# HEADQUARTERS 3RD TACTICAL FIGHTER WING

3TFW RADAR BOMBING AND NAVIGATION GUIDE

25 March 1981

**HEADQUARTERS 3RD TACTICAL FIGHTER WING**

**CLARK AIR BASE (PACAF)**

**APO SAN FRANCISCO 96274**

**OPR** : 3TFW/DOT (Capt Tirado)

Hq 3d Tactical Fighter Wing (PACAF)
APO San Francisco 96274
25 March 1981

3TFW RADAR BOMBING AND NAVIGATION GUIDE

1. This guide is a single source reference on radar navigation and bombing techniques, procedures and system facts. It has been developed for use by 3TFS aircrews as an aid in maintaining proficiency in the special weapons mission.

2. Suggestions and contributions for the improvement of this guide should be directed to 3TFW/DOT.

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# 3TFW RADAR BOMBING AND NAVIGATION GUIDE

This guide is a single source, quick reference document of various techniques, procedures and facts on F-4E radar bombing, navigation and systems. For more detailed coverage of this information refer to:

USAF FWS NUCLEAR WEAPONS DELIVERY REFERENCE TEXT

TO 1F-4E-34-1-1 TO 1F-4C-25-10

NAV/BOMB SYSTEM FACTS

1. Illumination of the NO-GO indicator (WRCS) at times other than BIT checks indicates an INS malfunction.

2. WRCS maximum offset in N/S, E/W windows is 99,900. Therefore the maximum distance directly north, south, east or west that an OAP can be from the target is 16.4 NM.

3. WRCS maximum navigation range is 30 NM. Exceeding this range from the target causes the range to remain at 30, and steering will be in error. (NOTE: Some aircraft's WRCS can navigate to 34 NM but the degree of accuracy is unknown).

4. In 25 NM scope the lateral range of the radar presentation from the center of the scope to either side is 12.5 NM at 25 NM. In 10 NM scope the lateral distance is 5 NM at 10 NM. The maximum offset of the crosstrack cursor is 12.5 NM at 25 NM and 5 NM at 10 NM.

5. When initially moving the cursors out of the zero position the along track cursor must be moved first.

6. Moving the range cursor below zero will cause steering to be 180° in error.

7. Maximum distance the along track cursor should be moved to is 23 NM. The cursor will move to 25 NM on the scope but can move electronically to 30 NM if the switch is held depressed. Example: If freeze is depressed and the cursor is electronically at 28 NM the curso on the scope will not track down until the cursor electronically reaches 25 NM.

8. Range is measured by the computer from the inside (near) edge of the along track cursor.

9. When using the bomb strobe, range is measured from the far (outside) edge of the strobe. The bomb strobe can be adjusted by utilizing a small screwdriver on the range strobe screw just forward of the radar antenna hand control.

10. The minimum size of the cursor can be refined to is approximately 200' (DSCG).

11. Always set the altitude of the target the cursors are refined on in the WRCS altitude window. Example: if using an OAP, set OAP's altitude; after insert, set target altitude if refining on show target.

12. The maximum target altitude accepted by the computer is 10,000'.

13. To prevent damage to WRCS when the OAP altitude is higher than the aircraft altitude, accomplish this procedure:

a. Substract your approach altitude MSL from the OAP altitude MSL.

b. Substract a. from your approach altitude MSL and place the resultant number in the altitude window.

14. Never select target find/offset bomb when aircraft altitude MSL is less than the altitude set in the altitude window. This is to prevent damage to the WRCS pitch servo.

15. When you freeze and insert visually directly over a point, the points' altitude is not necessary. (in the altitude window)

16. Cursors may drift 2-5 feet per second. This means a 300 feet error if drift is 5' and cursors are not updated in 1 minute. For good bombing accuracy it is necesaary to refine until as close to the target as practical.

17. WRCS steering is not possible when Dive Toss is selected.

18. The WRCS can be used for navigation by freezing and inserting over a turnpoint and flying a radial and range to the next turnpoint. If the turnpoint is further than 30NM, remain on the radial and at 30NM reset, freeze and insert and fly the remaining range.

19. With nav-comp, nav-comp set in the front cockpit:

a. The optical sight roll tabs indicate the number of degrees necessary to turn to arrive at a groundtrack direct to the target selected in the nav computer or by WRCS steering.

b. HSI heading marker gives same information as sight reticle.

c. HSI bearing pointer gives target bearing.

d. Course arrow indicates groundtrack being flown.

20. When the BDHI is in nav comp, aligning No. 1 needle with No. 2 needle gives groundtrack direct to target.

21. Release advance must be zero for integrated WRCS releases or bomb will release early by amount set.

22. ADI power off flag signals an AN/AJB-7 malfunction; also is displayed when fast erect switch is held depressed.

23. ADI vertical director flag indicates degree of TACAN strength.

24. To increase ARBCS accuracy, depress fast erect switch in level non accelerating flight (do not depress for more than 60 seconds.)

25. If any ARBCS circuit breaker is pulled or pops wait 60 seconds prior to pushing it back in (ARBCS gyros may not operate properly otherwise.)

26. Bomb cancel occurs if roll error (yaw/heading change) exceeds 30° during pullup flight path (release timer operation).

27. Sight reticle flashes if:

a. Bomb cancel occurs
b. Bomb button power loss
c. Loss of pitch stabilization
d. INS fails
e. Premature release of bomb button (some delivery modes)

28. Sight reticle disappears during release timer operation.

29. Maximum target range accepted by the WRCS for laydown mode is 24,900'

30. For LADD's, the pull-up timer requires a value greater than zero to obtain the ADI pull-up schedule. The release timer must have a value greater than zero to obtain a release signal.

31. If no VTRP is used in a LADD, set 1 second in the pull-up timer.

32. If the pickle button is depressed prior to activation for an ILADD, timers will start.

RADAR CONSIDERATIONS

1. A DCSG scope is 4 3/8" by 4 3/8". Distance between range scribes in all scope ranges is 7/8". Example: in 10NM scope 7/8" subtends 2 NM.

2. In 10 NM scope, radar returns have basically the same size as depicted in a 1:250,000 chart.

3. In 25NM scope, radar returns have basically the same size as depicted in 1:500,000 chart.

4. F-4E pulse length - 196.8' in short pulse
984' in long pulse

5. F-4E beamwidth - 3.7°. Beamwidth error (BWE) = 393 x range to target (NM). Divide by 2 and add to each side of target. Add tgt width to obtain total return size.

