MIDAIR COLLISION AVOIDANCE

Handbook

AFFTCP 11-3

EDWARDS AIR FORCE BASE
CALIFORNIA

Fellow Aviators,

This pamphlet is designed to increase your awareness of Edwards-based military flying operations in Southern California. It includes information on the R-2508 Complex to include: Restricted Areas, Military Operating Areas (MOAs), and Low-Level Training Routes (Figure 1). Hopefully, this information will help you better understand our local military operations and will facilitate an enjoyable, safe flying environment for all concerned.

I solicit your comments and recommendations for improvement. If you need additional copies of this pamphlet, they can be obtained from our website at:

www.edwards.af.mil/psafety/sef_main.html

Click on "MACA Pamphlet – AFFTCP 11-3."

If you have a group of 10 or more aviators and are interested in having my safety officers visit your organization and provide a Midair Collision Avoidance (MACA) seminar, call us at (661) 277-2623 (DSN: 527-2623), e-mail us from our website, or write us at:

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Chief of Safety

SUMMARY OF REVISIONS
Minor changes were made to airspace descriptions, techniques, and figures to clarify the information in this pamphlet for the General Aviation audience.

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COLLISION AVOIDANCE TIPS

Studies on midair collisions show most accidents occur below 8000 feet MSL and near airports, navaids, and other high density traffic areas. Here are some ideas to help reduce your midair collision potential:

1. Know where the high-density traffic is.

2. Fly as high as practical.

3. Obtain an IFR clearance or participate in radar flight following whenever possible, and continue to practice “see and avoid” at all times.

4. Use all lights at lower altitudes, especially when near airports.

5. Announce your intentions on unicom and use standard traffic pattern procedures at uncontrolled fields. Try to present a “predictable target.”

6. Always use your transponder with altitude reporting on (if available). Crosscheck accuracy with ATC whenever possible.

7. Use the appropriate hemispheric altitudes.

8. Constantly watch for other aircraft. Remember to “manage” your visual lookout as mentioned earlier in this pamphlet and understand the limitations of your eyes. Clear over the radio in addition to clearing visually.

9. Keep your windshield and windows clean and clear. A bug on the windscreen can obstruct and disrupt your visual lookout.

10. Learn proper task management in the air. Learn the proper methods to help you reduce your workload demands and timing crunches.

11. Do not get complacent during instruction. Instructors make mistakes too. Many midair collisions have occurred during periods of instruction or supervision.

12. When flying at night, do not use white light inside the aircraft. White light disrupts your night vision, even if used momentarily. Use a red light at night.

13. Beware of wake turbulence.

14. If another aircraft appears to have no relative motion in your windscreen but is increasing in size, it is on a direct collision course with you.

15. Execute appropriate clearing procedures before and during all climbs, descents, turns, abnormal maneuvers, or aerobatics.

16. Above all: AVOID COMPLACENCY!

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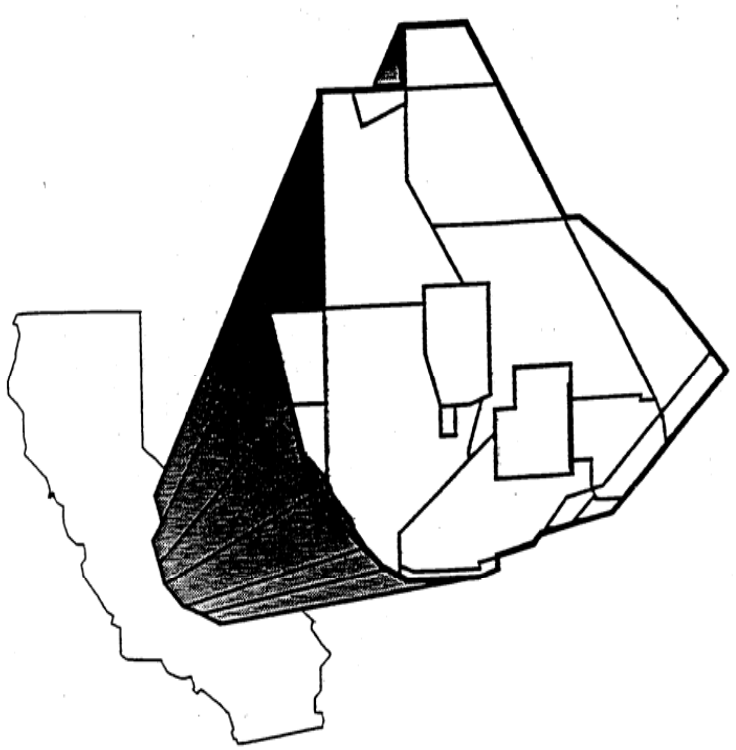
FIGURE 1. R-2508 COMPLEX



