# Report on the Review of the Traffic Patterns and the Study of Possible Further Safety Measures Concerning Futenma Air Station

August 2007

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IV. Possible further safety measures

## I. Preliminary remarks

### 1. Background

In August 2004, a CH-53D Sea Stallion assigned to US Marine Corps crashed near Futenma Air Station.

In the wake of the mishap crash, Unusual Occurrence Subcommittee under the Joint Committee examined the cause of the accident and the prevention of the recurrence, etc. The result was submitted to the Joint Committee as a "Report on the Crash Mishap of the US Helicopter in Okinawa" (hereinafter refer to as the "accident report"), and approved in February 2005.

### 2. Purpose of work

a. Since the accident was due to maintenance procedures, the US Marine Corps took necessary measures such as update of the maintenance manuals to prevent the recurrence of maintenance problems.

b. Furthermore, in the light of significance of the accident and the prevention of recurrence, to secure safety of the flights and residents, the accident report included the following recommendation:

"Local USFJ and Government of Japan agencies, and if necessary, central level agencies, will review air traffic patterns and study possible further safety measures. The result will be reported to the Joint Committee in an appropriate and timely manner."

This report addresses the result of the review and the study conducted in accordance with the recommendation.

### 3. Course of work

a. In accordance with the recommendation in above 2-b., the Japan-US Joint Group regarding the study (hereinafter referred to as the Joint Group) consisting of relevant members from Headquarters, U.S. Forces, Japan, U.S. Marine Corps in Okinawa, Defense Facilities Administration Agency, Naha Defense Facilities Administration Bureau, Ministry of Foreign Affairs and Okinawa Liaison Office, Ministry of Foreign Affairs have been working since April 2005 through discussions at five times of meetings and coordination by relevant members both at central and local level.

b. The US side provided the Japanese side with detailed information in series about the settings, etc. of the flight patterns of helicopters on and around Futenma Air Station and other issues to contribute to an effective implementation of the work.

The information was effective for the Japanese side to deepen its understanding of technical and professional issues regarding the work.

## II. Settings of airport traffic area, etc. and regional characteristics of areas established for the traffic patterns, etc. concerning Futenma Air Station.

### 1. Settings of airport traffic area, etc.

At first, this report gives an outline of the settings of the airspace under air traffic control of Futenma Air Station, and the current traffic patterns and approach/departure routes of the air station regarding helicopters.

#### a. Airport traffic area (ATA)

An airspace under air traffic control of Futenma Air Station is within a hexagonal column which connects the following 6 locations; 261404N/1274136E, 261649N/1274448E, 261700N/1274600E, 261911N/1274851E, 261900N/1275024E and 261200N/1274448E, and extending from the surface up to, but not including 2,000 feet. It is adjacent to the Kadena ATA in the north side, and it is adjacent to the Naha ATA in the southwest side.

In Futenma ATA, flight altitudes of helicopters, fixed wing aircraft except jet aircraft, and jet aircraft are designated up to, but not including 1,000 feet MSL (Mean Sea Level), from 1,000 feet MSL up to, but not including 1,500 feet MSL, and from 1,500 feet MSL up to, but not including 2,000 feet MSL respectively. (Encl. 1)

Note: One foot is about 30.48 cm.

#### b. Traffic patterns

Two elliptical shaped corridors located on both sides (north and south) of the runway are established as traffic patterns of Futenma Air Station to regularize the flow of landing helicopters (Encl. 2).

As for the traffic patterns, helicopters should maintain a flight altitude of 1,000 feet MSL until they reach base-leg (Note: See Encl. 3) and should maintain the flight altitude of 700 feet MSL when passing over the boundary of U.S. facilities and areas. (Note: The minor axes of the corridors vary depending on various factors such as performance and specifications of each type of helicopters, ground speed and weather conditions such as wind direction and wind speed. Therefore, the horizontal distance from the boundary of U.S. facilities and areas, and the ground tracks of the actual downwind-leg (See Encl. 2) differs from flight to flight.)

c. Approach/departure routes

Currently, three routes connecting Futenma Air Station and the following points designated as reporting points to the air station's tower are established as approach/departure routes of helicopters to ensure flight safety within Futenma ATA (Encl. 4).

① Point Kilo (over the vicinity of Kubasaki, Nakagusuku village)
② Point Tango (over the vicinity of Tsuha, Nakagusuku village)
③ Point Sierra (over the vicinity of Miyagi, Chatan town)

The routes via Point Kilo, Point Tango and Point Sierra are used for departure from runway 06 (from southwest to northeast) and landing to runway 24 (from northeast to southwest), departure from runway 24 and landing to runway 06, and departure /landing with runway 06 and runway 24 respectively. In principle, helicopters should maintain flight altitude of 1,000 feet MSL when passing each reporting point. (Note: The lines depicted in enclosure 3 are diagrammatic representation of the average route and actual flight paths in each route differ from flight to flight depending on various factors such as performance and specifications of each type of helicopters, ground speed and weather conditions such as a wind direction and wind speed.)

2. Regional characteristics of areas established for the traffic patterns, etc.

This section describes regional characteristics of Futenma Air Station and its surrounding areas as an issue related to the flight operations in the traffic patterns and approach/departure routes.

a. Weather

One of the important factors related to flight operations is a wind direction over the air station.

According to data during year of 2005 obtained from local ground weather observation at Futenma Air Station, a wind from the north and the east (from northwest to southeast in clockwise) accounts for more than 80 percent in each month from January to April and from September to December. Although the ratio of a wind from the southwest is comparatively larger in June and July, a wind from the north and east accounts for nearly 80 percent in a whole year (Encl. 5).

b. Geographical features

Geographical features of the air station and its surrounding areas are important factors of the flight operations as well as weather conditions described in Subsection a.

Area of the Futenma Air Station facility is almost a flat terrain while there is a slight vertical interval between the northwest side and southeast side. The elevation of the air station is between some 200 feet and some 250 feet above sea level. (Encl. 6).

On the other hand, when we take a look at the geographical features of the areas surrounding the air station, rather steep downward slopes with a vertical interval of some 150 feet lie between the field boundary of the northwest side of the centerline of the runway of the air station and Highway 58 (areas including Isa 1-choume, Oyama 1- and 2-choume, and Mashiki 1-choume of Ginowan City) (Encl. 7,8). As for the areas outside the field boundary of the southeast side of the centerline of the runway, upward slopes extends with a vertical interval of some 200 feet beyond Highway 330 to the edge line at approximately 500 feet above sea level extending from northeast to southwest along the east side of Okinawa Expressway (Encl. 9).

## Ⅲ. Review of the traffic patterns

### 1. Background of current settings and the aim of work

a. Current traffic patterns described in Ⅱ-1-b have been established by the US Forces from early times to regularize flow of the flights at the air station.

b. From 1995 to the next year, Aircraft Noise Abatement Subcommittee established under the Joint Committee aiming at examination of aircraft noise abatement or prevention around airfields was held by the governments of Japan and the United States. As a result of discussions on the flight patterns and the altitudes, agreements concerning the traffic patterns, operations and aircraft noise were made and approved by Joint Committee on 28 March of 1996.

The agreements include a measure which requires aircraft to maintain a minimum altitude of 1,000 feet MSL in principle near Futenma Air Station.

This measure was established in line with the purpose of Aircraft Noise Abatement Subcommittee to minimize undesirable effect by aircraft noise without disturbing the mission of US Forces, Japan so as to ease concern of the communities surrounding Futenma Air Station, regarding the aircraft noise.

c. As mentioned above, the both governments discussed the traffic patterns of the air station in the past and reached agreements related to the settings. This time, the Joint Group implemented necessary work as mentioned in the following section in order to verify the safety of helicopter flight operations in the current traffic patterns based on objective data mainly with analysis from the technical and professional points of view in accordance with the recommendation of the accident report.

2. Implementation of Verification

a. Overview of the helicopter flight operations in the traffic patterns

Post maintenance check flights, familiarization/proficiency flights, instrument training flights, etc. are being conducted in current traffic patterns of Futemna Air Station.

These flight operations are conducted by aircrew in the forefront who piled sufficient training at Marine Corps Air Stations in continental United States and Kaneohe Bay Air Base in Hawaii where Headquarters, Marine Forces Pacific is located.

Additionally, multiple (two or three) engines are installed to helicopters that are regularly operated at the air station (CH-46E Sea Knight, CH-53E Super Stallion, UH-1N Huey, AH-1W Super Cobra) as shown in specifications (Encl. 10-13), and so the reliability is being ensured compared with various helicopters in service for regular operations at other airfields in Japan.

b. Malfunction during a helicopter flight operation and its countermeasure

As mentioned in above Subsection a., reliability of the helicopter flight operations at the air station is ensured in both aircrew and the type of helicopters. On the other hand, Futenma Air Station is no exception about probability of occurrence of a malfunction in the air, which is a common concept among all the airfields.

The envisioned worst and typical malfunction during an aircraft flight operation is a situation when engines stop. However, as far as helicopter flight operations are concerned, there is an effective procedure to deal with such malfunction using a characteristic which enables pilot to "land safely with a lift from rotary wings in the event of a loss of power", which is well known as the concept of "autorotation" mentioned below.

c. Concept of Autorotation

Autorotation is a method to safely land helicopters in cases when a power from the engine to the rotor drive system is lost, and the procedure is as follows:

When the power has been cut off, the collective lever is immediately pulled down to the lowest position. This operation will maintain the number of rotations of the main rotor in an adequate range, and the air that flows through the blades will keep the blades rotating.

(In this case, to deal with the increasing rate of descend, velocity will be adjusted to a range to attain a minimum rate of descend.)

When the helicopter nears the ground, the nose is slowly pulled up. With this operation, the power of rotating main rotor will be converted to a lift, as well as slowing down. As the power of rotating the main rotor is used up, the helicopter will start to descent, so the collective lever is raised to reduce the rate of descent, bring the helicopter to a horizontal attitude, and to a cushioned landing.

(Encl. 14)

d. Autorotation chart

Operation manuals for each type of helicopter specifically regulates the implementation of the procedure mentioned in Subsection c.

Specifically, minimum rate of descent, glide angle, etc. that are calculated from flight characteristics and specifications of each type of helicopter combined with airspeed and altitude are schematized into autorotation chart. Referring to the chart, pilot selects best airspeed for actual flight conditions such as weather conditions, load weight and altitude. Thus the pilot can achieve best glide angle under any circumstances and calculate the landing point (Encl. 15).

Furthermore, by comparing the actual flight situation with the chart, it is possible to assume how to deal with stop of engine, which is the most serious malfunction in a flight operation (Encl. 16).

e. Flight situation in the traffic patterns

On conducting safety verification of helicopter flight operations in current traffic patterns of Futenma Air Station based on technical and professional issues mentioned in Subsection b. to d., the Joint Group conducted necessary confirmation work regarding the actual flight situation as a prerequisite for the verification.

As mentioned in Ⅱ-1-b, the horizontal distance from the boundary of U.S facilities and areas, and the ground tracks of the actual downwind-leg differs from flight to flight. According to the observation of the actual flights, the ground tracks of downwind-leg of the north traffic pattern mostly fall into areas from inside of the northwest side of the boundary of U.S facilities and areas to the east side of Highway 58 (Aragusku 2-choume, kyuna 1- and 2-choume, Isa 1-choume, Oyama 1- and 2-choume, Masiki 1-choume, Ojana 1-choume to 4-choume of Ginowan City) (Encl. 17,18).

As with the north side, the south pattern ground tracks of the downwind-leg shown in enclosure 2 mostly fall into certain areas around the southeast side of the boundary of U.S facilities and areas.

f. Check with parameters

Since at least two engines are installed to helicopters that are regularly operated at the air station as mentioned in Subsection a., the situation requiring autorotation procedure itself is an extremely rare case. However, as an example for assumption, listed below are examples of glide distance by autorotation described in operation manuals of each type of helicopter:

UH-1N (at altitude of 1,300 feet AGL)

- 7/8 nautical mile to horizontal direction with minimum rate of descent shown in autorotation chart
- 1 nautical mile to horizontal direction with maximum distance glide airspeed shown in autorotation chart

CH-53 (at altitude of 1,300 feet AGL)

- 3/4 nautical mile to horizontal direction with minimum rate of descent shown in autorotation chart
- 1 nautical mile to horizontal direction with maximum distance glide airspeed shown in autorotation chart

Note: One nautical mile is about 1,852m

These figures are parameters (limit values) regarding helicopters that are actually operated at the air station. Though there is a little difference in detailed figures among operating manuals of each type of helicopter, average glide rate (maximum glide distance) lead by autorotation chart is about 4 feet of forward glide for 1 foot of descent. (Encl. 19)

Furthermore, when we check the parameter with the current designated altitude of regular flights in the current traffic patterns of Futenma Air Station (1,000 MSL until base wind-leg) mentioned in Ⅱ-1-b., the figures corresponding to the altitude of some 750 feet (the figure that altitude of the air station (approximately 250 feet) was subtracted from 1,000 feet) are calculated as follows:

- 3/4 nautical mile to horizontal direction → approximately 2,600 feet
- 1 nautical mile to horizontal direction → approximately 3,500 feet

According to above mentioned analysis, helicopters at the designated altitude in the traffic patterns of Futenma Air Station can return to somewhere in the air station by performing autorotation procedure if the distance from the field boundary in a horizontal direction at the time of passing downwind-leg is some 2,500 feet (approximately 750 meters). Most of the flight areas mentioned in Subsection e. are covered by the area bounded by equidistance line of 2,500 feet from the field boundary. (Encl. 20)

g. Comparison with traffic patterns of other airfields

In addition to the analysis based on technical and professional points of view mentioned through Subsection f., we confirmed the altitude settings of helicopter traffic patterns of airfields used by other US Forces in Japan and Self Defense Forces to relatively evaluate the current altitude settings.