6. There is no spot size error in a DSCG radar, but there is block size error (BSE)

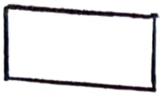
7. One NM = 6080'. One radar mile = 6000'.

8. Radar returns are distorted in size by:

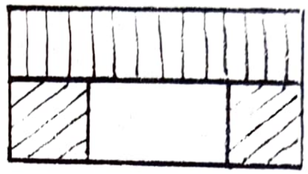
a. PLE - pulse length error - adds the F4 pulse length to the trailing edge of a show target and to the leading edge of a no show target.

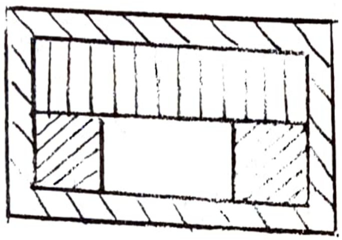
b. BWE - increases the lateral size of a return; it is the greatest of the inherent radar errors. BWE is dependent on the receiver gain getting and is difficult to predict. It decreases the lateral size of a no show target.

c. BSE - adds to all sides of the return.


ACTUAL SIZE OF OBJECT


BWE


BWE + PLE


BWE + PLE + BSE

9. Overall effect of errors; show targets appear larger, no shows appear smaller. Errors can be minimized by:

a. Do not select an aimpoint on the lateral side of a feature.

b. Center aim returns with crosstrack cursor or center of radarscope.

c. Show targets - center of actual aimpoint is approximately 1/3 of the way in from the leading edge of the return.

d. No-show target (example- lake) center is approximately 1/3 of the way in from the trailing edge of the no show area.

e. Use short pulse to minimize PLE.

f. Use minimum receiver gain.

g. Tilt antenna up to a paint target with lower side of beam to reduce clutter.

10. Rivers are hard to paint unless they are very wide, due to the radar inherent errors, especially when the river is parallel to your flight path.

11. Steel bridges 2000' and longer will paint if they are in a clutter free area.

12. Look for geometrical patterns when trying to identify towns (the geometrical pattern formed by several towns).

13. Changing between short and long pulse requires a gain adjustment.

14. Radar pointers - physically large features detectable at long ranges which help locate turnpoints, OAP's, targets. Select 1 or 2 pointers by OAP or turnpoint.

15. Pre-IP turnpoint - should be such that turn at IP to target does not exceed 30°.

16. IP Selections:

a. Easily identifiable (radar)

b. Approximately 3 minutes from target.

c. Visually confirmable.

d. Has radar pointers.

e. Low threat area.

f. All season point (consider tides, snow, etc.)

g. Radar reflective

h. Presents sufficient scope contrast with surroundings.

i. In radar line of sight.

j. Presents optimum aspect angle

k. Isolated or unique in shape

17. RTRP Selection:

a. Must be a precise aimpoint

b. As close to inbound track as possible

c. ILADD's

1) Show target - select OAP short of target (to facilitate refining on target after insert).

2) No show target - select OAP past the target to allow maximum time to refine cursors.

d. Bomb Strobe

1) Select OAP past target to minimize timer settings.

2) Radar can be used for azimuth control since OAP is past the target.

18. Use 1:50,000 or 1:62,500 scale charts to determine offsets, distances and target coordinates.

MINIMUM ENROUTE ALTITUDES

a. Refer to Appendix 2 for MEA computations.

b. On long nav legs or IP to target leg - select 2 MEA's along the track to permit lowest possible flight throughout the track.

c. When flying routes

1) If next leg has a higher MEA, climb to that MEA prior to the next leg.

2) If next leg has a lower MEA - descend to new MEA after established on new leg.

FUEL FACTS

1. F-4E with Tiseo, combat documentation cameras, pylons and wing tanks, ALQ-119, ALE-40, 2 Aim-7s, one B61 or B57 plus full fuel.

drag index = 39.6
weight = 52,300 lb

2. Rule of thumb - fuel used, from engine start to 300K on take-off is 2000 lb (includes 20 minutes ground time). Take-off to 300K is achieved in 45 seconds and puts you 2NM from the field. (temperature 30°C)

3. Rule of thumb - external wing tanks burn out 20 minutes after take-off at altitude and 15 minutes when low level (420K GS).

4. Fuel Flow, F-4E 50,000 lbs, drag index 40, temperature 30°C:

a. At 420K = 208 lb/min = 30 lb/mile

b. At 480K = 255 lb/min = 32 lb/mile

c. At 540K = 320 lb/min = 35.5 lb/mile

AAR PLANNING FACTORS

1. Estimate 3-5 minutes time on tanker for refueling each aircraft.

2. Refueling internal tanks is faster than refueling external tanks, i.e., for faster refueling consider not burning externals.

3. Request high pressure refueling for faster refueling.

4. Plan on using 8000 lbs/hour at 20,000' and 310K.

5. Have tanker shorten orbit if advantageous

TIME AND COURSE CONTROL

1. 420K = 1 mile every 8.6 sec = 709 fps
   480K = 1 mile every 7.5 sec = 811 fps
   500K = 1 mile every 7.2 sec = 845 fps
   540K = 1 mile every 6.7 sec = 913 fps

2. Increasing groundspeed from 420 to 540K saves 22% of planned timed at 420.

3. Increasing groundspeed from 420 to 480K saves 12% of planned time at 420.

4. Increasing groundspeed from 480 to 540K saves 11% of planned time at 480.

5. Normally time corrections should be done up to the IP only since it is necessary to fly planned time, groundspeed and heading from the IP to the target.

6. Take-off on time.

7. Plan on using 360K groundspeed to the start route point (SRP) to allow using increased speed to make up for late take-off.

8. Plan take-off from runway with longest distance to SRP.

9. F-4E drag index 40, temperature 30°C, military power, low level:

   accelerates 20K GS every 10 seconds. (requires 4[illegible] to accelerate 6[illegible] knots

10. If fuel permits, consider planning for 1 orbit at the SRP to insure you start at the SRP on time. A 360° turn at 30° bank and 420K takes 4 minutes.

11. Determining need for time correction prior to reaching next turnpoint:

   a. Take groundspeed in NM/minute.

   b. When target or turnpoint is at the groundspeed range or at a multiple of it, you are 1 minute or more out.

   c. Add the number of minutes to real time.

   d. Check the time you will be at the turnpoint versus the planned realtime at the turnpoint to determine time error.

   e. Example:

      1) Groundspeed 480K = 8NM/minute

      2) Turnpoint at 24 NM, you are 3 minutes out.

      3) Realtime is 0800:30, time at turnpoint will be 0803:30.