THE MIDAIR COLLISION POTENTIAL

Preventing midair collisions is why this pamphlet was written. In 1987, there was a fatal collision between a civilian Cessna 206 and a USAF military jet, a T-38. In 1997, there was a fatal collision between two military jets, an F-16 and T-38. The potential for future midairs remains relatively high in and around the R-2508 complex for a number of reasons:

1. The peculiar nature of flight testing creates an atmosphere where there is a high probability of a midair collision. Aircraft undergoing flight testing perform a number of maneuvers, some of which are highly aerobatic. A high performance jet can generate rates of climb or descent in excess of 20,000 FPM. Because the pilot has a number of critical test points to perform, he dedicates much of his time observing flight instruments instead of looking out of the cockpit. Most of the test activity is performed in Complex R-2508 (Figure 2).

2. The number of aircraft (civilian and military) operating in and around the R-2508 Complex – a finite amount of airspace – is increasing. Though this pamphlet is a product of Edwards AFB, there are many other R-2508 Complex military users: Nellis AFB, Naval Air Weapons Division–China Lake, Lemoore Naval Air Station, and Fresno Air National Guard are major users.

3. California's topography limits the usable airspace within the R-2508 Complex. The Sierra Nevada Mountains extend from the northwest into the western portion of the R-2508 Complex. Since the terrain reaches almost 15,000 Feet MSL, it takes away much of the area available for flight test, condensing it into a limited area. Additionally, to avoid spilling out the lateral boundaries of R-2508 Complex (the FAA frowns on such transgressions), military pilots often give themselves a 3-5 mile buffer along all boundaries. This further reduces the working airspace.

4. Civilian traffic through or around the R-2508 Complex usually flows through geographic corridors. Many of these corridors are located near military low-level routes. Areas of concern occur around Koehn Lake, Owens Lake, and the area called the "Trona Gap" (Figure 3 depicts areas of concentrated general aviation aircraft).

5. Many civilian aircraft transiting the R-2508 Complex do not use their transponders or Mode C (altitude reporting capability).

6. Finally, many civilian pilots do not contact the High Desert Terminal Radar Approach Control (TRACON), call sign "Joshua Approach" to request traffic advisories. **NOTE**: There are gaps in radar and radio coverage throughout the R-2508 Complex due to mountainous terrain.

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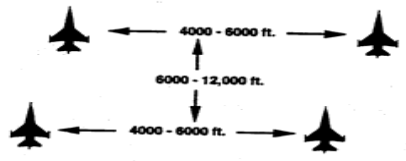
MILITARY FORMATIONS

Sage advice for anyone who spots a military aircraft is to look for another military near by – often the same type as the first aircraft. Military aircraft flock together. It provides mutual support and tactical efficiency, and is the way the military does business. Thus, it is safe to assume if you see one C-130 flying down Panamint Valley at 500 feet, there may be another C-130 near by. Some of the various military formations are shown below:

TACTICAL FORMATIONS:

Wartime formations are called "tactical formations." This usually means the aircraft are flying a mile or so apart horizontally and may be split vertically by as much as 6000 feet. You could see as few as two aircraft in tactical formation or as many as eight or more. Here is an example:



(NON-TACTICAL) FORMATIONS:

Military aircraft in a non-tactical formation (non-hostile) environment usually fly in a "standard" formation. By regulation, this means they must be within 1 mile horizontally and 100 feet vertically of each other. Usually the aircraft will be close enough together to spot them easily. Here are a few examples:

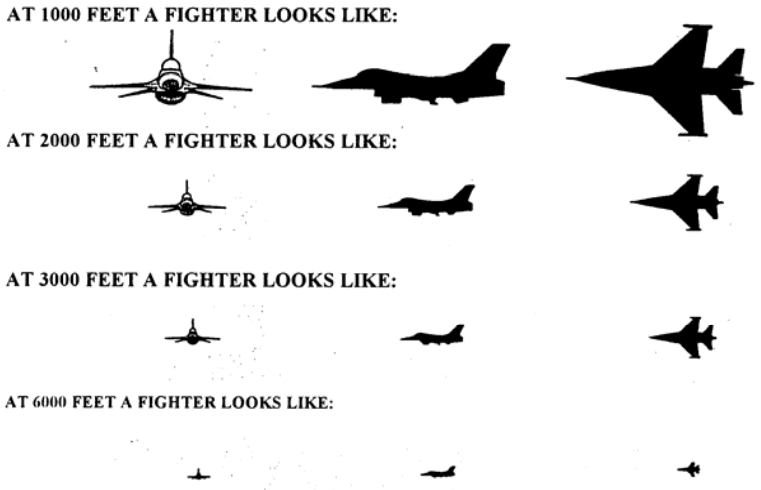
"FINGERTIP"
3'- 6' SEPARATION

ROUTE FORMATION
100' - 800' SEPARATION

CHECK SIX

You might think it is easy to spot a military aircraft because they are usually larger than an airplane you might own or use. Certainly, large military transport, bomber, or air refueling aircraft are "airliner" sized, but what about a fighter? Take a look at the figure below—it might give you an idea of relative fighter size.

