

**NAVAL AIR TRAINING COMMAND**



**NAS CORPUS CHRISTI, TEXAS**

**CNATRA P-557 (Rev. 06-06)**

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# **FLIGHT TRAINING INSTRUCTION**



## **ADVANCED MULTI-ENGINE LOW-LEVEL AND TACTICAL FORMATION**

**TC-12B/T-44A**

**2006**



DEPARTMENT OF THE NAVY

CHIEF OF NAVAL AIR TRAINING  
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1. CNATRA P-557 (Rev. 06-06) PAT, "Flight Training Instruction, Advanced Multi-Engine Low-Level and Tactical Formation" is issued for information, standardization of instruction, and guidance to all flight instructors and student aviators within the Naval Air Training Command.
2. This publication will be used as an explanatory aid to the Low-Level and Tactical Formation stages of multi-engine training. It will be the authority on the execution of all flight procedures and maneuvers herein contained.
3. Recommendations for changes shall be submitted via CNATRA TCR form 1550/19 in accordance with CNATRAINST 1550.6E.
4. CNATRA P-557 (Rev. 06-04) is hereby cancelled and superseded by P-557.

A handwritten signature in black ink, appearing to read "K. J. Sudbeck".

K. J. SUDBECK

By direction

Distribution:

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**FLIGHT TRAINING INSTRUCTION**  
**FOR**  
**ADVANCED MULTI-ENGINE LOW LEVEL AND TACTICAL FORMATION**  
**TC-12B/T-44A**  
**Q-2A-0092**  
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### INTERIM CHANGE SUMMARY

The following Changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE

The following interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

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## **CHAPTER ONE**

### **LOW-LEVEL NAVIGATION**

#### **100. INTRODUCTION**

This Flight Training Instruction (FTI) presents an overview of Low-Level (LL) Navigation. The purpose of LL navigation is to fly a selected ground track and arrive over a designated target drop zone (DZ) at a coordinated “Time Over Target” (TOT) or at a landing zone (LZ) at a “Time of Arrival” (TOA). Low-Level flight utilizing dead-reckoning procedures (holding a constant heading and airspeed for a predetermined amount of time), with location substantiated by reference to geographic checkpoints, may be the only method of navigation available to avoid detection in a combat environment. Our target will either be a drop zone and simulated airdrop procedures will be performed or a landing zone with a random tactical approach. Regardless of the objective, these techniques and procedures will provide the foundation needed to be a successful tactical pilot.

#### **101. LOW-LEVEL TASK MANAGEMENT**

The most crucial aspect of LL is proper task management. Many accidents are attributed to pilots flying into the ground because they did not prioritize tasks properly. The ever-important concept of Aviate, Navigate, Communicate, becomes even more crucial when flying in the low-level environment. Keeping the aircraft flying is always the number one priority. All the preflight planning, route study, chart reading, and timing control will not help a pilot complete his mission if he places those tasks before flying the aircraft and thus impacts the ground or other obstacles. Ensure that terrain clearance is always met first and then accomplish other duties (e.g., the navigate and communicate tasks). All tasks related to weather, enemy defenses, formation, navigation, cockpit switches, drop zone acquisition, aerial delivery, etc., collectively represent successful mission accomplishment. However, to successfully perform your mission, you must first survive. If you permit your priorities to break down, you may have just completed the enemy’s work. NEVER allow complacency or task overload to let you forget that the ground is DEADLY - and close at hand.

Comfort Level (CL) is the lowest altitude at which an aircrew can accommodate LL task loading and maintain safe terrain clearance. CL will vary according to terrain, aircrew skill, and currency. Flying requires sound judgment. If you exceed your CL, you probably are not getting anything out of the mission. The solution is to climb to a more comfortable altitude where you can once again begin learning.

#### **102. EMERGENCY ACTIONS**

Always be prepared for an emergency. Your actions in such a situation should have been thoroughly briefed; crew coordination is vital. Your first priority is an immediate climb away from the ground. Once at a safe altitude, MSA during training, handle the emergency as you head towards the nearest suitable airfield. Do not be complacent with a minor malfunction. For example, it might seem easy to troubleshoot a suspected float switch malfunction while you are

still at 500 feet AGL, but it would also be very easy to become distracted and troubleshoot yourself right into the ground. Remember that, as long as you are flying low-level, all malfunctions are serious. **Get away from the ground before troubleshooting any malfunction.**

### 103. CREW COORDINATION AND RESPONSIBILITIES

Crew coordination is essential to flight safety and mission accomplishment. All crewmembers must work together as a team. If you notice anything during a flight that has the potential to jeopardize mission accomplishment or flight safety, ensure all crewmembers are notified immediately.