      4) Planned realtime at turnpoint is 0803:00, therefore you are 30 seconds late.

f. You can also use this technique with planned groundspeed even though your actual groundspeed is different:

1) Actual groundspeed 455K

2) Planned groundspeed 420K

3) Turnpoint at 21NM, you should be 3 minutes out if you are on time.

4) Realtime is 0800:30, time to the turnpoint at 420K would be 0803:30.

5) Planned realtime at the turnpoint is 0803:30, therefore decelerate to 420K.

12. If you are IFR and have no radar to confirm your DR, and you are late or early, fly your planned heading, time and groundspeed for the leg you are on and compute a new groundspeed for the next leg.

13. Time Control Methods:

a. Incremental method

1) Convert groundspeed to miles per minute.

2) Multiply miles per minute by 10. This is your incremental speed adjustment.

3) Example:

groundspeed = 480K
miles per minute = 8
multiply by 10 = 80 incremental increase

4) Amount of correction time must be held:

determine seconds late or early
divide number of seconds by 10
this becomes the amount of time in minutes to hold correction.

5) Example:

incremental increase = 80K
time status = 30 seconds late
30 ÷ 10 = 3 minutes
increase groundspeed by 80K for 3 minutes or 40K for 6 minutes (to conserve fuel).

b. 10% Rule

1. Increase or reduce groundspeed by 10% for 10 minutes for each minute late or early.

2. Example:

groundspeed = 480K
30 seconds late
increase groudspeed by 48K for 5 minutes

c. 2/3/6 minute rule

1. Compute realtime when you should be 2 minutes from turnpoint.

2. When realtime occurs, determine how many miles you are away from turnpoint.

3. Multiply the mileage by 30. This is the groundspeed you must fly to be on time.

4. Example:

2 minutes to turnpoint (real time)
actual position 14 miles from turnpoint
14 x 30 = 420K GS required

5. For the 3 minute case, determine distance out from target multiply by 20; for the 6 minute case, multiply mileage by 10

6. Example:

6 minutes to turnpoint (real time)
actual position 52 miles from turnpoint
52 x 10 = 520K GS required

d. Losing Time

1. Over enemy territory you may not be able to decelerate below a certain groundspeed.

2. Perform a 360 degree turn by doing four 90 degrees turn. You will lose 1 - 1 1/2 minutes ( 3 g turns).

3. Perform S turn - four degree turns to get back on course. You will lose 45 seconds to 1 minute (3 g turns).

4. Perform turns over relatively threat free territory.

5. Preplan a route change to gain or lose time.

14. Course Control:

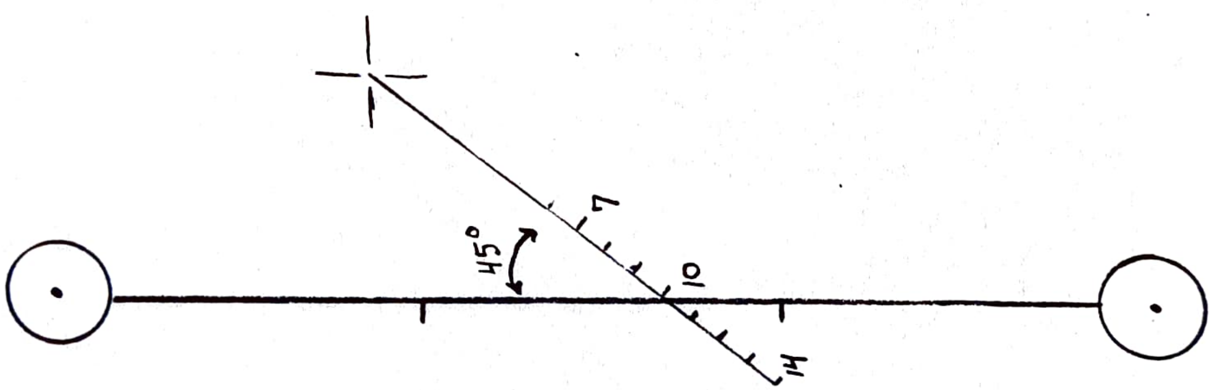
a. Fly good DR-compensate for crosswind (crab into the wind)

b. Determine distance off course:

1) In PPI scope estimate miles off course visually from the radar. Distance is laterally the same as longitudinally on a PPI scope. Take the distance the turnpoint is laterally offset from the center of the scope (when you are on course heading) mentally compare it against the distance subtended by 1, 5 or more miles on the scope.

2) Estimate number of degrees point is laterally off the center line when on course heading. Use the 1 degree = 1NM at 60NM rule. Therefore a point 10 degrees left of the nose at 30NM is 5NM to the left. This method is accurate when the point is ± 30° of the nose.

3) Draw a line from a show point along the route to and past your course line on the map (to maximum distance you expect to be off course). Put mileage tick marks on the line and you will be able to tell your position. For example, say your course line passes to the right of a show return along the route. Draw a line that intersects your course line at an angle of 30 to 45 degrees from the show return. If to be on the course line the show return must be 45 degrees left at 10 NM, but instead its 45 degrees left at 14 NM you can tell your position to the course line on your map.




c. Corrections to course:

1) 30 degrees Turn to Course (Method 1)

double distance off course (in miles)
compute time to fly that distance
turn 30 degrees toward course
turn back on course after expiration of time computed

2) 30 degrees Turn to Course (Method 2) Example:

Turnpoint 10 degrees left of nose (aircraft on course heading)
turn 30 degrees toward turnpoint
turnpoint will be 20 degrees right
as turnpoint approaches 30 degrees right, turn back on course

3) If you have bad INS use drift out.

RADAR NAVIGATION TURN

1. a. Locate turnpoint/OAP on radar

   b. Freeze/Insert cursors over turnpoint.

   c. Use the needle to get on course/center needle

   d. Turn when the WRCS range indicates zero and the needle/bearing pointer passes 90°.

   e. As a back-up, hack your clock when the WRCS range indicates you are 1 minute out (based on your groundspeed).

2. a. Locate turnpoint on radar

   b. Hack your clock when the target is 1 minute out in range on the radar (based on groundspeed).

   c. Fly direct to the turnpoint and turn on time.

3. a. Preplan a good radar show point within 10 NM past the turnpoint on the extended course line.

   b. When the point is on your radar the same range that it is from the turnpoint, you are over the turnpoints.

4. a. Preplan radar show point prior or past turnpoint.

   b. Compute aircraft time to turnpoint when you hack at a given range from the show point.

   c. Fly time to turnpoint.

