General Analysis

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Typical Japanese Military Targets

GENERAL ANALYSIS

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By Authority of
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JOINT TARGET GROUP
WASHINGTON, D. C.

FOREWORD

Air attacks on military targets must generally be planned on the spot. This folder is intended to furnish assistance for such planning. Consequently, recommendations are given for attacks of typical, rather than specific targets.

The recommendations are based on the information at present available from operations in all theaters, on the results of trials and experiments at proving grounds and other research centers, and on analysis of the characteristics of typical Japanese targets. As more information becomes available, necessary revisions in recommendations will be made and distributed to the holders of this folder.

Present plans contemplate consideration of the following targets:

- Airfields and installations.
- Guns, in open and protected.
- Ammunition and fuel storage.
- Supply depots.
- Mine fields.
- Personnel.

The recommendations on airfields and installations are included in the initial folder (part 1). Papers on the other targets will be issued as addenda.

All recommendations for the attack of airfields and installations with currently available weapons are stated in the Summary of the Airfields paper. The detailed sections of the paper and the appendices are included for Operations Analysis Sections, Air Ordnance officers, and others interested in the technical basis of the recommendations.

JOINT TARGET GROUP, WASHINGTON, D. C.

GENERAL ANALYSIS

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HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS

PUBLISHED IN OFFICE OF AC/AS INTELLIGENCE, A. A. F., BY COMBINED PERSONNEL OF U. S. AND BRITISH SERVICES FOR THE USE OF ALLIED FORCES

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Part I: AIR ATTACK OF JAPANESE AIRFIELDS

I. CONCLUSIONS

A. GENERAL

Weapon selection and target selection for the attack of Japanese airfields will depend upon the aim of the mission. Generally this is neutralization of the enemy's air power. Each specific attack must have a definite aim and this should be clearly defined.

The aim of a specific mission may be *temporary neutralization* of the airfield for a short period of time, or *sustained neutralization* over a longer period of time. The choice of weapons and targets will be determined by this specific aim.

For *temporary neutralization* the chief targets are the grounded aircraft and the landing areas.

For *sustained neutralization* the list of targets is extended to include, in addition to the above, hangars, repair facilities, storage facilities, and auxiliary installations.

B. TEMPORARY NEUTRALIZATION

1. Weapon Recommendations.

The primary objectives for temporary neutralization are grounded aircraft and landing areas. No other airfield installations (hangars, ammunition and fuel dumps, etc.) are of sufficient importance in this type of attack to recommend any particular weapons which may be more effective against them than those weapons selected as the most effective against landing areas and grounded aircraft. Damage achieved to these subsidiary installations may be considered as merely bonus. Grounded aircraft are best attacked by strafing with fighter aircraft. Where this is not operationally possible, bombing with high explosive bombs to give fragment damage is most effective. Landing areas are best attacked with high explosive cratering bombs.

TABLE 1.—*Weapon recommendations*

Target	Bomb	Nose fuze	Tail fuze
Aircraft in the open or in uncovered revetments.	20-pound F. (AN-M41).	Inst.	
Aircraft in covered revetments.	100-pound G. P.[1] (AN-M30).	0.01 if available or 0.1 sec.	0.01 sec.
Landing areas	100-pound G. P.[2] (AN-M30).	0.1 sec.	0.025 sec.

[1] The 100-pound G. P. bomb (AN-M30) will theoretically perforate 2 feet of 4,000 p. s. i. reinforced concrete when dropped from 20,000 feet altitude (striking velocity 860 f/s). However there is a high probability that the bomb will break up on 4,000 p. s. i. reinforced concrete slabs of thickness greater than 1 foot when released from altitudes over 4,000 feet.

[2] The 100-pound G. P. bomb (AN-M30) may break up if the thickness of concrete paving is 6 inches or more. The 250-pound G. P. bomb (AN-M57) is recommended for paved runways of thickness greater than 6 inches (rarely found in Japan).

2. Force Requirements.

The weight of attack required to accomplish temporary neutralization will depend on the area of the airfield and the portion under attack. Since there are considerable variations in size, individual estimates must be made for each target. These can be made by using as a basis the quantities given in tables 2 and 3 for an airdrome area equal to 10 million square feet (2,000 by 5,000 feet for instance). These give the total weight to be delivered to the target. Total weight to be dispatched must be determined in the field from known operational conditions peculiar to each unit.

Load requirements to damage or destroy grounded aircraft in the open, with the desired level of damage are given in table 2. An upper and a lower limit are given and it is believed that the required weight will fall between these two limits. (See appendix A for assumptions and computations.)

Load requirements for cratering landing areas sufficiently to destroy all possible strips usable by fighter aircraft are difficult to determine with any degree of certainty. Operational experience is the most reliable basis, but little exists, unfortunately. An analytical means of obtaining approximate requirements can be based on the assumption that all usable strips are parallel to each other; this is a reasonable assumption for long, narrow landing areas. The degree of temporary neutralization depends mainly on the number of bombs dropped, and only slightly on their size (provided they are large enough to perforate any surface layer), since for temporary neutralization, time of repair is usually a secondary consideration. Table 3 gives recommended numbers of bombs per 10,000,000

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TABLE 2.—*Fragment damage by H. E. bombs to grounded A/C*

Expected proportion A/C damage	Total weight required in tons for target area 10,000,000 square feet of target									
	Lower limit (4 fragment perforations 100 square feet)					Upper limit (7 fragment perforations 100 square feet)				
	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.
0.10	1.2	2.5	2.0	4.0	4.0	2.0	4.0	2.5	5.5	5.5
.20	2.5	5.0	4.0	8.0	8.5	4.0	8.5	5.5	12.0	12.0
.30	4.0	8.0	6.0	12.0	14.0	6.5	13.5	9.0	20.0	20.0
.40	5.5	12.0	9.0	18.0	20.0	10.0	20.0	12.5	27.0	27.0
.50	8.0	16.0	12.0	25.0	27.0	13.0	27.0	18.0	37.0	37.0
.60	10.0	20.0	15.0	32.0	35.0	17.0	35.0	24.0	50.0	50.0
.70	13.0	27.0	20.0	42.0	48.0	22.0	46.0	30.0	64.0	64.0
.80	18.0	36.0	27.0	55.0	62.0	32.0	61.0	40.0	86.0	86.0
.90	25.0	52.0	39.0	80.0	88.0	42.0	88.0	57.0	125.0	125.0

square feet dropped at random within target area for achieving temporary neutralization of fighter strips.

TABLE 3.—*Number of cratering bombs per 10,000,000 square feet for temporary neutralization of landing areas*

Absolute minimum (operational data)	200
Recommended minimum (operational data)	350
Minimum for 50 percent probability of success (theoretical)	450

3. Delay of Repairs.

To discourage and interfere with the filling of craters and other repair work in addition to damaging grounded A/C, it is recommended that Butterfly bombs (M83) and long delay G. P. bombs be used against airfields. These would be particularly effective if dropped just before dark to halt repair work during the night. It is also believed that night fighters carrying out small night raids would discourage repair work.

It is recommended that 10 percent of the total load carried be composed of Butterfly bombs fuzed delay and antidisturbance and that 5 percent of the total load be 100-pound G. P.'s fuzed long delay in equal numbers at 2, 6, 12, and 24 hours.

C. SUSTAINED NEUTRALIZATION

1. Grounded Aircraft and Landing Areas.

The most effective weapons against these two targets are those recommended for temporary neutralization. Whereas grounded A/C are always an important target, landing areas are not a worth-while target unless they are bombed often enough to keep them inoperative.

2. Hangars and Repair Buildings.

In the attack on these installations it is generally agreed that the primary object is to destroy their contents. Experience has shown that high-explosive weapons are most effective against hangars (unless the hangars themselves are of combustible construction), and incendiary weapons are most often effective against repair facilities.

The most destructive effects of H. E. bombs to hangars, repair facilities, and their contents are blast and fragmentation. H. E. bombs may also start fires in hangars by fragment penetration of fuel tanks in the aircraft. Contents may best be destroyed by H. E. bombs which explode above or beside them, or by bringing the structure down upon them. Experience has shown that small H. E. bombs (containing less than 200 pounds of explosives) do less damage per unit weight to structures and light machinery than larger bombs. Therefore, the 500-pound G. P. bomb is the smallest H. E. bomb that should be used. On the basis of available information, the 500-, 1,000-, and 2,000-pound G. P. bombs are very nearly equally effective, weight for weight, against these structures.

In order to fuze the G. P. bombs for maximum blast effect, account must be taken of European and Far Eastern experience which shows that only a small percentage (approximately 30 percent in Europe)[1] of the AN–M100 series tail fuzes are initiated by the light roofs of these structures. The recommended fuzing, where available, is 0.01 second nose/nondelay tail. Maximum blast and fragmentation damage will result whichever fuze initiates the bomb. An alternate fuzing is 0.1 second nose/nondelay tail. With this fuzing, if the tail fuze is activated by the roof, maximum structural damage results and if activated on the floor, very nearly maximum blast and fragmentation damage to contents results.

Incendiary bombs are recommended for the small repair shops and the larger repair shops of combustible construction. The AN–M50, 4-pound I. B. is recommended because of the greater chance of multiple hits required to start sustaining fires. Second choice is the AN–M47, 70-pound I. B. This will be particularly effective against the larger combustible structures if bombing techniques give a high degree of accuracy. The AN–M69, 6-pound I. B. is an effective alternate if the roofing is not heavier than corrugated iron or asbestos.

[1] See REN 396 and 405 "Target vulnerability notes reference data" (Ministry of Home Security).

TABLE 4.—*Weapon recommendations*

Target	Bomb	Nose fuze	Tail fuze
Hangars:			
Under 20,000 square feet.	500-pound G. P. (AN-M64).	0.01 second if available or 0.1.	Nondelay.
20,000 to 40,000 square feet.	1,000-pound G. P. (AN-M65).	do	Do.
Over 40,000 square feet.	2,000-pound G. P. (AN-M66).	do	Do.
Repair facilities:			
Hangar type	Same as for hangars.	Same as for hangars.	Same as for hangars.
Factory type:			
Wall bearing	4,000-pound L. C. (AN-M56).	Inst	Nondelay.
Steel framed	500-pound G. P. (AN-M64).	0.01 second or 0.1.	0.01 second.
Wood construction.	4-pound I. B. (AN-M50).		
Small shops	4-pound I. B. (AN-M50).		

3. Storage Facilities and Auxiliary installations.

Weapons recommended are listed in table 5. These are quite general and are to be taken merely as guides, since each target must be analyzed separately and in detail in order to determine the most effective weapon for an over-all attack.

TABLE 5.—*Weapon recommendations*

Target	Bomb	Nose fuze	Tail fuze
Fuel drums in the open.[1]	20-pound F	Inst	
Fuel tanks in the open.[1]	100-pound G. P	0.1 second	0.025 second.
Underground fuel storage.[1]	Smallest bomb that will penetrate.		
Ammunition in the open.[2]	20-pound F	Inst	
Ammunition underground.[2]	Smallest bomb that will penetrate.		
Spare parts	4-pound I. B. (AN-M50) alternate 6-pound I. B. (AN-M69).		
Food	do		
Administration buildings.	do		
Operations buildings	do		
Headquarters buildings.	do		
Barracks	do		
Mess halls	do		

[1] More complete discussion in section "Attack of fuel storage" of this folder.
[2] More complete discussion in section "Attack of ammunition storage" of this folder.

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS

II. INTRODUCTION

The aim of attack of airfields is the neutralization of the enemy's air power. This may be accomplished in a number of ways other than the attack of airfields. The other methods can be the destruction of the enemy's aircraft manufacturing and assembly facilities, the destruction of his sources of fuels and lubricants, etc. The tactical decision to attack the enemy's airfields will result from the need to neutralize his air power as a prerequisite for impending occupation of enemy held territory by our own ground forces, or when necessary to prevent the enemy from interfering with the movements of our supply forces or our strategic bombing operations on the enemy's military power.

Neutralization of the enemy's air power by attacking his airfields is difficult to accomplish, even for short periods, but it is possible. Recent reports from the Pacific Theater have indicated the need to accomplish neutralization with more certainty and less cost. The object of this report is to present the accumulated experience gathered from all parts of the world and to utilize this experience to establish the guiding principles needed to determine the most profitable methods and points for attack.

Most efficient destruction of the component parts of an enemy airfield will result from the proper choice of tactics and weapons. The *choice of tactics* will be governed by the conditions peculiar to the time and place of attack, and can best be *determined in the field*. It is the purpose of this report to indicate those tactics which have proven successful in all theaters of war so that this experience can be utilized to improve future operations. It is realized that in planning any particular attack the governing conditions will vary. This report can only suggest guiding principles.

Weapons recommended will be limited to those which are *immediately available in quantity* in the field. Other weapons, now available only in limited quantities, may become obtainable in greater amounts and restrictions on their employment lifted. An attempt will be made to assess their probable performance. Operational experience with these weapons is limited and therefore their probable performance can be based only on limited experimental experience and theoretical reasoning.

One outstanding fact, which has been established by experience in all theaters is the necessity for *sustained effort* if the airfield is to be kept out of action for more than a short period. Well-timed attacks, both day and night, at frequent but irregular intervals are essential to accomplish sustained neutralization. Spasmodic bombing is of little value.

The effect of repeated attacks in lowering the *efficiency and morale* of airfield personnel is attested to by experience drawn from all theaters of war. This effect can be an important factor in the neutralization of the enemy's air power, even when the actual physical damage is relatively small. This lowering of efficiency and morale from repeated attacks is intangible and difficult to evaluate. Experience to date does not indicate that it has been overestimated.

One of the chief aims of the attack of airfields is the *destruction of aircraft.* Aims which are usually secondary, such as the destruction of hangars, buildings, installations, bomb and fuel dumps, etc., may, in certain circumstances, form the primary object of the attack. It is the purpose of this report to present a structural analysis of the component parts of Japanese airfields and to indicate the effects of damage or destruction of these component parts upon the operation of aircraft and hence upon the strength of the enemy's air power.

For temporary neutralization of enemy airfields (a few hours to a few days at most) the two most important targets are *grounded aircraft* and *landing* areas. Experience has shown that it is easier to destroy aircraft on the ground than in aerial combat. Tactical surprise to catch the aircraft on the ground will pay dividends in planes destroyed. The relative importance of these two targets will be governed by the conditions peculiar to each airfield. Where the landing areas are restricted to paved or unpaved runways by the nature of the terrain, and alternate landing areas are not available, the importance of the runways as a target increases. It must be emphasized, however, that destruction of the landing area by cratering is extremely difficult to accomplish because of the great weight of bombs required to assure damage to all possible strips which can serve as runways. The ease with which runways can be repaired, even with limited mechanical equipment, does not make these desirable targets. Attack of landing areas is best accomplished at the beginning of the attack when it is desired to prevent the grounded aircraft from taking off for the balance of the raid. They are then vulnerable to attack from succeeding elements.

If *continued neutralization* is desired, the list of targets must include grounded aircraft, hangars, repair facilities, storage facilities, personnel facilities and defensive armament. The sustained effort required for continued neutralization must be emphasized.

III. TYPICAL JAPANESE AIRFIELD TARGETS

The following targets are typical of major airfields in Japan, Manchuria, Korea, China, and enemy-held islands of the Pacific.

a. Grounded aircraft.

b. Landing areas.

c. Hangars.

1. Simple truss structures (small, nearly square).
2. Arch type structures.
3. Long, continuous or multiple span structures.
4. Simple truss structures (large, long and narrow).

d. Repair facilities.

1. Hangar type structures.
2. Factory type structures.
3. Small repair shops.

e. Storage facilities.

1. Fuel and lubricants.
2. Ammunition.
3. Engine and airframe spare parts.
4. Food.
5. Dry goods.

f. Auxiliary installations.

1. Administration buildings.
2. Operations buildings.
3. Headquarters buildings.
4. Control towers.
5. Barracks.
6. Mess halls.
7. Taxiways.
8. Service aprons and hardstands.

NOTE.—Defensive armament (including A/A guns and auxiliary equipment) is not considered in this report since it is covered in discussion "Attack of guns" of this folder.

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IV. GROUNDED A/C

A. GENERAL

When the tactical decision has been made to render an airfield inoperative by damaging or destroying grounded aircraft, frequent attacks, both day and night, at irregular intervals, and opportunely timed (for example, when planes are being refueled) are essential if the airfield is to be kept out of action for more than a short period. Spasmodic attack has proven of little value whenever used. Attack of satellite airfields, concentrated in time, should be given due consideration in the over-all plan.

B. STRAFING ATTACK

In general, whenever operational conditions permit, *strafing is the most efficient method* of achieving damage or destruction to grounded aircraft. The great effectiveness of fighters and fighter/bombers in strafing attacks with machine guns (particularly with incendiary ammunition) and cannon has been proven by experience in all theaters of war. Operational evidence is not sufficiently complete to assess the effectiveness of air-borne rocket projectiles against grounded aircraft. Nevertheless, consideration should be given to their employment. The comparative accuracy of the air-borne rocket projectile at longer ranges, and the possible decreased risk to the launching aircraft because of this greater range, point to the possible advantages of this weapon.

C.-H.E. ATTACK

Damage or destruction of the grounded aircraft in the *open or in uncovered revetments with H. E. bombs* is accomplished primarily by projected bomb fragments. The 20-pound frag. bomb is most efficient (except for minimum altitude attacks) for this purpose. On a pound for pound basis its superiority is marked in that the total ground area that can be covered with fragments capable of effective damage to grounded aircraft is from one to three times that of any other H. E. bomb. The 20-pound frag. bomb is most effective when used from low to medium altitudes. From high altitudes an important percentage of effective fragments (perhaps up to 50 percent) is lost to usefulness because of the deeper penetration of the bomb into the ground before detonation, and because of the greater downward deflection of the fragments due to the greater vertical velocity of the bomb when the explosion occurs.

Comparative efficiencies of several H. E. bombs are given by the curves of Sheet ATSF/TMT/C5 in appendix A. These give the total weight of bombs required to damage or destroy the grounded aircraft with the desired degree of assurance. It is assumed that the target area covers 10,000,000 square feet and that all bombs are dropped at random within this area.

Where operational conditions permit its use from *minimum altitudes*, the 23-pound parafrag. bomb may be more efficient than the 20-pound frag. bomb. Because of a striking angle nearer to the vertical and a lower striking velocity, fragment density from the 23-pound parafrag. bomb may be as much as three times that of the 20-pound frag. bomb.

Where aircraft are in *uncovered revetments*, a hit (surface burst) within the revetment or at its mouth is required to damage or destroy the aircraft within. The greater probability of a hit within the revetment with the 20-pound frag. bomb follows from the greater number that can be carried per plane load. Operational evidence has shown that a 20-pound frag. bomb which lands inside a revetment up to 80 feet in width will effectively damage or destroy the aircraft within the revetment.

Neither present limited experimental evidence nor theoretical reasoning point to any superiority of the larger bombs *airburst* to the surface burst of an equivalent weight of 20-pound frag. bombs against aircraft in revetments. Although airburst will overcome shielding provided by natural ground contours or artificial revetments, the probability of damage or destruction to aircraft in revetments by a surface burst within the revetment with the 20-pound frag. bomb (for equal total loads) is still two or more times greater than for the larger bombs airburst at optimum height located over the target within effective range.

Grounded aircraft may be destroyed or effectively damaged by *debris* resulting from cratering. The vulnerable radius for damage from debris may be from two to four times the crater radius, depending upon the depth of penetration before detonation and the type of ground. Since, however, the effective ground area for debris damage is less than the effective ground area for fragment damage, this type of attack is not recommended when the primary target is grounded aircraft. Where the objective is neutralization of landing areas *and* damage to grounded aircraft, the successful cratering of the landing areas may be accompanied by considerable incidental damage to dispersed aircraft in the landing area, particularly if the debris is concrete or rock.

Where the attack is directed against aircraft in *covered revetments* (except in those cases where the covering acts merely as camouflage) the 20-pound frag. bomb (because of its instantaneous fuzing) will not penetrate the roof. The 100-pound G. P. bomb, fuzed 0.01-second delay, will be most effective. If the roof cover is heavy enough to preclude the use of the 100-pound G. P. bomb, attack of these targets is not profitable and neutralization of the airfield is best accomplished by attacks directed at other installations.

D. INCENDIARY ATTACK

Attack of grounded aircraft with *incendiary weapons* is generally not recommended. Incidental damage may be obtained when incendiary weapons are directed at other installations. Where low-level or minimum altitude attacks are operationally possible, consideration should be given to the employment of napalm bombs. There is insufficient operational evidence at present to draw any conclusions as to their comparative effectiveness.

V. LANDING AREAS

A. DESCRIPTION

Japanese landing areas are of two types. One is the long, narrow "landing strip" with adjacent areas of cleared and leveled ground. There may be one or more paved or unpaved runways whose orientation will be dependent upon the limitations of the terrain and the direction of the prevailing winds. The dimensions of the runways are determined by the type of aircraft using the airfield. Usually, runways for fighter aircraft will be about 100 to 200 feet in width and 3,000 to 3,500 feet in length. Runways for medium and heavy bombers will generally be 200 to 300 feet in width and 4,500 to 6,000 feet in length. The other type of landing area, known as a "landing ground," is a broad rectangular, triangular, or circular area which permits aircraft to take off or land in a variety of directions. It may have paved runways similar to those for landing strips or the entire area may be a cleared and leveled surface of grass, packed clay, or rolled earth.

The material used in surfacing the runway may be:

(1) concrete,
(2) asphalt,
(3) macadam,
(4) gravel,
(5) crushed stone,
(6) crushed coral,
(7) packed earth,
(8) grass (turfed or sodded).

Paving material used at any particular airfield can best be determined in the field from a knowledge of materials available, the amount and type of traffic, general climatic and geographic conditions, and any other intelligence information that may be obtainable. Many of the Japanese airfields do not have paved runways but there is a definite trend towards paving to provide all-weather fields. Information about the thickness of paving is limited, but in general it will be thinner than American paving. The thickness will vary with the nature of the subsurface material and the thickness of the base course. Concrete pavements are probably 4 to 6 inches thick, and asphalt paved runways (including base course) are probably 6 to 8 inches thick.

B. CRATERING ATTACK

Attacks on landing areas are intended to deny their use to enemy aircraft. This is accomplished by cratering the landing areas with high-explosive bombs, delay fuzed, to assure penetration into the ground before explosion. A successful attack requires a great weight of bombs, uniformly distributed over the area so that all possible strips in the area will be covered. In this connection it must be recognized that Japanese fighter aircraft require a comparatively small strip (50–75 feet in width and 1,500–2,000 feet in length) from which to operate. Because of the ease with which craters can be filled and the surface repaired, even with limited mechanical equipment, the airfield can be kept inoperative for only short periods. Even with extensive cratering, it is only necessary to make emergency repairs to the least cratered part of the landing area to enable aircraft to take off and land.

One successful attack on a landing area can be expected to keep the airfield unserviceable for only a limited number of hours. Where there are terrain restrictions upon the number of possible strips, a successful attack may keep the airfield out of operation for a longer period of time. Extensively bombed Japanese airfields which have been occupied by our forces have been put into service in an average time of 2 to 3 days, during which major repairs were made to various installations and repairs to runways were of a permanent nature.

Where surprise is an element of the attack, cratering of the landing area at the beginning of the strike will keep grounded aircraft on the ground and vulnerable to attack by succeeding elements of the attacking forces and will also minimize the possibilities of attack by air-borne fighters.

To insure effective surface damage to the landing area it is necessary for the bombs to be spread uniformly over the whole area. This is most easily accomplished by high-level pattern bombing. Cratering of the landing areas must be planned to do the greatest amount of damage to the surface area and/or to displace the largest volume of material. The decision as to which is more important must be based upon a knowledge of the ground structure and the surfacing material. In certain instances damage to the subsurface drainage system may necessitate major repairs; for this, large craters are required.

The effectiveness of H. E. bombs in cratering of soils depends upon (1) the type of soil, (2) depth of penetration of the bomb before detonation, (3) the type of bomb (i. e., its charge/weight ratio, etc.). Landing areas are commonly constructed on ground consisting of a compacted mixture of soils rather than only one specific soil. Available information (table 6) leads to the conclusion that the small G. P. bombs do more damage weight for weight. Damage is here defined to include both surface area destroyed and volume of material

TABLE 6.—*(from Div. 2, N. D. R. C.) Craters—surface area destroyed and volume displaced*

Bomb	Fuzing (seconds)	Surface area destroyed per pound of bomb (square feet per pound)		Apparent crater volume per pound of bomb (cubic yards per pound)		Volume of additional soil required to fill crater to original compaction per pound of bomb (cubic yards per pound)	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
100-pound G. P. AN-M 30	0.025 or longer	2.14	2.60	0.099	0.159	0.151	0.227
250-pound G. P. AN-M 57	0.025 or longer	1.46	1.78	.090	.149	.137	.211
500-pound G. P. AN-M 64	0.025 or longer	1.19	1.47	.088	.154	.137	.219
1,000-pound G. P. AN-M 65	0.10 or longer	.97	1.21	.092	.160	.143	.227
500-pound SAP AN-M 58	0.01	.85	1.03	.047	.087	.075	.124
2,000-pound G. P. AN-M 66	0.10 or longer	.78	.96	.093	.161	.144	.229
1,000-pound SAP AN-M 59	0.01	.67	.82	.075	.124	.075	.124

NOTE.—The above values are for *both* paved and unpaved runways when the bombs are dropped from altitudes *above 5,000* feet. When the altitude of release is under 5,000 feet, the values are only for unpaved runways.

displaced. The 100-pound G. P. bomb will be most effective for this purpose.

Recent experiments by N. D. R. C., Division 2, do not indicate any appreciable differences in crater dimensions between paved or unpaved areas for the common thicknesses of runway pavements when bombing from altitudes above 5,000 feet. Hence, the 100-pound G. P. bomb will be most effective for both paved or unpaved areas. However, where the paving is 6 inches or more of concrete, the 100-pound G. P. bomb may break up under impact; in this case the 250-pound G. P. bomb will prove more effective.

The crater dimensions depend on the depth of penetration before detonation. This will be determined by the delay in fuzing and the striking angle and velocity. Recent experiments and actual field study show that for hard ground the delay in fuzing (for G. P. bombs) is unimportant beyond a certain minimum. This results from the curved path of the bomb in the ground. Maximum altitudes of release are therefore only of importance in determining aiming accuracy and dispersion of the bombs. The possibility of ricochet of the bombs when the striking angle is flat will fix a minimum altitude of release. For the type of ground considered, it is believed that the maximum angle of impact should not exceed 45°, which will fix a minimum altitude of release at 3,000 feet for level bombing.