#### 1. Pilot Duties (pilot at the controls)

- a. Fly the aircraft (maintain heading, altitude and airspeed).
- b. Back up the Copilot (timing, landmark IDs, systems and fuel monitoring, etc.).
- c. Fly all takeoffs, landings, airdrops, and recoveries (both IMC and VMC).
- d. Maintain a continuous outside scan for traffic, birds, and terrain clearance and an inside scan for the decision height light and engine instruments.

#### 2. Copilot Duties (pilot not at the controls)

- a. Back up the Pilot at the controls.
- b. Navigate (use tactical pilotage to determine proper heading, altitude, airspeed and timing necessary to fly the route).
- c. Make appropriate time control adjustments to arrive at the objective point on time.
- d. Handle all assigned radio communications.
- e. Maintain a continuous outside scan for traffic, birds, and terrain clearance and an inside scan for the decision height light and engine instruments.

3. **Advisory Calls:** Mandatory advisory calls follow. (The copilot will make these calls except those designated for any crewmember.)

- a. Takeoff. State "ROTATE" at takeoff speed. Any crewmember noting a safety of flight malfunction before hearing "ROTATE" will state "ABORT" and a brief description of the malfunction (e.g., "Abort, left engine flameout.").
- b. Climb out: Transition altitude. One thousand feet below assigned altitude.

- c. Descent: Transition level. One thousand feet above assigned altitude. One thousand feet above initial approach fix altitude or holding altitude. One hundred feet above procedure turn and final approach fix altitude.
- d. Nonprecision approaches: One hundred feet above minimum descent altitude (MDA). "Minimums" at MDA.
- e. "Runway in sight." Call when the runway environment is in sight. Do not call too soon when obstructions to vision, such as fog, haze, or low stratus clouds, are present. "Go-around." Call at missed approach point if the runway environment is not in sight.
- f. Precision approaches: One hundred feet above decision height (DH). "Land." Call at DH if the runway environment is in sight and the aircraft is in a position for a normal landing. "Go-around." Make this call at decision height if the runway environment is not in sight or if the aircraft is not in a position for a normal landing.
- g. Low-levels: "Climb." Make this call anytime the decision height (DH) light comes on during low-level flight.
- h. Deviations. Tell the other pilot when altitude deviates 100 feet from desired altitude if no attempt is being made to correct the deviation. Any crewmember seeing a 200-foot altitude variation or potential terrain or obstruction problem will tell the pilot immediately.

#### 104. PREFLIGHT PLANNING

The success of LL depends almost entirely on thorough preflight planning. The primary method of LL navigation is dead reckoning (DR). DR is simply holding a constant heading and airspeed for a specified time. When planned correctly, DR navigation is virtually infallible with the exception of unforeseen winds. On low-level sorties, navigate using DR and make corrections by referencing ground checkpoints.

The following is a step-by-step outline for planning a LL mission. Use it as a checklist when planning your missions. An in-depth discussion of each step follows the checklist.

1. Select an appropriate LL route. Consult FLIP AP/1B for possible published military training routes (MTRs), or select a locally developed route. Estimate the fuel required and schedule the route (if an MTR).
2. Check the weather (preliminary forecast) and NOTAMS.
3. Choose the appropriate chart.
4. Mark the published points and draw the route corridor (if an MTR).

5. Use the Chart Updating Manual (CHUM) information to update obstacles on your chart.
6. Locate the drop zone or landing zone, select the initial point (IP), turnpoints, and checkpoints.
7. Draw course lines using radius of turn over turnpoints.
8. Use common chart symbology.
9. Determine headings, minimum and maximum altitudes, and times.
10. Compute groundspeed for each leg.
11. Calculate continuation fuels for each turnpoint.
12. Determine the route to the entry and exit points.
13. Complete DD Form 175 (if required).
14. Obtain final weather brief and DD form 175-1. Analyze final LL winds and make any required corrections.
15. Perform the mission brief, do a route study, and review emergency procedures.
16. Fly the mission.
17. Debrief the mission.