WIND COMPUTATIONS

1. INS Winds

   a. Range winds

      1) obtain difference between GS and TAS.

      2) GS greater than TAS - tailwind

      3) TAS greater than GS - headwind

b. Cross wind

1) TAS in NM per minute times drift in degrees.

2) Or, Mach number x 10 x degrees of drift

3) Wind direction is from the side opposite the indicated drift.

c. If INS is more than 5 miles off after 30 minutes of flight suspect INS winds.

d. Back-up INS winds by watching for smoke, dust, cloud shadow motion, intensity of waves on water (white caps).

2. LADD bombing winds - average the winds at

a. Run-in altitude

b. Winds 1/3 down from release to burst altitude

3. Range wind corrections are applied to timers using HATS - head add, tail subtract

4. Rangewind correction can be applied to activaterange (ILADD) by using SHAT - subtract head, add tail.

5. Cross wind can be corrected with the crosstrack cursor, or by heading change utilizing the fact that 1° heading change = 100' at 1 NM, 200' at 2NM, 300' at 3NM, etc.

INS UPDATE

1. To update the INS

a. Set the INS position update switch to SET prior to reaching the point of known coordinates.

b. Put the known coordinates on the present position latitude and longitude counters.

c. Place the position update switch to FIX and hold in this position (the INS updates at 3 minutes of latitude and 3 minutes of longitude per second).

d. When exactly over the known point, release the switch.

2. WRCS steering may still be operable with a bad INS (present position or groundspeed in error). Place the radar cursors over a radar return; if the cursors track the return, the WRCS is still receiving good velocity inputs. This can also be determined by freeze/inserting over a turnpoint and checking whether the radial and range given by the WRCS at the next turnpoint correspond with what the computed radial and range should be.

FORMULAS AND DEFINITIONS

1. $T_a$ = Pull-up timer - activation to pull-up.

2. $T_b$ = Release timer - pull-up to release

3. $T_c$ = bomb time of fall

4. $R_1$ = distance - activate to pull-up= TAS x 1.69 x Pull-up timer setting.

5. $R_2$ = distance - pull-up to release

6. $R_3$ = bomb range

7. K factor = correction in feet applied to bomb release position to account for 1 knot of wind. K factor = wind x 1.69 x time affected by the wind.

8. $K_{R3}$ = wind x 1.69 x $T_c$ correction is in feet

9. $K_{crab}$ =

a. If release timer less than 7.5 seconds

$$K_{crab} = .9K_{R3}$$

b. If release timer greater than 7.5 seconds

$$K_{crab} = 1.04\left(K_{R3} - \frac{R_3}{(TAS)(.707)}\right)$$ (LADDs only)

10. Determining pull-up timer: find distance from activate (or pickle) point to target. Subtract R2 + R3 (from ballistic chart). This is R1. Divide R1 by run-in velocity in feet per second (TAS x 1.69).

11. Timer correction factor = $\frac{T_a + T_b + T_c}{TAS}$

(for level and LADD deliveries)

12. Activate range ±

a. $R_3$ + (TAS) (1.69) ($T_a$ + $T_b$) (Level deliveries)

b. $R_2$ + $R_3$ from ballistic tables + $R_1$ (LADD's)

c. VTRP - target distance

13. Pull-up timers can be set from 0-60 seconds. Release timers from 0-30 sec. The minimum numerical setting that works is .1 second.

14. The Solid state timers operate on 28 volts DC.

ERROR ANALYSIS

1. Radar laydown

   a. Approach altitude

      1) higher - longer $T_c$ - longer bomb - wind error more

      2) lower - shorter $T_c$ - shorter bomb - wind error less.

2. LADD

   a. Release altitude - negligible if no wind. A 100' increase in altitude increases $T_c$ by 1 sec. Check descent rate for different bombs.

   b. Airspeed

      1) greater - higher release altitude and $T_c$, closer to target at pull-up. No wind result long bomb.

      2) slower - lower release altitude and $T_c$, farther from target at pull-up. No wind result -short bomb.

      3) MK - 106 : 1 knot TAS error causes 12.5' error.

      4) Error from TAS at release point is negligible due to ordnance's high-drag.

   c. Late pull-up

      1) Release altitude and $T_c$ less, aircraft closer to target at release. No wind effect - long bomb.

      2) Compensate by pulling more "g", higher climb angle. (effective mostly when release timer is greater than 6 seconds)

   d. G-build up (release timer settings of 10 sec or less)

      1) more g - $R_2$ shorter, short bomb
         higher release altitude & $T_c$ - wind affects more

      2) less g - $R_2$ greater, long bomb
         lower release altitude & $T_c$ - wind affects less

      3) A low g pull causes less error than a high g pull.

   e. Failure to maintain 3.5 g.

      1) long error - R2 greater

      2) $T_c$ is less - wind affects less.

# MISSION PLANNING

A. Checklist:

1) line-up card
2) Target coordinates
3) Charts
4) Plot target
5) estimate combat radius
6) plot enemy defenses
7) Wx brief
8) consult JMEM
9) Select weapon
10) Type burst
11) Delivery mode
12) Axis of attack
13) Select IP
14) Select OAPs/RTRP/VTRP
15) Compute offsets/ranges
16) Select airspeed
17) Timer/mil settings/release range
18) Escape maneuver
19) Route of flight
20) Flight profile
21) Airspeeds/acceleration points
22) Bank angles
23) Fuel
24) Draw route
25) Measure coordinates
26) Measure headings
27) Measure distances
28) MEAs
29) Compute times
30) Distance and time tick
31) Fence check/RWR/ECM
32) Bomb arm line
33) Highlight visual ID points/obstacles
34) Highlight radar pointers/make radar predictions
35) Select alternate delivery mode
36) TOT
37) Reattack option and fuel required (VFR, IFR)
38) T.O. time/start route time/real times
39) Frequencies/IFF/codes
40) Estimate wind corrected settings and D-value

41) FEBA/ADIZ penetration

42) IFR threat reactions

b. Determine

excess Fuel available
target area bingo
total distance to target
maximum feasible groundspeed to target
time to target at max speed
max late take-off and still make TOT.
Ejection/evasion/survival plan
alternate recovery bases.