These altitude settings are established individually based on various factors such as distance from paths of fixed wing aircraft and geographical features around the airfields. With regard to all of the Self Defense Forces' airfields which have downwind-leg above urban areas like Futenma Air Station, the designated altitudes range from some 500 feet MSL to 1,500 feet MSL. Compared with the figures, the altitude setting of the traffic patterns of Futenma Air Station (1,000 feet MSL) is considered to have no peculiar point from the safety point of view.

3. Result of work

The result of work regarding the items in Part Ⅲ based on above mentioned verification, etc. is as follows:

a. After the analysis of the current traffic patterns based on technical data and confirmation of the flight situation, it is confirmed that the designated altitudes enable helicopters to return to the air station by autorotation even in emergency since it enables helicopters to glide some 2,500 feet in a horizontal direction through the autorotation procedure, and most of the actual flight areas are within 2,500 feet from the air station.

b. Compared with traffic patterns of other airfields in Japan, there is no peculiar point in altitude settings of current traffic patterns of Futenma Air Station.

## Ⅳ. Possible further safety measures

1. Aim of work

1st Marine Aircraft Wing and its subordinate units engaged in flight operations, and Futenma Air Station under the command of Headquarters, US Marine Forces, Japan engaged in management of facilities have taken various measures related to flight safety at the air station.

In addition to those measures, based on the analysis of regional characteristics and the current flight situation of the air station and its surrounding areas, the Joint Group have set four issues, that is, 1) improvement of safety regarding the flight patterns, 2) introduction and utilization of new systems, 3) enhancement of aeronautical navigation aids, and 4) safety guidance to aircrew in accordance with the purpose of the recommendation of the accident report to further ensure the safety of residents as well as flight safety. The Joint Group conducted wide range of examination work on the four issues including extraction of newly feasible measures.

2. Improvement of safety regarding the flight patterns

1). Approach/departure routes

a. Current situation

As briefed in Ⅱ-1-c., currently three routes connecting Futenma Air Station and three points designated as reporting points to the air station's tower are established as approach/departure routes for helicopters.

Of these routes, the route via Point Sierra located to the north of the air station is used for coordination between the towers of Futenma Air Station and Kadena Air Base when flying from Futenma airspace to Kadena airspace or the opposite way. Basically helicopters make approaches and departures via Point Tango or Point Kilo except flying to/from Kadena Air Base direction to avoid traffic congestion in areas where the two airspaces are nearby.

b. Implementation of work

As mentioned above, the routes via Point Kilo or Point Tango located to the east of the air station and on Pacific coast are used primarily for approach/departure of helicopters (Encl. 21).

These routes have been established with detailed check for many years as a result of placing top priority on securing safety of the flights and residents basically by minimizing the flight time between the field boundary and the ocean and taking various factors into consideration such as geographical features of Futenma Air Station and its surrounding areas as mentioned in Ⅱ-2-b and the off set distance from structures on the ground affecting flight safety.

On the other hand, in light of the subject to study possible further safety measures, the Joint Group conducted examination based on the verification and analysis of the current situation of Futenma Air Station and its surrounding areas including air survey by a helicopter assigned to Marine Aircraft Group 36 in order to extract possible further safety improvement measures specifically and quickly from the wider point of view, especially concerning approach/departure routes on Pacific Ocean side.

c. Verification and analysis

Points Kilo, Tango and Sierra are Visual Flight Rule (VFR) Visual Reporting Points. It is extremely important to establish visual points that pilots can readily identify visually to secure flight safety. In light of this point, current two reporting points can be easily checked visually from the sky because of their distinguishing shapes. Additionally, even if helicopters fly in the both routes at the same time, appropriate off set distance among the helicopters can be maintained. Thus, they are the most appropriate visual points for approach and departure.

As to the approach/departure routes between Point Kilo and northern end of the runway, it connects the air station and Pacific Ocean almost in a straight line with the shortest distance in the air (approximately 2 nautical miles (about 3.7 kilometers) by ground tracks). The distance of the route over areas designated as the "use-defined district" according to

City-Planning Law which is considered as a standard of urban areas, extending from the outside of northeastern field boundary to the southwest side of Nakagusuku exit of Okinawa Expressway (the vicinity of Nodake Bridge) is limited to approximately 0.4 nautical mile (approximately 700 meters to 800 meters) (Encl.22 ).

Also, the route to the northeast passing Point Kilo is used more often for departure from the air station due to a weather characteristic of the air station where a wind from the north and the east accounts for nearly 80 percent in a whole year as mentioned in II-2-a.

On the other hand, because the current approach/departure route connecting the southern edge of the runway and Point Tango requires helicopters to turn more than 90 degrees azimuthally because of their positions, the distance of the flight paths differs from flight to flight depending on the type of helicopters and angles of bank chosen in response to speed, etc. Considering from the aspect of shortening the flight time and reducing the noise, it is desirable to fly with as short distance as possible or with as high speed as possible between the reporting point and the air station. However, heavy helicopters tend to have larger turning radius since there is certain adoptable angles of bank responding to the type, speed and other factors. For these reasons, the flight distance of the route via Point Tango and its ground track length in areas designated as the "use-defined district" according to City-Planning Law increase compared to the route via Point Kilo (Encl. 23).

Whereas, according to the result of air survey by Marine Air Group 36, the flight time between Point Tango and the air station is approximately 1 minute 20 seconds to 1 minute 40 seconds. This shows that the route is the route connecting the southern edge of the air station and Pacific Ocean with the shortest flight time. Moreover considering visibility of the point as a visual point for approach/departure as mentioned in the beginning of this subsection and other factors, there is no appropriate designating point other than this point.

d. Result of verification, etc. and further safety improvement measures

As described in Subsection c., after verification and analysis including air survey related to the approach/departure routes between Pacific Ocean and the air station which are the main inbound/outbound routes of helicopters, it is again confirmed that the current routes passing the designated reporting points (Point Kilo and Point Tango) have the shortest flight time over the ground and the safety can be maintained by reducing the flight time and the distance over urban areas as much as possible.

Also, weather data shows, of the two routes through above mentioned reporting points, there is a tendency that the route to the northwest (via Point Kilo) is used more often at the time of departure.

Based on the result of these verification, etc., the Joint Group extracted following specific measures which may contribute to further improvement of safety of the flights and residents with regard to the current routes passing the designated two reporting points.

① Measures regarding the route via Point Kilo

As mentioned above, at the time of departure from the air station the route to the northeast (passing Point Kilo) has less flight time over urban areas and has less effect on the residents. Therefore, priority will be given to the use of this route as much as possible while considering various conditions including weather, etc.

② Measures regarding the route via Point Tango

For the maximum safety of the flights and residents, the best way is to shorten the passage over urban areas as much as possible. Therefore, the basic principle to select the shortest path will be applied thoroughly to approach/departure via Point Tango as well as Point Kilo.

On the other hand, as mentioned in Subsection c. above, the current usual approach/departure routes connecting Point Tango and the southern edge of the runway requires helicopters to turn more than 90 degrees azimuthally due to their positions. Since the turning radius may increase depending on the type of helicopters, speed and weather conditions, selecting the shortest path to make over-flight of urban areas as short as possible may result in a large traverse of an area along south side of the air station (vicinity of southern edge of Ginowan City) which is designated as a district exclusive for residence, according to City Planning Law that is thought to have especially high population density (Encl. 24).

As for this point, for example, flight above the previously mentioned area along south side of the air station that is densely populated can be minimized by taking such procedures as extending and adjusting the turning area further to the south. Therefore, when using this route (transiting to and from Pt. Tango), detailed situation of the surrounding areas will be taken into consideration.

2). Traffic patterns

a. Current situation

As mentioned in Ⅱ-1-b., two elliptical shaped corridors located on both sides (north and south) of the runway are established as traffic patterns of the air station (Encl. 25).

As to the north pattern, a private structure of about 150 feet tall is located outside the field boundary (Encl. 26) and there is a difficulty in identifying the structure under low visibility conditions.

b. Further safety improvement measures

In light of above mentioned situation, concretization of the installation of obstacle lights onto the private structure will be pursued as a measure to further secure safety of the flight in the current helicopter traffic patterns and the residents.

3. Introduction and utilization of new systems

1). Introduction of an air control data processing system

a. Overview of air traffic control of an airfield

Currently Futenma Air Station carries out approach control targeting aircraft only under IFR (Instrument Flight Rules) with data from PAR (Precision Approach Radar) installed in the air station, and aerodrome control targeting aircraft under VFR flying near the air station or taking off and landing to the air station. The term PAR describes a landing aid facility to lead aircraft on final approach to the touchdown point of the runway safely by a three-dimensional manner while the air controllers grasp the correct approach path, misalignment of the approaching angle and the distance from the touchdown point on radar display.

Most of the airports for both military and civilian use conducting approach control and terminal radar control that targets aircraft making approach and departure in wider airspace have developed more advanced air control data processing systems which process data from ASR (Airport Surveillance Radar, covering much wider areas than PAR), SSR (Secondary Surveillance Radar), etc. and display target symbol accompanied by alphanumeric altitude, speed, identification, etc. on the monitors equipped in control room.

Specific examples include "ARTS" (Automated Radar Terminal System) and "TRAD" (Terminal Radar Alphanumeric Display System) equipped in major airports in Japan. These systems contribute to securing flight safety of the aircraft in the airports and surrounding areas with their advanced functions (Encl. 27).

b. Introduction of new system to Futenma Air Station

As mentioned above, current air traffic control of Futenma Air Station is limited to airdrome control targeting aircraft under VFR which account for most of helicopter flights and approach control targeting aircraft landing under IFR. So, safe approach control is possible with existing PAR.

In addition, Marine Corps in Okinawa introduced one of the above mentioned air traffic control data processing systems, which is the "BRANDS" (Bright Radar Alphanumeric System) to Futenma Air Station.

"BRANDS" is a system comprised of a data processor-conversion unit, remote control units and video indicators. The number, etc of target symbols that "BRANDS" can create on the display is smaller than "ARTS" listed in above Subsection a., but is almost equivalent function to "TRAD" when it comes to ASR/SSR data processing capability, radar tracking capability and other functions.

Futenma Air Station completed the installation of "BRANDS" in May 2006, and the system became operational at the end of July2006. By the introduction of this new system, the air field control which mainly relied on visual observation from the control tower will increase its efficiency, and the burden to air control staffs has been reduced. Effective utilization will be continuously planned, so it would contribute to further enhancement of safety.

2). Flight simulator

a. Introduction of APT

Marine Aircraft Group 36 based in Futenma Air Station received the APT (Aircrew Procedures Trainer) flight simulators for CH-46E Sea Knight and CH-53E Super Stallion from NAVAIR (Navy Air Systems Command) in Oakland from 2001 to 2002.

The APT flight simulator for CH-46E poses modified cockpit mock-up of CH-46E surrounded by 210 degree wide angle screen. It can create three-dimensional image of Okinawa including Futenma Air Station and its surrounding areas on the screen. Using the simulator, pilots can train and develop flight skills on the ground (Encl. 28).

Also, the APT flight simulator for CH-53E poses a three-dimensional image system as CH46E APT and is an operational flight trainer capable of instrument flight, NATOPS, emergency procedures and limited simulated visual flight (Encl. 29).

b. Effective utilization of the systems

Through the introduction of these advanced simulators, aircrew can pile various training including complicated procedure under various environments such as night time and adverse weather, and emergency procedure both in the air and on the ground that can't be conducted with real helicopters.

Therefore, effective utilization of the flight simulators will be pursued to continuously maintain and develop the skills of aircrew so as to further improve safety.