**Choose an MTR.** AP/1B provides textual and graphic descriptions and operating instructions for all MTRs. Three maps, covering the western, eastern, and central US, depict each low-level MTR. These maps provide some specific information pertinent to each route (length of route, direction of flight on the route, entry points, alternate entry and exit points, altitudes, etc.). When using MTR charts, make sure you know how to correctly identify entry and exit points. Common errors include incorrectly plotted coordinates and ignored restrictions (airports to avoid, radio calls to make, etc.). Finally, you should know what the confines of the route are (top, bottom, and lateral) so you can avoid unacceptable deviations. AP/1B breaks low-level MTRs into three main types: IR, VR, and SR Routes.

1. **IR Routes.** IFR Military Training Routes (IR) must be conducted on IFR flight plans regardless of weather conditions. Your flight plan must have the entry fix (radial and distance), route designator, and the exit fix (radial and distance). You must enter and exit the route via published entry and exit points or published alternate entry and exit points, and you must have a specific ATC clearance prior to entering or exiting the route. Once on the route, you must remain within the published route corridor (width and altitude). When practical, avoid flight within 1500 feet AGL or 3 NM of airports. While AP/1B allows IR routes to be flown in IMC, it also gives strong cautions when doing so.

2. **VR Routes.** AP/1B’s guidance on VFR Military Training Routes (VR) is much less restrictive. You should be on an IFR flight plan while going to and from your VR route. Your flight plan must have the fix (radial and distance) of your entry point. You need your exit fix (radial and distance) only if you are transitioning to IFR. You must still remain within the published route and avoid airports by 1500 feet AGL or 3 NM when practical. The weather requirements for flying a VR route are 3000 feet AGL and 5 miles visibility. Contact flight service (FSS) on frequency 255.4 when entering the route and squawk 4000. While on the route, you should monitor flight service.

