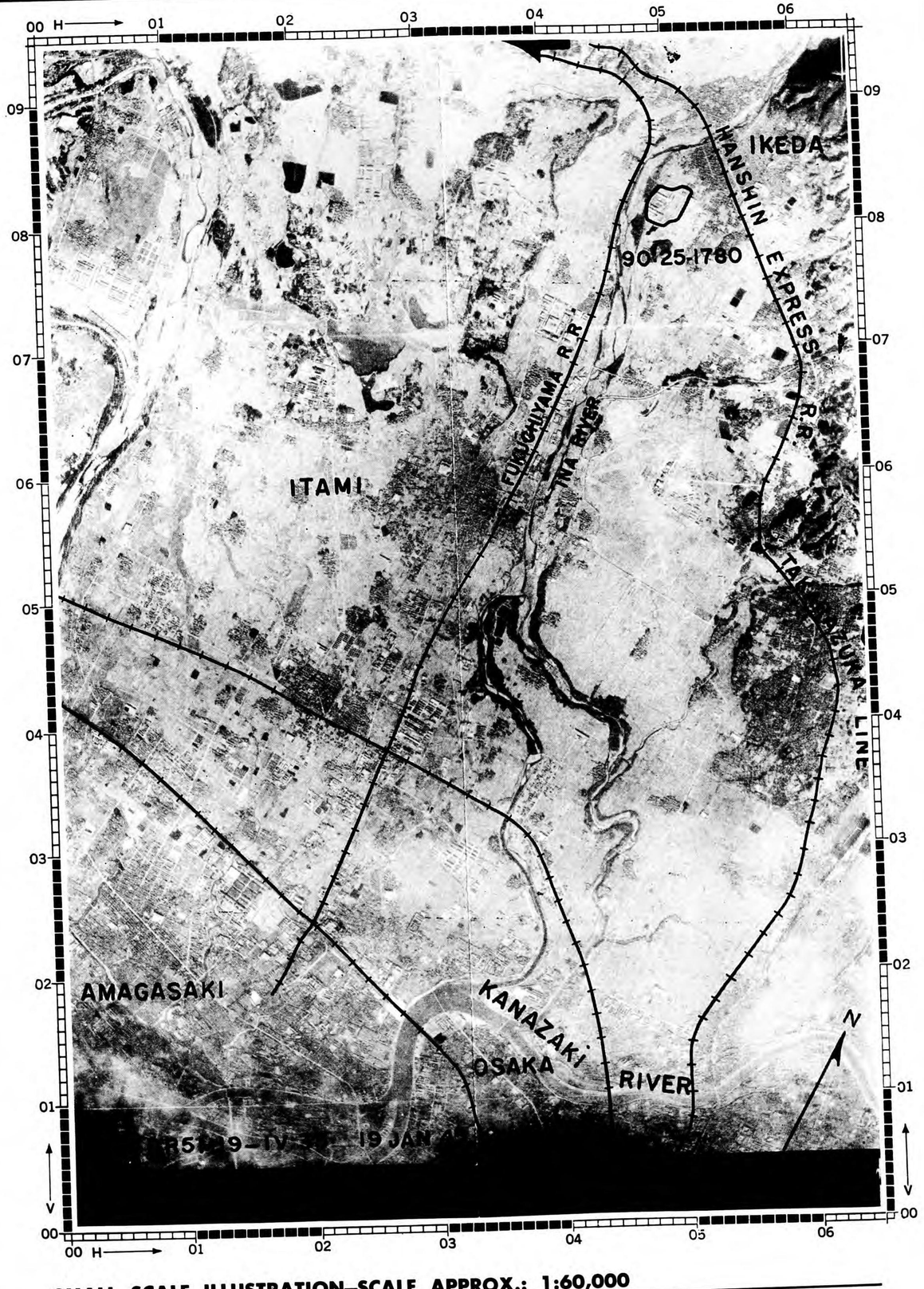
OSA[illegible] MACHINERY COMPANY
ITAM[illegible] JAPAN

SHEET . . . . . 90:25-1780—TL
DATE . . . . . 2 June 1945
TARGET 90:25-1780
CATEGORY
Bsc. Eqpt. Ind.—MACHY & MACH TOOLS
COORDINATES . . . . . 34°49'N 135°25'E
ALTITUDE . . . . . 65 feet

SIGNIFICANCE:

Machine tool producer of medium importance. Makes chiefly milling machines and special precision lathes. Also internal boring machines, drill presses, shapers and slotters. Supplies aircraft and ordnance industries in Osaka region.