Since successful cratering of landing areas can accomplish only temporary neutralization because of the ease with which repairs can be made, means to interfere with these repairs will extend the time the airfield is unserviceable. Long delay bombs, with fuze settings staggered from 2 to 24 hours and antipersonnel, antidisturbance "butterfly" bombs can be used for this purpose. Experience with the German "butterfly" bomb has shown that it is effective when used to disrupt repairs at night, and that this interference can be accomplished with considerable economy of effort. Consideration should also be given to the use of "crow's-feet" since experience has shown that they have a definite nuisance value, particularly at night.

VI. HANGARS

A. TYPES OF HANGARS

The primary function of a hangar is to provide a covered area for the storage, maintenance, and assembly of aircraft. Hangars are desirable but not essential as evidenced by the fact that aircraft have been operated successfully for long periods in tropical, temperate, and arctic climates and through all seasons with only canvas shelters or awnings. However, the hangars will contain aircraft, tools, and other repair and assembly equipment whose destruction will limit aircraft maintenance and assembly. In these cases the contents of the hangar will be the primary target and attack of the hangar should be directed towards this purpose.

Since the hangar serves only as a shelter, any structure having sufficient strength to support its own weight and to resist the external loads that may be applied by the weather and climate and having sufficient clear span of roof and doors to accommodate the aircraft will serve as a hangar. As a result, a wide variety of structures have been used.

An analysis of about 250 hangars, located in Formosa, Manchuria, Korea, and Southern Japan, from aerial and ground cover, indicates that Japanese hangars can be divided into four basic types.

1. Type 1 Hangar (Simple Truss).

This type of hangar, shown in figure ATSF/TMT/D1, is the one most commonly used by the Japanese. Approximately 70 percent of the total number of hangars investigated were of this type. The basic shape is shown in ATSF/TMT/D1a, type of trusses in ATSF/TMT/D1b and variations in roof details in ATSF/TMT/D1c. Varied designs result from different combinations of truss selection and roof details.

The roof trusses may be framed into columns which transmit the loads to the ground. In these cases the walls are merely panels whose function is to keep the building weather tight, hence they will be of relatively light materials. The roof trusses may also be supported on the external walls in which case the walls are likely to be of fairly heavy masonry construction. In either event, in both Japan and Formosa, the structures can be expected to be securely braced against horizontal forces since these areas are subject to earthquakes and typhoons. The lateral bracing may consist of external buttresses or external tie-rods or a system of internal bracing.

Roofs and nonload bearing walls will most frequently be of corrugated asbestos or corrugated galvanized iron. In areas where wood is especially plentiful, the roofs and walls may be sheathed in this material. Trusses and columns for hangars having spans exceeding 130 feet will probably be made of steel. Hangars having shorter spans may be framed in either steel or timber. It is probable that full use will be made of locally available materials.

Dimensions of hangars vary considerably. The frequencies with which clear span dimensions were observed are recorded in table 7.

TABLE 7

Clear span (feet)	Frequency of occurrence
50-70	2
70-90	14
90-110	58
110-130	16
130-150	45
150-200	11
Over 200	0

It will be noted that clear spans of approximately 100 and 140 feet are the most common. Lengths of hangars vary considerably and no attempt will be made at classification. Truss spacing will generally average 20 feet.

2. Type 2 Hangars (Arch Type).

This hangar is the next most common type of structure, comprising about 25 percent of all hangars investigated. The basic shape is shown in sheet ATSF/TMT/D2a. The arches may be framed in a variety of ways. Six representative types of arch framing are shown on sheet ATSF/TMT/D2b. The roof may be either gabled or curved. Since basically type 1 and type 2 hangars have the same shape, they may be difficult to distinguish. The rise to span ratio may be a distinguishing feature in identification since the ratio is generally larger for arches than for trusses, averaging about 1:3 for the former and 1:7 for the latter. This statement only indicates average conditions since arches can be built with a much smaller rise to span ratio.

Frequently, arch type structures do not have walls that can be distinguished from the roof. The arch frame may be carried down to ground level and covered throughout with the same material. This material may be wood sheathing, corrugated asbestos, or corrugated iron. Where walls exist, they will most frequently be of the panel type (nonload bearing) and the wall material similar to that on the roof. If walls are used, the horizontal thrust from the arches will require external buttresses or internal tie rods at ceiling level. The latter will not be often encountered because of the limitations on the clear height within the hangar.

Arches will most frequently be of steel. Of the arch type hangars investigated about three-fourths were of the type shown on sheet ATSF/TMT/P1 This steel, diamond mesh arch apparently has been developed by the Japanese as a prefabricated hangar of standard design. It has been particularly common at advanced bases to which materials must be shipped, such as the Kurile Islands and islands of the South and Central Pacific. Clear spans are usually 100 or 140 feet. This type of hangar is often found with attached sheds along one or both sides. These sheds are used to house the tools and equipment required for maintenance and repairs to the aircraft.

The shape of the roof may conform to that of the arch, or it may be gabled by using triangular framing above the true arch. The latter is particularly common. Monitors may or may not be added to the roof. The frequency of occurrence does not lead to any conclusions as to which is more common.

3. Type 3 Hangar (Long Multiple-Span).

A hangar of this type is shown on sheet ATSF/TMT/D3. It is similar to the assembly and manufacturing buildings commonly found in aircraft plants. These hangars are most often found at airfields associated with aircraft manufacture or modification centers.

These structures vary so markedly in size, shape, design, and material that no general description is possible. Doors may be either at the ends or along the sides. Clear spans may be as great as 250 feet, though it is probable that clear spans exceeding 150 feet will be very limited. These structures may be framed in either steel or timber though timber framing will generally not be used for clear spans exceeding 100 feet. Because of the variations in size, shape, and materials, these structures should be individually analyzed to establish type of construction, materials, and most effective weapons.

4. Type 4 Hangar (Simple Truss With Side Doors).

This is the most infrequently encountered type of hangar. Only two examples of this style of hangar were found, one of which is shown on sheet ATSF/TMT/D4. The hangars of this type were constructed with wooden trusses supported on masonry bearing walls. The roofs were covered with corrugated galvanized iron. Because of the few hangars of this type encountered, conclusions as to vulnerability must be arrived at individually.

B. TYPES OF DAMAGE

Attack of hangars of all types is intended to destroy contents. This may be done directly or it may be done indirectly by collapsing the hangar on its contents. The choice of weapons will be governed by the decision as to which method is more economical of effort.

For structural damage to the hangar (to collapse it on its contents) an explosive charge over 200-pounds is required to cut any of the important members. The 500-pound G. P. bomb is therefore the smallest that can be used. Detonation of the bomb is desired just below the roof level, since a bomb detonating in this position will also damage the hangar contents with its projected fragments. A nondelay tail fuze would be best for this purpose. However, the presently available tail fuzes are of the inertia type and function when the bomb is decelerated upon striking. The roofing material of the majority of the Japanese hangars is extremely light (corrugated asbestos, corrugated iron, and wood sheathing) so that unless the bomb hits a structural member it will probably not be sufficiently decelerated to activate the fuze. It is estimated that only about 30 percent of the bombs striking the roof will also strike a structural member. Consequently, unless the roofing material is heavy (over 3 pounds per square foot for small G. P. bombs) the inertia type fuze cannot be expected to function, and the 0.01 nose fuze should be used if available.

Structural damage to the hangar can also be accomplished by cratering at the supporting members. Since damage to the supporting members is limited to the area of the crater, and undermining of only one support will not generally cause structural collapse (because of the stability inherent in a continuous design), it is recommended that the bomb be capable of forming a crater large enough to include two adjacent supports. Usual spacing for supports is approximately 20 feet. This indicates that the smallest bomb to be employed should be the 500-pound G. P. bomb. Contents of the hangar may be damaged by crater debris from this bomb though this will usually be less than damage to contents from the fragments of a bomb exploding just below roof level.

VII. REPAIR FACILITIES

A. TYPE OF STRUCTURES

Repair shops are used for the assembly of aircraft, major repairs, and overhaul. The buildings usually contain valuable machine tools, machinery, spare parts, and supplies. Destruction of the repair shops will have no immediate effect upon the operation of the airfield. Where sustained neutralization is desired, destruction of the shops and their contents will limit the amount of repairs that can be made to damaged aircraft.

1. Hangar Type Repair Shops.—These are similar to the structures discussed under hangars and the structural analysis and weapon recommendations will be the same.

2. Factory Type Repair Shops.—The factory type repair shop will generally be found at permanent rear bases which are used as modification centers. The buildings are single story, industrial type with light steel or timber framed members. Saw-tooth roofs, to provide natural interior lighting, are commonly used in single story Japanese factory construction and will often be used for repair shops. In areas subject to high winds and earthquakes they can be expected to be framed and braced to resist these loads. In other areas they may be of wall bearing construction.

The limited number of structures examined permits subdivision only into two classes (1) short span buildings, (2) long span buildings (see sheet ATSF/TMT/D5). The short span buildings are characterized by small, practically square bays (approximate dimensions 25 to 35 feet) and low eave heights. Structural members may be of steel or wood. The exterior walls may be of masonry construction, in which case they will provide structural support for the exterior trusses, or they may be light panels of wood, corrugated asbestos or corrugated iron with the exterior supports for the trusses provided by exterior columns. The principal distinguishing characteristics of long span buildings are the longer spans of the roof trusses and the greater height to eaves. The spacing between trusses, which is governed by the economical spans for the roof purlins will not be materially different than for short span buildings. This results in long, narrow bays (approximate dimensions are 20 to 30 feet in width and 60 to 90 feet in length). The roof trusses will more often be made of steel in the long span buildings since they are more economical. Wood trusses should not be ruled out since the effort to conserve steel may result in timber trusses for the newer buildings. Walls and roof covering will be similar to those used for short span buildings.

Damage to the contents of the factory type repair shops may be more economically achieved by collapse of the structure. Where the construction analysis indicates that the buildings are of the wall-bearing type, damage to the structure is best accomplished by the blast effect of large H. E. bombs. Those structures which are framed and braced to resist lateral loads are more resistant to blast. Structural damage can be accomplished by cutting the structural members or undermining their supports.

3. Small Repair Shops are the most numerous. They are used principally to house the machine tools, machinery, spare parts, and supplies. These repair shops vary considerably in size and form. The most common type, however, is a rectangular building (long and narrow) with a gabled roof. This permits the use of a simple triangular roof truss, of short span, which can be framed in steel or timber and supported on bearing walls or exterior columns. Since 1937 the Japanese have made a considerable effort to minimize the use of steel. Repair shops of this type will therefore be most commonly framed in wood. In those areas where wood is abundant the walls and roof will be sheathed in wood. In other areas where wood is not easily available, the wall and roof covering may be of corrugated asbestos or corrugated iron.

Attack directed at the contents of the small repair shops will generally require the minimum effort. Since a large percentage of repair shops of this type are framed in wood and have walls and roofs sheathed in wood, incendiary weapons will be the most efficient for these structures. Repair shops built of materials other than wood are not vulnerable to fire (unless the contents are inflammable) and H. E. weapons are indicated for these targets. Repair shops with masonry bearing walls are vulnerable to blast and damage to the contents can be accomplished by collapse of the structure. Medium size G. P. bombs are indicated for the noncombustible repair shops.

VIII. STORAGE FACILITIES

A. KINDS OF STORAGE

The facilities built to house stores at Japanese airfields are designed to protect goods and supplies from exposure. They will vary considerably in shape, size, and form depending upon the conditions peculiar to each individual site. Permanent rear bases may have well-constructed structures in sufficient numbers to house most of the stores. Advanced bases are more likely to have makeshift arrangements and only the more perishable stores will be housed. Other stores are likely to be dispersed in the open, covered with tarpaulins, and camouflaged where possible.

The important airfield items that require storage are (1) oil and gasoline, (2) ammunition, (3) engine and air-frame spare parts, (4) food, (5) dry goods.

1. Oil and Gasoline may be stored either in small drums or large tanks. Where the storage is in drums, the total supply is broken up and dispersed in dumps throughout the airfield area. The dispersed groups of drums may be hidden from aerial identification by camouflage or attack made more difficult by protective revetments. In either case, wide dispersal will make destruction of the total supply exceedingly difficult, and since the total supply on hand is normally in excess of immediate needs, destruction of only part of this supply will be an inconvenience and not make the airfield inoperative.

Oil and gasoline may also be stored in large tanks. These will most often be found at the permanent rear bases. The tanks are usually buried or dug into sides of hills. Identification from the air will be extremely difficult. A successful attack on these facilities may have a more pronounced effect on the operation of the airfield if a large part of the supplies is concentrated in these tanks, but this is unlikely since emergency supplies are usually kept available for this contingency.

2. Ammunition of all types (including bombs) is usually stored in heavy reinforced concrete structures, underground vaults and/or dispersed in the open. At permanent rear bases the storage will ordinarily be in heavy concrete structures or underground vaults. The large amounts of ammunition ordinarily kept on hand often exceed the capacity of the permanent structures and the excess is piled in the open in protective revetments, or stored in light sheds. At advanced airfields permanent installations will be at a minimum and storage will be in dispersed open revetments and in light, camouflaged sheds.

Ammunition stored in the heavy concrete structures or underground vaults is a difficult target to attack. The concrete structures will generally be small in plan (a 50 by 50 foot building will seldom be exceeded) and have heavy roof slabs (4 to 5 feet thick) and side walls (2 to 3 feet thick). Underground vaults will be equally difficult to penetrate. Those subsurface vaults which are built into the sides of hills may have a tunnel entrance 30 to 50 feet long and the thickness of cover will be sufficient to make them bombproof to ordinary weapons.

Since ammunition stored in the open is dispersed, destruction of the entire supply is most unlikely. Individual groups are vulnerable to attack and can be destroyed. Destruction of only part of the supply will again be only an inconvenience and will not affect the operation of the field.

3. Engine and Airframe Parts may be stored in a variety of structures or if well crated or boxed may be stored in the open. Permanent storehouses are more likely at rear bases, and vary considerably in size. Variations in form will be more limited. Usually they are long, narrow buildings, one story high. The variations in width of these buildings will be only from 30 to 50 feet but the variation in length will be much greater, from 50 to 300 feet. The small span of these structures makes possible the use of simple, triangular roof trusses which may be of either steel or timber. The trusses may be supported on the exterior walls (wall bearing construction) or framed into columns. The materials used for roof covering may be wood sheathing, corrugated asbestos, or corrugated iron. The framed buildings will have walls of materials similar to that used for roof covering, but the bearing type walls will be of brick or concrete masonry.

The spare parts, whether stored in the open in their boxes and crates or in storehouses, are vulnerable to attack by fire. Storage in the open will be in dispersed groups so that wide coverage of the area is desirable. This indicates the employment of the small incendiaries to start many fires which can be mutually supporting. Attack of the storehouses will depend upon the tactics that can be employed. Where only area bombing is possible the small incendiaries are again indicated but where accuracy can be improved and the bombs directed at individual buildings, the larger I. B.'s will give a fast starting, developing fire which is more difficult to control.

4. Attack of Food Supplies is normally not worth while. Destruction of these supplies will not affect the operation of the airfield except in those cases in which the target is isolated and supplies are difficult to replace. The effect on the operations of the field will only be felt sometime after the destruction of food supplies and only in decreased efficiency and morale. The food supplies are normally kept in special storehouses at permanent airfields. These will be similar in construction to those used to store spare parts. Weapon selection will be determined by the same principles. At advanced bases the food supplies will be stored in wooden sheds or other makeshift shelters. Nonperishable supplies may even be stored in the open and simply covered with tarpaulins. Weapon selection will be as above.

5. Dry Goods fall in the same category as food supplies. They are less essential than food and their destruction can only be of nuisance value. Attacks directed at other targets may destroy these supplies. In no case are they of importance as a primary target.

IX. AUXILIARY INSTALLATIONS

A. BUILDINGS

1. Administration Buildings, etc.

Administration, Operations, and Headquarters Buildings and Control Towers can be grouped together since their functions are related. Experience has shown that their destruction is little more than an inconveneince since temporary and makeshift structures can be readily improvised. It should be emphasized that modern aircraft rely a great deal upon ground installations for their control so that destruction of these control centers will have a considerable, though only temporary, effect on the enemy's flying organization. An individual analysis of each airfield is required to assess the degree of disruption to airfield control due to destruction of these structures.

The multitude of types of buildings permits only the division into two classifications (1) combustible, (2) fire resistive and noncombustible. The former are likely to be found at new airfields (built since 1937), recent additions to old airfields and at advanced bases. The latter are more likely to be found at older airfields within the territories which Japan has controlled at least 10 to 15 years. The definition of these buildings into each classification will be determined by the type of material with which they are built. Combustible structures will have wooden frames, timber roof trusses and wood, corrugated asbestos, or corrugated iron siding and roofing. The majority of these structures will also have wooden floors. The fire resistive and noncombustible structures will have brick, stone or concrete load bearing walls, steel roof trusses, and tile, corrugated asbestos or corrugated iron roofing. Floors may be of either wood or concrete.

2. Living Quarters.

Destruction of *barracks and mess halls* will have no immediate effect upon the operation of the airfield. Temporary quarters can be readily improvised and only where sustained neutralization is required and the airfield is under continuous and repeated attack will destruction of these facilities result in decreased efficiency and morale of the airfield personnel, with consequent decreased efficiency of the airfield organization.

No fixed description of these components is possible because of the wide variations at various airfields. At permanent bases they are built principally of wood and resemble American construction. At advanced bases there will be even less uniformity of type and will be built of locally available materials. Where locally available materials are limited and have to be shipped in they will most often be canvas tenting.

B. OTHER INSTALLATIONS

Taxiways and service aprons are unimportant as a target in themselves. Destruction of these facilities will in no way affect the operation of the airfield and can only result in a small amount of inconvenience. They are important only in the sense that there may be grounded aircraft on them.

Revetments are constructed of a variety of materials and in a variety of shapes. They are used to provide protective screens for grounded aircraft or material stored in the open. Attack should never be directed at the revetments but at their contents.

In general, the auxiliary installations are secondary targets which may be damaged or destroyed by weapons directed at other targets. Because of the combustible nature of the majority of structures and their contents, incendiary weapons will be most effective. The wide dispersion of the individual elements calls for the employment of area bombing techniques with small incendiaries.

APPENDIX A—FRAGMENT DAMAGE TO GROUNDED A/C

1. Introduction.

These notes are intended to provide working data for the computation of load requirements for attack of airfields to accomplish destruction or effective damage with high explosive bombs to grounded aircraft in the open or in uncovered revetments. Destruction or effective damage is assumed to be attributable to the projected fragments of the high explosive bombs. Load requirements for aircraft in covered revetments or pens are not treated in these notes since damage or destruction will be limited to a direct hit on the revetment with a bomb capable of perforating the roof. Attacks directed primarily against aircraft in covered revetments or pens are not considered economical, because of the heavy load requirements to insure a reasonable probability of direct hits. Since the primary purpose of attack of grounded aircraft is to neutralize the enemy air force, other methods of attack will prove more profitable. Aircraft in covered pens may be destroyed or damaged if the point of burst is opposite the mouth of the pen, but this is unpredictable and results accomplished are to be considered as a bonus to the attack.

Load requirements for attack of airfields for destruction or damage to grounded aircraft are given on sheet ATSF/TMT/C5. The target is considered to be 10,000,000 square feet in area and the load requirements are given in total number of pounds carried. The requirements are presented in this form, because the stowage factors for the various planes are continually changing and the data presented this way can be readily interpreted in terms of operational requirements.

Because of the uncertainty of an adequate definition as to what constitutes destruction or effective damage, the load requirements are expressed in terms of an upper and a lower limit. It is believed that these limits adequately express the present state of knowledge on this subject. The lower limit is taken as four effective fragment hits per 100 square feet of vulnerable area and the upper limit as seven effective fragment hits per 100 square feet of vulnerable area. An effective hit is defined as that caused by a fragment with sufficient mass and velocity to perforate one-eighth inch mild steel.

The curves on sheet ATSF/TMT/C5 are based on assumed random distribution of bombs in the target area. It is assumed that all bombs strike within the target area and allowance should be made for aiming errors. These allowances are best estimated in the field where bombing accuracy can be currently evaluated.

When the 20-pound frag. bomb is to be used from high altitudes, the total load requirements should be increased, up to a factor of 2, to allow for the loss of effective fragments.

Where substantial numbers of grounded aircraft are in revetments, the mean areas of effectiveness of the larger bombs are reduced (for surface bursts) from the values given in table 15. The limit of reduction will be the area of the revetment when all aircraft are in revetments. In this limiting case the total number of bombs of any weight that will be required will be the same, and the number can be obtained by use of the formula

$$N=\frac{A}{M}\log_e\left(\frac{1}{1-P}\right)$$

N=Number of bombs required.
M=MAE=Area of revetment.
P=Percent saturation.
A=Target area.

2. Fragment Densities.

Basic to the computation of density requirements is the establishment of a mean effective area for each bomb. Because of the uncertainties which enter into the computation of the MAE it is possible only to give an upper and a lower limit which are "best guesses," but which reflect the present state of knowledge.

The computations for the MAE must take into consideration the expected density of effective fragments and their distribution from the point of burst of the bomb. Sufficient data can be accumulated for the expected densities from static detonation trials, but only meager information is available on expected densities and distributions for bombs dropped from aircraft. Static detonation trials do not take into consideration the change in direction and velocity of the fragment attributable to the striking velocity of the bomb.

Available information consists of data on expected densities prepared by the Office of the Chief of Ordnance, Research and Materials Division, Ballistic Section (Fragment Damage From Typical Shells and Bombs, TDBS Report No. 28, 27 May 1944). Fragments capable of perforating ⅛-inch mild steel plate are generally considered effective against grounded aircraft. *The tables give average densities for different directions from the burst and are applicable only to a large number of bursts with random orientation of the bomb axis to the target.* They do not take into consideration the effect of penetration into the ground before detonation nor the fragment density at different heights above the ground.

Comparison with several incidents in which aircraft were observed to be damaged or destroyed by German or British bombs, leads to the conclusion that the densities used and the method of computation give mean effective areas of the right order of magnitude.

Very little data on expected fragment densities has been collected from experimental trials for bombs dropped from aircraft in flight or from past military operations. Available data is limited to the 20-pound frag. bomb, M41. A comparison is made on Sheet ATSF/TMT/C1 between observed fragment densities and the calculated densities in TDBS Report No. 28 as a check on the reliability of the latter values.

(*a*) *Fragment densities for the 20-pound F. Bomb M41.*—A survey of fragment densities for the 20-pound frag. bomb, M41, was made by the Bombing Survey Unit, Mediterranean Allied Air Force ("The performance of the US–M41 Frag. Bomb", AC 5644). The following table (table 8) is reproduced from the report.

TABLE 8.—*Field observations of the fragmentation of the 20-pound M41 F. bomb*

	Incident	Fragment density per unit solid angle	Remarks
1	Bocca di Falco Airfield (Roof of barracks building)	1,365	All strikes, burst on hard surface, 13 inches thick concrete. Strikes on 3-foot high parapet wall.
2	do	684	Strikes penetrating ½ centimeter and more of parapet wall.
3	Fiume, Palermo	582	Vertical distance covered is 8 feet. Burst on fairly soft earth.
4	Bocca di Falco Airfield (Airfield wall)	626	Burst on tarmac or stone. Wall 3 feet high.
5	do	230	Do.
6	do	609	Do.
7	do	329	Do.
8	do	1,062	Do.
9	do	660	Do.
10	Railway Station, Milo	572	Burst on concrete. Target 5 feet high.
11	North African Trials	457	Burst in soft clay. Target 6 feet high.

Fragment densities for incidents 2–11 inclusive are averaged and plotted on sheet ATSF/TMT/C1. Comparison with fragment densities plotted from TDBS Report No. 28 shows that the latter are not unreasonable and qualitatively and quantitatively are in the right direction.

3. Damage to Grounded A/C.

The definition of effective damage is best related to the area of the grounded aircraft which is vulnerable to fragments having sufficient mass and velocity to perforate ⅛-inch mild steel plate. Data on these vulnerable areas are extremely scarce and the conclusions reached in these notes are based on only fragmentary evidence.

Ordnance Memo 8–17, Eighth Air Force-September 1943, categorically makes the statement that a fighter plane has a vulnerable area of 100 square feet and that four effective hits in this area will effectively damage the plane. No information is available as to how these figures were obtained.

In a report issued by the British Ministry of Home Security ("The Vulnerability of Aircraft to Fragments From Heavy Antiaircraft Shell Bursts in Flight, With Particular Reference to the Junkers Ju88 Bomber, A. C. 5420") it is considered that the minimum effective fragment density should be seven per 100 square feet. These tests were made with heavy antiaircraft shells in flight and a Blenheim bomber. Although the problem is different, the conclusions can be applied to give an indication of the requirements.

Tests ("Experiments on the Vulnerability of Military Aircraft to High Explosive Shell Fragments," Section T, OSRD Report XR–205, 8 September 1944) can be used in arriving at a vulnerable area. Assessed results of these tests give the vulnerable area as a function of the degree of damage. Considering that effective damage can be described as the inability of the plane to return to base within 1½ hours the vulnerable areas are quoted in table 9.

TABLE 9

Plane	Projectile	Equivalent vulnerable area (for one hit)
		Square feet
SB2A–4	5″/38	21.1
SB2A–4	90 mm.	8.4
SB2A–4	75 mm.	7.2
B–26–B	90 mm.	8.3

(*a*) *Mean area of effectiveness.*—The computations for the MAE will be made for an upper limit of seven hits per 100 square feet of vulnerable target area and a lower limit of four hits per 100 square feet. No adequate definition of effective damage is available and the indicated values are the best that can be given with present data.

The probability of obtaining the required number of hits can be obtained using the Poisson distribution which is applicable when the probability of any one fragment hitting is small, but because of the large number of fragments the average number of hits remains constant.