<p><b>IR-166</b></p> <p><b>ORIGINATING/SCHEDULING ACTIVITY:</b> COMTRAWING TWO NAS Kingsville, TX 78363 DSN 861-6283/6108 C512-595-6283/6108.</p> <p><b>HOURS OF OPERATION:</b> 0600-2400 local 7 days a week.</p> <p><b>ROUTE DESCRIPTION:</b></p> <table border="0"> <thead> <tr> <th style="text-align: left;">Altitude Data</th> <th style="text-align: left;">Pt Fac/Rad/Dist</th> <th style="text-align: left;">Lat/Long</th> </tr> </thead> <tbody> <tr> <td>As assigned to</td> <td>A NQI 116/24</td> <td>27°16.0'N 97°26.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>B NQI 134/31</td> <td>27°05.0'N 97°27.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>C BRO 339/56</td> <td>26°50.0'N 97°35.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>D NQI 197/41</td> <td>26°53.0'N 98°08.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>E NQI 254/41</td> <td>27°25.0'N 98°34.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>F LRD 079/34</td> <td>27°30.0'N 98°47.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>G LRD 050/36</td> <td>27°47.0'N 98°50.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>H LRD 047/51</td> <td>27°57.0'N 98°37.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>I NQI 274/32</td> <td>27°37.0'N 98°23.0'W</td> </tr> <tr> <td>SFC B 30 MSL to</td> <td>J NQI 244/16</td> <td>27°25.0'N 98°06.0'W</td> </tr> </tbody> </table> <p>NOTE: 0600 to sunset only - altitudes are SFC B 20 MSL.</p> <p><b>TERRAIN FOLLOWING OPERATIONS:</b> Authorized the entire route.</p> <p><b>ROUTE WIDTH</b> - 5 NM either side of centerline from A to I; 3 NM either side of centerline from I to J.</p> <p><b>Special Operating Procedures:</b></p> <ol style="list-style-type: none"> <li>(1) Route will be flown 250-420 knots, low-level navigation.</li> <li>(2) Alternate Exit: H.</li> </ol>	Altitude Data	Pt Fac/Rad/Dist	Lat/Long	As assigned to	A NQI 116/24	27°16.0'N 97°26.0'W	SFC B 30 MSL to	B NQI 134/31	27°05.0'N 97°27.0'W	SFC B 30 MSL to	C BRO 339/56	26°50.0'N 97°35.0'W	SFC B 30 MSL to	D NQI 197/41	26°53.0'N 98°08.0'W	SFC B 30 MSL to	E NQI 254/41	27°25.0'N 98°34.0'W	SFC B 30 MSL to	F LRD 079/34	27°30.0'N 98°47.0'W	SFC B 30 MSL to	G LRD 050/36	27°47.0'N 98°50.0'W	SFC B 30 MSL to	H LRD 047/51	27°57.0'N 98°37.0'W	SFC B 30 MSL to	I NQI 274/32	27°37.0'N 98°23.0'W	SFC B 30 MSL to	J NQI 244/16	27°25.0'N 98°06.0'W	<ol style="list-style-type: none"> <li>(3) Aircraft shall be scheduled with a minimum of 10 min longitudinal separation.</li> <li>(4) The primary method invoking MARSAs shall be by scheduling. All proposed users of IR-166 or any other approved IR route that is common with IR-166 or any part thereof, shall coordinate that route with TRAWING TWO, NAS Kingsville, TX.</li> <li>(5) MARSAs applies after acft have passed the entry point and until standard ATC separation is established after exiting the route.</li> <li>(6) The lost communication route and altitude for all acft filed to NAS Kingsville shall be Point J, direct NOI 270/015, maintain 7000 ft. Proceed via 15 mile DME arc either north or south as appropriate and complete the final portion of the TACAN 13R or 35R approach to NQI.</li> <li>(7) If NAS Kingsville is not the filed destination, all other proposed users shall exit at Point H, turn left, climb and maintain 7000 ft MSL and proceed as per the filed flight plan, while climbing, attempt to contact Houston ARTCC on 307.2 for further routing. If unable to contact the center, proceed to filed destination via route filed in flight plan or coded recovery route. CAUTION: Do not enter R-6312 without Yankee Target Control approval.</li> <li>(8) All entry and exit points shall be compulsory reporting points.</li> <li>(9) ATC freqs: Point A to H, 291.6 or as assigned; Point H to J NQI ATCF or as assigned.</li> <li>(10) Maintain 1500 feet AGL within 3 NM of Wyatt Ranch Airport located at 27°25.2'N 98°36.5'W 2 NM W of Point E.</li> <li>(11) Scheduling of, or amendments to shall be coordinated with the scheduling activity 2 hours prior to use in accordance with Letter of Agreement between COMTRAWING TWO, Houston ARTCC and NAS Kingsville ATCF</li> </ol>
Altitude Data	Pt Fac/Rad/Dist	Lat/Long																																
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**Figure 1-1 IR-66 Description**

3. **SR Routes.** Slow Speed Low Altitude Training Routes (SR) are flown at or below 1500 feet AGL at airspeeds of 250 KIAS or less. AP/1B specifically prohibits high speed aircraft from flying SR routes. Even though all time spent on an SR route is VFR, you must still file a flight plan. File to a fix most appropriate for the entry point of the route. If transitioning to IFR upon exiting, file to a fix most appropriate for the exit point of the route. Stay within the published corridor and squawk 1200 unless otherwise instructed by ATC. Aircraft flying SR routes must have weather of at least 1500 feet AGL and 3 miles.

To choose a low-level route, consult FLIP AP/1B. Locate your departure field and destination on the appropriate map and choose some potential routes (IR, VR, or SR). Figure 1-1 is the

route description for IR 166. Note that NAS Kingsville is the Scheduling Activity for this route. Coordinates are provided for each point and the corridor width is 5 NM (3 NM from I to J). Acceptable altitudes during the route are from the surface to 3000 feet MSL. Pay special attention to the Special Operating Procedures section for any additional restrictions that may apply. If an appropriate MTR does not exist, a local route may be developed. Local routes are designed to increase the flexibility of the missions and meet training objectives. They may be published or unfamiliar routes. Published routes, developed by the stage manager and distributed to everyone, may be MTRs or locally developed routes. Unfamiliar routes are local routes designed with the intent of being flown only once and are usually developed by the student and flown for their checkrides. Weather must be 1500/3 to fly a local route.