4. Enhancement of aeronautical navigation aid, etc.

1). Functional improvement of aeronautical navigation aid

a. Current situation

In order to secure safety of the flight operations on and around airfields, it is important to have various aeronautical navigation aids installed and managed properly.

Usually, an aeronautical radio navigation aid and aerodrome lights are installed in airfield facilities as an aeronautical navigation aid. As an aeronautical radio navigation aid, Futenma Air Station is installed with TACAN (extremely high-frequency omni-directional direction/distance measuring equipment) equivalent to VOR/DME (Very-high-frequency Omni-directional Radio Range/Distance Measuring Equipment) of standard airfield facility for civilian use. TACAN provides precise direction/distance information to aircraft flying in Futenma ATA and its surrounding areas.

As for aerodrome lights, Futenma Air Station has already standard equipments including lighting systems such as ALS (Approach Lighting System), RWY (Runway Lighting System) and ABN (Aerodrome Beacon), used for assistance to takeoff/landing at night and during IMC (Instrument Meteorological Conditions) and passage over the air station.

b. Measures for further functional improvement

As mentioned above, certain aeronautical navigation aids necessary for securing safe flight operations have been installed in Futenma Air Station.

On the other hand, in light of the recommendation to study possible further safety measures, the Joint Group examined measures for further functional improvement of these aeronautical navigation aids from the point of view that further safety will be achieved by more reliable aviation aids. As a result, following specific measures are extracted.

① Update of PAPI

PAPI (Precision Approach Path Indicator System) is one of airfield lighting systems installed near the runway edge to visually indicate the propriety of the approach angle to the aircraft landing under VFR (Encl. 30).

The PAPI system is a visual landing aid, that gives a white and red visual signal equally effective by day and night to provide the pilot with information, which allows the pilots to follow the correct approach angle to the touchdown point. The system itself is not complicated but current model in Futenma Air Station is of an older model, and parts for replacement are hard to find.

Therefore, the system will be replaced with a new model with an equivalent function, so a defect will not hinder the service.

② Installation of REIL

REIL (Runway End Identifier Lights) is also one of the airfield lighting systems. This system allows aircraft making approaches under VFR conditions and flying non-precision instrument approaches in IFR conditions to identify the runway threshold. REIL is comprised of lights installed on exterior of the runway edge. To facilitate the pilot to distinguish the lights and increase visibility from a distant, white flashing lights are used for the REIL (Encl. 31).

Currently, REIL is not installed in Futenma Air Station but its use is very beneficial in areas having a large concentration of lights either from the airport or the surrounding city with blinking business signs, traffic lights, etc. Therefore, the REIL will be newly installed in the air station to further improve flight safety.

2). Enlargement of clear zone

Assuring enough clear-zone (no obstacle area) within an airfield is one of the important technical issues for safe flight operations on and around the airfield.

Futenma Air Station has been taking necessary measures to keep certain areas around the runway and its extended line as no-obstacle zone to ensure safe flight operations.

On the other hand, in light of the study of further safety measures, detailed check and examination were conducted on the technical issue, that is the enlargement of clear zone considering further securing of flight safety by autorotation procedure to extract new measures. The details of specific measures are as follows.

① Removal of microwave antenna, etc.

The microwave antenna (about 140 feet high) located in southern area of the air station was used to receive radar information from Kadena Air Base and has outlived its usefulness. This is now an obstacle (Encl. 32).

Also, the former NBD building (Non-directional Radio Beacon) is no longer necessary for the mission of the air station and is now an obstacle (Encl. 33). Therefore, they will be demolished and removed.

② Trimming of tall tree at the approach end of Runway 06

The tree located outside the air station fence but on air station property, is growing year by year and there is a potential concern to the use of Runway 06. It will be trimmed (Encl. 34).

③ Removal of trees in the approach end of Runway 24

The trees located on the extended centerline of the runway may hinder an optimum climb for departure. Therefore, these trees will be removed (Encl. 35).

④ Removal of trees located in the left side of approach end on Runway 06

A lot of trees grow widely in the area of several hundred feet long along the centerline of the runway. They will be removed according to the airfield criteria to improve safety by keeping certain areas on the either side of the runway as a clear zone (Encl. 36).

⑤ Trim and remove trees and vegetation around TACAN

TACAN is an aeronautical radio navigation aid to provide aircraft with direction-distance information as mentioned in IV-3-1)-a, above.

In Futenma Air Station, it is installed on the north side of Runway 06 approach end. However heavy vegetation in this area reflects the signal generated from TACAN back to TACAN. This may provide erroneous and/or no information at all as to the aircraft's direction or distance to the runway.

To prevent such problems, all vegetation within 1,000 feet of the TACAN will be removed. Also, all trees that fall within the 1,000 feet radius from TACAN will be trimmed to a height of 10 feet below the elevation of the approach end of Runway 06 and/or to the highest natural elevation shielding the trees (Encl. 37).

5. Safety guidance to aircrew

Various new safety improvement measures mentioned in Section 1 through 4 mostly resulted from the examination from technical and professional point of view. A safety improvement measure which is equivalent to the above mentioned measures or even most important and effective is to thoroughly implement safety guidance at various unit levels to enable all the aircrew engaged in the flight operations to grasp the situation of the air station and surrounding areas accurately and achieve maximum safety of the flights and residents during all the operations.

Therefore, to further ensure safety of the flight operations at Futenma Air Station, safety guidance at each flight squadron as well as guidance to ensure maintenance procedure that was the cause of the accident mentioned in Preliminary remarks, will be further strengthened and thoroughly implemented.

## V. Closing remarks

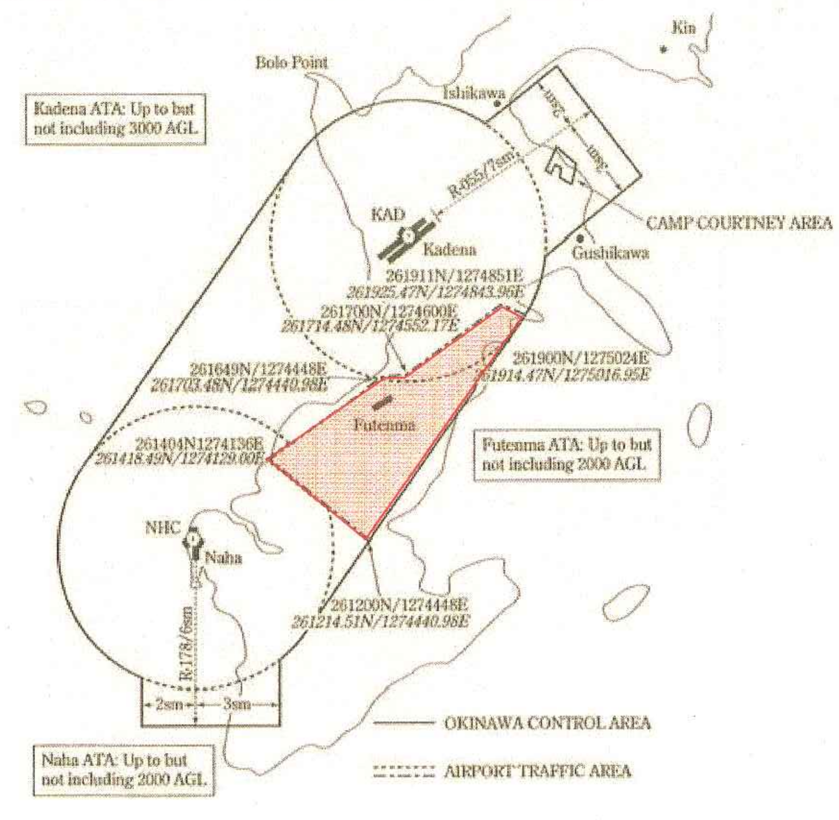
As mentioned previously, the Joint Group conducted detailed examination including extraction of newly adoptable various measures regarding the subjects based on analysis of the current situation of the flight operations, etc. in Futenma Air Station.

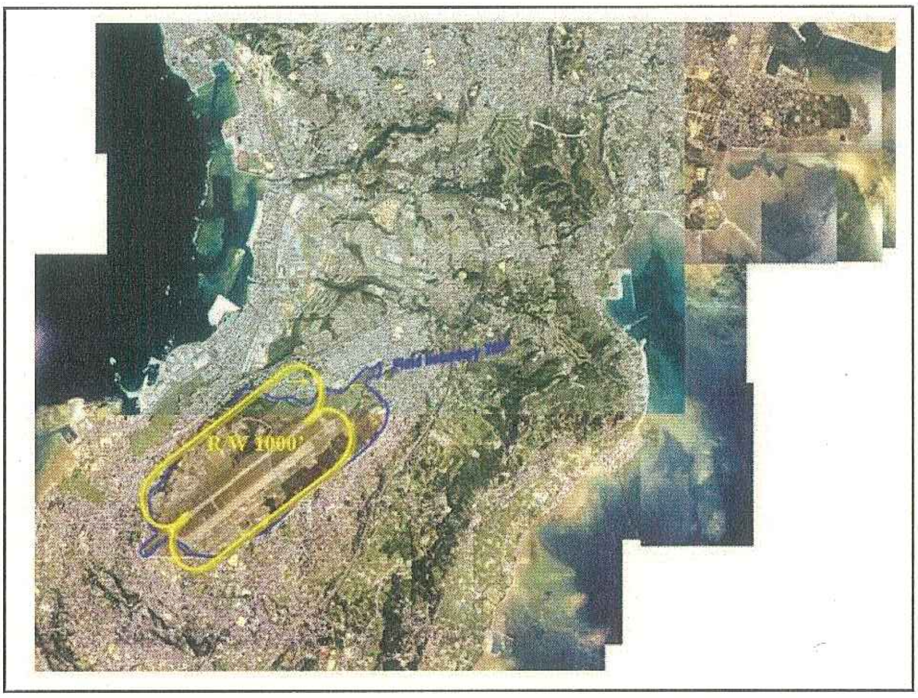
As a result of this study, it is confirmed that certain level of safety is ensured concerning the current helicopter flight operation at Futenma Air Station. However, it is considered to be appropriate that authorities of both Japanese and US governments steadily implement specific measures mentioned above in the future to further secure safety of the flights and residents.

# List of Enclosures

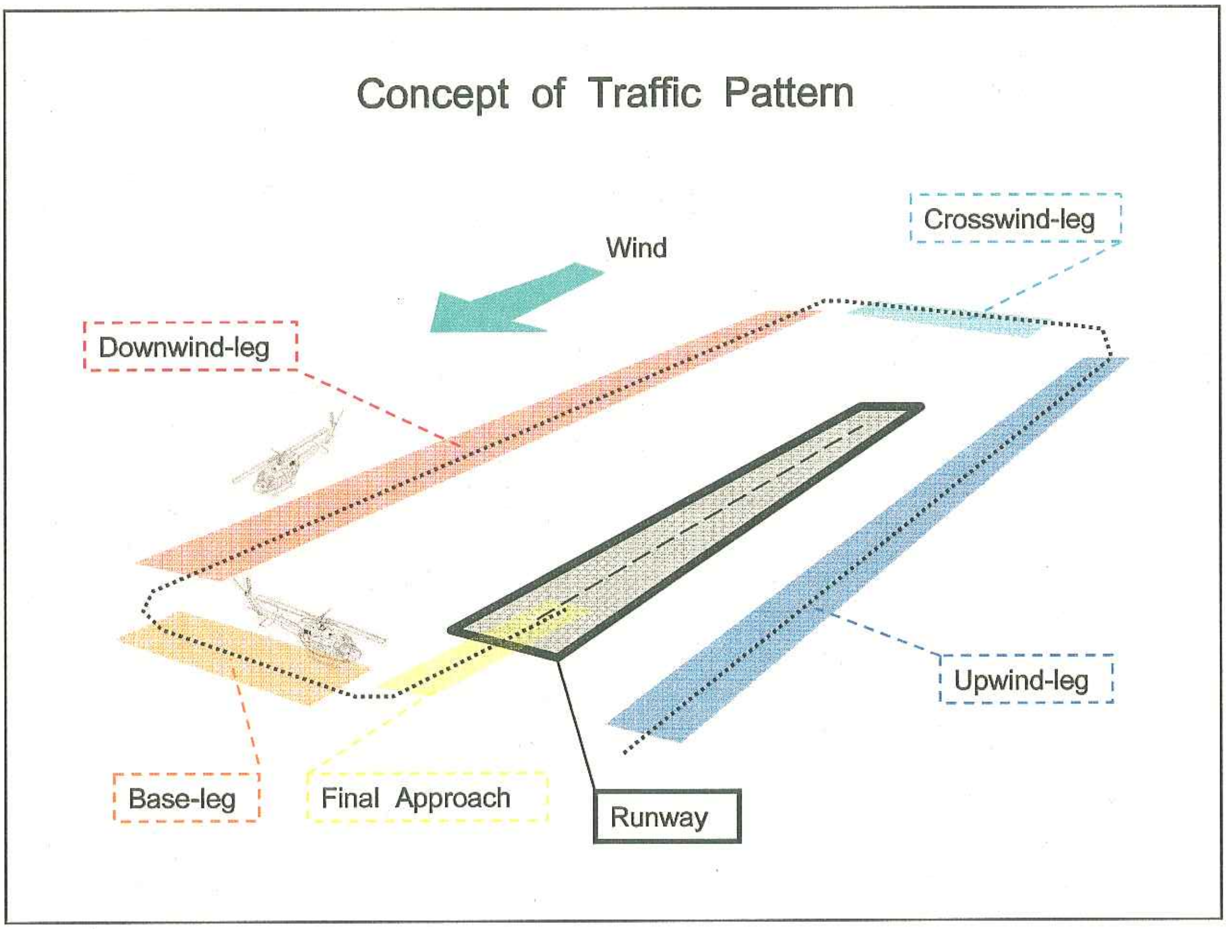
Encl.1

OKINAWA CONTROL ZONE / AIRPORT TRAFFIC AREAS




R/W 1000'