Let $p(x)$ = probability of exactly x hits.
m = average number of effective fragments = fragment density per square foot times area

Then $$p(x)=\frac{e^{-m}.m^{x}}{x!}$$

The computations for exactly 0, 1, 2 * * * hits per 100 square feet of vulnerable area are given in tables No. 10–14 inclusive. From these the probability of at least four or at least seven hits are computed. Figure ATSF/TMT/C2 is plotted for these values. The radii obtained are then used to compute the areas in figures ATSF/TMT/C3 and ATSF/TMT/C4 and the MAE is determined from these curves. (See table 15.)

TABLE 10.—*20-pound fragmentation bomb—M41—Probability of at least 4 hits per 100 square feet and at least 7 hits per 100 square feet*

Dist. fr. burst (feet)	Frag. density per 100 square feet	*p*(x) (x=0)	*p*(x) (x=1)	*p*(x) (x=2)	*p*(x) (x=3)	*p*(x) (x=4)	*p*(x) (x=5)	*p*(x) (x=6)	Prob. at least 4 per 100 square feet	Prob. at least 7 per 100 square feet
20	34.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	----------	----------
30	14.1	.00	.00	.00	.00	.00	.01	.01	0.99	0.99
40	7.19	.00	.01	.02	.05	.08	.12	.15	.92	.57
50	3.94	.02	.08	.15	.19	.19	.15	.10	.56	.12
60	2.47	.08	.21	.26	.21	.13	.06	.03	.24	.02
70	1.48	.23	.34	.25	.12	.05	.01	.00	.06	.00
80	.91	.40	.37	.17	.05	.01	------	------	--------	--------
90	.56	------	------	------	------	------	------	------	--------	--------
100	.33	------	------	------	------	------	------	------	--------	--------

TABLE 11.—*90-pound frag. bomb—M80—Probabilities of at least 4 hits per 100 square feet and at least 7 hits per 100 square feet*

Dist. fr. burst (feet)	Frag. density per 100 square feet	*p* (x) (x=0)	*p* (x) (x=1)	*p* (x) (x=2)	*p* (x) (x=3)	*p* (x) (x=4)	*p* (x) (x=5)	*p* (x) (x=6)	Prob. at least 4 per 100 square feet	Prob. at least 7 per 100 square feet
20	130.0	------	------	------	------	------	------	------	--------	--------
30	51.0	------	------	------	------	------	------	------	--------	--------
40	24.5	------	------	------	------	------	------	------	--------	0.99
50	12.0	0.00	0.00	0.00	0.01	0.03	0.07	0.14	0.99	.75
60	7.16	.00	.01	.02	.05	.08	.12	.15	.92	.57
70	4.76	.01	.04	.10	.15	.18	.17	.14	.70	.21
80	3.31	.04	.12	.20	.22	.18	.12	.07	.42	.05
90	2.36	.09	.22	.26	.21	.12	.06	.02	.22	.02
100	1.68	.19	.31	.26	.15	------	------	------	.09	--------
110	1.20	.30	.36	.22	.09	------	------	------	.03	--------
120	.88	------	------	------	------	------	------	------	--------	--------
130	.66	------	------	------	------	------	------	------	--------	--------
140	.51	------	------	------	------	------	------	------	--------	--------
150	.40	------	------	------	------	------	------	------	--------	--------

TABLE 12.—*100-pound G. P. bomb—AN-M30—Probabilities of at least 4 hits per 100 square feet and at least 7 hits per 100 square feet*

Dist. fr. burst (feet)	Frag. density per 100 square feet	*p* (x) (x=0)	*p* (x) (x=1)	*p* (x) (x=2)	*p* (x) (x=3)	*p* (x) (x=4)	*p* (x) (x=5)	*p* (x) (x=6)	Prob. at least 4 per 100 square feet	Prob. at least 7 per 100 square feet
20	--------	------	------	------	------	------	------	------	--------	--------
30	--------	------	------	------	------	------	------	------	--------	--------
40	33.6	------	------	------	------	------	------	------	--------	--------
50	18.2	------	------	------	------	------	------	------	--------	--------
60	12.1	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.99	0.95
70	8.47	.00	.00	.01	.02	.04	.06	.09	.97	.78
80	6.20	.00	.01	.04	.08	.12	.16	.16	.87	.43
90	4.54	.01	.05	.11	.17	.19	.17	.13	.66	.17
100	3.42	.03	.11	.19	.22	.19	.13	.07	.45	.06
110	2.58	.08	.20	.25	.22	.14	.07	.03	.25	.01
120	1.95	.14	.28	.27	.18	.09	.03	.01	.13	--------
130	1.50	.22	.34	.25	.13	.05	.01	------	.06	--------
140	1.11	.33	.36	.20	.07	.02	------	------	.02	--------
150	.83	------	------	------	------	------	------	------	--------	--------

TABLE 13.—*260-pound frag. bomb—M81—Probabilities of at least 4 hits per 100 square feet and at least 7 hits per 100 square feet*

Dist. fr. burst (feet)	Frag. density per 100 square feet	p (x) (x=0)	p (x) (x=1)	p (x) (x=2)	p (x) (x=3)	p (x) (x=4)	p (x) (x=5)	p (x) (x=6)	Prob. at least 4 per 100 square feet	Prob. at least 7 per 100 square feet
20	207.0	------	------	------	------	------	------	------	--------	--------
30	88.0	------	------	------	------	------	------	------	--------	--------
40	46.3	------	------	------	------	------	------	------	--------	--------
50	28.0	------	------	------	------	------	------	------	--------	--------
60	17.5	------	------	------	------	------	------	------	--------	--------
70	11.7	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.99	0.94
80	8.17	.00	.00	.01	.03	.05	.09	.12	.94	.68
90	5.84	.00	.02	.05	.10	.14	.16	.16	.83	.37
100	4.34	.01	.06	.12	.18	.19	.17	.12	.63	.15
110	3.26	.04	.12	.20	.22	.18	.12	.06	.42	.06
120	2.51	.08	.21	.26	.22	.14	.07	.02	.23	.01
130	1.96	.14	.28	.27	.17	------	------	------	.14	--------
140	1.56	.21	.33	.26	.13	------	------	------	.07	--------
150	1.26	.28	.36	.22	.09	------	------	------	.03	--------
160	1.02	------	------	------	------	------	------	------	--------	--------
170	.85	------	------	------	------	------	------	------	--------	--------
180	.72	------	------	------	------	------	------	------	--------	--------
190	.60	------	------	------	------	------	------	------	--------	--------
200	.52	------	------	------	------	------	------	------	--------	--------

TABLE 14.—*500-pound G. P. bomb—AN-M64—Probabilities of at least 4 hits per 100 square feet and at least 7 hits per 100 square feet*

Dist. fr. burst (feet)	Frag. density per 100 square feet	p (x) (x=0)	p (x) (x=1)	p (x) (x=2)	p (x) (x=3)	p (x) (x=4)	p (x) (x=5)	p (x) (x=6)	Prob. at least 4 per 100 square feet	Prob. at least 7 per 100 square feet
40	132.1	------	------	------	------	------	------	------	--------	--------
50	79.3	------	------	------	------	------	------	------	--------	--------
60	50.1	------	------	------	------	------	------	------	--------	--------
70	35.5	------	------	------	------	------	------	------	--------	--------
80	24.9	------	------	------	------	------	------	------	--------	--------
90	17.9	------	------	------	------	------	------	------	--------	--------
100	12.8	------	------	------	------	------	------	------	--------	0.99
110	9.40	0.00	0.00	0.00	0.01	0.03	0.05	0.08	0.99	.83
120	6.88	.00	.01	.02	.06	.10	.13	.15	.91	.53
130	4.90	.01	.04	.09	.15	.18	.18	.14	.71	.21
140	3.65	.03	.10	.19	.23	.21	.15	.09	.45	.11
150	2.82	.06	.17	.24	.22	.16	.09	.04	.31	.02
160	2.29	.10	.23	.26	.20	------	------	------	.21	--------
170	1.82	.16	.29	.27	.16	------	------	------	.12	--------
180	1.51	.22	.34	.25	.13	------	------	------	.06	--------

TABLE 15.—*Mean areas of effectiveness (MAE)*

Bomb	Lower limit, 4 effective hits per 100 square feet	Upper limit, 7 effective hits per 100 square feet
	Square feet	*Square feet*
20-pound F	9,200	5,500
90-pound F	19,900	11,800
100-pound G. P	29,700	20,200
260-pound F	37,900	24,300
500-pound G. P	65,000	46,700

4. Load Requirements.

Total weight requirements (tables 17 and 18 and sheet ATSF/TMT/C5) are computed by use of the method developed in Report No. 14, Far East Air Forces, Operations Analysis Section (Number of Aircraft Necessary for Proposed Military Operations, 15 August 1944).

Notation A=target area
M=mean area of effectiveness each bomb
N=number of bombs required
P=percent saturation (probability of destruction)

$$N=\frac{M}{A}\log_e\left(\frac{1}{1-P}\right)$$

The Table 16 gives values of $\log_e\left(\frac{1}{1-P}\right)$ for various values of P.

TABLE 16

P	$\log_e\left(\frac{1}{1-P}\right)$
0.10	0.105
.20	.223
.30	.357
.40	.511
.50	.693
.60	.916
.70	1.204
.80	1.609
.90	2.303

TABLE 17

Saturation	Number of bombs required for target area=10,000,000 square feet									
	Lower limit (4 hits per 100 square feet)					Upper limit (7 hits per 100 square feet)				
	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.
0.10	114	53	35	28	16	191	89	52	43	22
.20	243	112	75	59	34	407	189	110	92	48
.30	388	180	120	94	55	649	303	176	147	76
.40	556	257	172	135	79	928	433	253	211	109
.50	754	348	233	183	107	1,260	587	343	285	148
.60	998	461	309	242	141	1,676	776	453	377	196
.70	1,310	606	406	318	186	2,190	1,021	596	496	258
.80	1,750	808	542	424	247	3,210	1,362	796	662	344
.90	2,510	1,160	776	608	354	4,180	1,953	1,141	949	494

TABLE 18

	Total weight required in pounds for target area=10,000,000 square feet									
	Lower limit (4 hits per 100 square feet)					Upper limit (7 hits per 100 square feet)				
	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.	20-pound F.	90-pound F.	100-pound G. P.	260-pound F.	500-pound G. P.
0.10	2,300	4,800	3,500	7,300	8,000	3,800	8,000	5,200	11,200	11,000
.20	4,900	10,200	7,500	15,400	17,000	8,100	17,000	11,000	23,900	24,000
.30	7,800	16,200	12,000	24,400	27,500	13,000	27,300	17,600	38,200	38,000
.40	11,100	23,100	17,200	35,200	39,500	18,600	38,900	25,300	54,800	54,500
.50	15,100	31,400	23,300	47,600	53,500	25,200	52,800	34,300	74,200	74,000
.60	20,000	41,500	30,900	63,000	70,500	33,500	69,800	45,300	98,000	98,000
.70	26,200	54,500	40,600	82,700	93,000	43,800	92,100	59,600	128,000	129,000
.80	35,000	72,700	54,200	110,500	123,500	64,200	122,800	79,600	172,000	172,000
.90	50,200	104,500	77,600	158,300	177,000	83,600	176,000	114,100	247,000	247,000

5. Comparison with Observations.

The calculated distances from the point of burst within which grounded aircraft can be considered destroyed or effectively damaged may be compared with field observations to serve as a check on the accuracy of the method of computation.

Incident at Hilsea Airport, August 15/16, 1943 (REN 270).—Airspeed "Oxford" planes were destroyed or effectively damaged at about 130 to 150 feet from a German 500 kg. S. C. bomb. On the assumption that the effective radius varies as the cube root of the charge weight the radii are compared in table 19.

TABLE 19

Bomb	Charge weight (pounds)	Calculated		
		Effective radii based on comparison of charge weights (feet)	Effective radii based on upper limit of mean area effectiveness (feet)	Effective radii based on lower limit mean area of effectiveness (feet)
500 kg. S. C.	484	140		
500-pound G. P.	267	115	144	122
100-pound G. P.	57	69	97	80

"Bombing Trials at Ashley Walk Against Close Support Targets" (British Ordn. Bd. Proc. Q2390).—"Blenheim" bombers and "Kittyhawk" fighters were targets to determine the effectiveness of air burst 500-pound M. C. bombs. Conclusions reached were that the planes were effectively damaged or destroyed within 150 feet of the burst, whether air burst or surface burst.

Summary of results were that 12/12 planes received substantial damage within 150 feet of burst and 3/10 planes received substantial damage between 150 to 250 feet of burst.

Comparison on a basis of charge weights is given in table 20.

TABLE 20

Bomb	Charge weight (pounds)	Calculated		
		Effective radii based on comparison of charge weights (feet)	Effective radii based on upper limit of mean area effectiveness (feet)	Effective radii based on lower limit mean area of effectiveness (feet)
500-pound M. C.	210	150		
500-pound G. P.	267	162	144	122
100-pound G. P.	57	97	97	80

Report on the 20-pound Frag. Bomb (O. A. S. 15th A. F., Mar. 1944).—"The effective radius for damage to grounded aircraft for the 20-pound Frag. bomb is 60 feet." This is somewhat greater than the calculated effective radii which are 42 and 54 feet for the upper and lower limits, respectively.

The rather meager data on which comparison can be made between calculated and observed effective radii does not show any marked discrepancies and leads to the conclusion that the calculated values of mean area of effectiveness are of the correct order of magnitude.

APPENDIX B—LOAD REQUIREMENTS FOR CRATERING LANDING AREAS

The number of bombs to be dropped on a landing area in order to crater it so that no possible strip suitable for fighter aircraft will remain, is difficult to compute theoretically. By making certain simplifying assumptions, approximate numbers can be derived.

A reasonable basic assumption will be that all landing strips are parallel to the larger dimension of the landing area. This can only be true if the area is restricted in width. It is also assumed that all bombs are dropped at random and land inside the area.

The problem may be approached by assuming that the area is divided into parallel rectangles, each the size of a fighter landing strip. By means of the area bombing calculator developed by the Applied Mathematics Panel, NDRC, the number of bombs required to be dropped to obtain at least one hit in each rectangle can be determined. This will give the required number if the bombs land in the most favorable position in each rectangle. Since this is unlikely, because the requirement is only that the bomb land within the rectangle, the number determined will be the lower limit of the number required.

If the dimensions of the rectangle are reduced so that each is half of the required dimensions of the fighter strip, then a hit anywhere in each rectangle will leave no strip of the required dimensions uncratered. With a hit in each reduced rectangle, all possible strips will be cratered, but it may still be possible, with a favorable distribution of bombs in the adjacent rectangles, to miss a rectangle and still leave no usable strip. The number of bombs determined using the reduced rectangles is then the upper limit of the number required.

To illustrate the computations to determine the number of bombs required, a landing area will be taken equal to 10,000,000 square feet. It will be assumed that fighter aircraft will require a minimum strip 50 feet wide and 1,500 feet long. If the assumption is made that the craters will be 20 feet in diameter, the entire area can be divided into rectangles, each 70 feet wide and 1,520 feet long. For the 10-million-square-foot area there will be 95 rectangles of these dimensions. The area bombing calculator will then give the number of bombs required per rectangle to get at least one hit in each section with the desired degree of probability. The total number of bombs is then the product of the number per section and the number of sections. This is the lower limit of the required number since the full dimensions of the strip were used.

The upper limit of the required number is determined in the same way, but since the dimensions are reduced, each rectangle will measure 35 by 760 feet. This will give 380 rectangles for the 10-million-square-foot area.

TABLE 21.—*Number of cratering bombs required for temporary neutralization of landing area (10,000,000 sq. ft.)*

Probability	Lower limit (full landing strip, 70 x 1,520 feet)	Upper limit (reduced landing strip 35 x 760 feet)
0.50	465	2,375
.60	495	2,500
.70	530	2,640
.80	570	2,830
.90	645	3,110

To evaluate the accuracy of this method of computing the load requirements for cratering landing areas, comparison is made with a study prepared by Division 2, N. D. R. C., which analyzed attacks of seven Japanese airfields. The conclusions of this study were that a bomb density of 0.02 hit per 1,000 square feet is the absolute minimum that can be used, while the recommended density is 0.033 hit per 1,000 square feet. Bomb hits on the landing strips of the seven airfields consisted of the following:

182—1,000-pound G. P. bombs, 146—500-pound G. P. bombs, 127—100-pound G. P. bombs, and 76—1,000-pound G. P. or 2,000-pound G. P. bombs.

The original computations (Table 21) used a serviceable strip 50 feet wide and 1,500 feet long and a 20-foot diameter crater. Since the bombs landing on the strips of the seven airfields were 500-pound G. P. bombs or larger, the computations were repeated, assuming 40-foot diameter craters. The 10,000,000-square-foot area is then made up of 74 rectangles, each 90 by 1,540 feet, for the lower limit, and 296 rectangles, each 45 by 770 feet, for the upper limit of bombs required.

TABLE 22.—*Number of bombs required to crater 10 million-square-foot landing area*

Probability	Lower limit		Upper limit	
	Number for full landing strip (90 x 1,540 feet)	Number per 1,000 square feet	Number for reduced landing strip (45 x 770 feet)	Number per 1,000 square feet
0.50	318	0.032	1,770	0.177
.60	352	.035	1,875	.188
.70	385	.038	1,995	.200
.80	418	.042	2,130	.213
.90	470	.047	2,340	.234

An examination of the above figures shows that the lower limit of the required bomb density is approximately the same as that recommended by the study of the observed strikes on the seven airfields.

TYPICAL JAPANESE MILITARY TARGETS

PART II—RADIO AND RADAR

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS—AFTER SHEET ATSF/TMT

I. SUMMARY

Table 1.—Weapon selection summary

Radar Installations
Radio Communications
Direction Finders
Navigational Aids [1]

Type of attack	Effective weapon	Fuzing nose/tail
Min. and low	Strafing or Napalm	
Low	5 inch HVAR	I/ND.
Dive	100 lb. GP [2]	I/ND.

[1] Navigational Aids not yet known to be used in Japan. Recommendations based on typical German installations. 100 lb. GP can be used from medium altitude against Navigational Aids.

[2] In planes able to carry as many, or nearly as many 250 lb. or 500 lb. bombs as 100 lb. GP, the larger bomb is recommended.

Attack of Japanese radio and radar installations is best directed against the vulnerable small components and the skilled personnel. The targets are small, fragile, lightly constructed, often camouflaged, readily damaged but easily repaired or replaced. A successful attack demands high accuracy in locating the target and adequate briefing of the pilot in addition to selection of the most efficient tactics and weapons. It is believed that attack by fighter/bombers strafing with machine gun fire or attacking with the 5 inch rocket will accomplish destruction of these installations with the minimum effort. Attack with 100 lb. GP bombs will require a greater effort, depending upon operational conditions and plane loading characteristics.

II. GENERAL ANALYSIS

Japanese radio and radar installations are important targets and are fairly vulnerable to air attack.

In such attack, careful and detailed planning is highly important. Definite targets must be selected and the pilot fully briefed regarding them. Diversionary attack by other aircraft to draw the anti-aircraft fire is recommended; consequently precise timing of the strike is required to achieve maximum results.

The targets to be treated are limited to land based installations; shipborne and airborne equipment is not considered. The installations are grouped in four main divisions, namely:

1. Radar installations.
2. Radio communication installations.
3. Direction finder installations.
4. Navigational aid installations.

Although these are all functionally different and do not resemble each other closely, they have similar components and about equal vulnerability to attack. Each consists of an antenna, a transmitter and/or receiver and a power supply. The electronic parts in the transmitter and receiver are the critical elements and most vulnerable. Because these targets are small and often camouflaged or concealed, identification from the air is very difficult; consequently, thorough photo reconnaissance is essential.

III. JAPANESE RADAR

1. Function and Use.

Radar development by the Japanese has lagged far behind that of the Allied Nations or the Germans. Although the types developed to date by the Japanese are inferior to our own, it is known that they have received German aid in the form of technical information and technicians. New and improved equipment can, therefore, be expected to be in development and in operational use in the future.

2. Structural Analysis.

Present information on Japanese radar is far from complete. It is known that the Japanese Navy has reached a much more advanced state along this line than the Japanese Army. There is no present evidence to indicate that they have any special equipment other than early warning, gun control and searchlight control radar. Nor is there evidence that the Japanese have a separate coast watching chain similar to that employed by the Germans, but it is certain that radar sited on the coast will be used for ship reporting as well as aircraft tracking.

The Japanese normally locate early warning radar on the highest accessible point to be defended. Installations frequently consist of two early warning radars, allowing one to search when the other has started to track, thus guarding against feints or diversionary attacks. Early warning radars of both the 360° and sector sweep types have been observed. There is also some indication that the radars are beamed in the direction from which attack is expected and do not

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rotate. This is possible with the wide beamed Japanese radars.

Known types of Japanese early warning radar consist of fixed, mobile and portable units. Of these the fixed type is most easily identified and located. A typical installation, illustrated in Fig. ATSF/TMT–2/D1, consists of a light steel or wooden framework mounted on a rotating base set on a concrete foundation. The cabin, about 10 by 10 by 10 feet, which houses the operating personnel and the transmitter and receiver, and the aerial array, 15–18 feet high and 25–30 feet wide, are fixed to the framework. Although the antenna is the only part which must necessarily be exposed, there is no evidence to indicate that the Japanese have built elaborate structures to house and protect the vital equipment, as the Germans have sometimes done. Observed installations have consisted of a low, protective revetment, a few feet high and of diameter slightly larger than the radar screen.

Information obtained from Japanese POW's indicate that the mobile and portable early warning radars depend upon concealment and camouflage for protection. The aerial array is generally smaller and consists of a wooden framework which is often manually rotated. The transmitter-receiver is often housed in a tent. Figure ATSF/TMT–2/D2 shows one such early warning radar installation. A probable mobile early warning radar is shown in figure ATSF/TMT–2/D3.

Although it is known that the Japanese have anti-aircraft radar gun control and radar searchlight control, not much is known to date about their construction. A probable fire control and searchlight control radar is illustrated in figure ATSF/TMT–2/D4. It is essentially similar to the early warning radar except for the provision for elevating the radar screen. Another type of fire control radar is shown in figure ATSF/TMT–2/D5. This radar, which was captured on Peleliu Island, Palau Group, was located in the center of a 4-foot high revetment. The large framework, which supports the aerial array, the vital equipment and seats for four operators who ride the mount, was set on a concrete base level with the ground.

3. Weapon Selection.

It is believed that the most vulnerable elements of the radar installations are the transmitters and receivers. These are composed of many small fragile parts which are very lightly protected if at all. In addition, trained personnel are difficult to replace and the attack should be designed to kill as many as possible.

Data from past experience upon which to base weapon recommendations are limited. Experience in the pre D-day attacks on German coastal radar installations indicates that machine gun fire is a very damaging form of attack. In addition, the installations can be attacked successfully with dive bombers carrying small instantaneously fused GP bombs. The best bomb is the one that can be carried in the greatest number.

The Napalm filled droppable tank is another weapon that can be employed profitably against these targets since many of the installations have wooden cabins and wooden frameworks for the support of the aerial array. The equipment also is vulnerable to fire. It is known that the Napalm bomb will cover an area of 20,000–30,000 square feet with severe fire and will destroy any inflammable material in this area. Attack should be made from altitudes less than 150 feet in order to obtain the greatest coverage. Current information on accuracy does not permit a definite statement on the probability of hitting the target, but in almost every instance any fire bomb that strikes 25–150 feet short of the target will prove effective. Few Napalm bombs should prove complete duds since those that fail to ignite upon impact are ignited by the flames from adjoining fire bombs while, as a last resort, unburned Napalm gel can be ignited by strafing.

4. Force Requirements.

To illustrate the calculation of the force required to destroy a typical radar installation the following computations are made. The target will be the radar cabin whose dimensions are 10 x 10 x 10 feet. This is enclosed in a protective revetment 30 feet in diameter. It is expected that a hit anywhere inside the revetment with a 100-lb. GP bomb will destroy the installation, or that a hit on the cabin with the 5-inch rocket projectile will destroy it.

The following accuracies will be taken:

(1) Dive bombing, CEP=200 feet.
(2) Medium level, CEP=600 feet.
(3) Rocket attack, CEP=30 feet.

NOTE.—CEP for rocket attack is determined by assuming that 50% will land within a circle of 20 mil radius. It is believed that a 500 yard range is necessary to identify this small target properly.

The single shot probabilities of destroying the installation are given in Table 2. Two values are given for each type of attack. The more conservative is based upon an assumed random distribution of hits; the other upon a normal distribution.

TABLE 2.—*Single shot probabilities*

Type of attack	Random distribution	Normal distribution
Dive bombing	0.0028	0.0039[1]
Medium level	.00031[1]	.00043
Rocket attack	.0177	[1].0246

[1] Dive bombing and rocket hits follow a *normal* distribution, while medium level hits give a nearly *random* distribution.

Table 3 shows the number of bombs or projectiles which must be individually aimed at the target for each of several probabilities that it will be destroyed.

TABLE 3.—*Number of bombs or rockets required to destroy typical radar installations*

Probability	Rocket attack 5-inch H. V. A. R. CEP=30 feet		Dive bombing attack 100-lb. GP bomb CEP=200 feet		Medium level attack 100-lb. GP bomb CEP=600 feet	
	Random distribution	Normal distribution	Random distribution	Normal distribution	Random distribution	Normal distribution
0.25	16	12	102	74	930	675
0.50	39	28	247	177	2,250	1,630
0.75	78	56	494	354	4,500	3,260
0.90	129	92	820	588	7,450	5,410

Most efficient selection of tactics and weapons depends upon operational conditions which can only be assessed in the field. To illustrate the method of selection it will be assumed that a 50% probability of destruction is desirable. It will also be assumed that the aircraft assigned to the mission can carry the following loads: (1) rocket carrying aircraft, 8 rockets, (2) dive bomber, 2 or 4 100lb. GP bombs and (3) medium level bomber, 20 or 40 100 lb. GP bombs. The number of sorties required will therefore be:

	Random Distribution	Normal Distribution
Rocket attack	39/8=5 sorties	28/8=4 sorties.
Dive bomber attack	247/2=124 sorties	177/2=89 sorties.
	247/4=62 sorties	177/4=45 sorties.
Medium level attack	2250/20=112 sorties	1630/20=82 sorties.
	2250/40=56 sorties	1630/40=41 sorties.

It is evident that, in this case, rocket attack will accomplish the desired results with the minimum effort. Stowage requirements and assumed accuracies may alter the indicated relative efficiencies, particularly between the dive bombing and medium level attack. An additional advantage of dive bombing over medium level will result from the difficulty in locating the target from medium altitudes.