c. Determine abort criteria for:

engine failure
utility hydraulic/PC failure
Generator failure/bus tie open/28 V DC failure
Fuel transfer failure
Intercomm failure
Radio and IFF failure
enemy defenses
RWR/ECM failure
Weather
Other

d. Determine back-up for:

bomb fails to arm first try
groundspeed indicator failure
TAS indicator failure

INS failure
Timer failure / no activation tone / aircraft clock failure
Radar failure (cycle thru standby or go emergency)
SPC out (substract altimeter lag from release altitude)
failure to identify RTRP/VTRP
disruption of navigation by enemy defenses
AAA, SAM or MiG attack on IP- target leg
jamming of aircraft radar
camouflage/enemy passive deception techniques
bomb cancel
weapons release failure

e. Crew Coordinate

tank jettison
throttle control IP-tgt
who mashes pickle button and when
transfer of pickle

Switchology verification

precoordinate sequence of challenge and response
include which station selected
insure all circuit breakers in

time and course control methods
back-up hack of aircraft clock for deliveries
transition from RLADD to VLADD
action if IP or target not positively identified
EMR procedures
Primary recovery instruments (escape maneuver)
recall procedures
bomb chute malfunction/failure/ hung bomb with chute deployed

f. Electronic Emission Control

radar - full time or intermittent use
CW - on or standby
Radar altimeter - on or off
IFF

standby or normal
Mode 4A/B

APX - 80A

Mode 4A/B
Alarm override - off
Active or passive

TACAN - receive only
SST 181 beacon - off
ECM Pod - as required

GROUND SYSTEMS CHECKS

a. Bomb range strobe calibration

b. Tgt Find/Offset Bomb check (determine crosstrack cursor center)

c. Bomb Range Calibration/Integration Check (set 29.92 in altimeter - read altitude - set altitude in WRCS altitude window).

d. Check both bomb buttons work.

e. Check timers for all planned settings.

f. Check both aircraft clocks.

g. Calibrate bomb strobe/cursors in short pulse.

h. Calibrate range scribes against hit targets if used as bombing strobes.

i. Title recording devices

j. Preposition switches.

k. Insure arming crew removes all safety pins

AIRBORNE SYSTEMS CHECKS

Perform ILADD with switches safe

a. Check cursor drift

b. Check activation at proper range/steering/timers

c. Maneuver in excess of 30° bank before and after activation to check for bomb cancel criteria.

d. Check INS groundspeed and groundtrack indications, and present position

EXECUTION

1. Have first 2 INS coordinates and OAP offsets and altitude set prior to take-off (do not go tgt find until above OAP altitude). Have zero offsets & altitude if flying the tail of the cursors.

2. Consider pilot flying leg times, GIB elapsed time-crosscheck both with real time.

3. Prior to all turnpoints, GIB informs pilot of next leg heading, time, airspeed, altitude. Pilot climbs prior to next leg if MEA is higher and descends after established on next leg if MEA is lower.

4. Hack at planned start route time regardless of position from SRP if TOT is required. If not, hack over SRP. Hack clocks, freeze and insert if flying tail.

5. Depart SRP on heading, time, altitude and groundspeed. Insure drift corrected heading is flown. GIB double check pilot is flying correct heading speed and altitude after every turnpoint.

6. DR is the primary means of navigation-heading, speed, time.

7. After each turnpoint, select a scope range that includes the next turnpoint or radar pointer. Recommended first priority after heading, altitude and speed are established is to identify the next turnpoint (or course to it) on radar ASAP. This will make the turnpoint (radar pointer) easier to identify.

8. Initiate TIMS - TIME, INERTIAL, MAP, SCOPE

a. TIME - check map time tick for DR position

b. INERTIAL - read bearing and distance to next turnpoint

c. MAP - check for predicted radar images and visual points (call to pilot).

d. SCOPE - look for predicted patterns at appropriate ranges and bearings; identify turnpoint early.

9. If you can't identify turnpoint

   a. check radar range

   b. check gain and tilt, radar in operate

   c. check long pulse, short pulse.

   d. Re-check heading.

   e. Re-initiate TIMS

   f. Do not go scope to map!

   g. Fly DR - if in doubt of aircraft position turn on DR.

   h. Correct course and time errors ASAP.

   i. Utilize radar turn procedures at the turnpoint.

10. Do not wait till you are at the next turnpoint to figure out whether you are late or early. Use the radar/WRCS to determine that when you are still 1-3 minutes out.

11. If you are flying WRCS steering to the turnpoint, reset nav computer so as to have the coordinates of second and third turnpoints downtrack ready.

12. Perform airborne weapons systems check on first or second leg.

13. Check INS accuracy on 1st turnpoint and pre-IP turnpoint. Update INS as required.

14. At the turnpoint, initiate TROT - TIME, RESET, OFFSETS, TARGET

   a. TIME - check time at turnpoint (early, on time, late).

   b. RESET - depress reset button if using WRCS steering.
      freeze and insert if flying cursor tail
      reset radar scope range

   c. OFFSETS - set offsets and altitude of next turnpoint/OAP
      (NOTE; delay this part of TROT if the offsets are big).

   d. TARGET - insure INS has steering to next turnpoint and that it coincides with planned range and bearing (this is one way of checking INS accuracy).

15. Do not waste time on TROT; double check heading, altitude and speed ASAP after roll-out and start looking for the next turnpoint - especially if you are on a short leg.

16. Initiate TIMS

17. Course control has higher priority than time control due to:

   a. Off course gets you lost.

b. Course errors result in time errors.

c. Your MEA may no longer be valid.

18. Plan acceleration point prior to the IP. You should be (ideally) wings level, on-speed and altitude departing the IP to maximize systems accuracy and time control (hard maneuvers and accelerations will induce greater errors in the INS, cursors and ARBCS).

19. Consider INS update at IP.

20. Prior to IP have as many weapons switches set as possible to allow more time for target acquisition, threat reaction, INS winds, etc.

21. Re-hack all clocks at IP.

22. Fly planned groundspeed until 30 seconds prior to activation/pickle, and then transition to TAS. Reason:

a. Given

Planned groundspeed - 500K
Wind - 10K head
3 minute leg (180 seconds) to pull-up
IP to tgt flown at 500K TAS
Actual groundspeed - 490K
Error = (1.69) (10) (180) = 3042 feet short

b. If you must EMR using IP to pull-up/release time, your bomb will be short or long if you have rangewind and you fly TAS instead of groundspeed.

23. Consider using target 1 for help in finding OAP/RTRP.

24. Derive INS winds and correct timers/course.

25. Hit fast erect switch (level, non-accelerating flight).

26. Minimize maneuvers, airspeed changes to increase INS accuracy (especially after insert or no-show targets).

27. Use radar as primary steering instrument

28. Select short pulse.

29. Consider narrow scan after OAP/RTRP/TGT identified (this updates target position 2.6 times faster than wide scan).

30. Recommend using medium contrast on the radar for best definition. Adjust brightness control .

31. If you are on a short IP to target leg and OAP windows are not set

a. Find the OAP first.
b. Freeze cursors over the OAP.
c. Set in OAP altitude.
d. Set in OAP offsets.
e. Refine and insert.