WHAT A FIGHTER LOOKS LIKE AT VARIOUS DISTANCES



To put things in perspective, if you are flying at 120 knots and are approaching an F-16 head-on traveling at 500 knots (a typical fighter speed flown on low-level routes) you will close at about 1000 feet per second. If your initial separation was 6000 feet, you would have about 6 seconds to react prior to impact. That is if you were able to recognize the "dot on the horizon" as a conflict. Not much time! It takes approximately 3-5 seconds for a pilot to recognize a threat, make a decision, and initiate action. Also keep in mind the F-16 pilot will have an even tougher time seeing you if your aircraft is smaller than his.

The bottom line: keep your visual look-out honed–commonly referred to in the fighter community as…

"CHECK SIX"

FIGURE 2. R-2508 COMPLEX VERTICAL DIMENSIONS

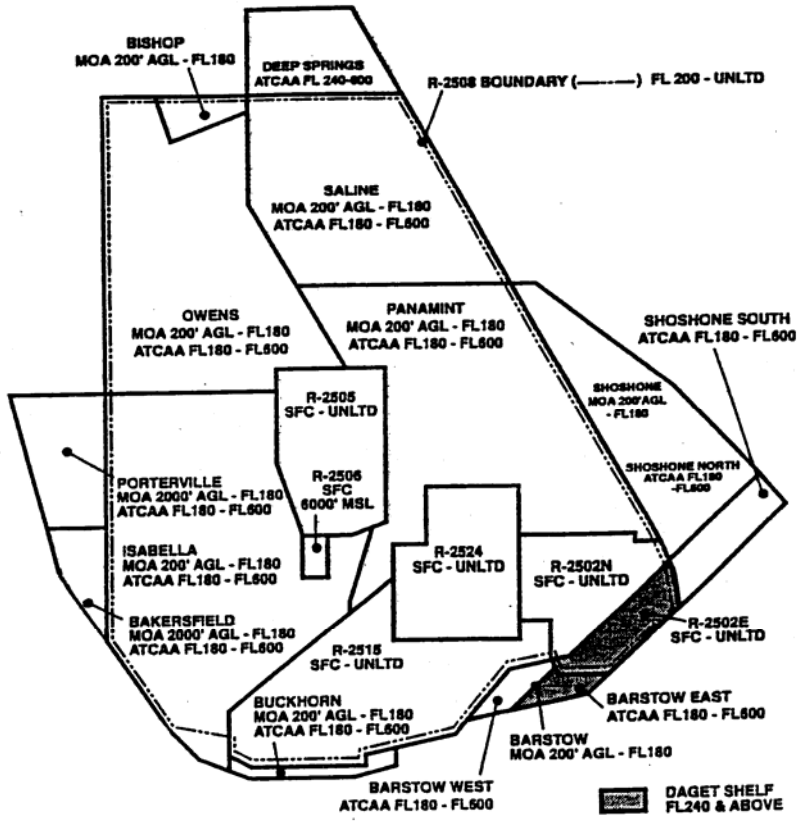
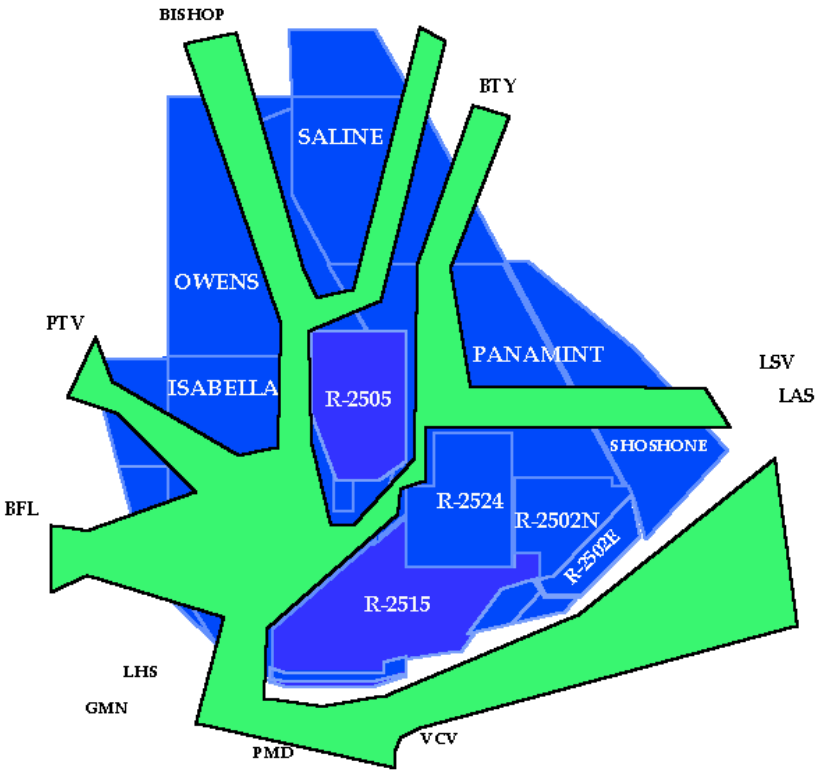