LARGE SCALE ILLUSTRATION—SCALE APPROX.: 1:15,000



SMALL SCALE ILLUSTRATION—SCALE APPROX.: 1:60,000

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File No. 662,780.1

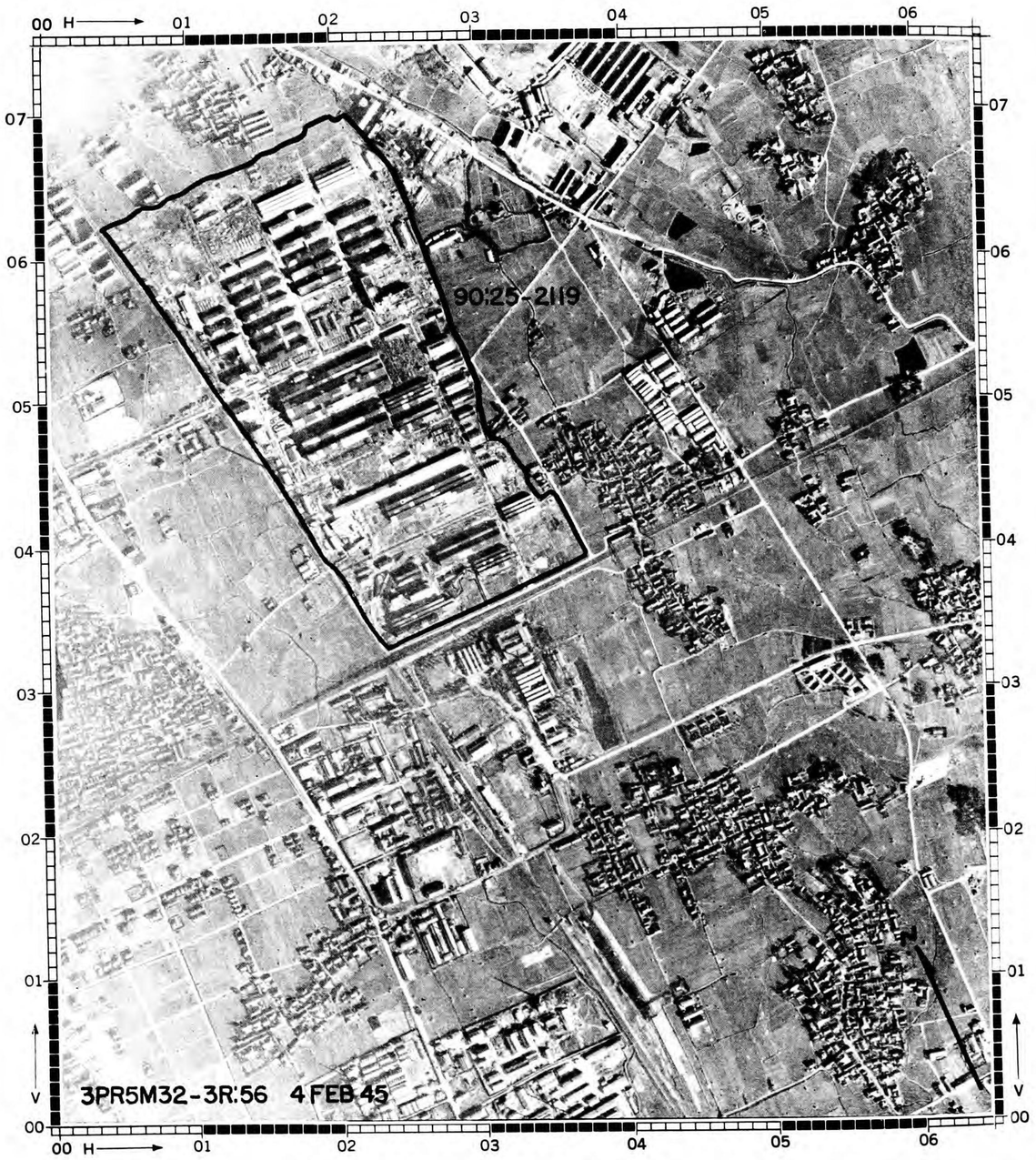
JOINT TARGET GROUP, WASHINGTON, D. C.
TARGET LOCATION SHEET

MITSUBISHI ELECTRIC CO., ITAMI PLANT
AMAGASAKI JAPAN

SHEET No. .....90.25-2119—TL
DATE.....22 May 1945
TARGET No. 90.25-2119
CATEGORY.....Bsc. Eqpt. Ind.—Machy. and Mach. Tools
COORDINATES ....34°45'N 135°26'E
ALTITUDE .....20 feet

SIGNIFICANCE:

This is a new plant of one of the three major Japanese producers of electrical equipment. It is believed important for production of heavy equipment. No specific information on products has yet been obtained.



LARGE SCALE ILLUSTRATION—SCALE APPROX.: 1:10,800

SMALL SCALE ILLUSTRATION—SCALE APPROX.: 1:61,000

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

YA[illegible]UK[illegible]WA ELECTRIC MFG. CO.
YAWATA JAPAN

SHEET No. 90.34-1126–TL
DATE. .....23 May 1945
TARGET No. 90.34-1126
CATEGORY .....Bsc. Eqpt. Ind.–
Machy. and Mach. Tools
COORDINATES ....33°52'N 130°46'E
ALTITUDE .....20 feet

SIGNIFICANCE:

Producer of both light and heavy electrical equipment. Reported to have important output of electric motors, mostly of small sizes. Also generators and magnetos. Produces principally for coal mines in the Yawata region.

LARGE SCALE ILLUSTRATION–SCALE APPROX.: 1:4,930

SMALL SCALE ILLUSTRATION–SCALE APPROX.: 1:59,200

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

SHEET No. . .93.3-164—TI
DATE. . . . .30 April 1945
PAGE 1

MANCHURIA MACHINE TOOL COMPANY

TARGET No. . . .93.3-164
OBJ. No. 93.3