IV. RADIO COMMUNICATION

1. Function and Use.

Radio communication is an integral part of the Japanese military system and has been developed to a high degree. Equipment ranges from low frequency (long range) to high frequency (short range) types. The installations differ so widely that no possible generalizations can be made. Although the installations are vulnerable to attack, improvization is readily accomplished and disruption of the radio communications system is most difficult.

2. Structural Analysis.

A typical installation consists of a small building, of approximate dimensions 20–40 feet, one or two stories high. The structure may be of almost any type capable of housing the vital equipment and the operators. Many buildings are of wooden construction. Protective measures are non-existent or most limited. The antenna towers are the most distinguishing features of a radio communications station. A single mast represents an installation of the high or very high frequency range, two or more masts less than 300 feet high probably belong to a low frequency installation, while two or more towers 400–600 feet high are certain to belong to a low frequency system.

3. Weapon Selection.

The most vulnerable element of a radio communications system is the equipment housed in the control building. Since destruction of the building will also destroy the equipment, weapon selection and type of attack should be based upon the nature of this structure. Since most radio communications installations are housed in small wooden buildings, weapons and tactics recommended are similar to those for radar installations, although a particular target may require other weapons.

V. DIRECTION FINDERS

1. Function and Use.

A direction finder is used to determine the direction and the distance of the source from which radio impulses are being sent. As such it can give bearings to aircraft or ships and guide these craft to an airport or harbor.

2. Structural Analysis.

Most identified Japanese direction finder stations are of the type illustrated in Fig. ATSF/TMT–2/D6. This consists of a small square structure, shown in figure ATSF/TMT–2/D7, of approximate dimensions 20 by 20 feet and 30 feet high, set in the center of a larger square at whose corners are the towers supporting the antenna. The structure, which houses the equipment, is believed to be the most vulnerable component. The majority of such structures encountered to date have been built of wood.

3. Weapon Selection.

It is believed that the weapons and tactics recommended for radar installations are equally applicable to direction finder installations.

VI. NAVIGATIONAL AIDS

1. Function and Use.

A navigational aid station transmits a radio beam of certain intensity and direction for aircraft or ships to ride to their objectives.

The Japanese have no known true navigational aids but it is known that they have received German assistance and it is possible that German type navigational aids may be encountered in the future. Several German type navigational aids are illustrated in figure ATSF/TMT-2/D8.

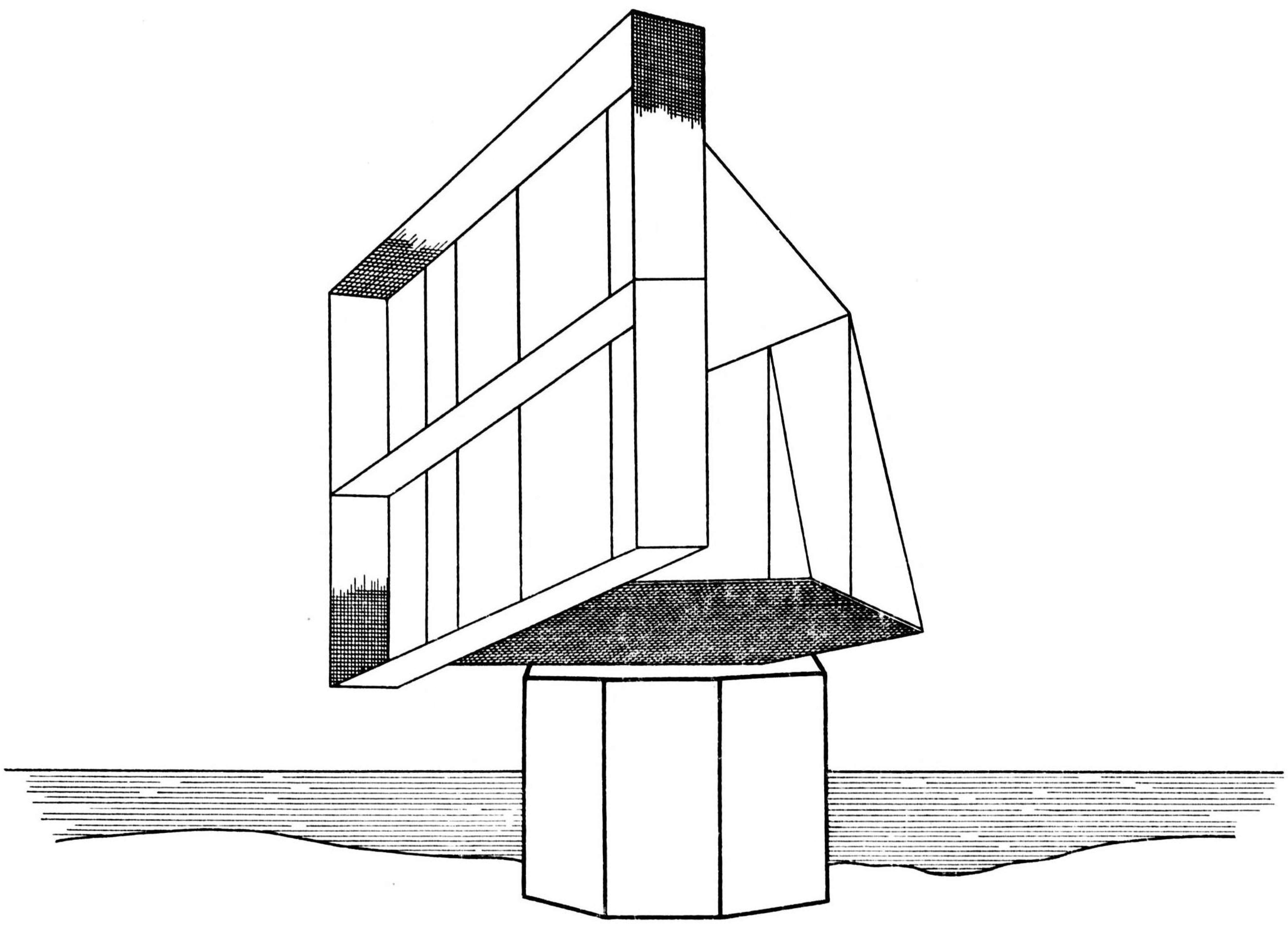
2. Structural Analysis.

These installations are larger than those previously treated. Type 1 (Ruffian) consists of a spiral-like revetment which protects the equipment and a horizontal cross arm, 45 feet long, extending outside the walls. Type 2 (Benito) consists of a horizontal cross arm, 65–70 feet long, mounted on a small rotating base which may be set on the structure housing the equipment or on a mound nearby. Type 3 (Knickbein) consists of a large horizontal arm in a very broad V, mounted on two supports, span about 145 feet, which rotates on a peripheral track.

3. Weapon Selection.

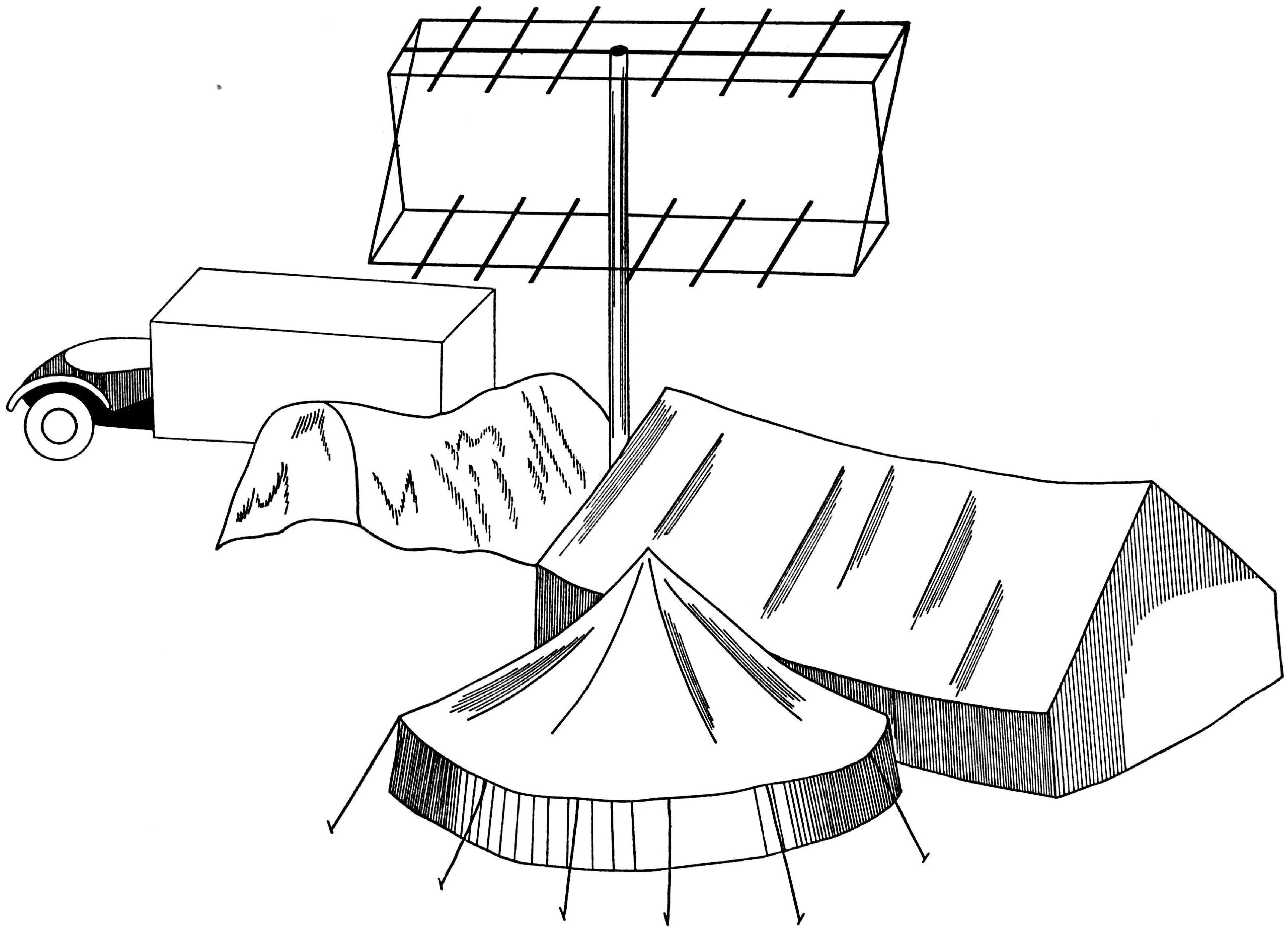
It is the German practice to protect their installations as far as possible with substantial antiblast walls. It is believed that these installations are best attacked by dive-bombing with fighter/bombers armed with 100 lb. GP bombs or 5-inch rockets, fuzed instantaneous, since a direct hit is necessary for destruction.

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS—AFTER SHEET ATSF/TMT-11, PAGE 4



JAPANESE FIXED EARLY WARNING RADAR

Screen and cabin mounted on high concrete base. 10′ x 10′ cabin not shown. 28′ x 18′ box-like metal screen for aerial array; often found with low concrete base and low revetment with diameter slightly larger than screen.



JAPANESE PORTABLE EARLY WARNING RADAR

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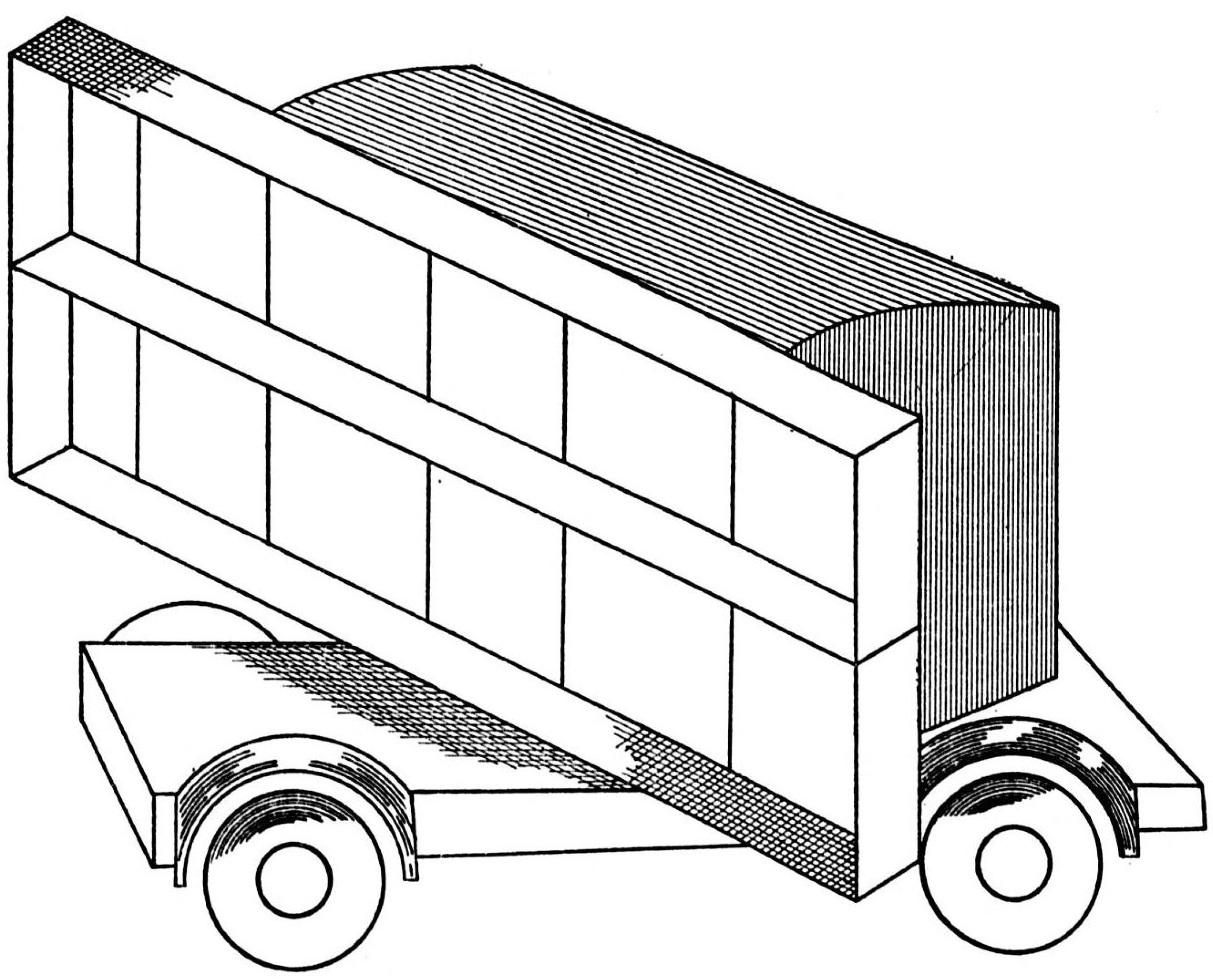

JAPANESE MOBILE EARLY WARNING RADAR

Believed to be self-contained unit having own power supply—trailer requires separate tractor for mobility.

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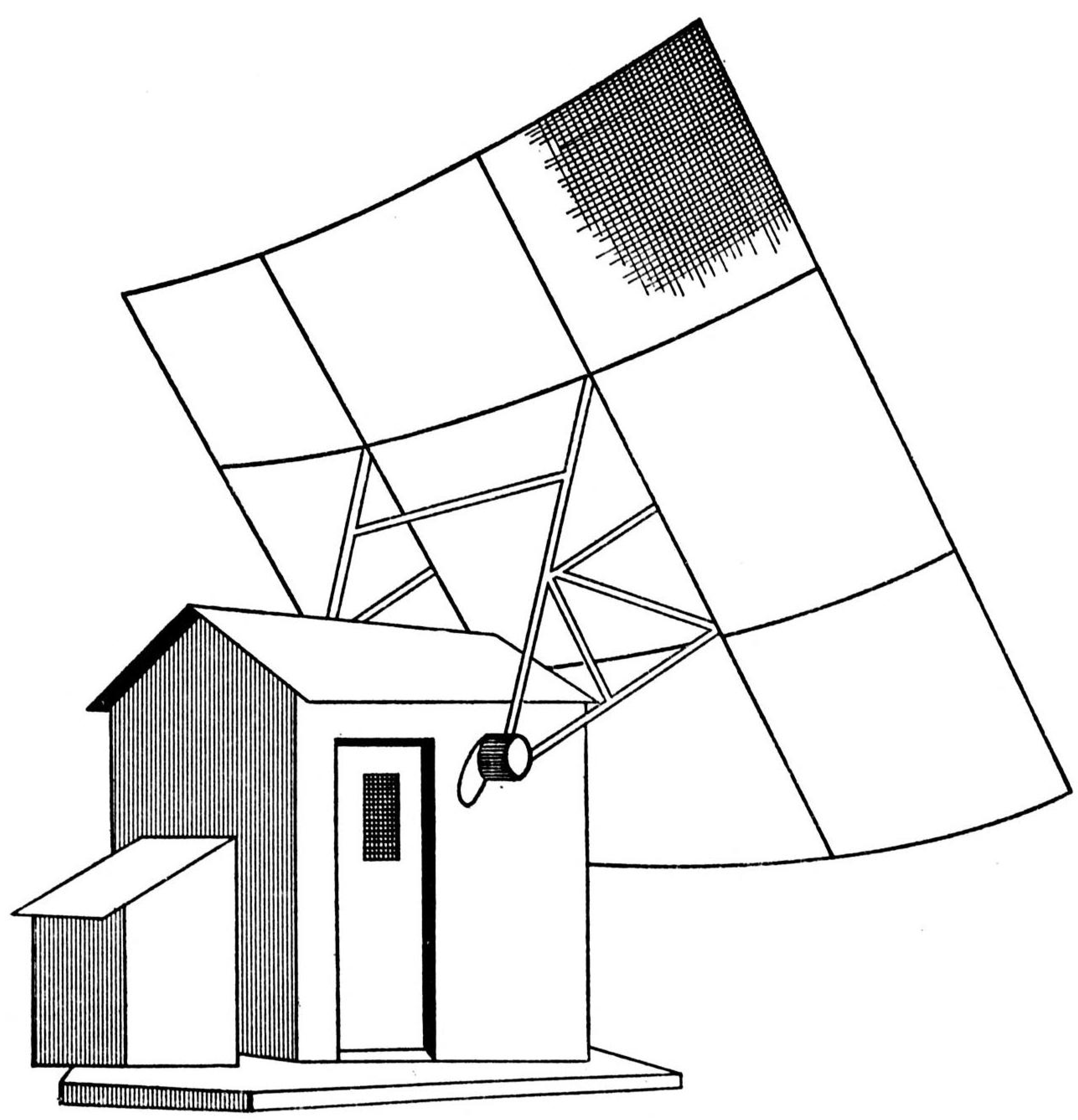
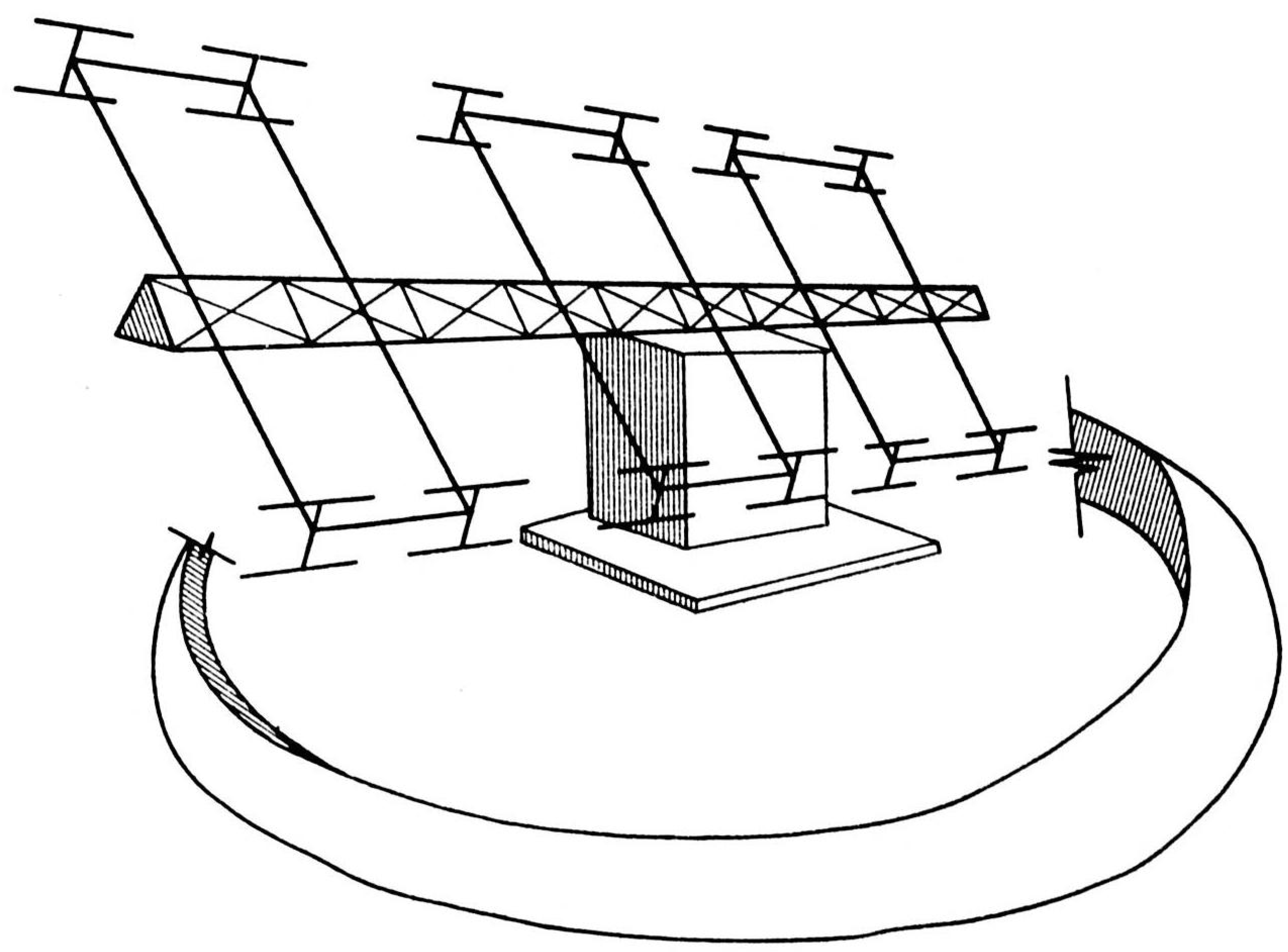


PROBABLE JAPANESE A. A. & S. L. CONTROL RADAR

HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS—AFTER SHEET ATSF/TMT-11, PAGE 4