**Estimate Fuel Required.** When selecting a low-level route, consider the total fuel required to take off, climb to altitude, cruise to the entry or alternate entry point, fly the route(s), climb to altitude again, cruise to destination IAF, execute a penetration and landing, plus reserve and required alternate fuel. Estimating the fuel required prior to the actual planning of the low-level may save you time and effort.

**Coordinate and Schedule the Route.** When you schedule a route (may not be required for local routes), tell the scheduler your planned entry and exit times (Z), total time on route, groundspeed, type aircraft, call sign, and your name and phone number. Once scheduled, you own the route during that time period, but only during that time period. For example: to schedule MTRs in the local area, contact Kingsville Base Ops and provide the following information: route number, time of entry, call sign, exit time, type of aircraft, and PIC. If you are unable to meet your entry time, you must reschedule by contacting Kingsville Base Ops. Consult the AP/1B maps to identify crossing routes. It is a good idea to call the schedulers of crossing routes to check for potential conflicts along your route.

**Check the Weather and NOTAMS.** A preliminary look at weather and NOTAMS is next. Give the weather forecaster an accurate description of your proposed route. For day routes, ask for winds at 500 feet AGL and for night routes, use 1500 feet AGL. Ensure that you are briefed on the forecast weather for the entire route and divert fields. The minimum weather to fly an IR or VR route is 3000/5; SR and locally published routes require 1500/3. The weather minimums for flying night low-levels will be the highest leg altitude plus 500 feet. Check NOTAMS for arrival and departure airfields.

**Choose the Appropriate Chart.** The paragraph titled "Choose an MTR" describes different navigational charts and the features of each. The chart you choose for your LL depends upon the degree of detail necessary to complete the mission. Different charts will be required for different types of missions. As a general rule, the greater the altitude, speed and distance of a flight, the smaller scale of the chart. The type of information needed on the chart may determine the best chart to use. Some missions may require two or more types of charts. For example, a mission will typically require a TPC for the route and a JOG for the run-in to provide more detail.

To prevent misunderstandings about references on the chart, ensure all crewmembers use the same scale chart. Be aware that different charts will show different references for the same checkpoint (a road "Y" on a TPC may appear as a road "X" on a JOG).



Ensure your chart covers the entire route of flight, sufficient areas along your route, and alternate or emergency fields. If you need more than one chart to completely cover the entire route, overlap the identical features on both charts and tape or glue the charts together. Trim all charts to a minimum size for ease of handling in the cockpit but be sure not to trim off alternate airfields. Initially, do not trim your chart any closer than 22 NM of centerline until emergency safe (ESA) and minimum safe altitudes (MSA) have been calculated. Make sure the chart you select is current (see CHUM paragraph below).

**Mark the Published Points and Draw the Route Corridor.** Plot the points defined in the route description section of FLIP AP/1B. You are not required to use these points as turnpoints or checkpoints, but they define the centerline of the route from which you will draw the route corridor. Take your time and plot the points carefully. Draw the route corridor as defined in AP/1B. One technique is to draw a straight line very lightly in pencil between each published point and use that line to measure the width of the route corridor. You may want to identify or highlight the points that conflict with crossing routes. Locally developed routes do not have a defined route corridor.

**Use the CHUM.** The CHUM contains a cumulative listing of uncharted obstructions 200 feet and higher. When vertical obstructions form a multiple complex, only the highest obstruction within this complex is listed. Plot all CHUM obstructions within 22 NM of course centerline.

First, be sure your chart is current. The National Imagery and Mapping Agency (NIMA) updates aeronautical charts on a regular basis. Each chart has a basic publication date and an edition number. Next, find the Chart Updating Manual (CHUM) and the latest monthly CHUM supplement which list changes (new obstructions, etc.) discovered since the last revision. The CHUM data can also be obtained electronically by modem, contact NIMA at DSN 693-4005 or commercial (314) 263-4005. In Figure 1-2, the current edition (13) was last revised in May 1993. Locate and make all changes to the chart by using the latitudes and longitudes given in CHUM. Annotate on the chart the date of the CHUM used to update. The route or areas you will be using are the only areas necessary to update. (The two altitudes listed are for obstruction heights in AGL and MSL).