Overhead & Closed Traffic : Helicopter patterns are at 1000 ft MSL
Over the field boundary : At 700 ft MSL
Wind
Downwind-leg
Note: Yellow arrows indicate the direction of flight in northeast wind.
Base-leg


Concept of Traffic Pattern
Crosswind-leg
Wind
Downwind-leg
Upwind-leg
Base-leg
Final Approach
Runway


Pt.Sierra
Route vir Pt.Sierra (Departure/landing with RW06 and RW24)
Pt.Kilo
24
Route vir Pt.Kilo (Departure from RW06 and landing to RW24
06
MCAS Futenma
Route vir Pt.Tango (Departure from RW24 and landing to RW06
Pt.Tango

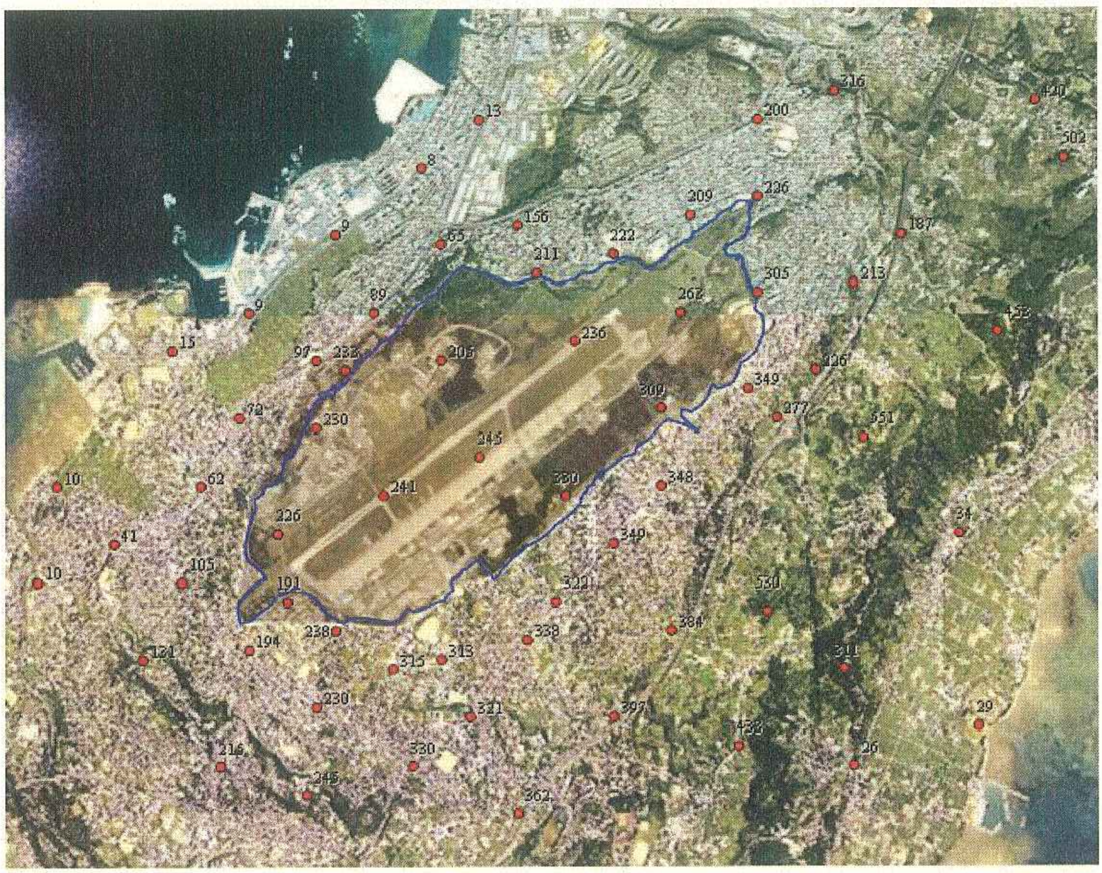
MCAS Futenma Wind Direction Historical Figures for the last 12 Months (Mar 06, wind direction number of days per month)

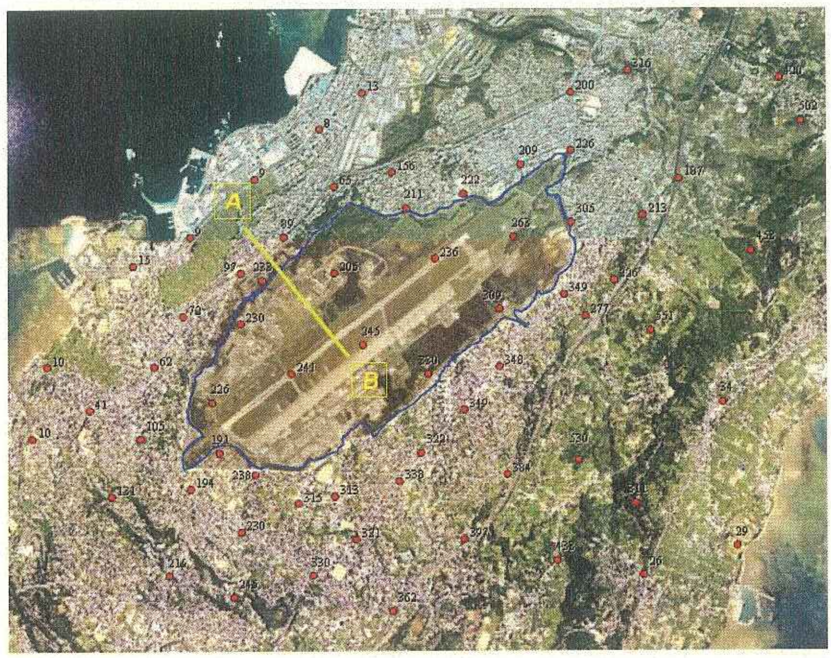
| Month | Dir | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | 8 | 5 | 7 | 4 | 2 | 0 | 0 | 2 | 2 | 8 | 5 | 3 | 46 |
| | NE | 11 | 11 | 6 | 8 | 4 | 5 | 7 | 0 | 12 | 15 | 14 | 14 | 107 |
| | E | 2 | 1 | 4 | 6 | 14 | 2 | 1 | 5 | 9 | 4 | 2 | 1 | 51 |
| | SE | 1 | 3 | 4 | 8 | 1 | 2 | 5 | 11 | 5 | 4 | 3 | 1 | 48 |
| | S | 0 | 2 | 0 | 1 | 1 | 3 | 7 | 0 | 0 | 0 | 1 | 0 | 15 |
| | SW | 2 | 3 | 2 | 1 | 6 | 17 | 11 | 9 | 0 | 0 | 3 | 0 | 54 |
| | W | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 8 |
| | NW | 7 | 3 | 4 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 12 | 30 |
| | VRB | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 |
| | Total | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | 365 |

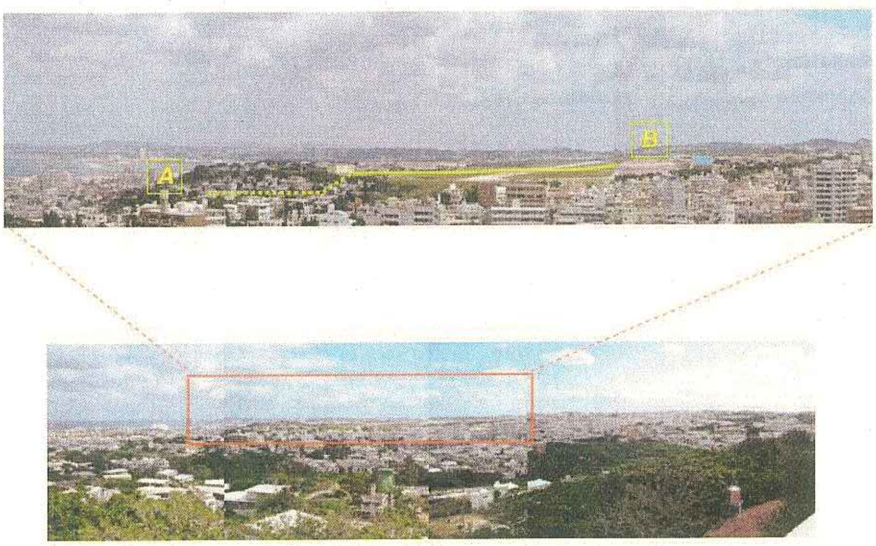
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total (N, NE, E, SE, NW) | 29 | 23 | 25 | 27 | 22 | 9 | 13 | 18 | 29 | 31 | 25 | 31 | 282 |
| Average (%) | 94% | 82% | 81% | 90% | 71% | 30% | 42% | 58% | 97% | 100% | 83% | 100% | 77% |

* Note wind shift during summer months

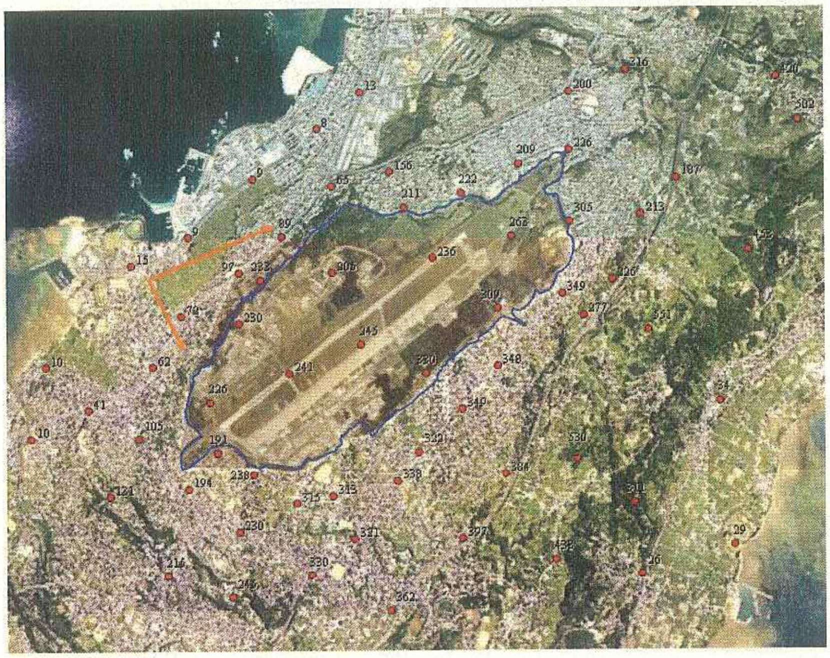
** VRB means winds are "variable" from multiple directions of less than 6 kts



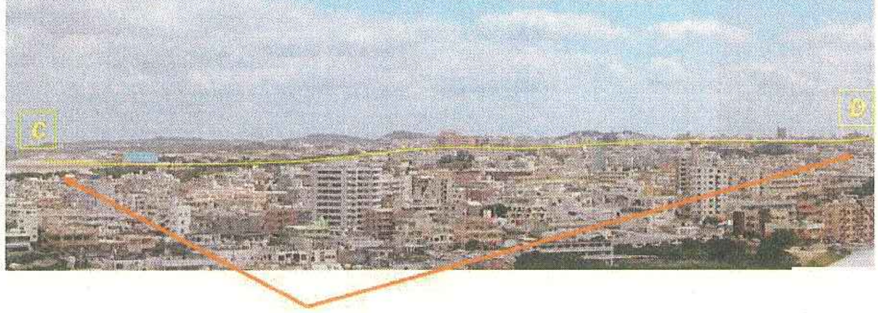

A
B


A
B

Encl. 8




C
D


C
D

# CH-46E Sea Knight Helicopter

**Primary function:** Medium lift assault helicopter
**Manufacturer:** Boeing Vertol Company
**Power plant:** (2) GE-T58-16 engines
**Thrust:**
*Burst:* 1870 shaft horsepower (SHP)
*Continuous:* 1770 SHP
**Length:**
*Rotors unfolded:* 84 feet, 4 inches (25.69 meters)
*Rotors folded:* 45 feet, 7.5 inches (13.89 meters)
**Width:**
*Rotors unfolded:* 51 feet (15.54 meters)
*Rotors folded:* 14 feet, 9 inches (4.49 meters)
**Height:** 16 feet, 8 inches (5.08 meters)
**Maximum takeoff weight:** 24,300 pounds (11,032 kilograms)
**Speed:** 145 knots (166.75 miles per hour)
**Ceiling:** 10,000 feet (+)
**Crew:**
*Normal:* 4 - pilot, copilot, crew chief, and 1st mechanic