WEAPONS DELIVERY

1. Always assume you will make an IFR delivery - however, your primary delivery will be VFR if you can visually identify your VTRP when you arrive at the target area.

2. To switch to a VLADD from an ILADD:

   a. Prior to the VTRP, set activate switch inboard.

   b. Depress bomb button over VTRP.

3. To switch to a VLADD from a fixed bomb strobe pre-coordinate whether you will:

   a. Continue with the bomb strobe ladd.

   b. Re-hack clock and use clock time (it's probably too late to reset timers).

4. VLADD Back-up/EMR (estimated manual release)

   a. Pilot calls hack at VTRP

   b. WSO hacks clock

   c. If timers fail or no tone

      1) Pilot pulls on time or ground reference.

      2) get off the pickle button

      3) go direct

      4) pickle on release altitude

      5) push Nuc jettison

5. R/VLADD: if timers are started and the pickle button is released prior to bomb release, you must recycle out of TLADD to set up another release.

6. VLADD - if you can't see VTRP

   a. Use preplanned visual reference for R2 +R3 to begin pull-up.

   b. Use back-up mil setting on the target to initiate pull-up.

   c. 2-3 NM from the target pop to release altitude, estimate bomb range and pickle in direct.

7. Integrated LADD (ILADD) - primary IFR delivery

FCP switches set- select one loaded station only or bomb may not come off.
Tone switch - as required
VTR and RWR on
short pulse
receiver gain - minimum usable
Contrast - set (reduce range grid brightness to minimum usable) (DSCG)
antenna - tilt up - use lower side of radar beam
Wind corrected timers - set with predicted winds
activate switch inboard
target find switch - outboard
range switch - outboard
release advance - zero
activate range - set
OAP offsets - set
TGT/OAP altitude - set (D-value)
identify radar pointers/OAP/target
FREEZE cursors on OAP/target - call to pilot
check INS winds/wind indications
correct timers if necessary (HATS)
narrow scan
refine cursor size to minimum
refine cursors on OAP/TGT - correct for crosswind

refine until last possible moment
INSERT - call to pilot (insert can be done early if refining on tgt)
Using OAP - watch for correct cursor jump after insert
ACTIVATE - only after insert
only after cursor have jumped and settled (OAP)
do it outside the activate range!
call to pilot
refine if possible
re-check release switches hot
re-check winds
hack clock at activate tone (back-up)
pickle after activate tone - both confirm pickle
shack

8. ILADD Back-up/EMR

a. Unable to find OAP/TGT/radar, cursors or INS fail/no activate tone

1) Compute IP to pull time

2) Pull on time

3) Off the pickle (both confirm)

4) direct

5) Pickle/Nuc jettison on altitude

b. Timers unreliable/fail

Activation is independent of timers - when activation tone is heard, always hack aircraft clock as a back-up. If the pull-up tone does not come on after the clock indicates the pull up timers setting is over:

1) Consider overpulling g to compensate for late pull-up.

2) Off the pickle (both confirm)

3) direct

4) Pickle/Nuc jettison on altitude

c. Determine a time to pull-up based on the OAP/tgt at any of these ranges: 8, 6, 4 NM (using the DSCG range scribes). As you proceed with the ILADD, re-hack clock when the target/OAP touches the far edge of the scribe. If there is an ILADD malfunction (including failure to activate) pull on time and release on altitude (go direct).

Example:

OAP 2 NM past tgt
8 NM scribe

substract release range from 6 NM
compute time to travel this range
add pull-up timer setting
this is the time from hack to pull-up
and should be more accurate than IP to pull-up time
compensate for: 1 radar NM = 6000', 1 NM = 6080'

9. Bomb Strobe Deliveries

If you determine prior to the IP (or if there is sufficient time after the IP) that the ILADD system will not work - do bomb strobe delivery.

a. Target find inboard if using bomb strobe (outboard ok if use range scribes).

b. If using 3 or 2 NM scribes consider using B-scope (tgt/OAP should be ± 10° of nose maximum due to the B-scope distortion).

c. If using narrow scan decide whether it's best to

1) center the scan on the tgt/OAP

2) put the scan to the left or right of the tgt/OAP

This may be critical for 3 or 2 NM bomb strobes to help you maintain your "tally ho" on the tgt/OAP inside 5 NM by allowing you to track the tgt/OAP's position relative to a recognizable features beside it.

d. Wait until tgt/OAP is at 4 NM before switching from 10 to 5 NM scope so that you do not lose the target when switching scopes (the blob on the nose at 4 NM is the target).

e. Do not take your eyes off the tgt/OAP inside 4 NM due to the high probability of not being able to reidentify it (because of distortion and rapid antenna tilt changes required).

f. Pickle in the rearcockpit for maximum accuracy.

g. Frontcockpit hack clock on pickle call to have an EMR back-up if timers fail.

h. Consider transferring pickle (use challenge and response) and GIB handling throttles (if threat permits).

10. Bomb Strobe EMR

a. Timers fail

1) use frontcockpit hack

2) off pickle (both confirm)

3) consider overpulling g to compensate for late pull-up.

4) direct

5) Pickle/Nuc jettison on release altitude

b. Late transition from ILADD to bomb strobe.

1) inbound to the target you determine an ILADD will not work and there is time to do a bomb strobe delivery but not enough to change the timers.

2) Call hack at pickle point

3) Pilot hacks clock

4) go direct

5) pickle/Nuc jettison on release altitude

11. Level deliveries EMR

a. Compute IP - release time. Fly groundspeed.

b. The techniques discussed for ILADD/RLADD deliveries are applicable to integrated and fixed bomb strobe level deliveries.

12. Other Delivery Considerations

a. Radar fails IP-target

1) recycle through standby (current overload)

2) go emergency (overtemperature, low pressure)

3) If it fails after cursor insert continue with the ILADD, the radar is not needed.

b. Select only the correct station on the DCU-94

1) Each station has been assigned a priority

2) Priority is: centerline, left inboard, right inboard, left outboard.

3) If two stations are selected, only the station with higher priority will receive a release pulse, even if it is empty.

4) Nuc push to jettison will release all stations selected.

c. If you abort a pass and decide on a re-attack

1) RECHECK ALL SWITCHES

2) MAKE SURE DIRECT IS NOT SELECTED if planning another TLADD.