TPC G-20D, Edition 13, May 93				
N Delete	Tower	229 – 1344	35 55 40N	97 30 20W
N Add	Tower	295 – 1070	35 56 09N	96 16 46W
N Delete	Tower	300 – 1300	34 50 43N	97 37 03W
N Add	Tower	331 – 3513	33 39 47N	101 35 54W
N Delete	Tower	200 – 970	33 50 50N	96 40 42W
N Add	Tower	320 – 1117	33 30 30N	95 25 30W
N Change	Tower 345-840 to multi towers	500 – 987	33 38 50N	95 01 16W
N Add	Tower	709 – 3815	33 03 52N	101 52 35W
N Add	Tower	449 – 3287	32 57 18N	101 08 55W
N Add	Tower	500 – 1033	32 25 01N	96 46 11W

**Figure 1-2 Updating Chart Manual Data**

### **Locate the Drop Zone/Landing Zone and Initial Point (IP), Turnpoints, and Checkpoints.**

1. **The Drop Zone/Landing Zone and Initial Point (IP).** Locate the objective first. Drop zones are normally defined as either circular or rectangular and by size. A rectangular drop zone will have a defined run-in course, which the aircraft must follow during the run-in. A circular drop zone does not have a specified run-in course and may be approached from any direction. Landing Zones are anything from major airfields to dirt strips. Check the orientation, length, width, low in close obstacles, and gather any other information that may impact your mission. In either case, choose an easily recognizable IP approximately 10 minutes from the target. The IP provides a last checkpoint from which a final heading and timing update for the run-in can be made. Choosing an IP that requires a minimal initial heading change normally ensures a more precise final course to the target. Prominent intersections of rivers, roads, or terrain features make good IPs.

2. **Selecting Turnpoints and Checkpoints.** A checkpoint is a landmark used to identify the aircraft's position. Be sure to select a checkpoint with a distinctive feature so you will be able to positively identify it. Look for a peculiar bend in a road or river, an odd shaped lake or town, the highest terrain in the area, or an airfield with a distinctive runway layout. Checkpoints should be fixes that you anticipate being able to find. Figure 1-3 describes good features to use for checkpoints. The position of the fix, relative to its anticipated position, provides course guidance information. Arrival over checkpoints at an anticipated time confirms the accuracy of the wind prediction and indicates reliability of the predicted track and GS. If checkpoints are crossed at the wrong time, the GS is in error. If the aircraft passes near but not over a checkpoint, the ground track is off. These statements assume you are planning on flying directly over a checkpoint. You may use checkpoints that are near, yet not on, the route. A checkpoint directly on course may be hard to find when you are directly over it. Use it as an aiming point instead. The interval you choose between checkpoints depends on the speed of your aircraft and the availability of checkpoints. Pick a distinctive checkpoint where a change in direction will be made. Turning directly over the turnpoint will place you on course for the next leg. Choose an

obvious turnpoint but try to avoid heavily populated areas as much as possible for community relations as well as tactical reasons.

Construct your desired ground track from the entry point to the IP, using distinctive turnpoints. Note the avoidance criteria for civil airfields and noise sensitive areas published in the special operating procedures. Also consider aircraft turn performance and width of the route when selecting your turnpoints.

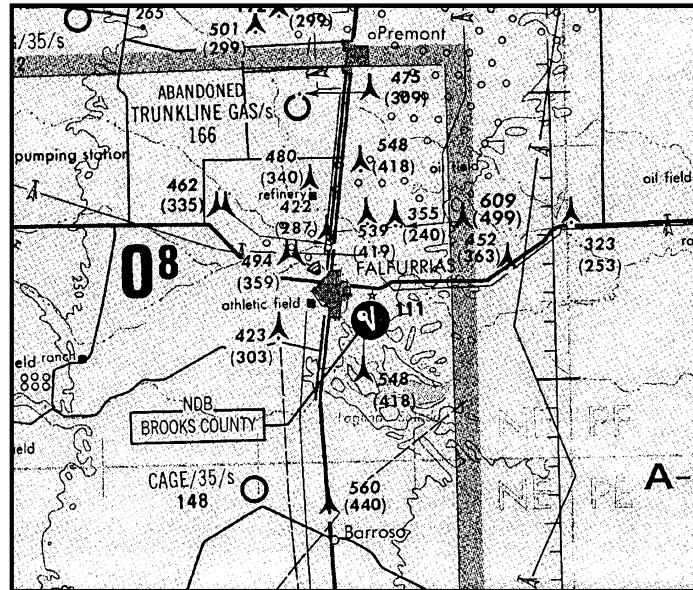
You are free to select any turnpoints that will keep your ground track within the corridor. Select two or three checkpoints for each leg, usually left or right of course, to monitor progress and determine course or timing corrections. A checkpoint is good only if it provides you with useful information. It must have a distinctive feature you will be able to recognize.