OBJ. FOLDER No. . .93.1-5
CATEGORY . Bsc. Eqpt. Ind., Machine Tool Industy

MUKDEN MANCHURIA

LAT. . . . . .41°48'N
LONG. . . . . .123°28'E
ALT. . . . . .160 feet

SIGNIFICANCE

The most important Manchurian machine tool producer. It services the nearby aircraft and ordnance industries. Production is known to include lathes and milling machines, with an annual capacity of around 500 lathes. It is also variously reported to manufacture other types of machine tools, such as boring mills, gear cutters and grinders, and steam engines, boilers, and construction machinery.

Construction of the plant was started in 1939, with the backing of the adjacent Manchuria Iron Works (TARGET 93.3-166). Poor construction work and materials caused many difficulties, and for at least the first year and one-half both quality and quantity were very low. Present quality is unknown.

LOCATION

(Refer to Illustration No. 93.3-164 P2). This plant is part of a target complex which includes the Mukden Arsenal (TARGET 93.3-46) to the S and SE, its subsidiary Manchuria Iron Works (TARGET 93.3-166) adjacent on the S and SW, and the Manchuria Airplane Mfg. Co., Plant No. 1 (TARGET 93.3-177) at the E end of the arsenal. It is situated in the eastern suburbs of Mukden approximately 4600 feet E of the edge of the old walled city. The Hun River flowing generally NE-SW lies to the S and E with its nearest point about 2.4 miles SE; a tributary of the Hun passes near the N edge of the compound. The target is bounded on the NW by the Mukden-Fushun highway; a RR spur from the Mukden-Kirin line to the arsenal passes on the W. The target is on the eastern edge of the Mukden built-up area.