JAPANESE A. A. & S. L. CONTROL RADAR

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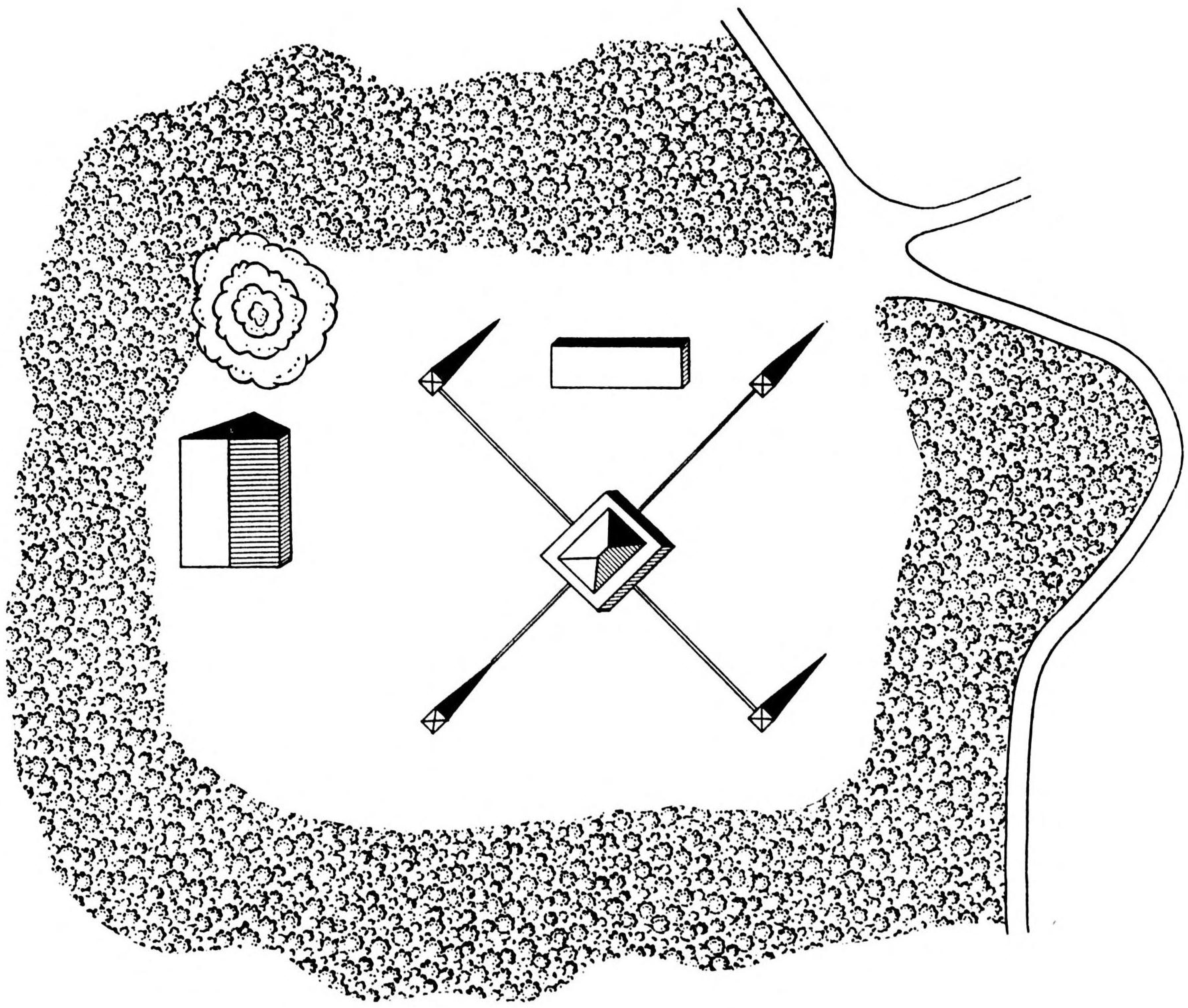
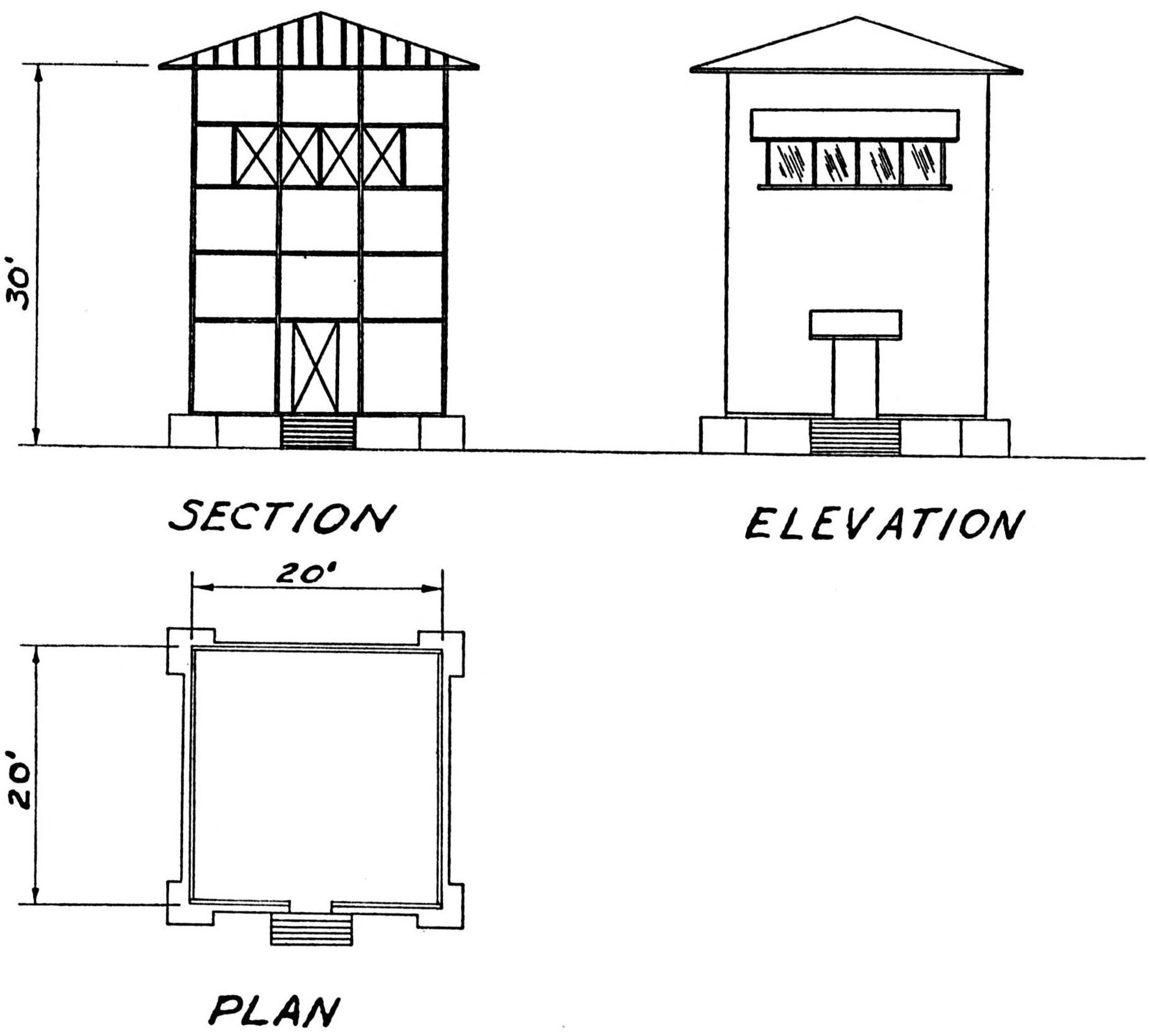


TYPICAL JAPANESE DIRECTION FINDER STATION

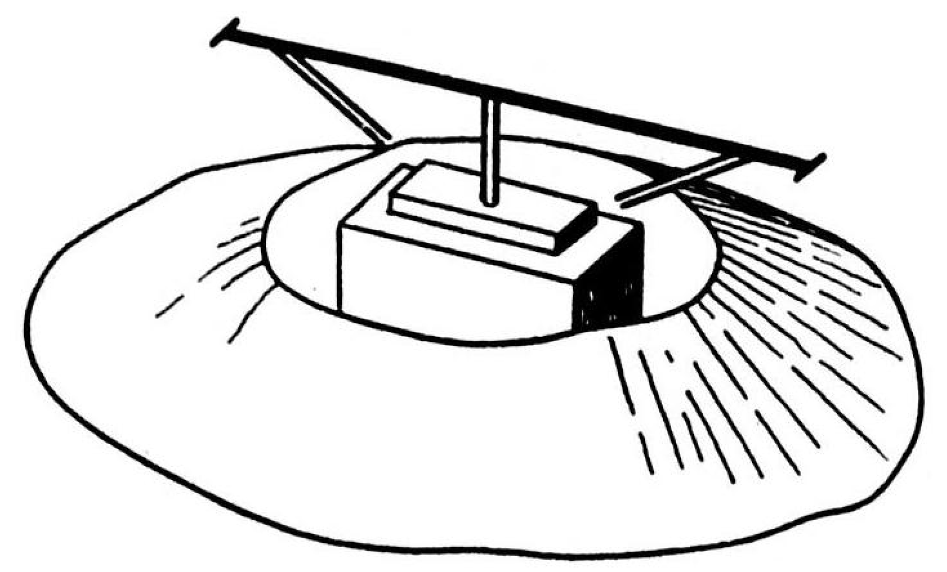
ADCOCK INSTALLATION

4 Towers at Corners of 140′ square

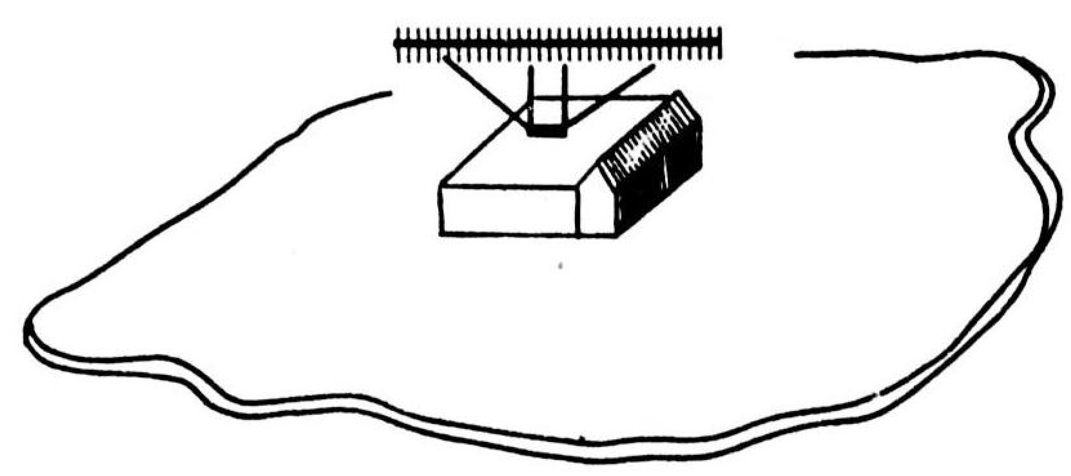
HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS—AFTER SHEET ATSF/TMT-II, PAGE 4



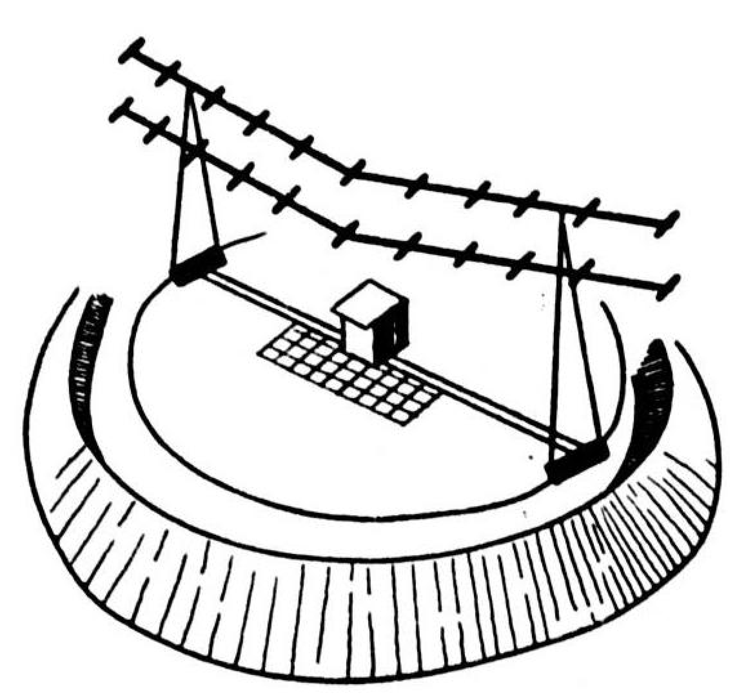
TYPICAL JAPANESE STRUCTURE HOUSING D. F. EQUIPMENT



"RUFFIAN"



"BENITO"



"KNICKBEIN"

GERMAN TYPE NAVIGATIONAL AIDS

JOINT TARGET GROUP, WASHINGTON, D. C.
GENERAL ANALYSIS

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Date: 24 March 1945
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HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER—TYPICAL JAPANESE MILITARY TARGETS—AFTER SHEET NO. ATSF/TMT-II

TYPICAL JAPANESE MILITARY TARGETS
PART III—FUEL STORAGE

I. SUMMARY

Oil and fuel stored for military purposes is frequently an unsatisfactory target for aerial attack, unlike storage for naval and civilian uses. This is because military storage is generally dispersed in comparatively small units that are difficult to identify and sometimes resistant to attack.

Exposed tanks are the best targets. They can be attacked successfully with small GP bombs or with rockets which will spill contents and start fires. Strafing should accompany rocket attack.

Buried tanks are generally too difficult to identify and to attack to be recommended as primary targets. Some damage to them may be expected from large bombs intended for other installations.

Bomb resistant structures, although too small and unimportant to be recommended as targets for bombing, can be expected to suffer some damage from any very large bombs missing adjacent primary targets. If these structures are to be primary targets, the preferred weapon is the 5″ HVAR (High Velocity Aircraft Rocket), with slight delay fuzing, aimed at sides.

Fuel dumps are suitable for strafing with incendiary bullets.

TABLE I.—*Weapon recommendations for attack of military fuel storage*

Target	Recommended weapons for attack as primary target			Other effective weapons if incidental to attack of adjacent target		
	Type of attack	Weapon	Fuzing nose/tail	Type of attack	Weapon	Fuzing nose/tail
Surface tanks. (Steel; 20′-75′ diam. 30′ high).	Min. level. Low and med. level (not below 500′). High level.	5″ HVAR and strafing. 100 lb. GP (table 2). None.	I/ND 0.1/0.025	Med. and high level.	Any GP bombs.	Delay
Buried tanks. (Steel or concrete; 1′-6′ earth cover).	None	----------	----------	Med. and high level.	500 lb. or larger GP or SAP provided perforation occurs (table 3).	0.1/0.1
Storage in bomb-resistant structures (concrete walls 1′-3′; roofs 2′-5′).	Min. level. Med. and high level.	5″ HVAR, nose plug. None.	/.015	Med. and high level.	1,000 lb or larger GP or SAP provided perforation occurs (table 3).	0.1/0.025
Cans or drums in open or in light structures.	Min. level. Med. and high level.	(1) Strafe with incendiary bullets. (2) 5″ HVAR. None.	I/ND	----------	IB Small GP. FRAG.	---------- I/ND

II. TYPES OF STORAGE

Most military installations have one or more of the following types of fuel storage:

1. Surface tanks.
2. Buried tanks.
3. Tanks or drums in bomb-resistant structures.
4. Drums or cans in the open or in light structures.

Although fuel is essential for the operation of any installation, fuel storage is not always a profitable primary target. The tanks are usually small and dispersed over a large area, requiring heavy attack for moderate success. They may be camouflaged, hidden by natural cover or buried, and are, in general, hard to locate. Exposed tanks are good targets for strafing or rocket attack. Damage to fuel supplies by bombs intended for other targets will frequently be significant. Upon occasion, it may be that neutralization of a particular installation can best be accomplished by destroying fuel supplies.

III. SURFACE TANKS

Surface tanks are primarily used for bulk gasoline, and to a less extent diesel oil. They are usually of steel plate but occasionally are of concrete. The tanks found at military bases usually range from 20 to 75 feet in diameter and up to 30 feet in height. The plates of steel tanks vary from 3/16 inch on roof and higher side courses to ½ inch at bottom. Seams may be either riveted or welded.

Such tanks can best be destroyed by spilling the contents through ruptured side plates, following this with ignition. Rupturing of steel tanks can be accomplished by rockets or small HE bombs, but the 5-inch HVAR is preferred because of its aimability. It should be fuzed instantaneous nose. Strafing with cal .50 incendiary ammunition will prove effective and should always accompany minimum altitude attack by other weapons.

For bombing, the 100 lb. GP 0.1/0.025 is recommended. For full tanks this fuzing will result in detonation approximately 10 feet below the roof when bomb is dropped from 4,000 feet.

Bombs falling outside a tank can do only negligible damage to it, while those inside must explode within a certain distance from the plates to cause rupture. Table 2 shows the expected effectiveness of 100 GP bombs against steel oil tanks.

TABLE 2—*Effectiveness of 100 pound GP against steel tanks*

Tank diameter in feet	Plate thickness 12 feet below top	Effective distance (inward from plating) 100 lb. GP	Tons/1,000,000 square feet for 50% expected destruction
		Feet	
Under 45	3/16	10.0	55
45–90	1/4	8.5	25
90–110	5/16	7.5	20
110–130	3/8	7.0	17

IV. BURIED TANKS

Buried tanks serve the same purposes as surface tanks. They may be of steel or of reinforced concrete, the roof being supported by columns. Cover consists of 1 to 6 or more feet of earth.

Such tanks are usually difficult to locate and are sufficiently well protected to be immune to attack except by large bombs. Damage can be produced only by a direct hit or by a very near miss. The probability of fire is small, while a fire, if started, will not spread to neighboring tanks and is comparatively easy to extinguish. The greatest effect to be expected is loss of fuel through seepage. The extent of such seepage depends on the nature of the subsoil which cannot be ascertained with any accuracy.

The selection of weapons depends upon the amount of earth cover and upon the thickness of concrete slab (if any). This information is usually not available. For this target the best weapon will be the smallest GP or SAP (fuzed 0.1/0.1) that will perforate the tank cover. Table 3 gives combinations of earth and concrete penetrable by various bombs from different heights.

At Saipan, buried steel tanks 220 feet in diameter were found. Roofs were of 2 foot reinforced concrete, supported by steel I-beams, and covered with 5 to 6 feet of earth. From Table 3, it can be seen that nothing smaller than the 500 lb. SAP would be useful against such tanks.

In general, buried tanks are very unsatisfactory targets.

V. TANKS OR DRUMS IN BOMBPROOF SHELTERS

Oil stored in bombproof structures is usually diesel oil used for electric power generation. Storage is in steel tanks approximately 10 feet in diameter and 10 feet high or in standard 50-gallon drums. Buildings are of reinforced concrete 20 to 50 feet square with 2-foot walls and 2- to 5-foot roofs. To destroy contents completely a weapon must perforate, explode inside, rupture the tanks, and start a fire.

The 5″ HVAR with SAP nose and .015 tail fuze is the best weapon due to its aimability and penetrating power. Attack should be directed against the walls rather than the roof since 3 feet is about the upper limit for perforation.

GP bombs smaller than 1,000 lb. will have no effect. Consequently, damage to this type of storage can only be expected when 1,000 lb. or larger GP are used against nearby installations. *Because of the size of the structures and the relative unimportance of this type of storage, this should never be a primary bombing target.*

TABLE III.—*Heights of (level) bomb release (in units of 1,000) feet for perforation of earth plus reinforced concrete (3,400 p. s. i.) heights less than 2,500 feet are not recommended because of likelihood of ricochet*

Bomb	100 GP		250 GP			500 GP			1,000 GP			500 SAP					1,000 SAP						
Thickness earth (ft.) \ Concrete thickness (ft.)	0	(Lim) 1	0	1	(Lim) 1.5	0	1	(Lim) 1.5	0	1.5	(Lim) 2¼	0	2	3	4	5	0	2	3	4	5	6	7
0	----	5	----	3.5	5	----	3	4.5	----	4	5	----	3.5	8	14	25	----	2.5	5	9	14	22	30
2.5	2.5	10	2.5	6	8.5	2.5	6	8	2.5	5.5	9	2.5	6	12	20	----	2.5	4	7.5	12.5	17.5	30	----
5	5.0	25	2.5	9	14	2.5	8.5	12	2.5	8	13	2.5	8	15	30	----	2.5	5	10	15	30	----	----
7.5	7.5	----	6.5	12	30	4.5	12	16	3.0	11	25	----	----	----	----	----	----	----	----	----	----		
10	----	----	10.5	22	----	7	21	30	5	20	----	4	15	30	----	----	3.0	10	15	30	----	----	----
15	----	----	----	----	----	12.5	----	----	10.5	----	----	7.5	30	----	----	----	5	15	30	----	----	----	----
20	----	----	----	----	----	30	----	----	20	----	----	10.5	----	----	----	----	7.5	30	----	----	----	----	----
25	----	----	----	----	----	----	----	----	----	----	----	20	----	----	----	----	10.5	----	----	----	----	----	----
30	----	----	----	----	----	----	----	----	----	----	----	30	----	----	----	----	17.5	----	----	----	----	----	----
35	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	25.0	----	----	----	----	----	----

NOTE

1,000 AP perforates about 25% more than 1,000 SAP.
1,600 AP perforates about 40% more than 1,000 SAP.
Increasing concrete strength to 5,000 p. s. i. decreases perforation by about 25%.
Decreasing concrete strength to 2,000 p. s. i. increases perforation by about 25%.
Dive bombing (60° or steeper) is equivalent to level release from about 1,500 feet greater altitude.
LIM indicates maximum concrete thickness perforable without break-up.
For earth thickness from 2/3 to 3/2 maximum indicated there is high probability of bomb coming to rest and detonating in contact with concrete slab. Such tamped explosions are almost as effective as when perforation occurs.

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VI. CANS OR DRUMS IN THE OPEN OR IN LIGHT STRUCTURES

Cans or drums stored in the open or in light structures are generally used for gasoline, diesel oil, and lubricating oil for mechanized units or for motor transport. At outlying airfields they may be used for aviation gasoline.

Containers are of light metal and easily damaged. Fuel dumps are usually small and dispersed over a considerable area to prevent fire spread.

The object of attack is to start a fire which will spread through an entire unit. The most effective attack is by strafing with incendiary bullets. The 5-inch HVAR with fragmentation nose and instantaneous fuzing is also effective.

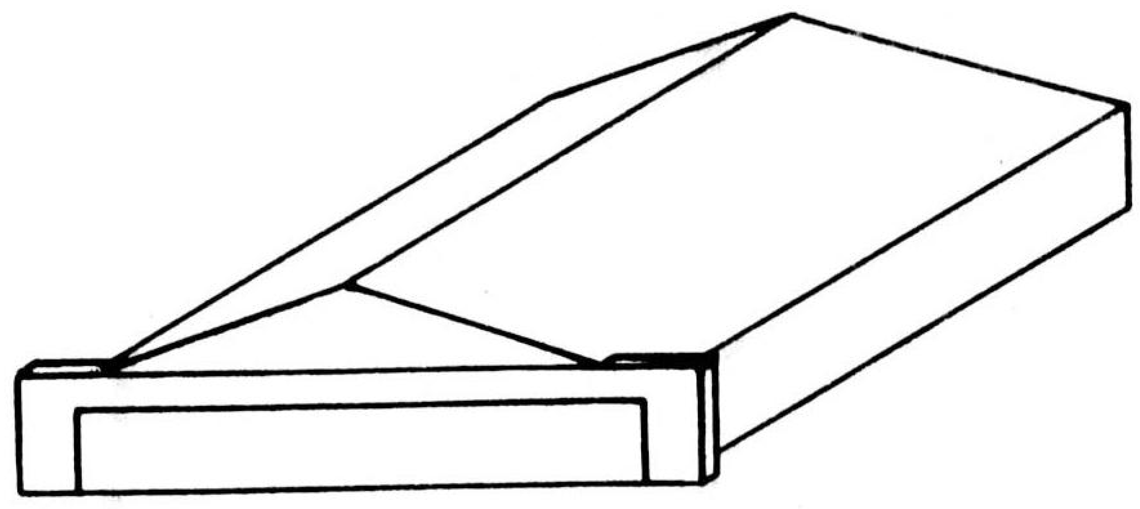
These dumps are not suitable primary targets for bombing attack. However, fragmentation and incendiary bombs that miss nearby primary targets can be expected to do useful damage.

Sheet No. ATSF/TMT/D1
Date 25 Feb 1945

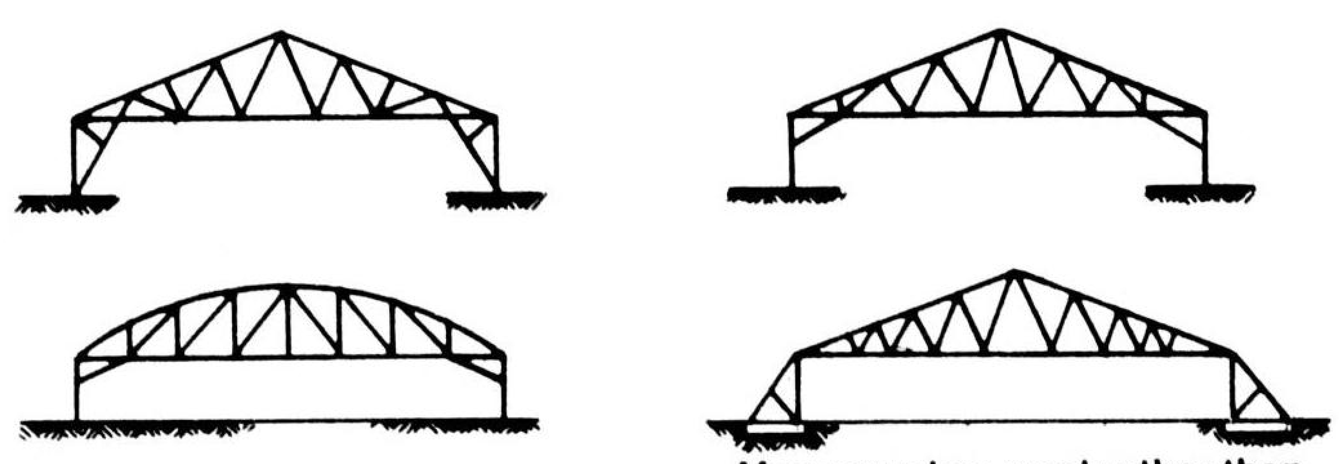
JOINT TARGET GROUP - WASHINGTON, D.C.