FIGURE 3. AREAS OF CONCENTRATED GENERAL AVIATION AIRCRAFT.



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One method of block scan is the 'side-to-side' motion. Start at the far left of you visual area and make a methodical sweep to the right, pausing in each block to focus. At the end of the scan, return to the panel. The second form is the 'front-to-side' version. Start with a fixation in the center block of your visual field. Move your eyes to the left, focusing in each block, swing quickly back to the center block, and repeat performance to the right.

There are other methods of scanning of course, some of which may be as effective for you as the two preceding types. Unless some series of fixations are made, however, there is little likelihood that you will be able to detect all targets in your scan area. When the head is in motion, vision is blurred and the mind will not register targets as such.

Developing an efficient time-sharing plan takes a lot of work and practice, but it is just as important as developing good landing techniques. The best way is to start on the ground, in your own airplane, or the one you usually fly, and then practice your scan during every flight. Also, take a few moments to brief your passengers on the importance of detecting traffic; they can greatly assist you in your responsibility to **SEE AND AVOID!!!**

SCANNING TECHNIQUES

So you want to know what is the perfect scan? There is none, or at least there is no one scan that is best for all pilots. The most important thing is for each pilot to develop a scan that is both comfortable and workable. The best way to start is by getting rid of bad habits. Naturally, not looking out at all is the poorest scan technique, but glancing out at intervals of five minutes or so is also poor when you remember that is only takes seconds for a disaster to happen. Check yourself the next time you are climbing out, making an approach, or just bouncing along over a long cross-country route. See how long you go without looking out the window.

So much for the bad habits. Learn how to scan properly; first by knowing where to concentrate your search. It would be preferable, naturally, to look everywhere constantly, but that not being practical, concentrate on the areas most critical to you at any given time. In the traffic pattern especially, clear yourself before every turn, and always watch for traffic making an improper entry into the pattern. On descent and climbout, make gentle S-turns to see if anyone is in your way. (Make clearing turns, too, before attempting maneuvers, such as pylons and S-turns about a road.) During that very critical final approach stage, do not forget to look behind and below, at least once; and avoid Tunnel Vision. Pilots often channelize their attention on approach in an attempt to nail their landing.

In normal flight, you can generally avoid the threat of a midair collision by scanning an area 60 degrees to the left and right of your central visual area. This does not mean you should forget the rest of the area you can see from your side windows every few scans. Horizontally, the statisticians say, you will be safe if you scan 10 degrees up and down from your flight vector. This should be increased to 45 degrees within MOAs due to high rates of climb and descent. This will allow you to spot any aircraft that is at an altitude that might prove hazardous to your own flight path, whether it is level with you, below and climbing, or above and descending. The slower your plane, the **GREATER** your vulnerability; hence, the greater scan area required.

SCAN PATTERNS

Your best defense against midair collisions is an efficient scan pattern. Two basic scans that have proved best for most pilots are called the 'block' system. This type of scan is based on the theory that traffic detection can be made only through a series of eye fixation at different points in space. Each of these fixes becomes the focal point of your field of vision (a block 10-15 degrees wide). By fixating every 10-15 degrees, you should be able to detect any contrasting or moving object in each block. This gives you 9-12 blocks in your scan area, each requiring a minimum of one to two seconds for accommodation and detection.

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The next few pages describe the R-2508 Complex. They will show the "types of airspace" contained within the complex, give you some geographical references, and highlight where the bottlenecks occur. **NOTE:** The R-2508 Complex is depicted on the Los Angeles, San Francisco, and Las Vegas Sectional Charts.

THE R-2508 COMPLEX

The R-2508 Complex is one of the largest military "special use" areas in the United States. Located around the Mojave Desert, it covers almost 16,000 square miles. Since this airspace is used extensively by all the military services, you need to be aware of the potential conflicts you might encounter when transitioning the area. This knowledge will help reduce the risk of a midair collision. A number of civilian communities, airports, and recreational parks underlie the confines of the R-2508 Complex increasing the potential for a midair conflict (Figure 4).