DESCRIPTION AND LAYOUT

(Refer to Illustration No. 93.3-164 P3/1). The target area is irregular in shape measuring about 1650 feet N-S and varying from 1250 feet to 1750 feet E-W. The SW corner of the compound is occupied by a large foundry and pattern shop layout (buildings 2-4, 6, 7, 15). Buildings 11-14, N-S through the center, are the main machine shops with assembly taking place in one or more of buildings 11-13, each measuring about 325 x 200 feet. A boiler house (17) and an adjacent small standby power plant (16) are at the center of the S edge.

PRIMARY OBJECTIVES

(Refer to Illustration No. 93.3-164 P3/1). The main shop buildings Nos. 11-13, followed by the smaller shop No. 14.

CONSTRUCTION AND VULNERABILITY

(Refer to Illustration No. 93.3-164 P3/1). Buildings are short to medium span, one story structures with double pitch roofs. Most structures have roof lighting either by monitors or by upward extension of a portion of one side of the roof to form an apparent sawtooth roof. Roofs are of corrugated iron on horizontal wood timbers and rafters over steel trusses. Major buildings are fully framed in steel or concrete with masonry panel walls; minor buildings have brick bearing walls.

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 would be most effective:

AN-M64 500-lb GP, fuzed 0.01 sec. nose/Non delay tail (if 0.01 sec. nose fuzes unavailable, 0.1 sec. fuzing should be used).

AN-M47 70-lb incendiary.

Against short to medium span buildings, the 500-lb bomb will cause more structural damage than larger GP's. The 0.01 sec. fuzing gives the best chance of detonating the bomb beneath the roof and thus damaging machines as well as the structure. Explosion of the bomb under the roof can be expected to create considerable damage to the spans and increase the likelihood of roof collapse.

Experience has shown that on targets in which fire divisions are compactly arranged and the combustibility of contents is relatively low, the AN-M47 is the most effective bomb. The height of the primary buildings also makes the 70-lb bomb a better choice than other incendiaries. Some additional fire damage also can be expected from the effects of HE bombs, especially as the important buildings have combustible roof timbers and rafters.

CAMOUFLAGE, DECOYS, AND SMOKE SCREENS

Photography of 13 December 1944 shows no use of camouflage painting or of decoys. Smoke screens were used at adjacent airplane plant and arsenal during attack of 7 December 1944.

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

TOGAMI ELECTRIC WORKS
SAGA JAPAN

SHEET No. 90.35-1259–TL
DATE.....23 May 1945
TARGET No. 90.35-1259
CATEGORY.....Bsc. Eqpt. Ind.–
Machy. and Mach. Tools
COORDINATES ....33°16'N 130°18'E
ALTITUDE .....25 feet

SIGNIFICANCE:

Heavy electrical equipment plant of medium importance producing automatic switches, switchboards and power plant equipment. It is reported to be making electrical apparatus for the Navy.