TYPICAL JAPANESE MILITARY TARGETS. PART 1-AIRFIELDS
TYPE 1 JAPANESE HANGAR STRUCTURES

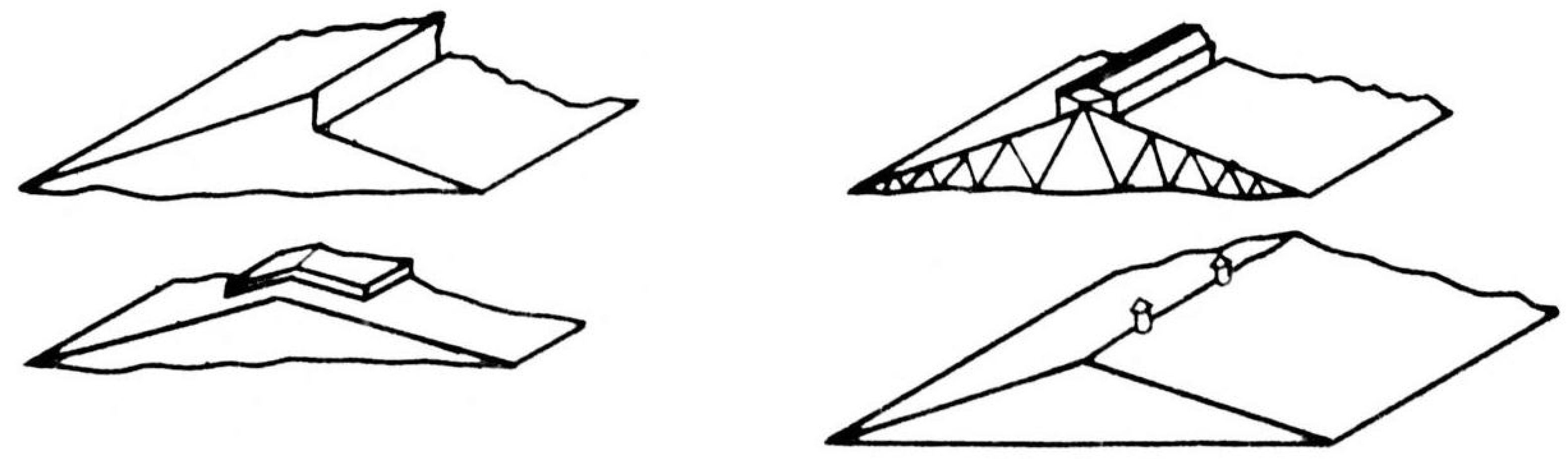
HOLDERS OF JTG FOLDERS SHOULD
THIS SHEET IN AIR TARGET SYSTEM
TYPICAL JAPANESE MILITARY TARGE



(a) BASIC SHAPE



(b) ROOF TRUSSES



(c) ROOF DETAILS

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Date 25 Feb 1945

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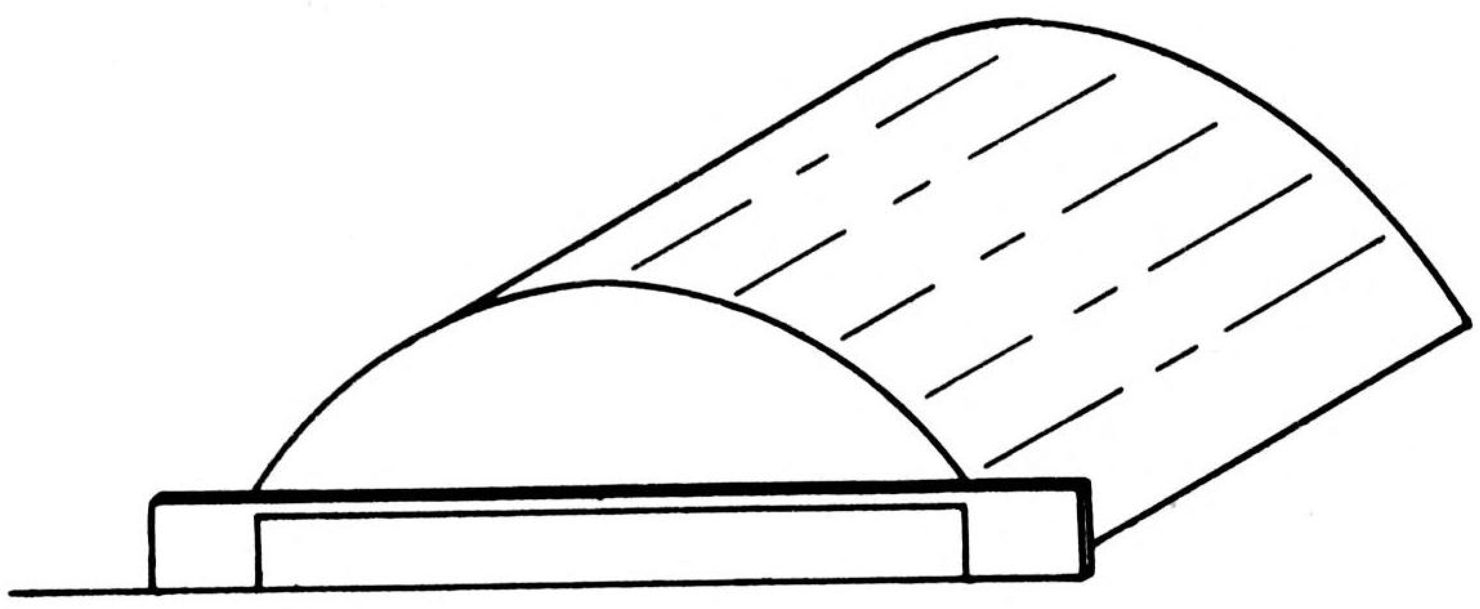
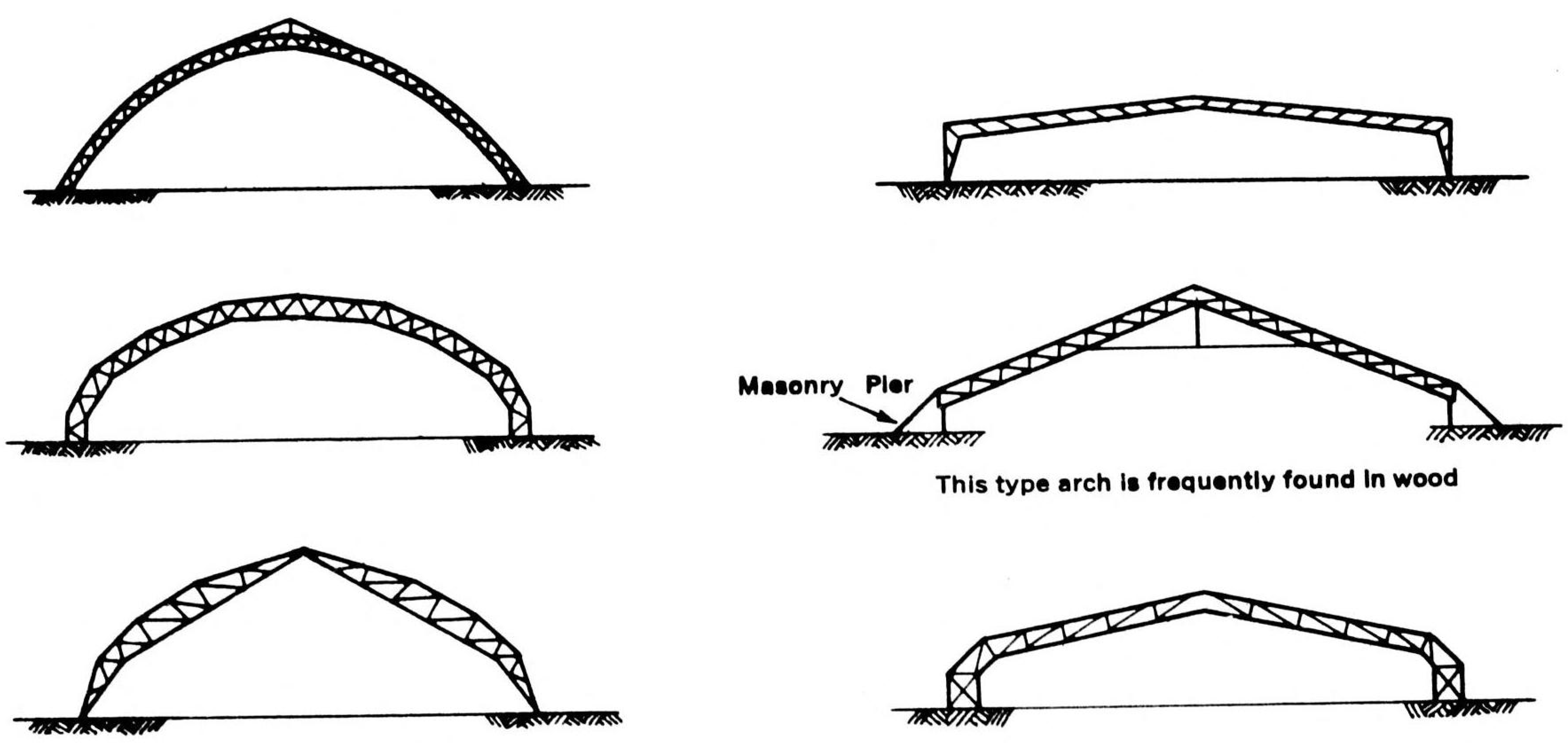
TYPICAL JAPANESE MILITARY TARGETS. PART 1-AIRFIELDS
TYPE 2 JAPANESE HANGAR STRUCTURES

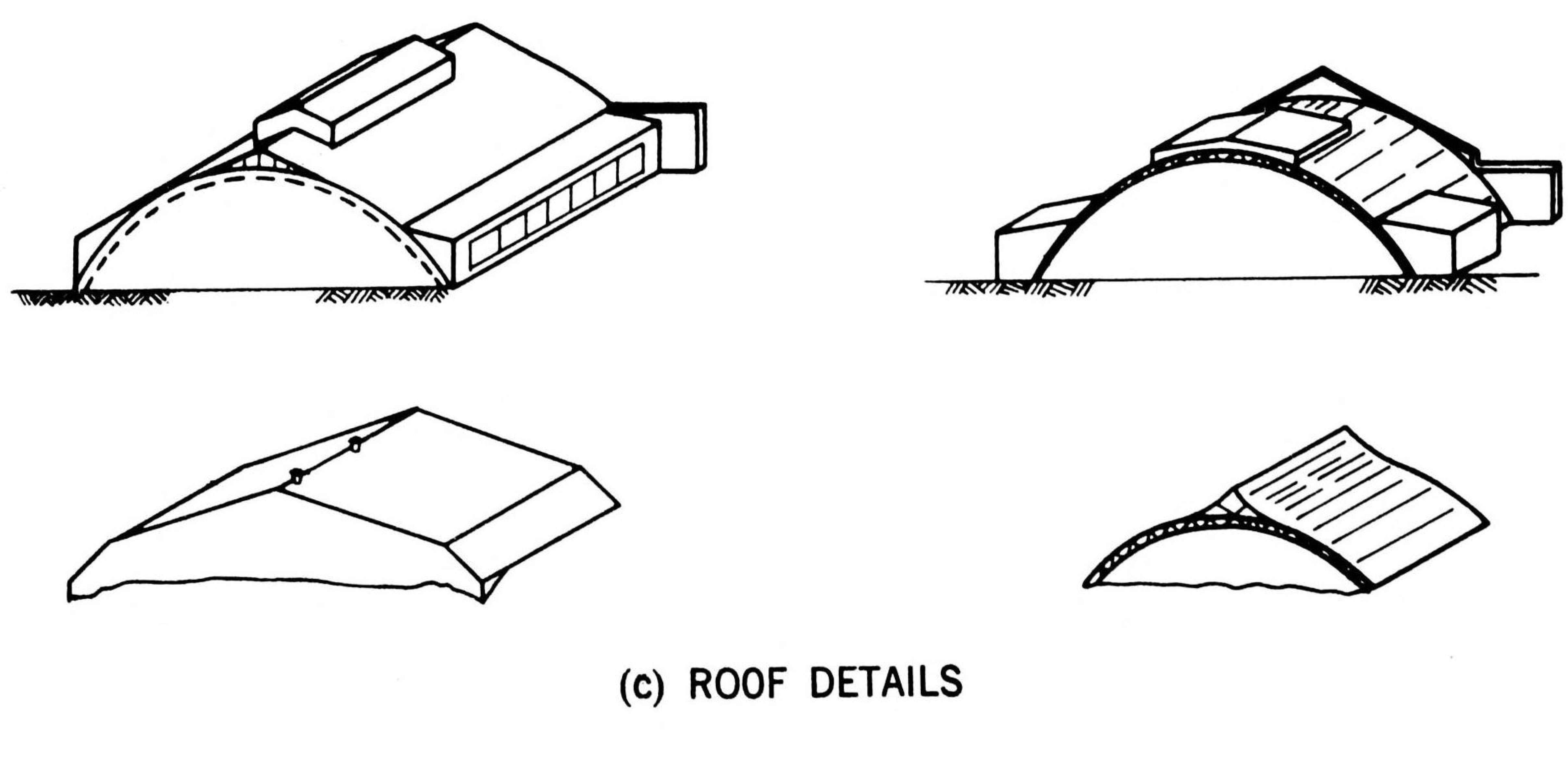
HOLDERS OF JTG FOLDERS SHOULD INSERT THIS SHEET IN AIR TARGET SYSTEM FOLDER: TYPICAL JAPANESE MILITARY TARGETS



(a) BASIC SHAPE



(b) POSSIBLE ARCH FRAMING



(c) ROOF DETAILS

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Date 25 Feb. 1945

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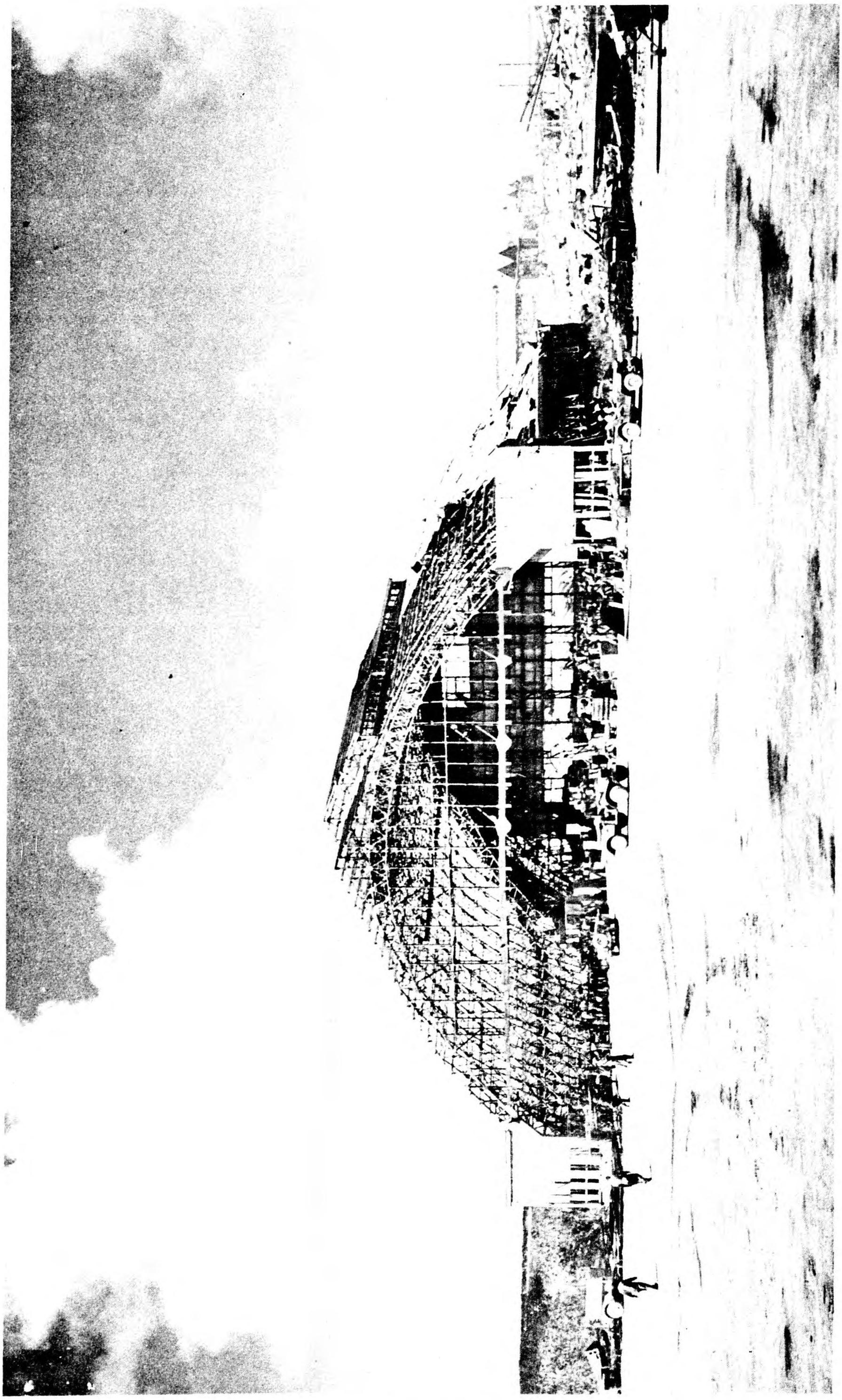
TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS

TYPE 2A PREFABRICATED JAPANESE HANGAR



(P)

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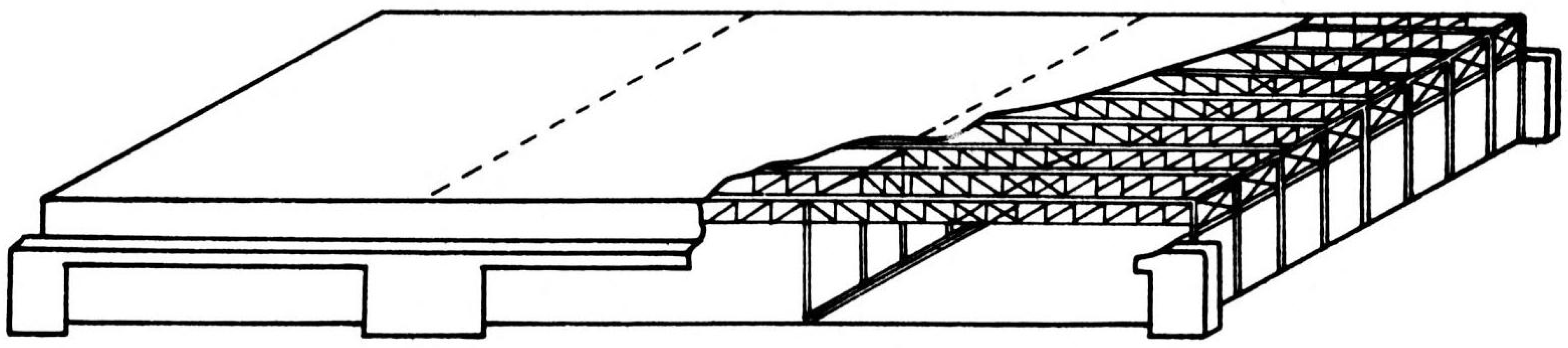
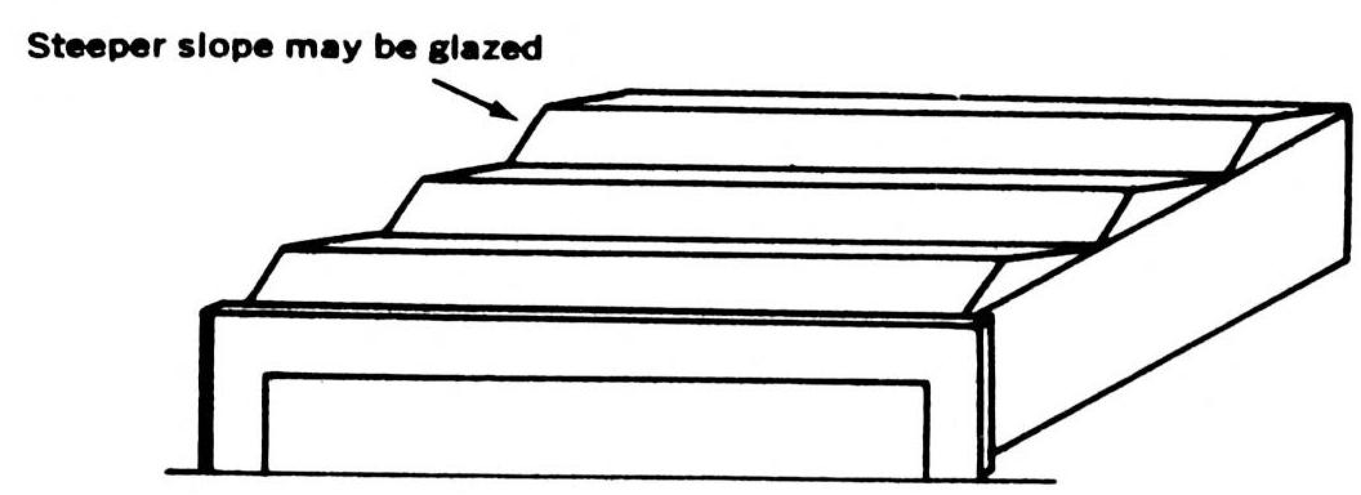
TYPICAL JAPANESE MILITARY TARGETS. PART 1-AIRFIELDS
TYPE 3 JAPANESE HANGAR STRUCTURES



(a) BASIC SHAPE



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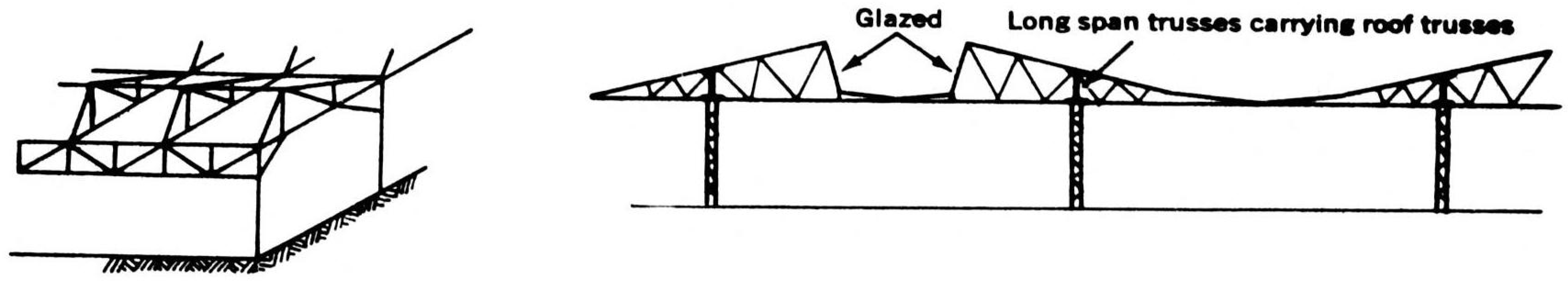

(c) POSSIBLE FRAMING DETAILS

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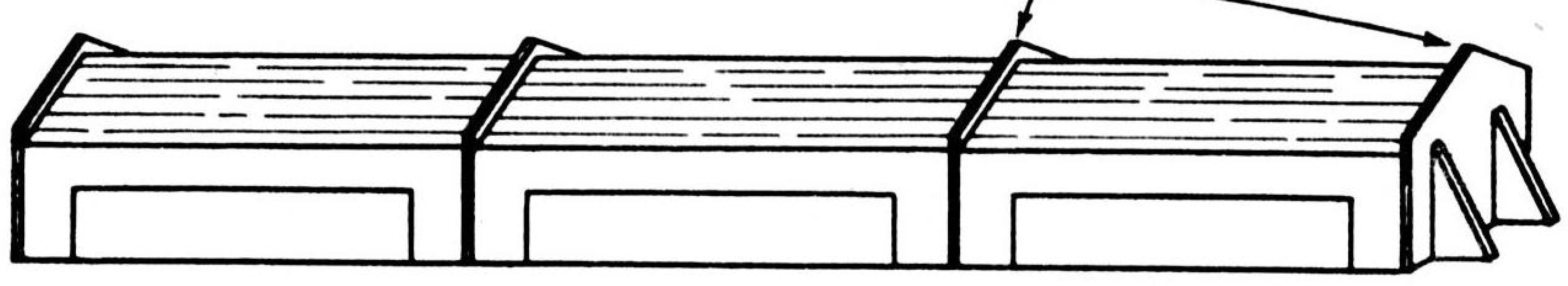
Date 25 Feb 1945

TYPICAL JAPANESE MILITARY TARGETS. PART 1-AIRFIELDS
TYPE 4 JAPANESE HANGAR STRUCTURES



HANGAR AT EAST AIRPORT, MUKDEN, MANCHURIA

Length 770′

Width 75′

Construction: Brick walls with corrugated galvanized iron roof, probably supported on wood trusses.

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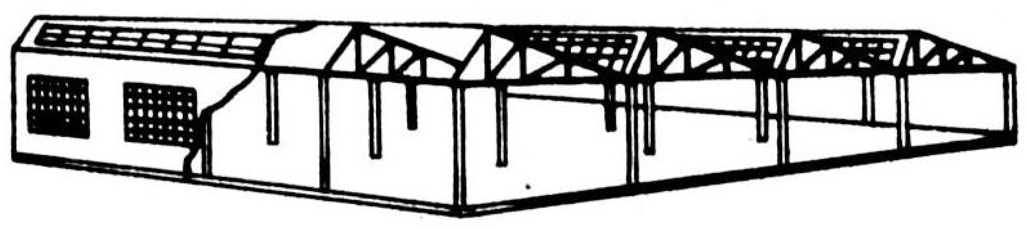
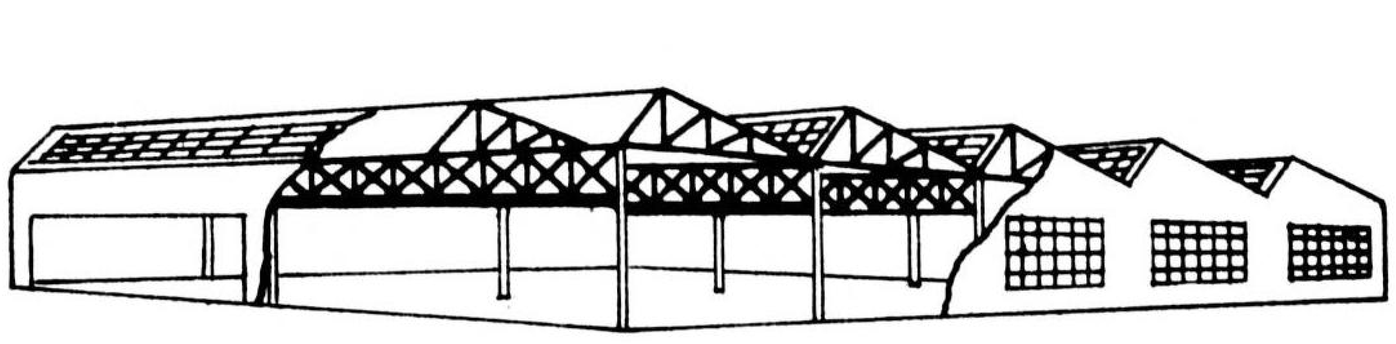
TYPICAL JAPANESE MILITARY TARGETS. PART 1-AIRFIELDS
JAPANESE FACTORY TYPE REPAIR SHOPS