For flights inside the complex, realize that borders between restricted areas and military operating areas (MOAs) are normally hard boundaries for general aviation aircraft. However, these borders may be soft boundaries for military aircraft. You may find fast moving aircraft coming from directions you see as a wall.

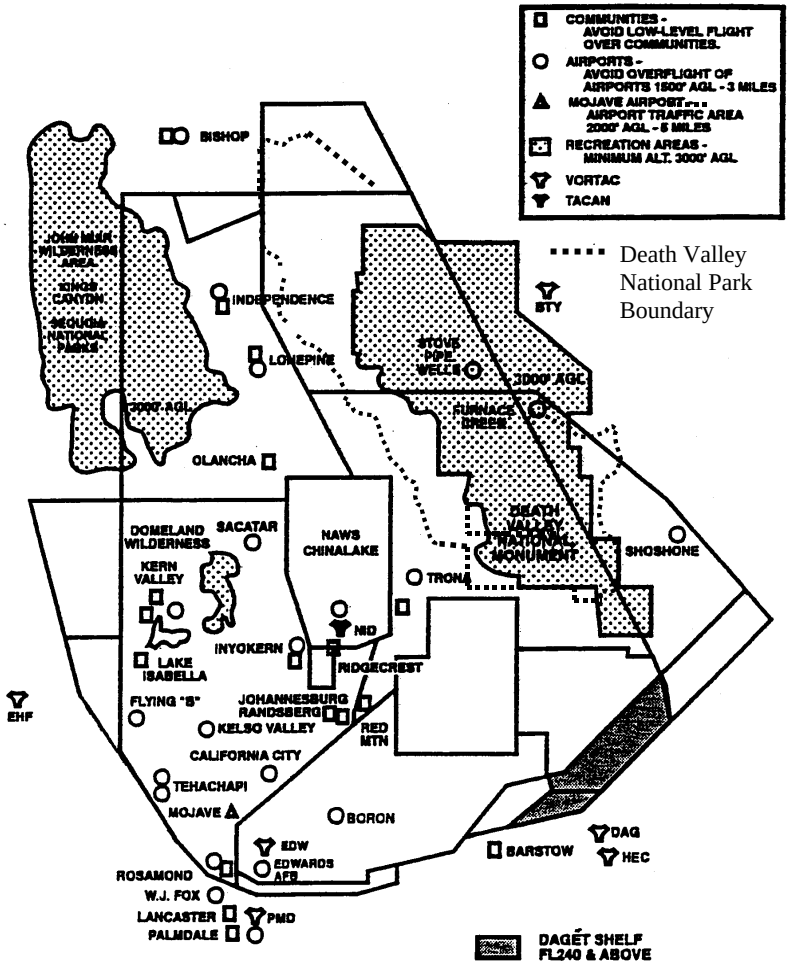
For flights just outside the complex, avoid the airspace boundaries by at least 3 nautical miles as a rule of thumb. This provides you with some buffer airspace since military traffic may fly right up to the complex boundary.

RESTRICTED AREAS

Restricted Areas are areas where extreme hazards exist in the form of unusual (and often "invisible") threats to aircraft, such as artillery firing, aerial gunnery, laser firing, guided missiles, unmanned aircraft and some flight test. These areas are active ("hot") on a continuous basis unless released. During such "released periods," the FAA controlling agency may permit aircraft to operate in certain Restricted Areas. When active, you must obtain approval from the military controlling agency prior to entering a restricted area. In most cases, approval will not be granted.

Restricted Areas are assigned a number. For example, R-2515 is the Restricted Area surrounding Edwards AFB. Further, some Restricted Areas are contained within larger Restricted Areas. For example, R-2515 (Edwards area) sits inside of the lateral boundaries of R-2508. The difference usually involves the specific altitude blocks you are to avoid (Figure 5).

FIGURE 4. COMMUNITIES, AIRPORTS, AND RECREATION AREAS.



Note: The shaded areas depict recreation areas that all military users must overfly above 3,000' AGL for noise abatement. Although Death Valley National Park has grown to the new boundaries depicted above, the 3,000' AGL restriction only applies to the shaded region of the park, by agreement between the Department of Defense and the National Park Service.

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THE BLIND SPOT

We all have a "blind spot." Potential for a midair collision lies within this blind spot. At one mile this area could be 800 feet by 500 feet, and at 5 miles, this area could be almost a mile wide. One way you can compensate for the blind spot is to move your head around while doing your scanning and look more than once at a given direction.

Here is a demonstration on locating your blind spot. With your right eye closed, look at the cross on the right. Move the paper back and forth about a foot away from your eye; the circle on the left will disappear. When that happens, the circle is in your blind spot.