# CH-53E Super Stallion Helicopter

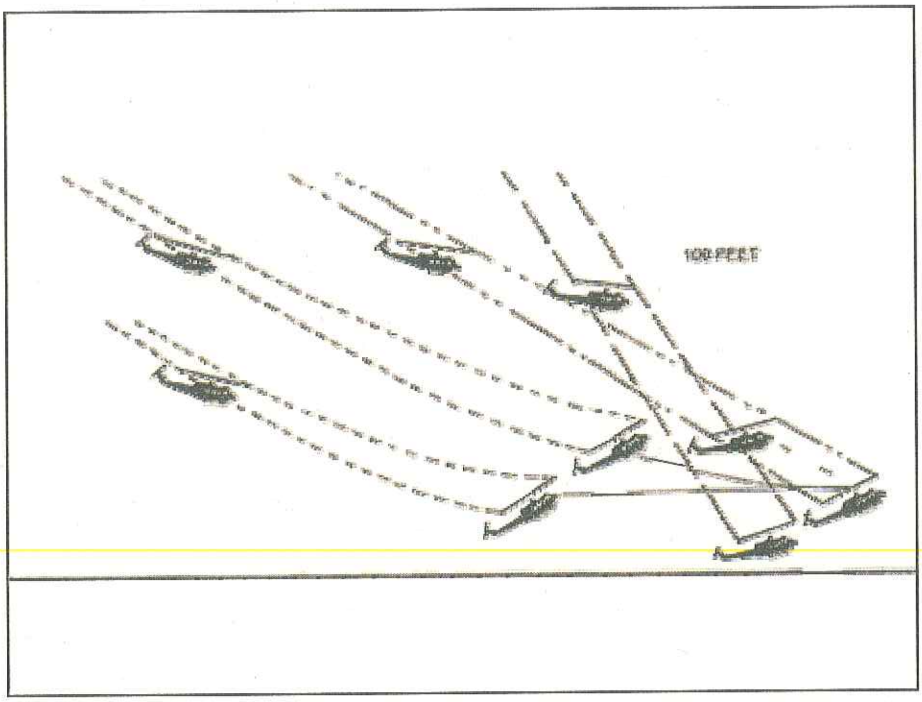
Primary function: Transportation of heavy equipment and supplies
Manufacturer: Sikorsky Aircraft
Power plant: Three General Electric T64-GE-416 turboshaft engines producing 4380 shaft horsepower each.
**Length:** 99 feet 5 inches (30.3 meters)
**Height**: 28 feet 4 inch (8.64 meters)
Rotor diameter: 79 feet (24.07 meters)
Speed: 172.5 miles per hour (150 knots)
Maximum takeoff weight:
*Internal load:* 69,750 pounds (31,666 kilograms)
*External load:* 73,500 pounds (33,369 kilograms)
Crew: 3

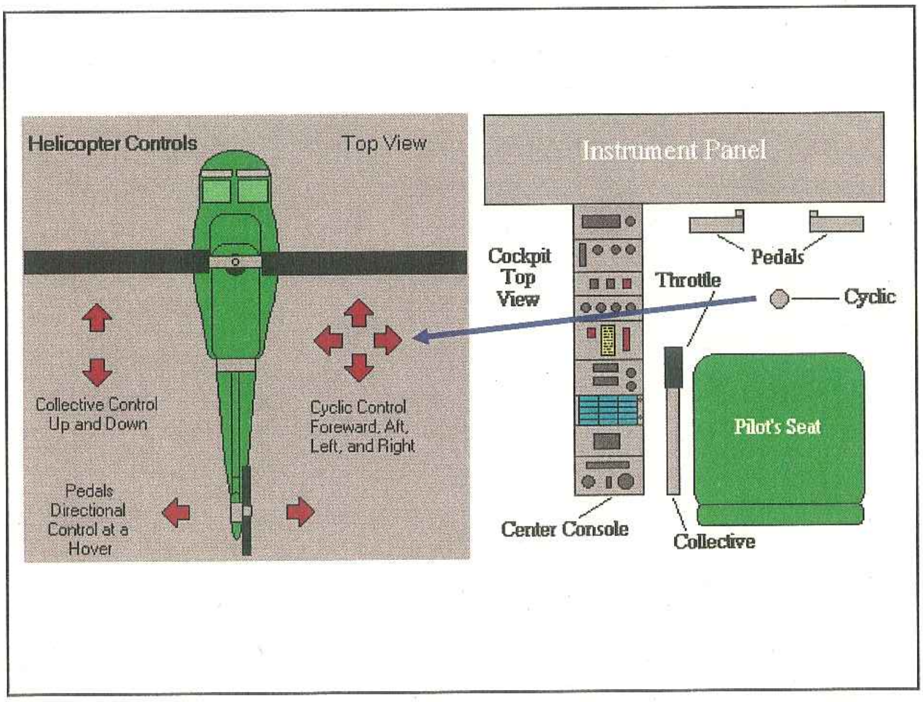
# UH-1N Huey Helicopter

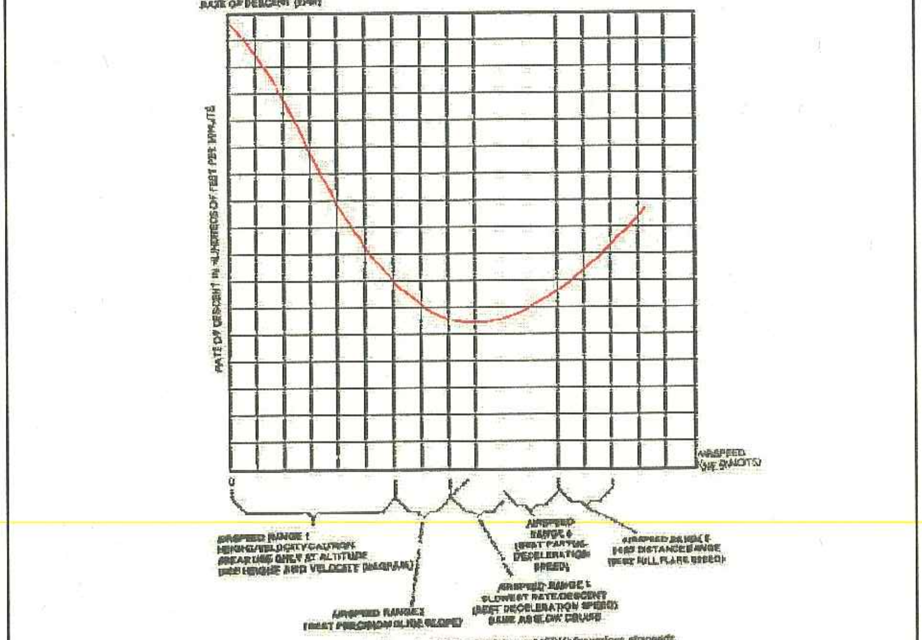
Primary function: Utility helicopter
Manufacturer: Bell Helicopter Textron
Power plant: Pratt and Whitney T400-CP-400
Power: *Burst:* 1290 shaft horsepower
*Continuous:* 1134 shaft horsepower
Length: 57.3 feet (17.46 meters)
Height: 14.9 feet (4.54 meters)
Rotor Diameter: 48 feet (14.62 meters)
Speed: 121 knots (139.15 miles per hour) at sea level
Ceiling: 14,200 feet (4331 meters)
Maximum takeoff weight: 10,500 pounds (4,767 kilograms)
Crew:
*Officer:* 2
*Enlisted:* 2
Features: The UH-1N is a twin-piloted, twin-engine helicopter used in command and control, resupply, casualty evacuation, liaison and troop transport

# AH-1W Super Cobra Helicopter

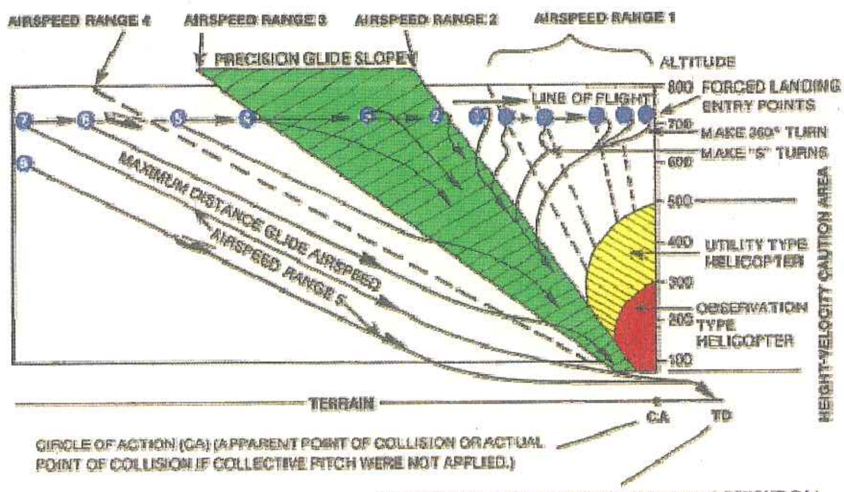

Primary function: Attack helicopter
Manufacturer: Bell Helicopter Textron
Power plant: Two General Electric T700-GE-401 engines
Thrust:
*Full:* 2082 shaft horsepower
*Continuous:* 1775 shaft horsepower
Length: 58 feet (17.67 meters)
Height: 13.7 feet (4.17 meters)
Rotor Diameter: 48 feet (14.62 meters)
Speed: 147 knots (169.05 miles per hour)
Maximum takeoff weight: 14,750 pounds (6,696.50 kilograms)
Ceiling: 18,700 feet (5703.5 meters)
Crew: 2 officers


100 FEET

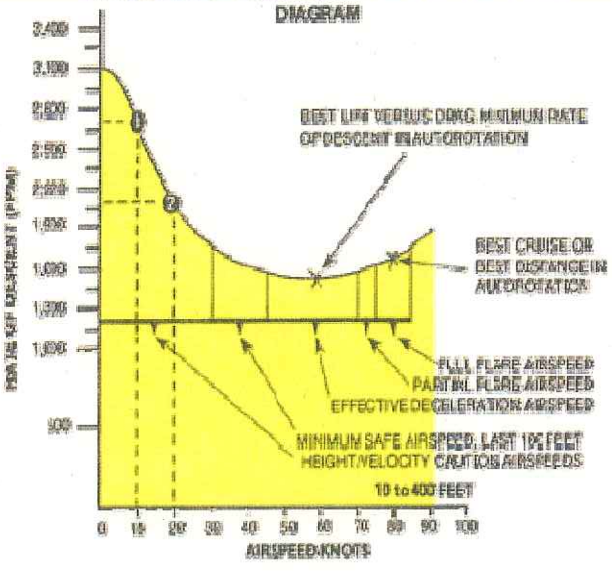

Helicopter Controls
Top View
Collective Control Up and Down
Cyclic Control Foreward, Aft, Left, and Right
Pedals Directional Control at a Hover
Instrument Panel
Cockpit Top View
Pedals
Throttle
Cyclic
Pilot's Seat
Center Console
Collective



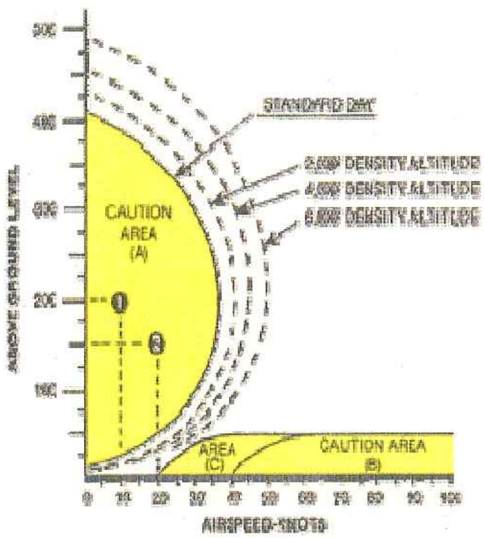
Steady-state autorotative rate of descent (FPM) for various airspeeds.