(a) SHORT SPAN BUILDINGS



(b) LONG SPAN BUILDINGS

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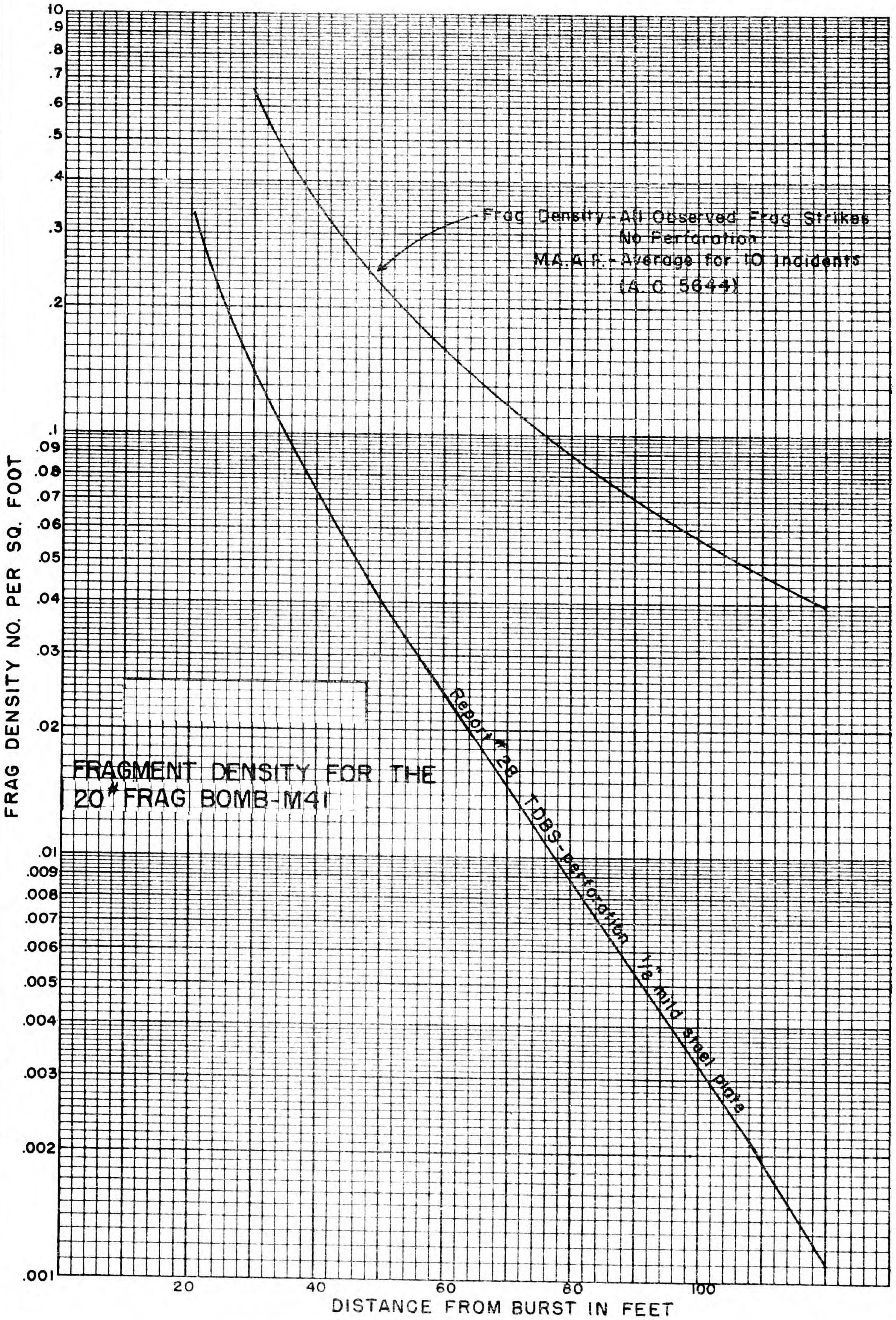
Date 25 Feb. 1945

TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS



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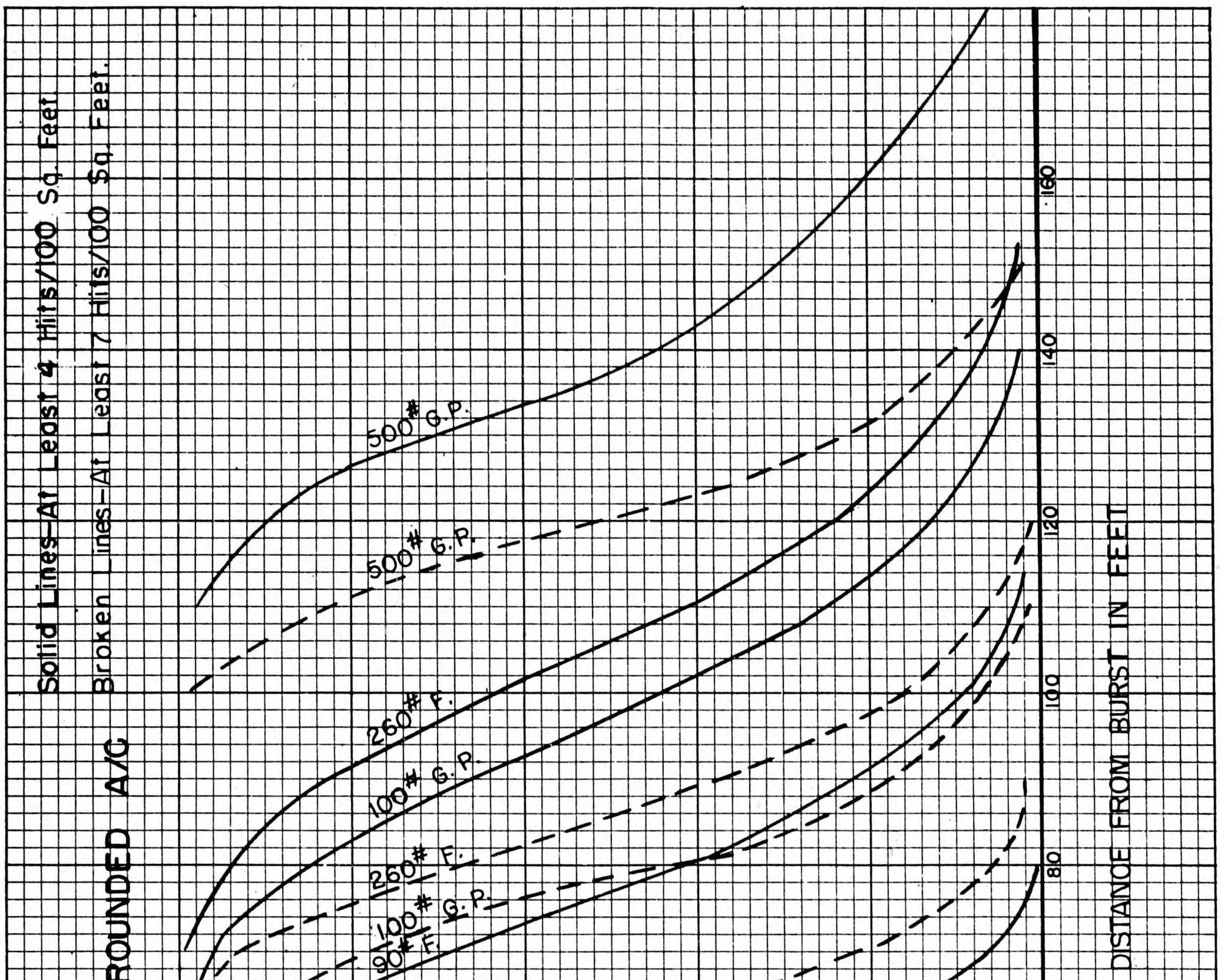
TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS



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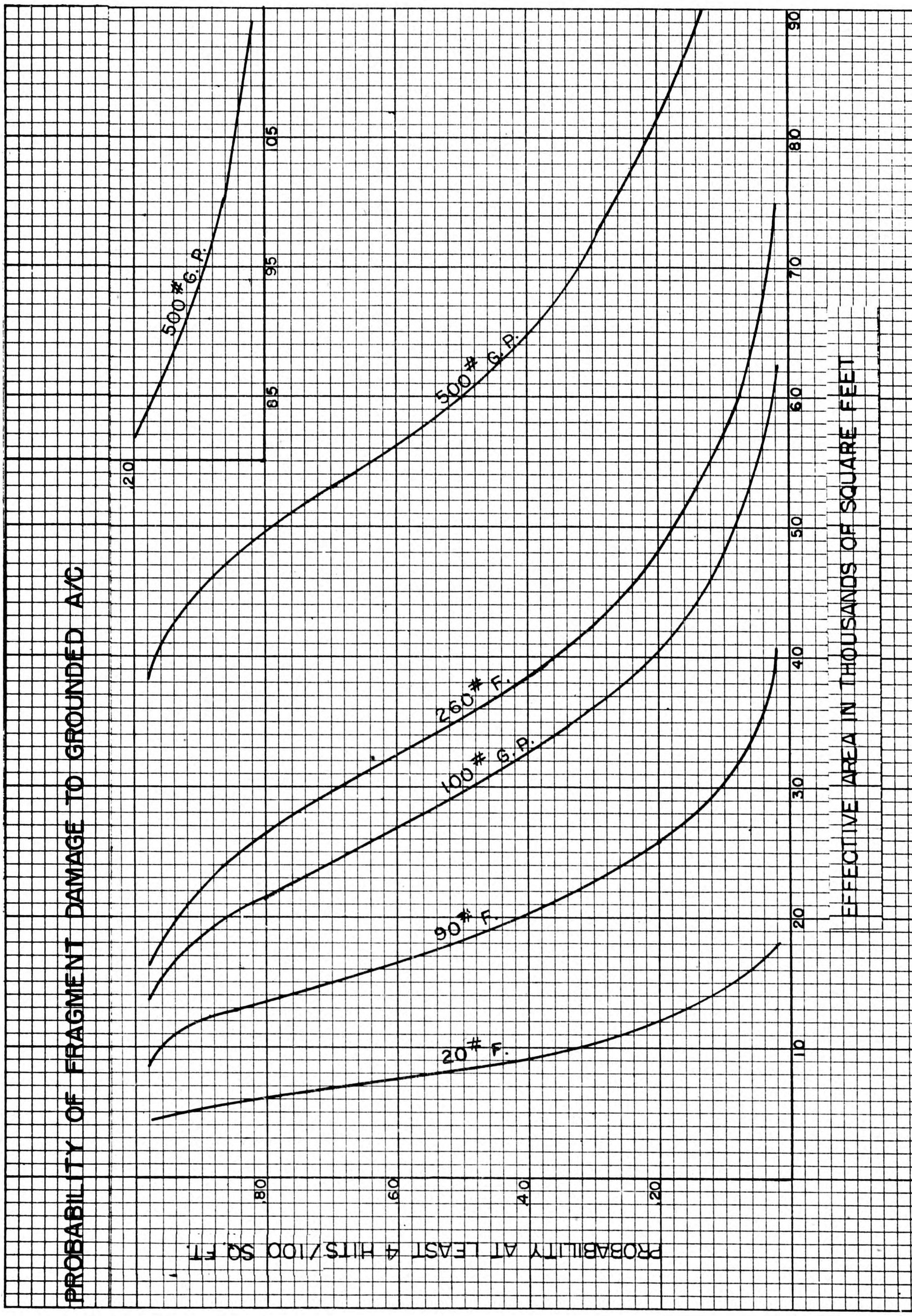
TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS



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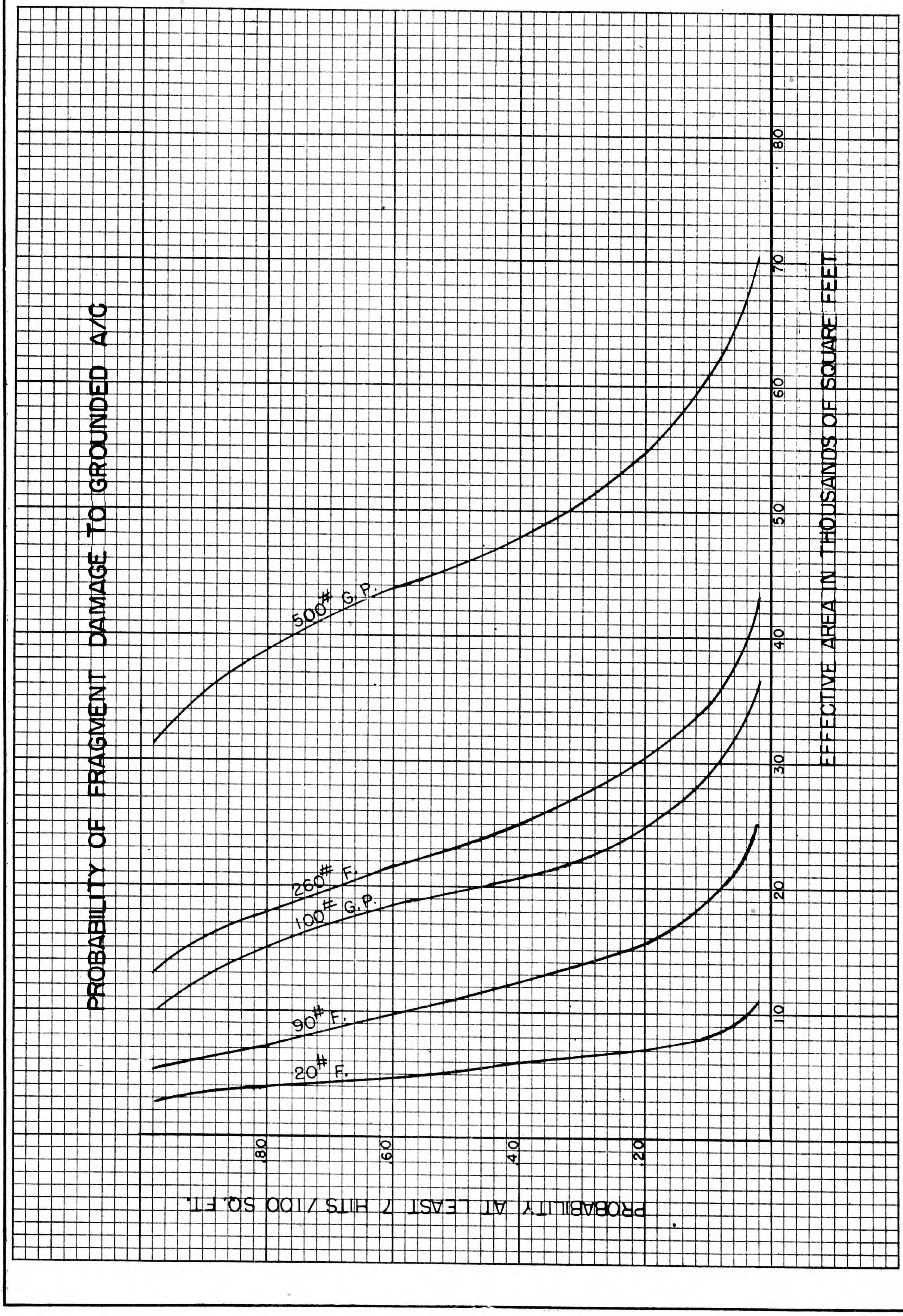
TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS



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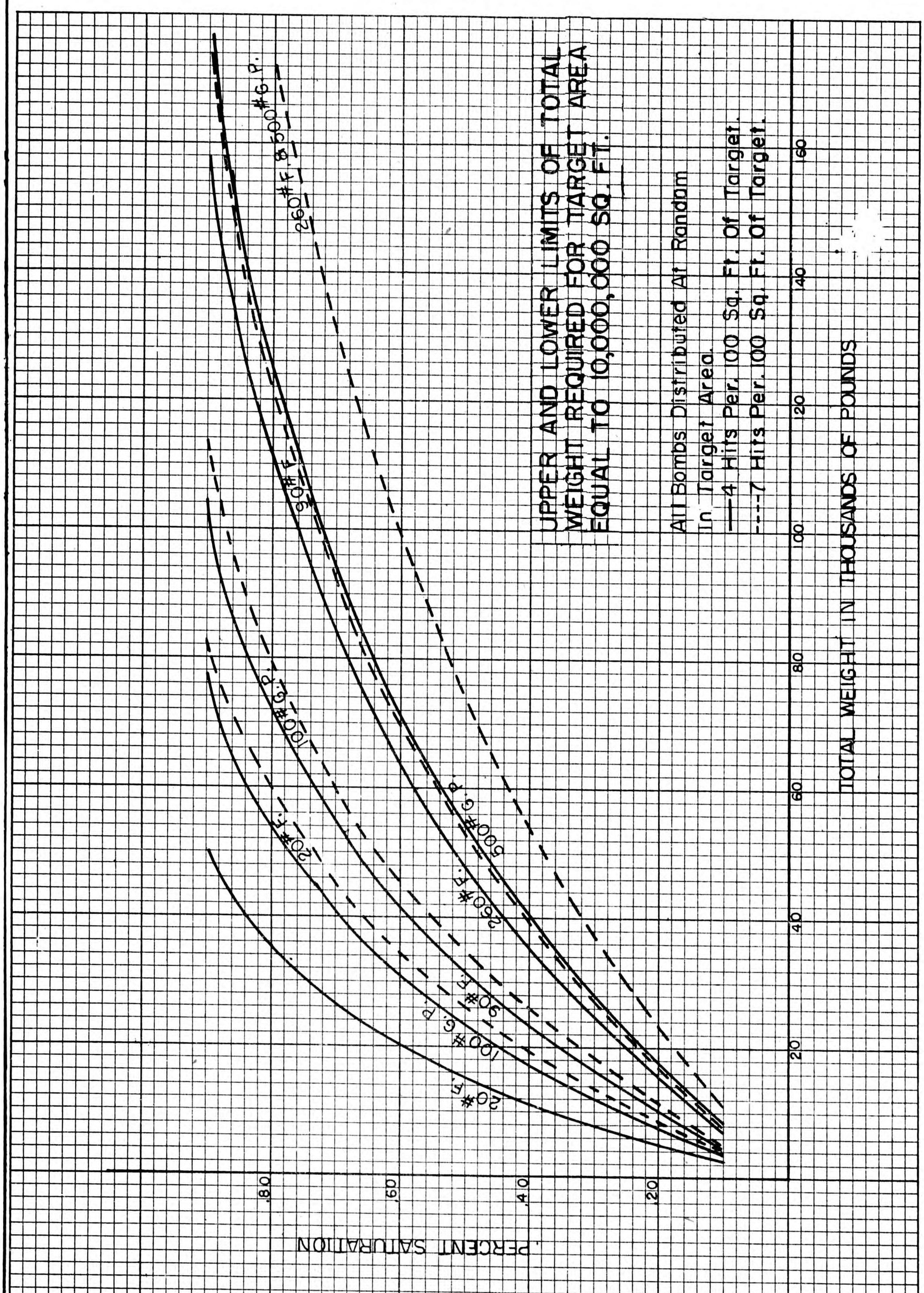
TYPICAL JAPANESE MILITARY TARGETS. PART I - AIRFIELDS



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Date **March 1945**

Issue No. **3**

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C. I. U.
XXI BOMBER COMMAND
APO 234, c/o POSTMASTER
SAN FRANCISCO, CALIFORNIA

(Combined PI Sections: 3rd Photo Recon Squadron and 35th Photo Tech Unit)

APPROVED AIRFIELD NAMES AND TARGET NUMBERS

4 May 1945

Attached is a list of airfields with names and target numbers which have been approved by XXI Bomber Command and Joint Target Group. All reports previously issued by the XXI Bomber Command C.I.U. should be changed to agree with the attached list.

Following abbreviations are used in attached Report.

SS - Seaplane Station
ASS - Auxiliary Seaplane Station

Hamilton D. Darby
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APPROVED AIRFIELD NAMES AND TARGET NUMBERS

29 April 1945

The following name changes have been made in Japanese Airfields:

Tomobe	to	Tsukuba
Tsukuba	to	Tsukuba West
Kikuchi	to	Tamana
Koteyama	to	Utsunomiya
Kurume	to	Metatsubara
Kushimoto	to	Shionomisaki
Shimomizo	to	Sagami
Sekimoto	to	Shimodate
Utsunomiya	to	Utsunomiya So.
Waifu	to	Kikuchi
Kuroiso	to	Nasuno

The following airfields have been confirmed by aerial photography, and AAF Target Numbers assigned as indicated. All maps, reports etc, should be corrected upon receipt of this list.

Target Area	Target Number	Name	Coordinates
90.25	2650	Akashi	34/40 N--134/57 E
90.24	1213	Akenogahara	34/32 N--136/40 E
90.34	1125	Ashiya	33/53 N--130/40 E
90.17	2750	Atsugi	35/27 N--139/27 E
90.32	2615	Bofu	34/02 N--131/33 E
90.38	2500	Byu	31/18 N--130/26 E
90.19		Chichi Jima, SS, Nanpo Shoto	27/05 N--142/11 E
90.38	2501	Chiran	31/21 N--130/26 E
90.17	1412	Chofu	35/40 N--139/32 E
90.14	2751	Choja	35/18 N--140/24 E
90.14	1464	Choshi	35/43 N--140/48 E
90.16	2811	Dodo	35/39 N--138/27 E
90.17	1410	Edogawa	35/42 N--139/55 E
90.23	2651	Fukuchiyama	35/18 N--135/10 E
90.18	2752	Fuji	35/07/30 N--138/39/00 E
90.17	2753	Fujisawa	35/21 N--139/28 E
90.34	2502	Fukuma	33/47 N--130/29 E
90.35	2503	Fukushima	33/13 N--130/32 E
90.35	663	Gannosu	33/40 N--130/24 E
90.37	2504	Goryo S.S.	32/30 N--130/12 E
90.19	2812	Hachijo Jima (Nanpo Shoto)	33/05 N--139/48 E
90.35	2505	Hakata S.S.	33/39/30 N--130/22 E
90.21	1222	Hamamatsu	34/45 N--137/43 E
90.25	2653	Hanshin	34/35 N--135/36 E
90.17	337	Haneda	35/33 N--139/46 E
90.10	2883	Harano	37/37 N--140/57 E
Nansei Shoto		Hegina (Ishigaki Jima)	24/23 N--124/12 E
90.23	2654	Himeji	34/53 N--134/52 E
Nansei Shoto		Hirara (Miyako Shima)	24/47 N--125/19 E
90.30	660	Hiro S.S.	34/13 N--132/37 E
90.30	2627	Hiroshima	34/21/30 N--132/27/00 E
90.30	2617	Hiroshima S.S.	34/21/30 N--132/27/00 E
90.30	795	Hiroshima North	34/24 N--132/29 E
90.37	2506	Hitoyoshi	32/13 N--130/49 E
90.14	1487	Hokoda	36/09 N--140/34 E
90.14	2754	Hyakurigahara	36/11 N--140/26 E
90.38	2507	Ibusuki S.S.	31/15/30 N--130/40 E
90.20	2655	Ifuna	34/56 N--136/30 E
90.14	2755	Iida	36/27 N--140/26/30 E
90.14	2756	Ikisu	35/53 N--140/39 E
90.13	2757	Imaichi	36/44/30 N--139/47 E
90.35	2508	Imajiku	33/35 N--130/15 E
90.14	2758	Imba	35/48 N--140/10 E
90.16	2759	Ina	35/50/45 N--137/59/30 E
90.38	2548	Inujo-Tanega Shima-Nansei Shoto	30/33 N--131/01 E

Approved Airfield Names and Target Numbers, cont'd.

90.17	2760	Irumagawa	35/50/30 N--139/24/30 E
90.35	2509	Isahaya	32/51 N--130/05/30 E
		Ishigaki-Ishigaki Shima-Nansei Shoto	24/20/30N-124/12E
90.14	2761	Ishioka	36/14 N--140/15/30 E
90.14	2762	Ishioka East	36/12 N--140/18 E
90.25	2656	Itami	34/47 N--135/26 E
90.36	2510	Itazuke	33/35 N--130/27 E
90.38	2511	Iwakawa	31/34/30 N--131/01 E
90.10	2885	Iwaki	37/25 N--141/02 E
90.30	732	Iwakuni	34/08 N--132/14 E
90.30	2618	Iwakuni S.S.	34/08 N--132/15 E
90.37	2512	Izumi	32/05 N--130/19 E
90.37	2513	Kagami	32/34/30 N--130/36/30 E
90.20	249	Kagamigahara	35/23 N--136/53 E
90.38	2514	Kagoshima	31/33 N--130/34 E
90.38	2515	Kagoshima S.S.	31/33 N--130/34 E
90.25	2657	Kakogawa (Onoe-Takasago)	34/44 N--134/49 E
90.24	2658	Kameyama	34/53 N--136/29 E
90.20	2659	Kamezaki	34/54 N--136/58 E
90.11	2660	Kanazawa	36/38 N--136/40 E
90.14	2763	Kanemaru	36/51/30 N--140/05 E
90.27	2585	Kannonji	34/07 N--133/41 E
90.38	1378	Kanoya	31/22 N--130/50 E
90.38	2516	Kanoya East	31/22/30 N--130/54 E
90.33	2517	Karasehara	32/13 N--131/33 E
90.14	1465	Kashima S.S.	36/00 N--140/23 E
90.17	2764	Kashiwa	35/54 N--139/57 E
90.14	1466	Kasumigaura	36/02 N--140/12 E
90.14	1491	Kasumigaura S.S.	36/03 N--140/14 E
90.14	2765	Katori	35/44 N--140/37 E
90.35	2518	Kikuchi	32/56/30 N--130/48 E
90.35	2519	Kikutomi	32/52 N--130/46 E
90.13	2766	Kiryu	36/20 N--139/18 E
90.14	373	Kisarazu	35/23 N--139/55 E
90.14	2767	Kisarazu S.S.	35/23 N--139/55 E
90.14	2768	Kitaura S.S.	36/00 N--140/34 E
90.20	2661	Kiyosu	35/13 N--136/50 E
90.25	1702	Kobe S.S.	34/43 N--135/17 E
90.28	2586	Kochi	33/32/30 N--133/41 E
90.13	2769	Kodama	36/13 N--139/08 E
90.16	2770	Kofu	35/38 N--133/31 E
90.13	2771	Koga	36/12 N--139/46 E
90.13	2772	Koizumi	36/17 N--139/24 E
90.38	2520	Kokubu	31/43 N--130/45 E
90.20	2662	Komaki	35/15 N--136/56 E
90.15	2663	Komatsu	36/23/30 N--136/25 E
90.27	2587	Komatsushima S.S.	34/00 N--134/38 E
90.27	2588	Komatsushima South A.S.S.	34/00 N--134/36 E
Nansei-Shoto		Koniya A.S.S (Amami Oshima)	28/09 N--129/18 E
90.14	1465	Konoike	35/55/30 N--140/41 E
90.38	2521	Korimoto	31/45/30 N--131/06/15 E
90.10	2773	Koriyama	37/22 N--140/24 E
90.20	2664	Kowa S.S.	34/46 N--136/55 E
90.13	1644	Kumagaya	36/09 N--139/18 E
90.35	2522	Kumamoto	32/48/30 N--130/46 E
90.35	2523	Kumanosho	32/43 N--130/45 E
90.24	2665	Kumozu	34/39 N--136/33 E
90.27	2619	Kurashiki	34/30 N--133/44 E
90.30	656	Kure	34/13/30 N--132/37 E
90.30	2620	Kure S.S.	34/13/30 N--132/37 E
90.24	2666-	Kushimoto S.S.	33/27/30 N--135/47 E
90.38	2524	Kushira	31/25 N--130/55 E
90.13	2774	Maebashi	36/23 N--139/01 E
90.13	2775	Magechi	36/07 N--139/22 E
90.22	2667	Maizuru S.S.	35/33 N--135/14 E
90.22	2668	Maizuru North S.S.	35/33/15 N--135/15 E
90.17	1416	Matsudo	35/47 N--139/58 E

Approved Airfield Names and Target Numbers, cont'd.