CONDITIONS	GOOD CHECK POINTS	POOR CHECK POINTS
	<p><b>MOUNTAINOUS AREAS</b></p> <p>Prominent peaks, cuts and passes, gorges. General profile of ranges, transmission lines, railroads, large bridges over gorges, highways, lookout stations. Tunnel openings and mines. Clearings and grass valleys. Radio aids.</p>	<p>Smaller peaks and ridges, similar in size and shape.</p>
	<p><b>COASTAL AREAS</b></p> <p>Coastline with unusual features. Lighthouses, marker buoys, towns and cities, structures. Radio aids.</p>	<p>General rolling coastline with no distinguishing points.</p>
	<p><b>SEASONAL AREAS</b></p> <p>Unusually shaped wooded areas in winter. Dry river beds if they contrast with surrounding terrain. Dry lakes.</p>	<p>Open country and frozen lakes in winter unless in forested areas. Small lakes and rivers in arid sections of country—in summer—when they may dry up. Lakes (small) in wet seasons in lake areas, where ponds may form by surface water.</p>
	<p><b>HEAVILY POPULATED AREAS</b></p> <p>Large cities with definite shape. Small cities with some outstanding check point; river, lake, structure, easy to identify from others. Radio aids, prominent structures, speedways, railroad yards, underpasses, rivers and lakes. Race tracks and stadia, grain elevators, etc.</p>	<p>Small cities and towns, close together with no definite shape on chart. Small cities or towns with no outstanding check points to identify them from others. Regular highways and roads, single railroads, transmission lines.</p>
	<p><b>OPEN AREAS FARM COUNTRY</b></p> <p>Any city, town, or village with identifying structures or prominent terrain features adjacent. Prominent paved highways, large railroads, prominent structures, race tracks, fairgrounds, factories, bridges, and underpasses. Lakes, rivers, general contour of terrain; coastlines, mountains, and ridges where they are distinctive. Radio aids.</p>	<p>Farms, small villages rather close together, and with no distinguishing characteristics. Single railroads, transmission lines and roads through farming country. Small lakes and streams in sections of country where such are prevalent, ordinary hills in rolling terrain.</p>
	<p><b>FORESTED AREAS</b></p> <p>Transmission lines and railroad right-of-ways. Roads and highways, cities, towns and villages, forest lookout towers, farms. Rivers, lakes marked terrain features, ridges, mountains, clearings, open valleys. Radio aids.</p>	<p>Trails and small roads without cleared right-of-ways. Extended forest areas with few breaks or outstanding characteristics of terrain.</p>

Figure 1-3 Selecting Checkpoints

There are a few specific details to be considered for each type of landmark.

1. **Town.** Look at the size and shape. Look at road patterns leading to and from the town.
2. **Road.** What is its direction? Does it have two lanes or four lanes? Are there any prominent turns or intersections? Is the road paved or dirt?
3. **Railroad Tracks.** What is their direction? How many tracks (single or multiple track)? Are there any prominent turns or crossings?
4. **River.** What is its direction? How wide is the river? Sometimes the only indication of a river is a line of vegetation (as in South Texas). Does the river wind back and forth or is it fairly straight? Are there any forks along the river? Is the river located on flat ground or in a valley?
5. **Lake.** How large is the lake? How is it shaped? Is there a dam? Are there any islands? Do rivers flow into the lake?
6. **Bridge.** Not every bridge is shown on a chart; but where a highway or railroad crosses a river, there is usually a bridge of some sort.
7. **Crossing and Intersection.** Usually there is an overpass or marked crossing when a road or railroad crosses a major highway. Note how many roads make up the intersection and their direction/orientation.
8. **Airport.** An airport can range from a single dirt strip to a multiple-runway complex. From the charts, enroute supplement, and other FLIPs, you will get a fairly good description of the airport. How many runways are there? What is the runway made of? If there is a rotating beacon, where is it located? Although airports can be very helpful in identifying your position (small dirt or abandoned runways are usually not helpful), avoid overflight to minimize potential traffic conflicts. Also consider the direction and altitudes of any instrument approach procedures into the airport. A quick look at an instrument approach plate will help you determine the best direction of fly around most airports.
9. **Terrain.** Is there a large peak, deep canyon, or other prominent terrain feature? Examples include a marsh, sand dunes, or other isolated features to help you fix your position.