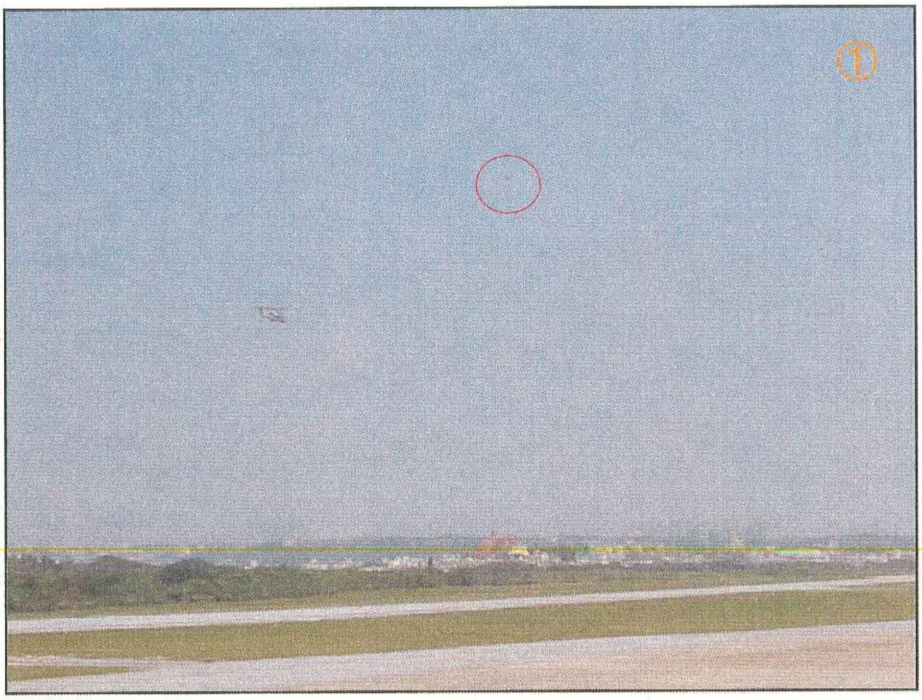


TYPICAL
"AUTOROTATION RATE OF DESCENT VERSUS AIRSPEED"
DIAGRAM



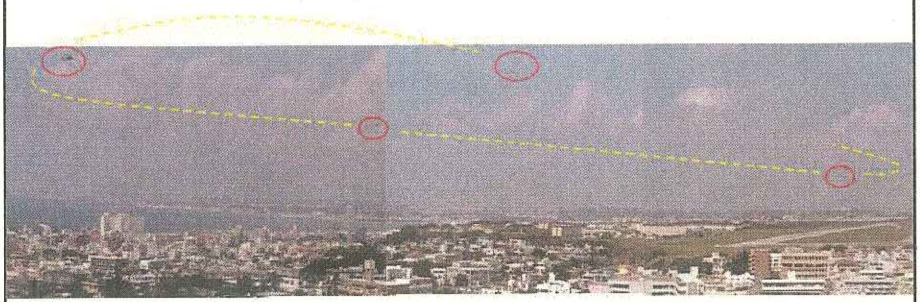

TYPICAL "HEIGHT-AND-VELOCITY" DIAGRAM

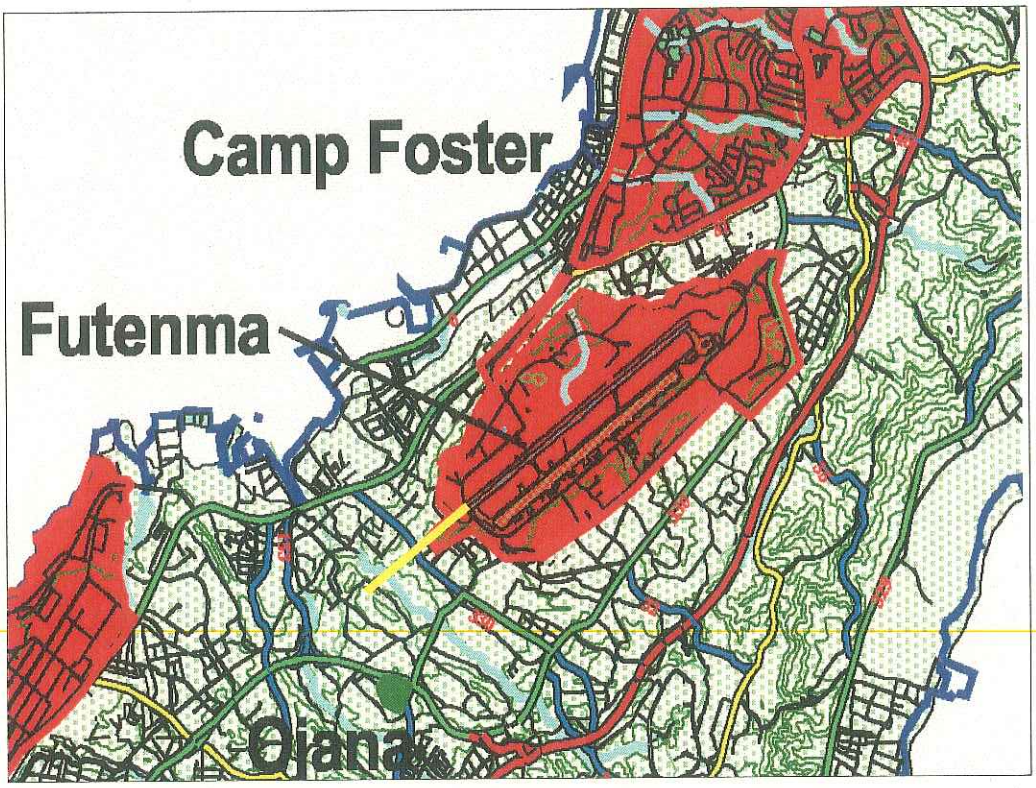



①


②

③






The yellow line off of the approach end of Runway 06 represents a horizontal distance of 4000 feet. This indicates very basic parameters derived from autorotation charts from various type/model/series that indicate a standard day of Pressure Altitude 2992, no wind, temperature of 30 degrees centigrade, and does not factor in the following:

-Pilot experience

-Density Altitude

-Aircraft type

-Weight

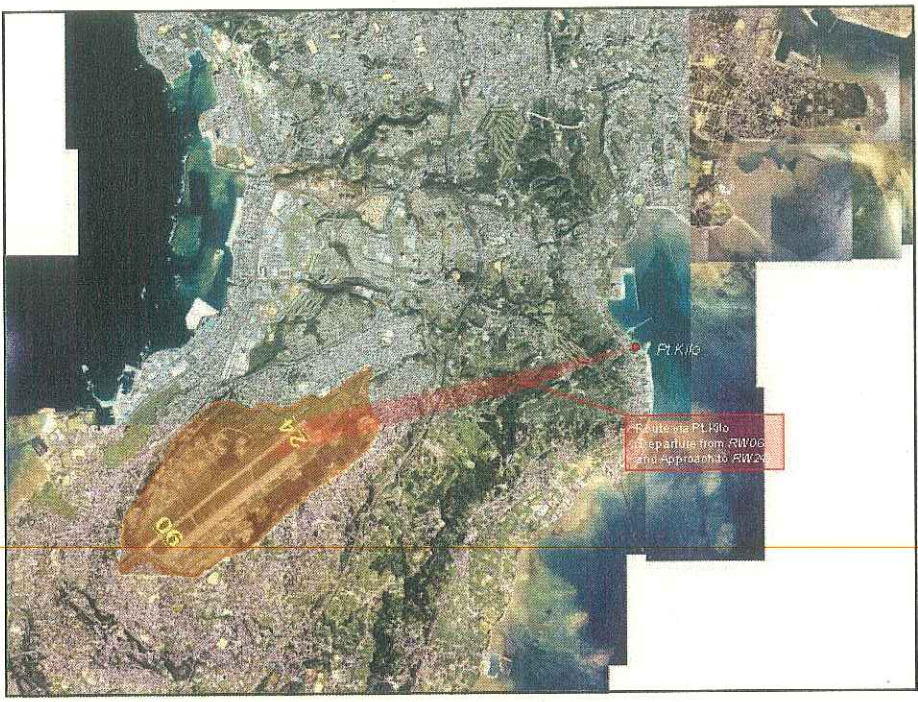
Each type/model/series manual states that anywhere from ¾ of a mile to one mile of distance should be able to be accomplished horizontally from 1300 feet AGL. The yellow line indicates a distance of 4000 feet as an average, and shows the distance from the end of the runway at which an aircraft SHOULD be able to enter into an autorotation at Futenma and make the paved runway.

Encl. 20

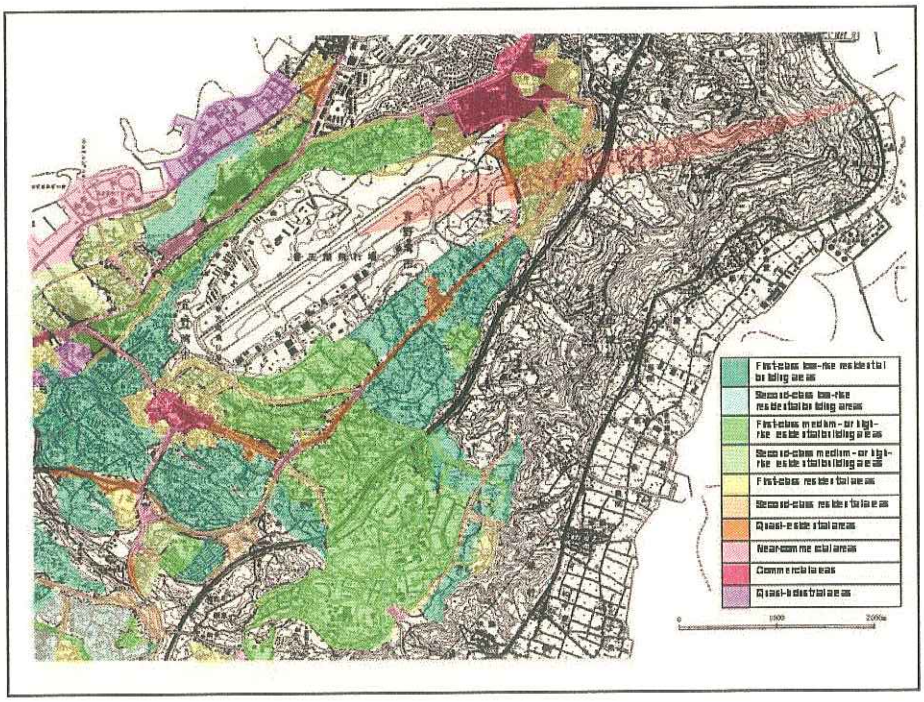
Encl. 21


Pt.Kilo
Route via Pt.Kilo (Departure from RW06 and Approach to RW24)
Route via Pt.Tango (Departure from RW24 and Approach to RW06)
24
06
MCAS Futenma
Pt.Tango

Encl.22



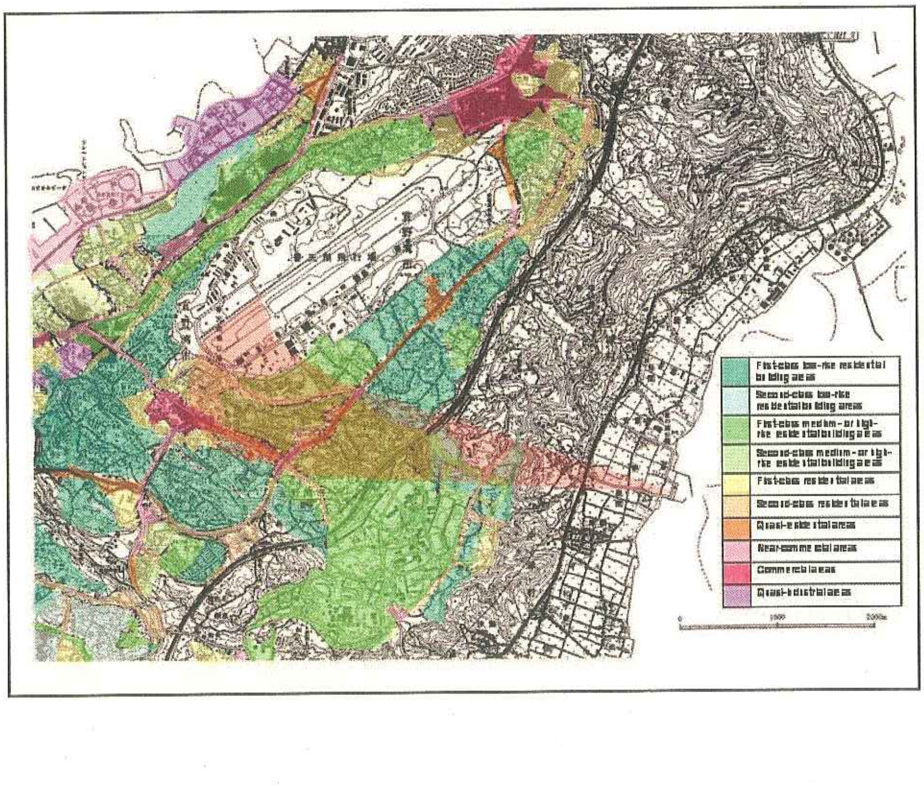
Pt.Kilo
Route via Pt.Kilo
Departure from RW06
and Approach to RW24
24
06