MOTION

Against a stationary irregular background, an aircraft needs only to move a few minutes of arc per second to reveal its presence to an alert observer. However, against a featureless background, like a cloudless blue sky, the aircraft's perceived motion must be much faster to be noticed. What complicates the detection of relative motion is the fact that the eyes themselves are constantly moving.

EXPOSURE TIME

An aircraft that darts in and out of clouds presents a special challenge to the viewer. When an aircraft is not continually exposed to view, the observer must judge its speed and direction in order to follow and predict its path behind clouds or obstructions. A small, slow moving object that presents little contrast against its background can easily be lost during casual observation.

MORE INFORMATION

As you become fatigued, your eyes grow less efficient at the task of seeing airborne aircraft. Only well rested eyes can ensure good vision. Structural parts, windshield/canopy distortion, poor cockpit lighting, and instrument glare can limit your vision. To combat part of the problem, make your windshield spotless.

Total darkness, fog, total overcast, and cloudless blue skies, all present the pilot with a monotonous field. In such conditions, though you attempt to look at things in the distance, your eyes normally focus on a point 1 to 2 meters away. This is called Empty Field Myopia (Search Myopia) and reduces your chances of seeing a distant aircraft. To improve your airborne visual lookout, try to first focus on distant objects – clouds or the ground – then move your gaze to the sector of the sky to be searched.

About 1/3 of a second is required for the eye to focus on each fixation. Your scan should be slow and methodical. Learn to scan by dividing up the sky in sectors, about 30 degrees each. Fix your gaze in that sector for a second or two. Investigate any movement, then move to the next sector. Remember to occasionally focus on a distant object to avoid myopia. If you have trouble focusing at long ranges, try squinting. Squinting compresses the eyeball and changes its focal length, making distant aircraft come into focus.

At lower altitudes, the easiest aircraft to spot is on the horizon. Shadows sometimes help pilots to detect other aircraft. To spot the aircraft, look from the shadow to the sun. Obviously, the lower an aircraft is, the closer it will be to its shadow.

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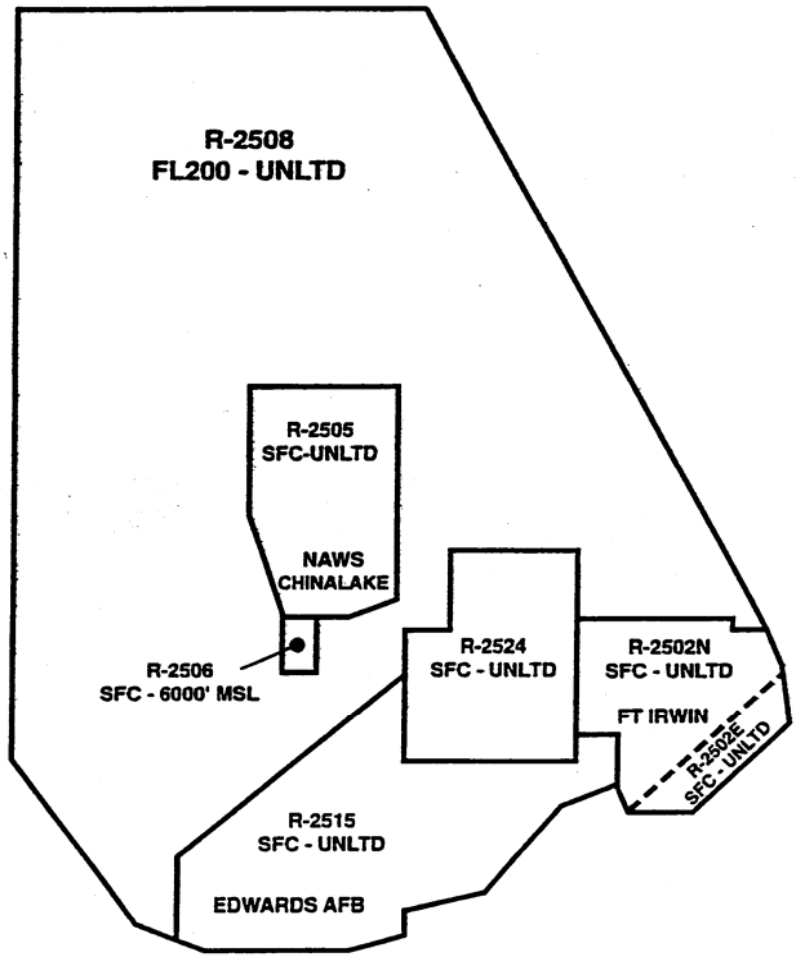
FIGURE 5. RESTRICTED AREAS VERTICAL DIMENSIONS



MILITARY OPERATING AREAS (MOA)