90.12	2776	Matsumoto	36/10/30 N--137/56/30 E
90.13	2777	Matsuyama	36/02 N--139/22 E
90.29	2589	Matsuyama West	33/49 N--132/43 E
90.20	2669	Meiji	34/54 N--137/02 E
90.35	2525	Metatsubara	33/19 N--130/25 E
90.13	2778	Mibu	36/27 N--139/50 E
90.26	2621	Miho	35/29 N--133/14/30 E
90.21	2670	Mikatagahara	34/47 N--137/44 E
90.25	2671	Miki	34/46 N--134/57 E
90.15	2696	Mikuni	36/14/30 N--136/11/30 E
Nansei-Shoto		Minami Daito-	25/51 N--131/14 E
90.25	2672	Minato	34/19 N--134/45 E
90.22	2673	Mineyama	35/36 N--135/05 E
90.14	1468	Mito	36/23 N--140/35/30 E
90.14	2779	Mito South	36/20 N--140/29 E
90.20	2674	Mitsubishi	35/01 N--136/56 E
90.33	2526	Miyaji	32/56 N--131/06/30 E
90.14	2780	Miyakawa	35/39 N--140/30 E
90.38	~~2527~~ 1379	Miyakonojo	31/44 N--131/03 E
90.38	2528	Miyakonojo North	31/48 N--131/04 E
Nansei-Shoto		Miyara-(Ishigaki)	24/22 N--124/15 E
90.38	2529	Miyazaki	31/53 N--131/27 E
90.14	2781	Mobara	35/26 N--140/19 E
90.20	2676	Nagoya S.S.	35/04 N--136/51/30 E
90.20	2675	Nagoya	35/04 N--136/51 E
90.20	2677	Nagoya East	35/07 N--137/09 E
90.35	2530	Najima S.S.	33/39 N--130/26 E
90.17	2783	Narimasu	35/46 N--139/37/30 E
90.14	2784	Naruto	35/34 N--140/25 E
90.14	2785	Nasuno	36/58 N--140/00 E
90.09	2889	Niigata	37/57 N--139/07 E
90.29	2590	Niihama	33/55 N--133/08 E
90.19	2786	Nii Jima	34/22 N--139/16/30 E
90.25	2679	Nishinomiya	34/43 N--135/22 E
90.33	2531	Nittagahara	32/06 N--131/26 E
Nansei-Shoto		Nobara (Miyako Shima)	24/45 N--125/20 E
90.23	2680	Ogura	34/53 N--135/46 E
90.18	2787	Oi	34/16 N--138/09 E
90.33	1308	Oita	33/15 N--131/38 E
90.33	2532	Oita S.S.	33/15 N--131/37 E
90.21	2681	Oitsu	34/42 N--137/22 E
90.27	2622	Okayama	34/36 N--133/55/30 E
90.20	2682	Okazaki	34/59 N--137/08 E
90.36	849	Omura	32/56 N--129/56/15 E
90.36	2533	Omura S.S.	32/55 N--129/56 E
90.25	2683	Osaka East	34/41 N--135/36 E
90.17	2788	Osawa	35/54 N--139/45 E
90.17	2789	Oshima	34/47 N--139/22 E
90.13	2790	Ota	36/15 N--139/21 E
90.17	1417	Otawa	35/12 N--139/37 E
90.23	2684	Otsu S.S.	35/02 N--135/52/30 E
90.34	2623	Oura S.S.	34/24 N--130/57 E
90.34	2624	Ozuki	34/03 N--131/03 E
90.17	2791	Palace	35/40 N--139/42 E
90.38	2534	Ronchi	31/47/30 N--130/44 E
90.14	2792	Ryugasaki	35/56 N--140/12 E
90.33	2535	Sadohara	32/01/30 N--131/21 E
90.33	1306	Saeki	32/58 N--131/56 E
90.33	2537	Saeki S.S.	32/58/30 N--131/55 E
90.17	2793	Sagami	35/31 N--139/21 E
90.35	2538	Saitozaki	33/39 N--130/21 E
90.17	2794	Sakato	35/57 N--139/25 E
90.25	2685	Sano	34/24 N--135/19 E
90.36	754	Sasebo	33/08 N--129/44 E
90.36	2539	Sasebo S.S.	33/07 N--129/44 E
90.36	834	Sasebo East, A.S.S.	33/09 N--129/45 E
90.20	2686	Seto	35/12 N--137/02 E
90.38	2540	Shibushi	31/28 N--131/04 E

Approved Airfield Names and Target Numbers, cont'd.

90.35	2541	Shigashima A.S.S.	33/39 N--130/19 E
90.14	2795	Shimazu	36/02 N--140/15 E
90.13	2796	Shimodate	36/16 N--139/57 E
90.14	1470	Shimoshizu	35/39 N--140/09 E
90.24	2687	Shionomisaki	33/26/30 N--135/45 E
90.14	2797	Shiroi	35/48 N--140/01 E
90.35	2542	Shisojima	33/27 N--130/36 E
Nansei Shoto		Shitooke(Kikai-Shima)	28/21 N--130/02 E
90.17	1407	Showa	35/43 N--139/22 E
90.34	2543	Sone	33/50 N--130/57 E
Nansei-Shoto		Sukuma(Miyako-Shima)	24/44 N--125/18 E
Nanpo-Shoto		Susaki(Chichi-Jima)	27/05 N--142/11 E
90.27	2591	Suta S.S.	34/14 N--133/38 E
90.20	1130	Suzuka	34/51 N--136/35 E
90.35	1236	Tachiarai	33/24 N--130/37 E
90.28	2592	Tachibana A.S.S.	33/52 N--134/38 E
90.17	1404	Tachikawa	35/43 N--139/25 E
90.17	1415	Takahagi	35/54 N--139/22 E
90.27	2593	Takamatsu	34/17 N--134/04 E
90.~~25~~-27		Takamatsu Emergency	34/21 N--134/01 E
90.27	2594	Takuma S.S.	34/14 N--133/39 E
90.35	2544	Tamana	32/54 N--130/34 E
90.25	2688	Tambaichi	34/34 N--135/49 E
90.13	2798	Tatebayashi	36/14 N--139/29 E
90.14	371	Tateyama	34/59 N--139/50 E
90.14	2799	Tateyama S.S.	34/59 N--139/51 E
90.21	2690	Tenryu	34/39 N--137/50 E
90.38	2545	Tojimbara	31/26 N--130/17/30 E
90.14	2800	Toke	35/33 N--140/14 E
90.17	1406	Tokorozawa	35/48 N--139/29 E
Nansei-Shoto		Tokuna Shima	27/50 N--128/55 E
90.27	2595	Tokushima	34/08 N--134/36 E
90.36	2546	Tomie	32/39 N--128/50 E
90.33	2536	Tomitaka	32/24 N--131/38 E
90.26	2625	Tottori	35/31/30 N--134/10/30 E
90.11	2691	Toyama	36/44/30 N--137/11 E
90.21	2692	Toyohashi	34/43 N--137/19 E
90.17	1408	Toyooka	35/48 N--139/22 E
90.35	2547	Tsuiki	33/41 N--131/02 E
90.14	1489	Tsukuba	36/19 N--140/19 E
90.14	1472	Tsukuba West	36/10 N--140/01/45 E
90.12	2802	Ueda	36/24 N--138/14 E
90.24	2693	Ueno	34/46 N-136/09 E
90.33	1307	Usa	33/33 N--131/21 E
90.13	2801	Utsunomiya	36/32/30 N--139/59 E
90.13	2803	Utsunomiya South	36/31 N--139/53 E
Nansei-Shoto		Wan-Kikai-Shima	28/19 N--129/56 E
90.10	2894	Yabuki	37/12 N--140/21 E
90.14	2804	Yachimata	35/41 N--140/21 E
90.18	2805	Yaizu	34/48 N--138/18 E
90.17	2806	Yamagatanito	35/58 N--139/32 E
90.16	2807	Yamanaka	35/26 N--138/49 E
90.23	2694	Yashiro	34/55 N--134/59 E
90.14	1474	Yatabe	36/01 N--140/07 E
90.23	2695	Yokaichi	35/05 N--136/13 E
90.17	1402	Yokohama S.S.	35/24 N--139/38 E
90.17	298	Yokosuka	35/19 N--139/39 E
90.17	2808	Yokosuka S.S.	35/19 N--139/39 E
90.17	2809	Yokota	35/45 N--139/22 E
90.17	2810	Yomiuri	35/37 N--134/37 E
90.26	2626	Yonago	35/27/30 N--133/20 E

Approved. Hamilton D. Darby
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MAJOR, AC

DISTRIBUTION: "B"

UNITED STATES PACIFIC FLEET
COMMANDER FIRST CARRIER TASK FORCE

File No. A8

Serial: 0014

SECRET

6 February 1945.

From: Commander FIRST Carrier Task Force, Pacific.
To : Distribution List.

Subject: Airfield Information Sheets, Western HONSHU, SHIKOKU, KYUSHU areas.

Enclosure: (A) Subject sheets for fields number 150 through 161, 200 through 217, 300 through 359, inclusive.

1. Enclosure (A) presents, as of 1 February, 1945, the best available information on airfields in the Empire area west of longitude 135° E, excluding the eastern end of SHIKOKU, and the northern coast of HONSHU. Later and more accurate information will be disseminated as more complete photographic coverage becomes available.

C. G. STEELE,
By direction.

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LANGLEY	1
RANDOLPH	1
ComCarDiv-7	1
ENTERPRISE (F)	1
SARATOGA	1

SECRET

Type: MLG

Runways:
Field is triangular 3000 x 5300 x 6200, packed earth or turf surface. No R/W.

Facilities:
1 large hangar, and A/C engine and assembly plant with 10 large shops and 20 small shops at East end of field.

Dispersal:
R19B-4F around South, North, and Northwest sides of field.

Defenses:

Plane Counts:

18 Dec. 1944,	No count.			
18 Jan. 1945	U/I	S/E	4	
		T/E	29	probably Nick and Lily.
		U/I	8	
		Total	41	

Remarks:
Photos of 18 Jan. 1945, and 18 Dec. 1944.
RR yard just N of field.

AKASHI 34-40N, 134-57E

Field No. 202

SECRET

Type: MLG

Runways:
5000 x 4000 probably surfaced

Facilities:
Facilities prob. in NE corner of field.

Dispersal:
Distant oblique - no count possible.

Defenses:

Plane Counts:
Count impossible.

Remarks:
Photos of 18 Dec. 1944.
A/F on reclaimed land.
Photos of 18 Jan. 1945.
No more information.

AKO 34-43N, 134-23E (prob.)

Field No. 205

Type: HLG

Runways:

7500 x 3800 sandy.

Runways:

1. 4850 x 1000 NW/SE

2. 5950 x 800 E/W U/C.

Facilities:

2 large hangars, 8 small hangars, 10 shops on East side of A/F.

Barracks area to Northeast of airfield.

Dispersal:

R-18B NW of, and around sides of a/f.

Defenses:

Plane Counts:

20 Aug. 1944 - 4 S/E a/c.

6 Oct. 1944 - 56 A/C.

Remarks:

Photos of 6 Oct. 1944.

Army combat VF base

Branch of Tachiarai air depot.

SECRET

Type: MAD

Runways:

1. 4300 x 180 N/S surfaced.
2. 5400 x 200 NW/SE u/c.

Facilities:

No hangars, 5 shops.
Warehouse and barracks area to SW of field.

Dispersal:

R-16F around edges of field.

Defenses:

Plane Counts:

Small scale photo. No a/c observed.

Remarks:

Photos of 9 Dec. 1944. Army field.

BOFU (Tonomi) 34-02N, 131-33E

Field No. 215

SECRET

Type: HLG

Runways:
Roughly rectangular 6000 x 5400 approx.
2 R/W: 6600 x 660 N/S
5850 x 1110 NW/SE
both runway packed earth.

Facilities:
2 shops southwest of field plus 11 barracks.

Dispersal:
R-48-F and extensive system of t/w

Defenses:

Plane Counts:
No a/c 1 Jan. 1945.

Remarks:
Photos of 1 January 1945.

SECRET

Type: HAD

Runways:

Y shaped field 7200 x 7200 surfaced.

Facilities:

2 small hangars and 9 shops in NE corner of field. Thus no indication that reported branch Army depot is a significant installation.

Dispersal:

R-6-B, 12-F on south side of field.

Defenses:

Plane Counts:

30 Dec. 1944: 1 medium a/c, 16 small a/c
1 Jan. 1945: 5 s/e.

Remarks:

Photos of 23 Dec. 1944 and 1 January 1945.
Field reported to be branch depot of Tachiarai Army Air Depot.
In past has been base for Army recce units.

CHIRAN 31-21N, 130-26E. Field No. 325

SECRET

Type: MLG

Runways:
5000 x 3000

Facilities:
Servicing area off West side of field.

Dispersal:
Small scale oblique. No dispersal visible.

Defenses:

Plane Counts:

Remarks:
Photos of 9 Dec. 1944. Probable field. Small scale oblique.

FUKUGAWA 34-04N, 131-45E Field No. 214

SECRET

Type: FAD

Runways:

Approx:
1. 4000 x 100 NW/SE.
2. 3000 x 100 NE/SW
Surfaced u/c.

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:
Photos of 18 June 1944.

FUKUMA 33-47N, 130-29E. Field No. 344

SECRET

Type: MLG

Runways:
5000 x 4000 unsurfaced. Probably u/c.

Facilities:
2 small hangars, 3 shops at Southeast corner of field.

Dispersal:
(poor oblique cover) No count possible.

Defenses:

Plane Counts:
Small scale - no count.

Remarks:
Photos of 6 Oct. 1944. Navy training field.

FUKUSHIMA 33-13N, 130-32E

Field No. 337

SECRET

Type: SS

Runways:

Ample run; sheltered.

Facilities:

3 large hangars, 10 shops, 3 ramps.

Dispersal:

Defenses:

Plane Counts:

Remarks:

Photos of 26 Dec. 1944. Float plane training unit here.

FUKUYAMA (Honshu) 34-29N, 133-26E Field No. 208

SECRET

Type: FAD

Runways:

3450 x 270 NW/SE
3450 x 270 NE/SW
2550 x 100 N/S
2250 x 100 NNW/SSE
All R/W surfaced.

Facilities:

4 small hangars, 1 large hangar, 12 shops. All on E. side of field.

Dispersal:

R-14-F on S/W side of field.

Defenses:

Plane Counts:

November 1944: 39 small a/c, 4 medium a/c.
30 December 1944: 17 t/e, 10 s/e.

Remarks:

Photos of 6 October 1944 and 30 December 1944.
Photos do not substantiate reported depot facilities. However, field is major Army ferry base and may become important as staging base for attack planes.

GANNOSU (FUKUOKA) 33-41N, 130-24E. Field No. 343

SECRET

Type: SS

Runways:

Ample run; sheltered.

Facilities:

1 ramp, 4 small hangars, 5 shops, barracks and miscellaneous buildings.

Dispersal:

No dispersal visible.

Defenses:

Plane Counts:

2 S/E a/c. 6 Nov. 1944.

Remarks:

Photos of 6 Nov. 1944.

GORYU 32-30N, 130-12E

Field No. 356

Type: SS

Runways:
Ample run; sheltered.

Facilities:
12 ramps, 4 large hangars, 6 small hangars, 5 shops.

Dispersal:
No dispersal observed.

Defenses:

Plane Counts:
6 Oct. 1944. Small scale - 26 - 30 a/c.

Remarks:
Photos of 6 Oct. 1944. Naval air replacement shop here.

Type: MLG

Runways:
5000 x 3000 NW/SE partly surfaced.

Facilities:
10 small hangars, 3 large hangars, 10 shops on SW side of field.

Dispersal:
Approx. 35 revetments in extensive dispersal area off North end of field.

Defenses:

Plane Counts:
Count impossible.
14 Jan. 1945 S/E 34.
15 Jan. 1945 44 A/C (incomplete cover)

Remarks:
Photos of 18 Dec. 1944.
Photos of 14 Jan., 15 Jan. 1945.

Type: FAD

Runways:
1 asphalt surfaced R/W reported.

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:
No photo coverage. Information from gound sources. Reported Navy field.

Type: FLG?

Runways:
3900 x 3900

Facilities:
Ample facilities:

Dispersal:

Defenses:

Plane Counts:
Information from captured document.

Remarks:
Reported Naval training station.

SECRET

Type: ?

Runways:

Facilities:

Dispersal:

Defenses:

Plane Counts:

No photo cover. Air group reported here uses carrier type land based bombers.

Remarks:

IBUSUKI 31-13N, 130-39E (Approx). Field No. 327

Type: SS

Runways:

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

No photo coverage.

SECRET

Type: FLG?

Runways:

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

Photos of 1 Jan. 1945 despatch report of photo coverage. Photos not yet received.

ICHIKI 31-39N, 130-22E. Field No. 329

SECRET

Type: FAD.

Runways:

Triangular:
1. 4200 x 300 NNE/SSW surfacing u/c.
2. 4200 x 300 E/W u/c.
3. 4200 x 300 WNW/ESE u/c.

Facilities:

4 small hangars, 5 shops on South side of a/f.

Dispersal:

Ample dispersal u/c at NW edge of field.

Defenses:

Plane Counts:

6 Oct. 1944. 2 S/E a/c.

Remarks:

Photos of 6 Oct. 1944.

IMAJIKU 33-35N, 130-15E. Field No. 349

SECRET

Type: FAD

Runways:

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

Reported Navy field on east central coast of Tanega Shima. No photo coverage.

INUJO 30-33N, 131-01E.

Field No. 359

SECRET

Type: HLG

Runways:
6000 x 3000 E/W u/c.

Facilities:
2 large hangars, 6 small hangars. 10 shops on south side of field.

Dispersal:
Dispersal area Nortbh of field.

Defenses:

Plane Counts:
Small scale - no count.

Remarks:
Photos of 6 Oct. 1944. Reported Naval intermediate training.

ISAHAYA 32-51N, 130-06E. Field No. 355.

Type: FAD

Runways:
1. 4000 x 150 NE/SW surfacing u/c.
2. 3650 x 150 N/S paved.

Facilities:
7 bldgs. around field.
Barracks and warehouse area at North end of field.

Dispersal:
R-21F. Approximate 60' taxiway parallels N/S R/W and is paved.

Defenses:

Plane Counts:
No count. (no a/c observed)

Remarks:
Photos of 6 Oct. 1944. (incomplete coverage)

Type: HAD

Runways:
5000 x 6000 surfaced.

Facilities:
Extensive bldgs. along West side of field.

Dispersal:
Extensive dispersal area off NW corner of a/f.

Defenses:

Plane Counts:

Remarks:
Photos of 9 Dec. 1944. Cloudy Oblique - incomplete coverage.
Navy base for combat VF and VB. Carrier groups in training here. Naval air replacement shop here.

SECRET

Type: SS

Runways:

Facilities:

Extensive facilities.

Dispersal:

Defenses:

Plane Counts:

Remarks:

Photos of 9 Dec. 1944. (cloud covered).

SECRET

Type: MLG

Runways:

4500 x 4500 grass.

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

Photos of 23 Dec. 1944. Photos not yet received.
Navy training and Naval air branch work shop here.

IZUMI 32-05N, 130-20E. Field No. 330

SECRET

Type: FAD

Runways:

Dogleg shaped field 4200 x 1200, aggregate surfaced.
1 r/w 1710 x 300 N/S, concrete.

Facilities:

9 small hangars, 1 large hangar on W. side of field.
1 large assembly type bldg and 42 other bldgs. to W. of hangars, probably the reported depot installations.

Dispersal:

R-14F NW of field.

Defenses:

Plane Counts:

26 December 1944: 15 a/c, mostly small.
1 January 1945: 7 s/e.

Remarks:

Navy VF training and combat VF base.
Dive bombers also probably based here at present time.

KAGOSHIMA 31-33N, 130-34E. Field No. 322.

Type: ASS

Runways:

Ample run.

Facilities:

Dispersal:

Defenses:

Plane Counts:

1 F/P 23 Dec. 1944.

Remarks:

Despatch report of 23 Dec. 1944 photos.

SECRET

Type: HAD u/c

Runways:

L-shapped field 4600 x 3750

Runways: (in triangle)

1. 2800 x 340 NW/SE, hard surfaced.
2. 1900 x 340 WNW/ESE, hard surfaced.
3. 1800 x 340 N/S, hard surfaced.

Plus 3000' extension to ESE - surfacing u/c.

Facilities:

6 large hangars, 20 shops off base of runway triangle.
1 large hangar, 8 small hangars, 10 shops off East end.

Dispersal:

R-30F around West and South edges of field.

Defenses:

Plane Counts:

15 Dec. 1944.
S/E 32
T/E 6
14 Jan. 1945.
S/E 30
T/E 23
15 Jan. 1945.
S/E 26
T/E 27

Remarks:

Photos of 15 Dec. 1944, Jan 15, 1945.
Important advanced training field for Army VF pilots.
Also branch of Osaka Army Air depot.

KAKOGAWA 34-44N, 134-49E. Field No. 203

SECRET

Type: FAD

Runways:
Field 5000' square.
1 surfaced R/W.

Facilities:
Extensive facilities were planned.

Dispersal:

Defenses:

Plane Counts:

Remarks:
No photo coverage. Information from captured documents. Planned as Navy operational training field.

SECRET

Type: MAD

Runways:

5880 x 3800 gravel surface.
runways:
1. 5440 x 160 E/W
2. 5300 x 160 ENE/WSW
Both concrete.

Facilities:

4 large hangars on Southeast of field.
8 large hangars, 12 small hangars, 30 air depot buildings North of field.

Dispersal:

R111B-11F around and adjacent to field.

Defenses:

Plane Counts:

25 Dec. 1944.

Tabby	3
Tess	1
Betty	19
Unidentified T/E	31
Unidentified S/E	16
Total	70

Remarks:

Photos of 25 Dec. 1944. Navy field used by combat VB and VBM. Army bombers may be training here. Major Naval air depot here.

KANOYA 31-22N, 130-50E. Field No. 314.

SECRET

Type: MAD

Runways:
5500 x 3000, surfaced.

Facilities:
Hangars in NW corner of field.

Dispersal:
None visible in distant oblique photos.

Defenses:

Plane Counts:
None possible in distant oblique photos.

Remarks:
Photos of 1 January 1945.
Base for Navy combat VF. Importance has grown in past two months.

KANOYA EAST (KASANOHARA, KASAMBAI) 31-23N, 130-54E. Field No. 315

SECRET

Type: HAD

Runways:

L-shaped 5900 x 5800 gravel surface.

Facilities:

15 large hangars on West side of field, plus three u/c.

Dispersal:

No revetments visitble.

Defenses:

Plane Counts:

25 Dec. 1944 - 13 T/E a/c.

Remarks:

Photos of 25 Dec. 1944 (partial cover). Branch army depot reported here.

KARASEHARA (Kawanami) 32-13N, 131-33E

Field No. 308

SECRET

Type: MAD u/c

Runways:
5200 x 4800, surfacing u/c.

Facilities:
9 double hangars, (plus 2 u/c)
10 shops in Southwest corner of field.

Dispersal:
No revts. observed.

Defenses:

Plane Counts:
Poor photo - no count
Incomplete coverage.

Remarks:
Photos of 21 Nov. 1944.
Branch of Tachiarai Air Depot.
Army training.

Type: FLG

Runways:
Field is 3800 x 4060, earth.

Facilities:
2 hangars, 3 shops at SW corner of field.
Concrete service apron.

Dispersal:
None seen.

Defenses:

Plane Counts:
25 December 1944: no count possible

Remarks:
Photos of 25 December 1944.

SECRET

Type: MAD

Runways:

4870 x 380, 115° concrete.

Facilities:

1 hangar.

Dispersal:

R-19B

Defenses:

Plane Counts:

Remarks:

Report of photos 1 Jan. 1945.
Photos not yet received.
Details indefinite.

KITAHARA 31-48N, 130-44E. Field No. 320

SECRET

Type: MAD

Runways:
Field is 4500 x 4500.
1 r/w 4500 x 300 NW/SE, surfaced.

Facilities:
12 small hangars, 10 shops in NE corner of field.

Dispersal:
None observed.

Defenses:

Plane Counts:
18 January and 28 January 1945. Counts impossible.

Remarks:
Photos of 18 January and 28 January 1945.
Navy training unit reported here.

KOCHI 33-32-30N, 133-41E. Field No. 161

SECRET

Type: FAD

Runways:

Irregular field, L-shaped.
3780 x 2250, gravel surfaced.

Facilities:

8 small hangars at East side of field. Also 16 shops and storage bldgs, plus 7 barracks.

Dispersal:

R-28-F off N. and SE sides of field.
Concrete service apron in front of hangars.

Defenses:

Plane Counts:

1 January 1945: 94 a/c.

Remarks:

Photos of 1 January 1945.
Reported Navy intermediate training field.
Photos show revetments camouflaged with netting but not completely obscuring revetted a/c of u/i type.

KOKUBU 31-43N, 130-45E

Field No. 319

SECRET

Type: ?

Runways:

Facilities:
Just to E. of field is the Kumamoto Aircraft plant.
Products unknown
10 assembly type buildings plus 55 miscellaneous buildings.

Dispersal:

Defenses:

Plane Counts:
6 a/c 24 Dec. 1944.

Remarks:
Report of photos of 24 Dec. 1944.
Photos not yet received.
Army training.
Army Air depot reported.

KUMAMOTO (Kikuchi) 32-50N, 130-44E. Field No. 332

SECRET

Type: HAD u/c

Runways:

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

Despatch report only. Photos not yet received.

KORIMOTO 31-45-30N, 131-06-15E. Field No. 363

SECRET

Type: HAD

Runways:

Irregular field 6000 x 5000, gravel surfaced.
Possible extension u/c to W of field.

Facilities:

1 large hangar on S side of field.
2 small hangars, 10 shops in SE corner.
Assembly plant or A & R shop to S of field and joined by t/w.
20 main bldgs, sawtooth roofed.

Dispersal:

R4 in NW corner of field.

Defenses:

Plane Counts:

25 December 1944: 12 s/e.

Remarks:

Photos of 25 December 1944, distant oblique.
Army training field. Branch of Tachiarai Army Air Depot.
Lack of ground information of products of plant indicates it makes trainers.
May also be just A & R shop of depot.

KUMAMOTO (KIKUCHI) 32-48-30N, 130-46E. Field No. 332.

SECRET

Type: SS

Runways:

3 ramps in 1939.

Facilities:

Dispersal:

Defenses:

Plane Counts:

Remarks:

No photo coverage.
Information from captured document.

KURE 34-14N, 132-37E. Field No. 210