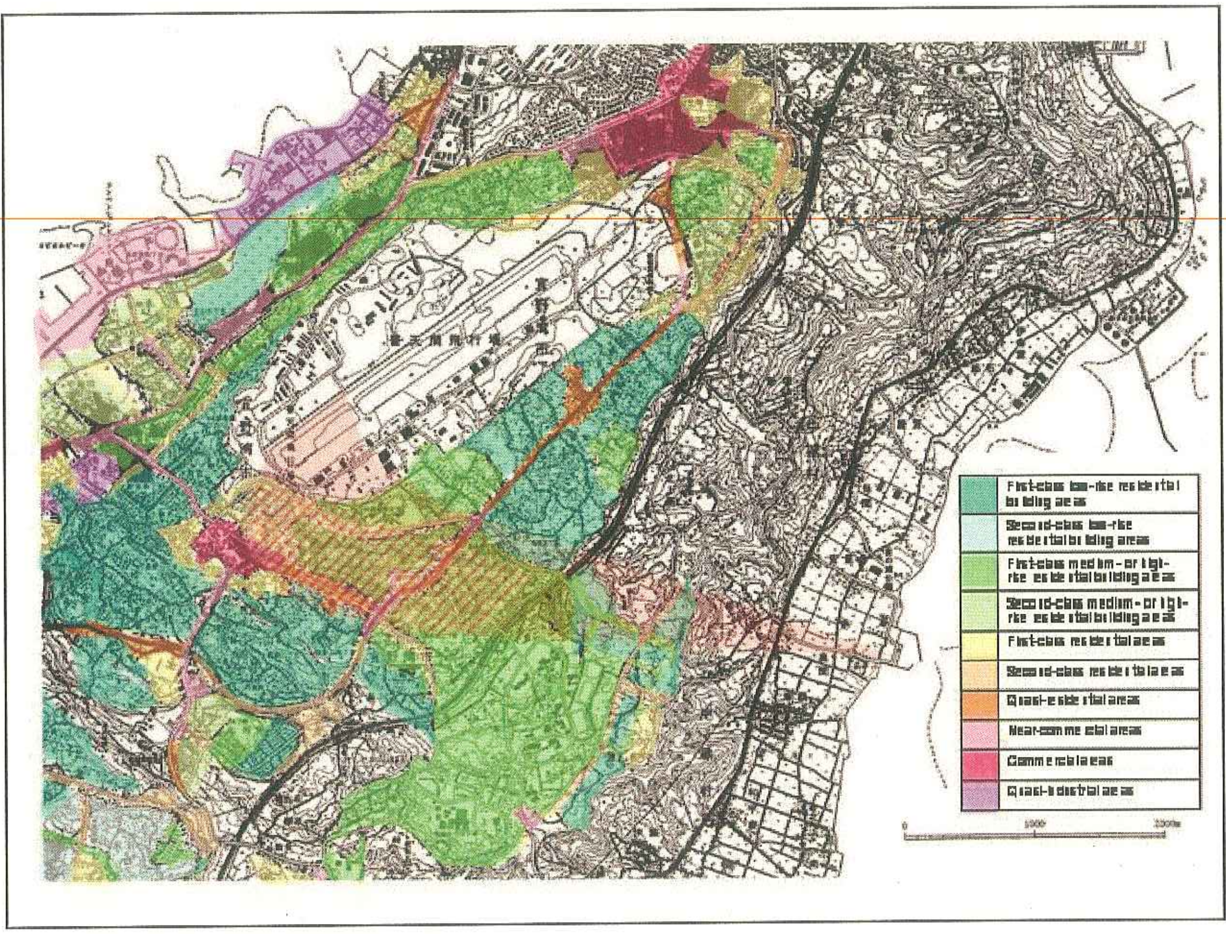
First-class low-rise residential building areas
Second-class low-rise residential building areas
First-class medium- or high-rise residential building areas
Second-class medium- or high-rise residential building areas
First-class residential areas
Second-class residential areas
Quasi-residential areas
Near commercial areas
Commercial areas
Quasi-industrial areas
0
1000
2000m

Encl. 23

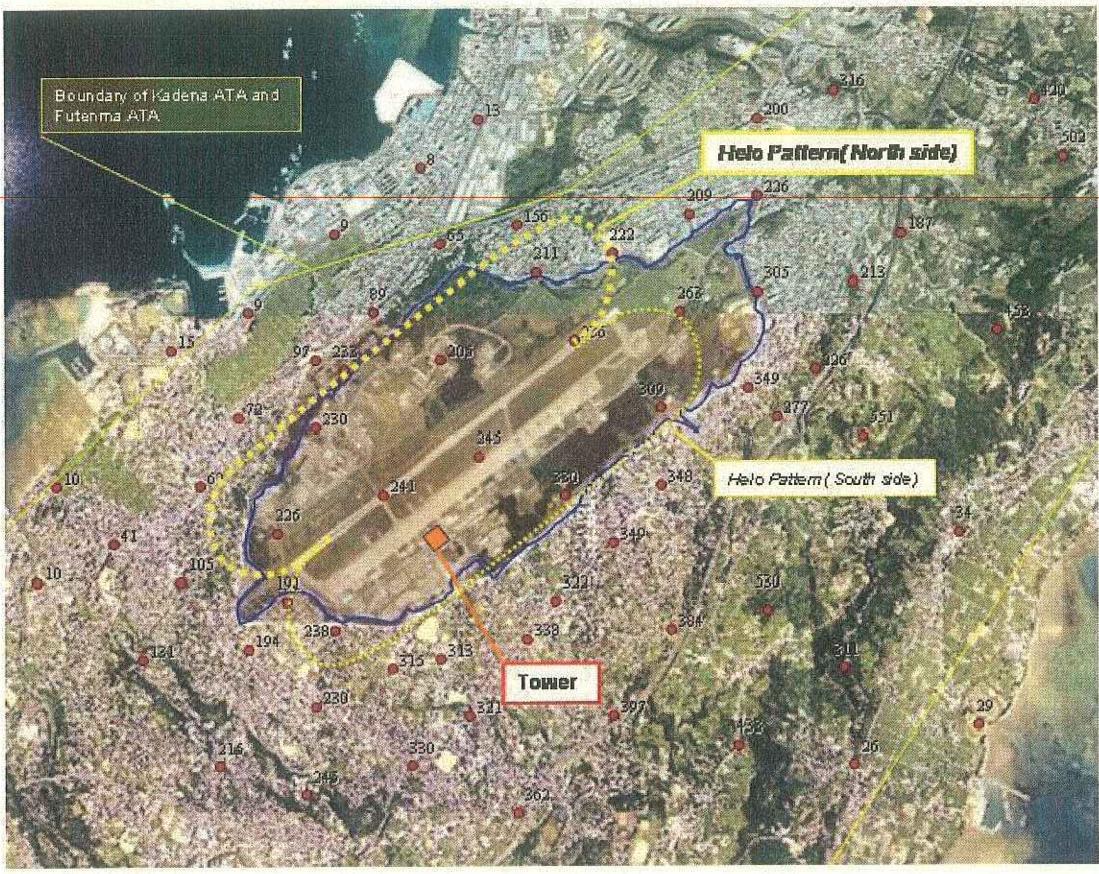
24
06
MCAS Futenma
Pt.Kilo
Route via Pt.Tango
(Departure from RW24
and Approach to RW06)
Pt.Tango

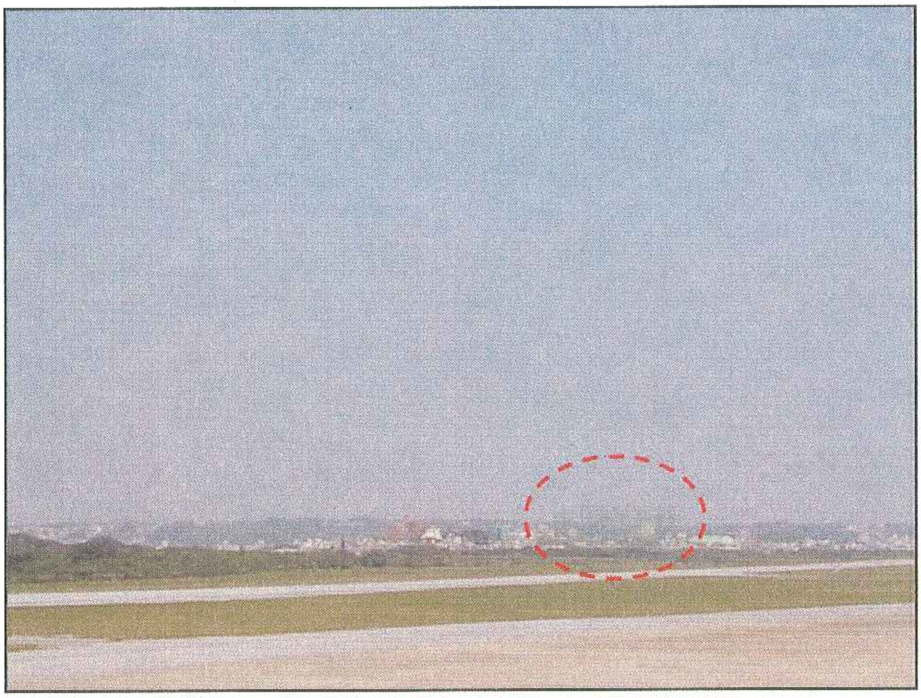



First-class low-rise residential building areas
Second-class low-rise residential building areas
First-class medium- or high-rise residential building areas
Second-class medium- or high-rise residential building areas
First-class residential areas
Second-class residential areas
Quasi-residential areas
Near-commercial areas
Commercial areas
Quasi-industrial areas
0
1000
2000m

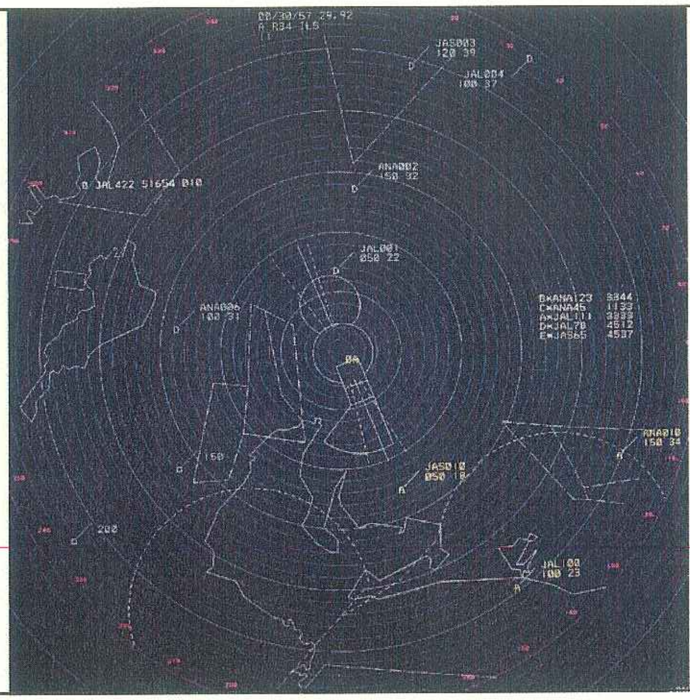


Encl. 25

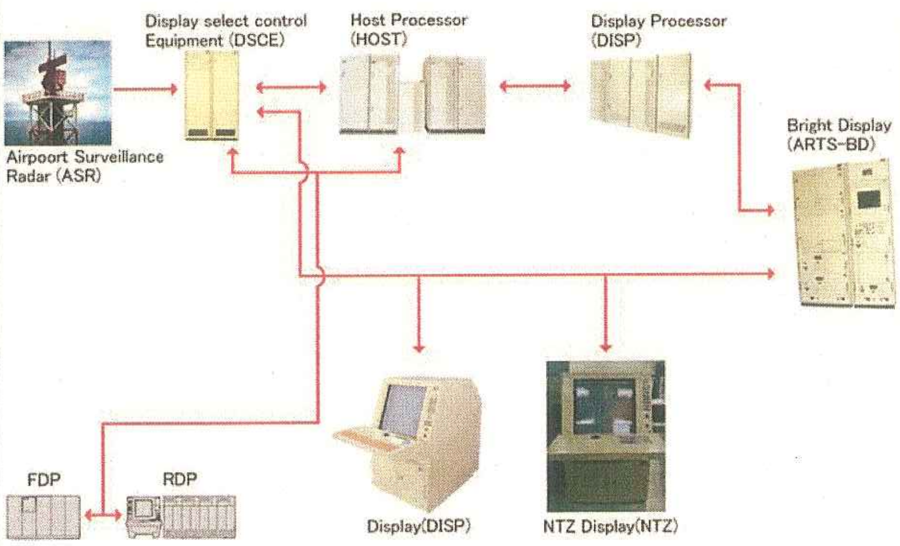

Boundary of Kadena ATA and Futenma ATA
Helo Pattern( North side)
Helo Pattern ( South side)
Tower