This is airspace established to separate/segregate certain military activities from IFR traffic and to identify for VFR traffic where these activities are conducted. These activities include air combat maneuvers, air intercepts, acrobatics, low altitude flight, etc. MOAs are depicted on your sectionals so you will know where they are. The vertical dimensions of the MOAs in the R-2508 Complex range from 200 feet up to, but not including FL 180 (Figure 6)

You may fly through an MOA any time you like, and you do not need to coordinate with anyone prior to or during your flight. However, considering the potential conflicts with military users, it is highly advisable to contact High Desert Terminal Radar Approach Control (TRACON), call sign "Joshua Approach," for traffic advisories; as well as squawk Mode 3/C and use landing/taxi lights for better visibility.

MILITARY TRAINING ROUTES

These routes, further classified as IR Routes and VR Routes, are low-level navigation routes running through and around the R-2508 Complex. On these routes, aircraft can travel in excess of 500 knots as low as 200 feet. (In fact, many of the Military Training Routes have a base altitude designated as "surface," and military aircraft may operate right on the deck!). Many of the turn points along the Military Training Routes are road intersections or other well-defined geographic points YOU might use yourself for a cross-country flight. Additionally, each military user may also establish low-level routes that are contained entirely within the R-2508 complex. These routes are not published on sectionals. Figure 7 shows low-level routes used by Edwards Air Force Base.

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KNOW THE LIMITS OR YOUR VISION

DETECTION

The Detection of an airborne object depends on six conditions:

- Image Size
- Luminance
- Contrast
- Adaptation
- Motion
- Exposure Time

IMAGE SIZE

An aircraft seen at long range appears as a dark dot – not as an identifiable shape. Aircraft detection is different under day or night conditions. During the day, the further from your fovea (center of vision) the object falls, the larger the image must be in order to be noticed. At night, on the other hand, detection is sometimes superior if the target image falls on the peripheral retina (off center) rather than the fovea.

LUMINANCE AND CONTRAST

Luminance and contrast go hand in hand. An object will be visible only when it is sufficiently brighter or darker than its background – in other words, when there is enough contrast.

In addition to brightness and contrast, color and shape differences offer clues to the presence of aircraft. When an object and background are contemporary colors (yellow and blue, green and black, red and white), detection becomes easier. Similarly, when objects are long and thin as opposed to round and flat, they are easier to detect. An aircraft seen lengthwise is easier to notice than one approaching head-on of equal size.

DARKNESS ADAPTATION

The eye requires at least 30 minutes, sometimes much longer, in darkness to regenerate visual purple so that the eye can distinguish objects under low illumination. Conversely, when the eyes have been accustomed to darkness, they need time to adapt to bright light.

A FEW WORDS ON WAKE TURBULENCE

You may be able to see and avoid the big aircraft, but one thing you cannot see is their wake turbulence. There is an area of potential disaster behind and below every commercial and military aircraft. Wake turbulence can be deadly, especially when it is encountered close to the ground. You should exercise extreme caution whenever you fly in the vicinity of large aircraft and ensure adequate separation for the type of aircraft (see AIM). Wake turbulence can be so severe, you could lose control of the aircraft and/or cause catastrophic structural failure.

Remember the wake turbulence rule: an aircraft's wake turbulence is worst when it is heavy, flying slow, with flaps up. Additionally, helicopters as well as modern fighters create significant wake turbulence that should be avoided.