3) Recycle out of TLADD/back to TLADD.

d. Example of past errors:

1) Crew with known timer failure select direct during RLADD they pickle instead of hacking clock (habit pattern) when bomb strobe touches RTRP.

2) Crew aborts first pass (failed to identify OAP/RTRP/TGT) crew decides on re-attack utilizing a TLADD delivery crew forgets DIRECT is selected
result - bomb 5 NM short (RLADD)

e. Discuss whether a long or short bomb error is more desirable on the basis of target area terrain.

f. Heavy thunderstorms in the area can affect the expected pattern of radar returns at the target or during a nav leg.

D-VALUE

1. D-value must be applied to insure correct slant and horizontal range is computed by the WRCS. Errors of 300' and more can occur if it is not applied.

2. Information needed from Weather:

a. Forecast target altimeter setting for TOT

b. D-value lapse rate per 1000 feet at the target.

3. Determination

| | | |
|---|---|---|
| a. | Forecast target altimeter setting | 29.72 |
| b. | Substract 29.92 | 29.92 |
| c. | Difference x 1000 is surface D-value (+ or -) | -.20 = -200' |
| d. | Run-in altitude MSL | 3000' |
| e. | Substract target altitude MSL | 1000' |
| f. | Run-in altitude AGL | 2000' |
| g. | D-value lapse rate per 1000' | +50' |
| h. | D-value change to 2000' AGL | +100' |
| i. | Add surface D-value to determine total D-value | -200' |
| j. | Total D-value at 2000' AGL = | -100' |

4. Application - D- value change to your run-in altitude AGL must be applied to indicated approach altitude MSL. Total D-value is applied to the target altitude window. The D-value sign is reversed and applied.

| | | |
|---|---|---|
| a. | Run-in altitude MSL | 3000' |
| b. | Change in D-value, reverse sign and add | -100 |
| c. | Indicated altitude to fly = | 2900 |
| d. | Target altitude MSL (altitude window) | 010 |
| e. | Total D-value, reverse sign and add | + 001 |
| f. | Corrected altitude window | 011 |

Appendix 1

Photocopy and cut-out this figure to help you in time control. Example: 17NM from turnpoint you find you only have 2 minutes to get there. Go to the 17 NM line where you can see that accelerating to 500k will get you to the turnpoint close to on time.

| DISTANCE | 400 | 420 | 450 | 480 | 500 | 540 |
|---|---|---|---|---|---|---|
| 1 NM - | :09 | :09 | :08 | :08 | :07 | :07 |
| 2 ---- | :18 | :17 | :16 | :15 | :14 | :13 |
| 3 ---- | :27 | :26 | :24 | :23 | :22 | :20 |
| 4 ---- | :36 | :34 | :32 | :30 | :29 | :27 |
| 5 ---- | :45 | :43 | :40 | :38 | :36 | :33 |
| 6 ---- | :54 | :51 | :48 | :45 | :43 | :40 |
| 7 ---- | 1:03 | 1:00 | :56 | :53 | :50 | :47 |
| 8 ---- | 1:12 | 1:09 | 1:04 | 1:00 | :58 | :53 |
| 9 ---- | 1:21 | 1:17 | 1:12 | 1:08 | 1:05 | 1:00 |
| 10 --- | 1:30 | 1:25 | 1:20 | 1:15 | 1:12 | 1:07 |
| 11 --- | 1:39 | 1:34 | 1:28 | 1:23 | 1:19 | 1:14 |
| 12 --- | 1:48 | 1:42 | 1:36 | 1:30 | 1:26 | 1:20 |
| 13 --- | 1:57 | 1:51 | 1:44 | 1:38 | 1:34 | 1:27 |
| 14 --- | 2:06 | 2:00 | 1:52 | 1:45 | 1:41 | 1:34 |
| 15 --- | 2:15 | 2:08 | 2:00 | 1:53 | 1:48 | 1:41 |
| 16 --- | 2:24 | 2:17 | 2:08 | 2:00 | 1:55 | 1:47 |
| 17 --- | 2:33 | 2:25 | 2:16 | 2:08 | 2:02 | 1:54 |
| 18 --- | 2:42 | 2:34 | 2:24 | 2:15 | 2:10 | 2:00 |
| 19 --- | 2:51 | 2:42 | 2:32 | 2:23 | 2:17 | 2:07 |
| 20 --- | 3:00 | 2:50 | 2:40 | 2:30 | 2:24 | 2:13 |
| 21 --- | 3:09 | 3:00 | 2:48 | 2:38 | 2:32 | 2:20 |
| 22 --- | 3:18 | 3:09 | 2:56 | 2:45 | 2:39 | 2:27 |
| 23 --- | 3:27 | 3:17 | 3:04 | 2:53 | 2:46 | 2:33 |
| 24 --- | 3:36 | 3:24 | 3:12 | 3:00 | 2:53 | 2:40 |
| 25 --- | 3:45 | 3:33 | 3:20 | 3:08 | 3:00 | 2:47 |
| 26 --- | 3:54 | 3:42 | 3:28 | 3:15 | 3:07 | 2:53 |
| 27 --- | 4:03 | 3:51 | 3:36 | 3:23 | 3:15 | 3:00 |
| 28 --- | 4:12 | 4:00 | 3:44 | 3:30 | 3:22 | 3:07 |
| 29 --- | 4:21 | 4:09 | 3:52 | 3:38 | 3:29 | 3:14 |
| 30 --- | 4:30 | 4:17 | 4:00 | 3:45 | 3:36 | 3:20 |
| 31 --- | 4:39 | 4:26 | 4:08 | 3:53 | 3:43 | 3:27 |
| 32 --- | 4:48 | 4:34 | 4:16 | 4:00 | 3:50 | 3:34 |
| 33 --- | 4:57 | 4:43 | 4:24 | 4:08 | 3:58 | 3:41 |
| 34 --- | 5:06 | 4:51 | 4:32 | 4:15 | 4:05 | 3:47 |
| 35 --- | 5:15 | 5:00 | 4:40 | 4:23 | 4:12 | 3:54 |
| 36 --- | 5:24 | 5:09 | 4:48 | 4:30 | 4:19 | 4:00 |