**ARTS (Display)**

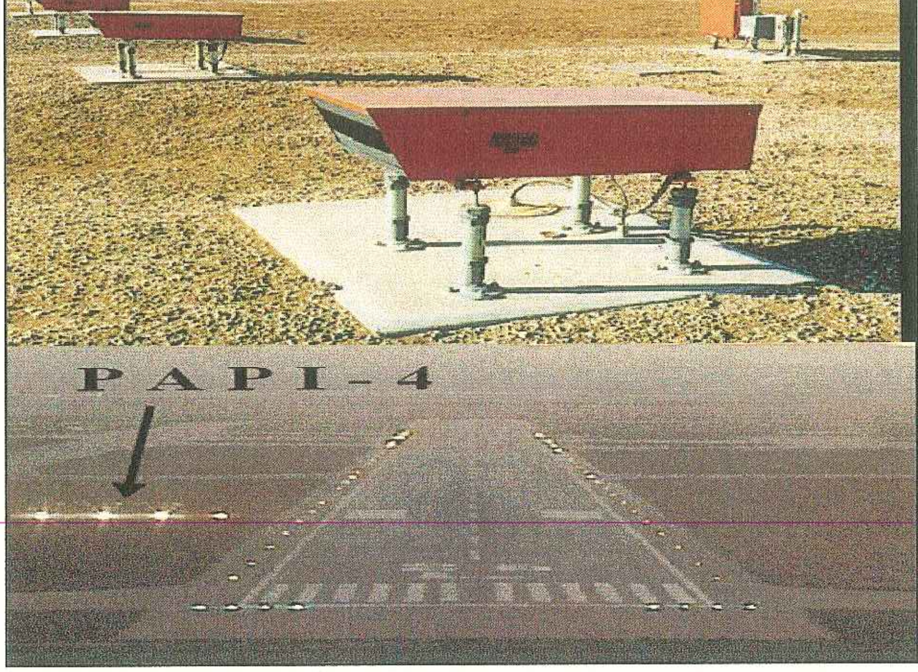


**ARTS (Configuration)**

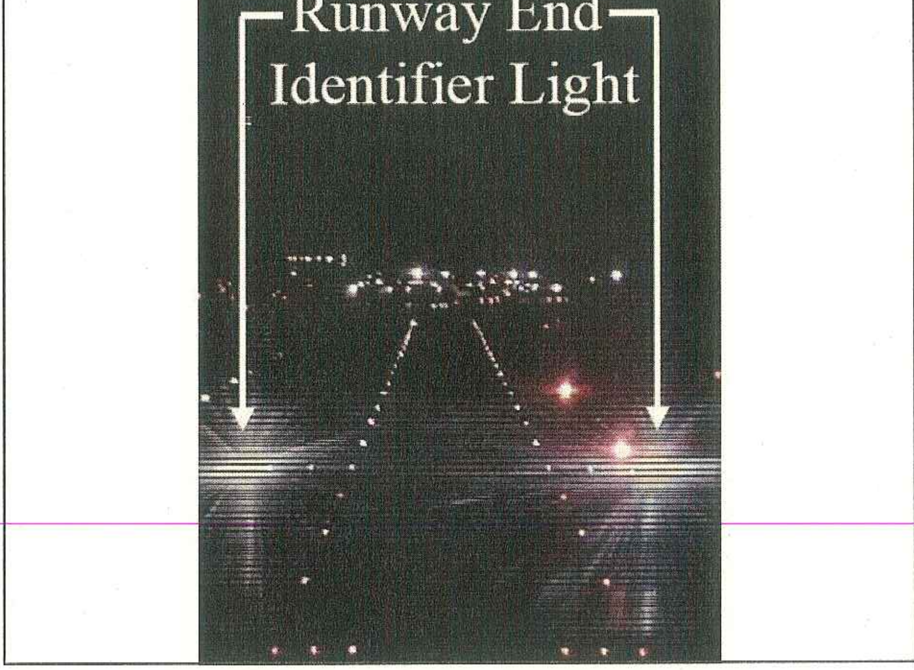


CH-46E Aircrew Procedures Trainer (APT)

**CH-53E Aircrew Procedures Trainer (APT)**


PAPI - 4


PAPI
PAPI


Runway End
Identifier Light

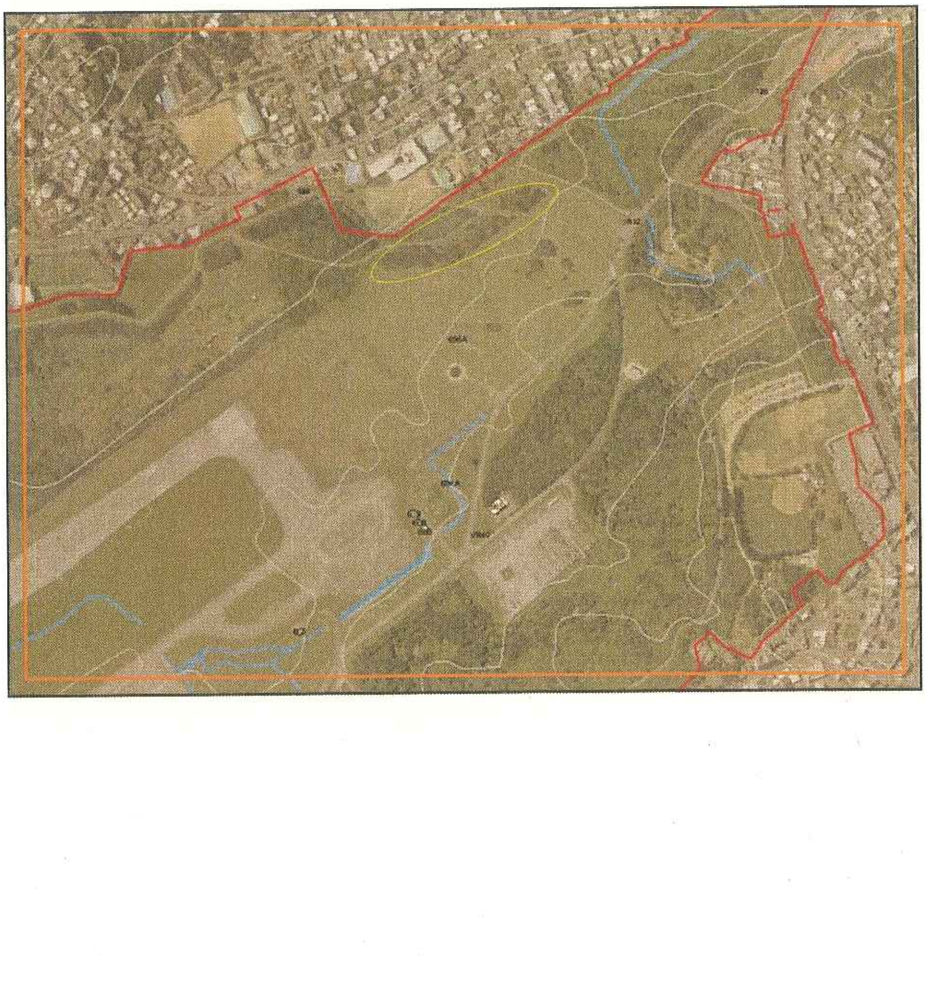

REIL
REIL
REIL
REIL

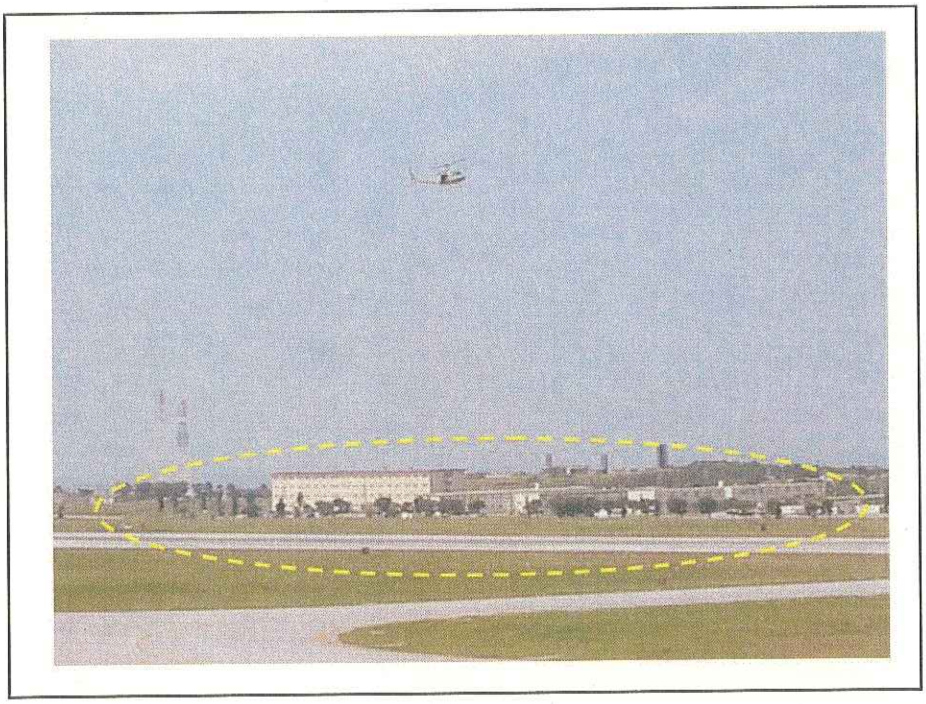

Microwave
Antenna

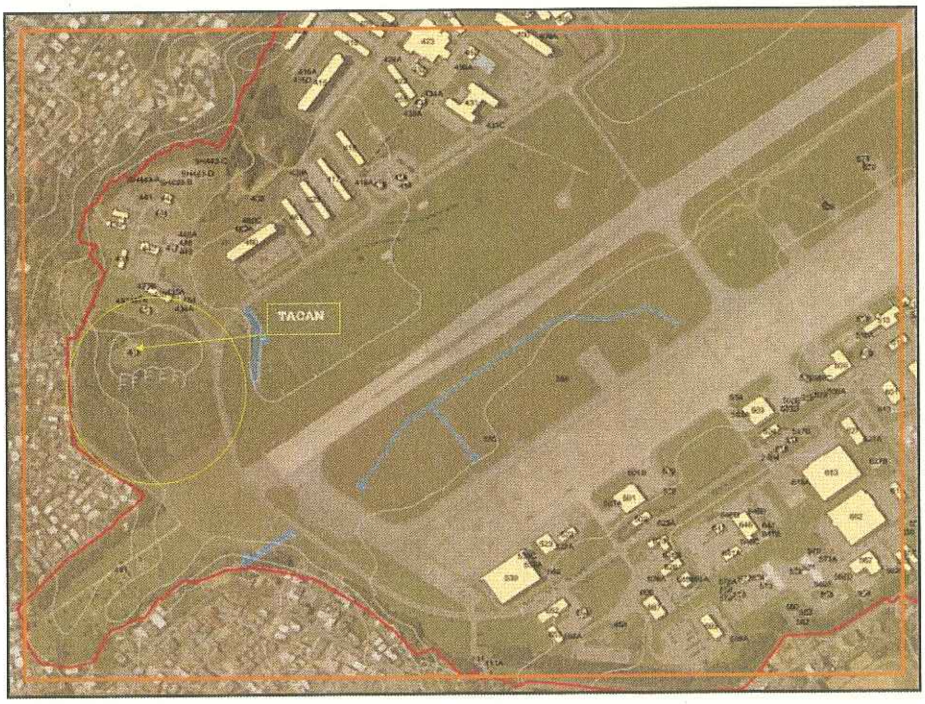

Microwave Antenna

Encl. 33


Encl. 35






TACAN