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FIGURE 6. MILITARY OPERATION AREAS VERTICAL DIMENSIONS

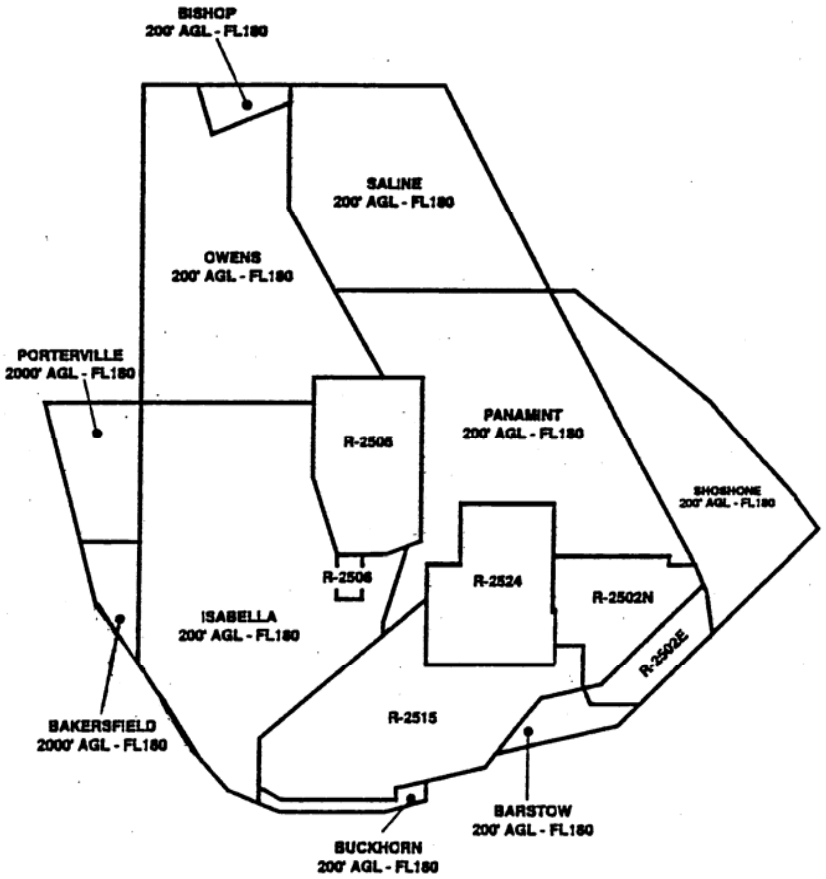
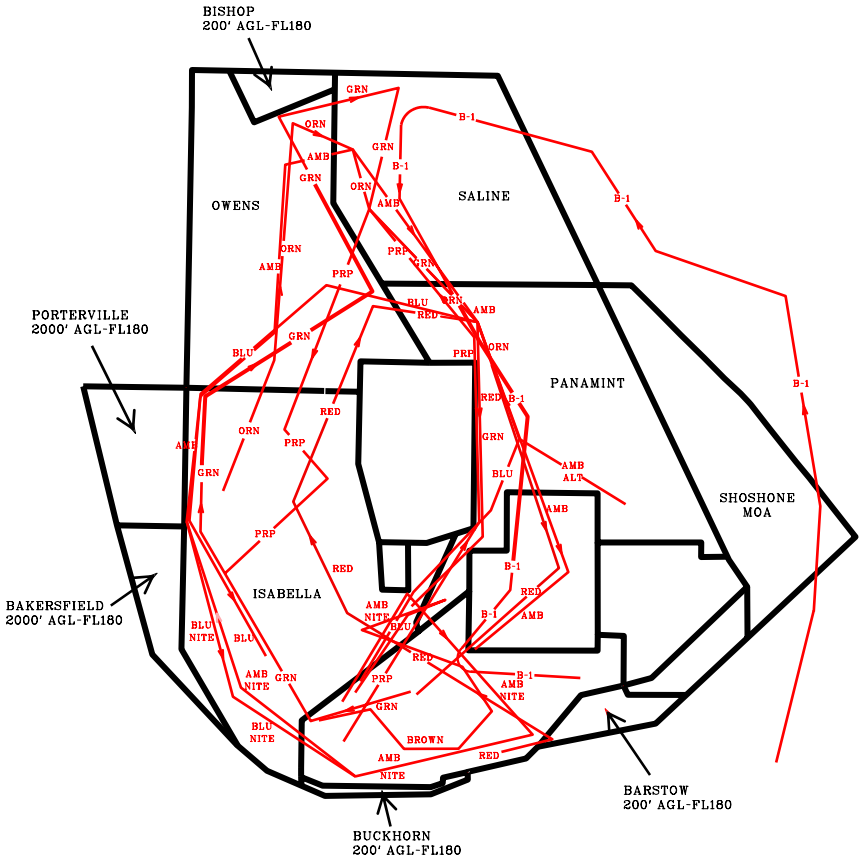


FIGURE 7. LOW LEVEL TEST AND TRAINING ROUTES



SUGGESTED PROCEDURES FOR TRANSITING THE R-2508 COMPLEX

1. Prior to flying into the R-2508 Complex – those areas you are "legal" to fly through – contact the nearest FAA Flight Service Station for all NOTAMS pertaining to the special use areas associated with the Complex.

2. The best source of information on scheduled military activities in R-2508 is the Central Coordinating Facility (CCF) located at Edwards AFB. They can be contacted from 0600 – 1800 Monday through Friday, closed Saturday, Sunday, and holidays. The CCF phone number is (661) 277-2508.

3. If you enroute (airborne), contact Joshua Approach Control (see your sectional for the appropriate frequency). Joshua Approach will give you airspace status and VFR traffic advisories.

4. Plan your flight thoroughly. Look at your sectional before you take off.

5. Use your radio, transponder (Mode 3/C), and your eyes.

6. Fly the proper hemispheric altitudes.

7. Turn on all your external lights including your landing or taxi lights (if possible). This makes you more visible.

By taking a few precautions, you can safely transit the R-2508 Complex!