Appendix 1

| NM | 400 | 420 | 450 | 480 | 500 | 540 |
|---|---|---|---|---|---|---|
| 37 | ---5:33 | 5:17 | 4:56 | 4:38 | 4:26 | 4:07 |
| 38 | ---5:42 | 5:26 | 5:04 | 4:45 | 4:34 | 4:13 |
| 39 | ---5:51 | 5:34 | 5:12 | 4:53 | 4:41 | 4:20 |
| 40 | ---6:00 | 5:43 | 5:20 | 5:00 | 4:48 | 4:27 |
| 41 | ---6:09 | 5:51 | 5:28 | 5:08 | 4:55 | 4:33 |
| 42 | ---6:18 | 6:00 | 5:36 | 5:15 | 5:03 | 4:41 |
| 43 | ---6:27 | 6:09 | 5:44 | 5:23 | 5:10 | 4:48 |
| 44 | ---6:36 | 6:17 | 5:52 | 5:30 | 5:17 | 4:54 |
| 45 | ---6:45 | 6:26 | 6:00 | 5:38 | 5:24 | 5:00 |
| 46 | ---6:54 | 6:34 | 6:08 | 5:45 | 5:31 | 5:07 |
| 47 | ---7:03 | 6:43 | 6:16 | 5:53 | 5:38 | 5:13 |
| 48 | ---7:12 | 6:51 | 6:24 | 6:00 | 5:45 | 5:21 |
| 49 | ---7:21 | 7:00 | 6:32 | 6:08 | 5:53 | 5:28 |
| 50 | ---7:30 | 7:09 | 6:40 | 6:15 | 6:00 | 5:35 |
| 51 | ---7:39 | 7:17 | 6:48 | 6:23 | 6:07 | 5:42 |
| 52 | ---7:48 | 7:26 | 6:56 | 6:30 | 6:14 | 5:48 |
| 53 | ---7:57 | 7:34 | 7:04 | 6:38 | 6:21 | 5:54 |
| 54 | ---8:06 | 7:43 | 7:12 | 6:45 | 6:29 | 6:00 |
| 55 | ---8:15 | 7:51 | 7:20 | 6:53 | 6:36 | 6:07 |
| 56 | ---8:24 | 8:00 | 7:28 | 7:00 | 6:43 | 6:13 |
| 57 | ---8:33 | 8:09 | 7:36 | 7:08 | 6:50 | 6:20 |
| 58 | ---8:42 | 8:17 | 7:44 | 7:15 | 6:58 | 6:27 |
| 59 | ---8:51 | 8:26 | 7:52 | 7:23 | 7:05 | 6:33 |
| 60 | ---9:00 | 8:34 | 8:00 | 7:30 | 7:12 | 6:41 |
| 61 | ---9:09 | 8:43 | 8:08 | 7:38 | 7:19 | 6:48 |
| 62 | ---9:18 | 8:51 | 8:16 | 7:45 | 7:26 | 6:54 |
| 63 | ---9:27 | 9:00 | 8:24 | 7:53 | 7:34 | 7:00 |
| 64 | ---9:36 | 9:09 | 8:32 | 8:00 | 7:41 | 7:07 |
| 65 | ---9:45 | 9:17 | 8:40 | 8:08 | 7:48 | 7:13 |
| 66 | ---9:54 | 9:26 | 8:48 | 8:15 | 7:56 | 7:20 |
| 67 | --10:03 | 9:34 | 8:56 | 8:23 | 8:03 | 7:27 |
| 68 | --10:12 | 9:43 | 9:04 | 8:30 | 8:10 | 7:33 |
| 69 | --10:21 | 9:51 | 9:12 | 8:38 | 8:17 | 7:41 |
| 70 | --10:30 | 10:00 | 9:20 | 8:45 | 8:24 | 7:48 |

## Determining Minimum Enroute Altitudes for Low Level Portions of Your Route

1. You must use TPC's or JOG's for your low level high terrain determination. For the IP to end escape portion use the JOG (1:250,000) plus the TPC (1:500,000), and use the highest terrain from either of these two.

2. When searching for high terrain use a 4 NM wide corridor, 2 NM either side of track and 2 NM radius of start and end points.

3. Do not use man made obstructions in determining high terrain.

4. When computing high terrain consider:
   a. Spot Elevations- use the highest spot elevation w/in the corridor plus the Vertical Reliability Factor (VRF) for 1:250,000, or the Vertical Error Factor (VEF) for 1:500,000.
   b. Contour Elevations- use the highest solid contour elevation w/in the corridor plus one half the next higher solid contour interval plus the VRF, or the VEF.
   c. Broken Contour Elevations- use the highest broken contour elevation w/in the corridor plus the full contour interval (see #5) plus the VRF, or the VEF.

5. In PACAF, the Vertical Reliability Factor for JOG's (1:250,000) is 164'. The Vertical Error Factor for TPC's (1:500,000) is 250'. The VRF and the VEF are usually the same as the contour interval for the chart.

6. Maximum Terrain Elevations (MTE) are on TPC's only. They are shown for each 30 minutes of Latitude and Longitude, in the center of the block. The MTE representes the maximum elevation w/in the 30 minute block. Compare this figure with the highest terrain in your corridors, if the computed high terrain is higher than the MTE, the MTE will be used as the highest terrain for MEA determination.

7. To compute MEA, take the highest terrain elevation for each leg, add 164' for 1:250,000 (JOG's) or 250' for 1:500,000 (TPC's), then round the total of these two figures up to the next 100'. Next, add the Standard MEA Factor of 500' for day low levels. For night low levels, the minimum altitude is 1,000' above the highest terrain or obstacle w/in 10 NM of your planned course.[2]

Example:

| | |
|---|---|
| Highest Spot Elevation | 5151' |
| VRF for JOG | +164' |
| | 5315' |
| Round to the next higher 100' | 5400' |
| Add Standard MEA Factor | +500' |
| MEA is | 5900' |

8. For navigation legs entirely over water, the MEA is 500'.

9. For check rides, or quality assurance for day to day low levels, have one or two flight members recheck your MEA calculations.

REFERENCES:
1. AFR 55-25, Vol 1/PACAF SUP 1, May 24 79', Ch. 4.5
2. MCR 55-4, Vol 1, PACAF, Ch. 9, pg. 9-2.2.

Appendix 3 ORI CRITERIA

ORI CRITERIA (PACAFR 123-3, 6 Feb 78)

1. 85% of low level turnpoints must be ± 1 NM

2. 85% of sorties must make assigned TOT ± 2 minutes (bomb impact).

3. 50% of sorties must have a successful radar release. (PASS/FAIL ITEM). Radar bombs must be filmed.

4. 85% of sorties must make a TOT within the TOT window and have a successful release on the first pass (PASS/FAIL ITEM).

5. 50% of bombs dropped must be within 1000' of target (PASS/FAIL ITEM).

6. Tone switch - outboard.