LARGE SCALE ILLUSTRATION–SCALE APPROX.: 1:9,000

SMALL SCALE ILLUSTRATION–SCALE APPROX.: 1:60,000

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TARGET NO. 93.3- 164

APPROX. COORDINATES 41° 48'N 123°28'E

PHOTOGRAPHED 19 JUNE 1944

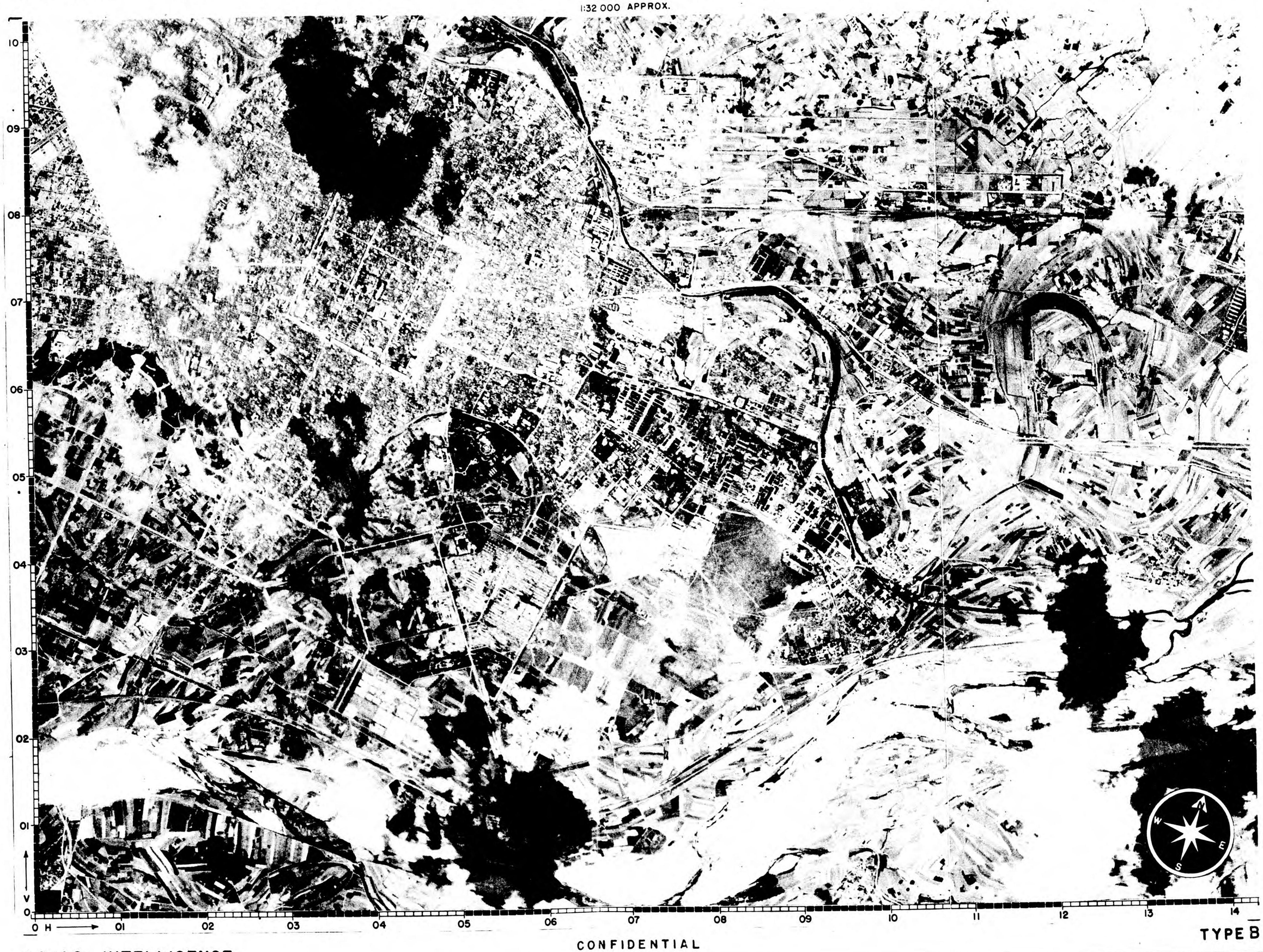
MANCHURIA MACHINE TOOL CO.
MUKDEN MANCHURIA

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

ILLUSTRATION NO. 93.3-164 PI

30 AUGUST 1944

CONFIDENTIAL



TYPE B

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TARGET NO. 93.3- 164

APPROX. COORDINATES 41° 48'N 123°28'E

PHOTOGRAPHED 19 JUNE 1944

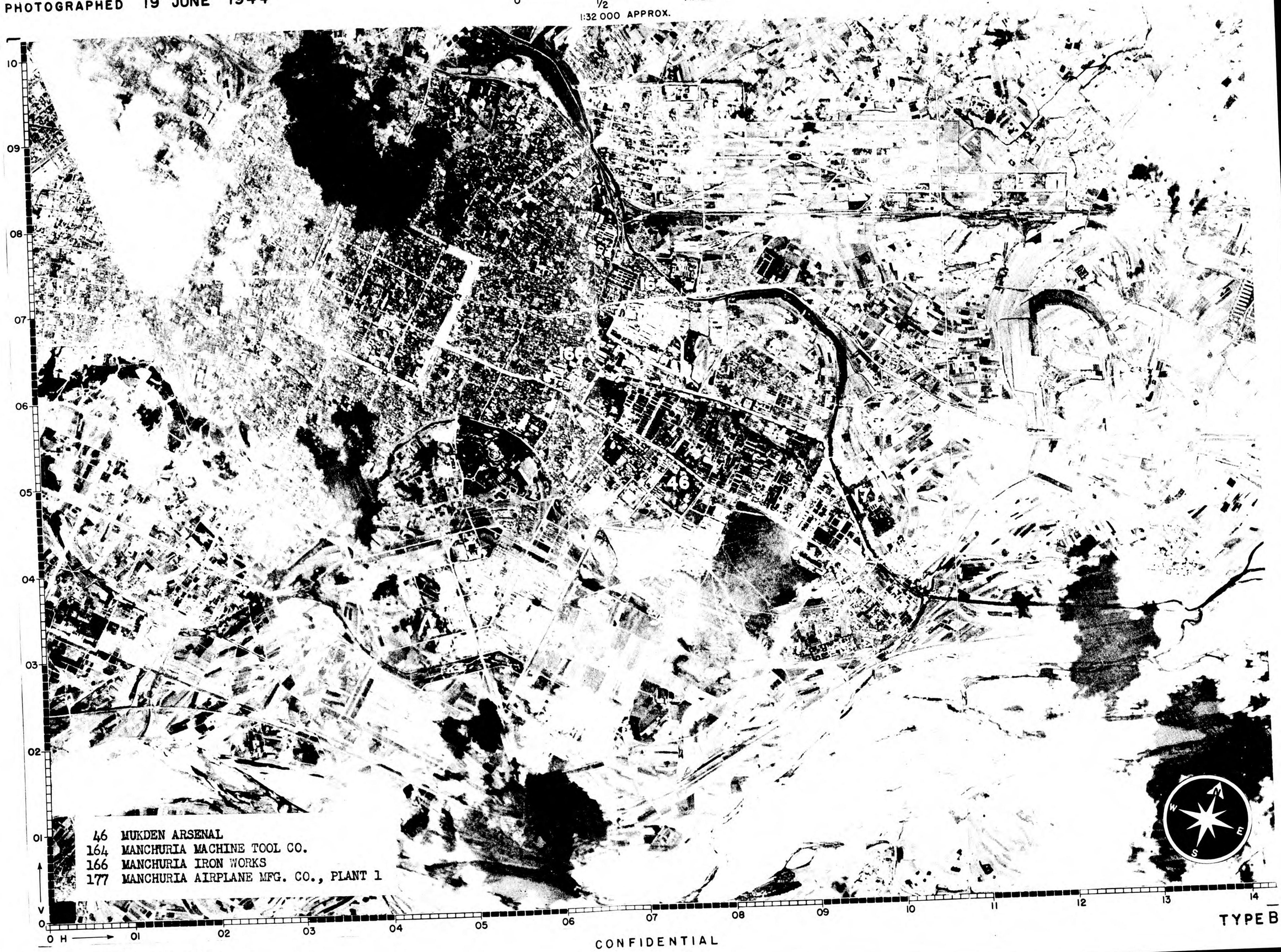
MANCHURIA MACHINE TOOL CO.
MUKDEN MANCHURIA

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

ILLUSTRATION NO. 93.3-164 P2

30 AUGUST 1944

CONFIDENTIAL



TYPE B

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APPROX. COORDINATES 41° 48' N 123° 28' E

PHOTOGRAPHED 19 JUNE 1944

MUKDEN MANCHURIA

0 500 1000 1500 2000 2500 3000 FEET

0 1/4 1/2 MILE

1:6000 APPROX.

30 AUGUST 1944

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BOILER HOUSE 1
PATTERN & MOULDING SHOPS 2, 3, 4
FORGE & FOUNDRY 5, 6, 7
POWER HOUSE 8
PROBABLE HEAT TREATING 9
SHOPS 10, 11, 12, 13
GARAGE 14
PROBABLE MACHINE SHOP 15
STORAGE BUILDINGS 16
LIGHT INDUSTRIAL GROUP 17

TYPE B

NOT TO BE TAKEN INTO AIR

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Total	= 157	
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Date 30 January 1945

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