**Figure 1-4 Ground References**

As a composite example, look at the town of Falfurrias, TX, shown in Figure 1-4. First, the town is fair sized (not just a few buildings), has an oblong shape, and is more or less oriented north and south. There is a highway and railroad (single track) running north and south parallel to each other with each railroad to the east. To the west of the highway is a powerline, also running north and south. An east-west highway passes through town. To the southeast of town is the Brooks County Airport (asphalt runway - 3300 feet) with a beacon on the north side of the field. Farther to the southeast (about 5 NM) is a lake generally oriented east-west with two inlets and bays at the western end. The southern inlet crosses the highway and railroad to the south of town, and although there are no bridges indicated, there are two. Note the tower west of the airport. To the northwest of town, an east-west powerline joins the north-south line. Note this powerline crosses the east-west highway at a prominent bend. These are only a few of the details that can be extracted from the chart.

**Determine Turn Radius over Turnpoints and Draw Course Lines.** Prior to drawing course lines on your chart, you must consider the turn radius of your aircraft. Your turn radius can be determined from the turning performance chart located in AFMAN 11-217 VOL 1. Turn radius varies with TAS and bank angle. Use a tactical plotter to plot turn radius at various airspeeds and bank angles. Align the straight edge of your plotter along your cruise line to the turnpoint. For example, draw the turn radius using 30° angle of bank and 180 KIAS (on the tactical plotter 20°/150 KIAS). The course line to your next turnpoint should begin as a tangent line to the turn radius. Continue this process for each turnpoint.

The IP to Drop Zone segment, or Run-In, should not include a turn radius. You should plan to cross the IP on heading, altitude, and airspeed for the Run-In.

**Required Chart Symbols.** The use of each symbol shown in Figure 1-6 is briefly discussed below.

1. **Turnpoint.** This circle symbol identifies those points from route entry to the IP used to identify turns. Circle the turnpoint so as not to obliterate detail.
2. **Checkpoint.** A checkpoint may or may not be marked with a particular symbol. It may be identified as easily as remembering it from your route study, highlighting it with a marker, marking it with an arrow, or actually circling it. Checkpoints are used to update your course and time between turnpoints.
3. **Initial Point (IP).** This square symbol identifies the turnpoint prior to the drop zone. It is a prominent point where an accurate track and time hack can be obtained. Since the IP is so vital to your ability to find the drop zone, make it distinctive. A good technique is to limit your heading change over the IP to 30° or less to ensure accuracy in navigation and timing. Whenever possible, plan your low-level so you do not need to turn over the IP. Recheck your clock at the IP for the run-in.
4. **Drop Zone/Landing Zone.** This triangle symbol identifies the ground reference for you to be *over on time for air-drop or touching down for air-land!* If you plan the flight correctly and fly the plan accurately, you will find yourself over the target on time.
5. **Advisory Box.** This symbol is used anywhere on the chart when information needs to be highlighted. Examples of information included in an advisory box include mandatory reporting points, frequency changes, or a route restriction with which you need to comply.
6. **Course Arrow Box.** This symbol is used at each turnpoint and the IP. There should be enough information contained in the course arrow box to enable you to fly the low-level. However, too much information will keep your head inside the cockpit at a time when you need to be flying the aircraft. You can personalize the information as you see fit.
7. **Alternate and Emergency Airfields.** This symbol is used to mark all suitable airfields that may be used for divert fields in case of aircraft emergencies, weather, etc.
8. **Controlling Obstacle.** This diamond symbol is used to mark the highest manmade obstacle, structure or terrain feature within 5 NM either side of your course. This point is used to determine your Minimum Safe Altitude (MSA). This symbol will also be used to mark the Emergency Safe Altitude (ESA) which is based on the highest manmade obstacle, structure or terrain feature within 22 NM of your course.

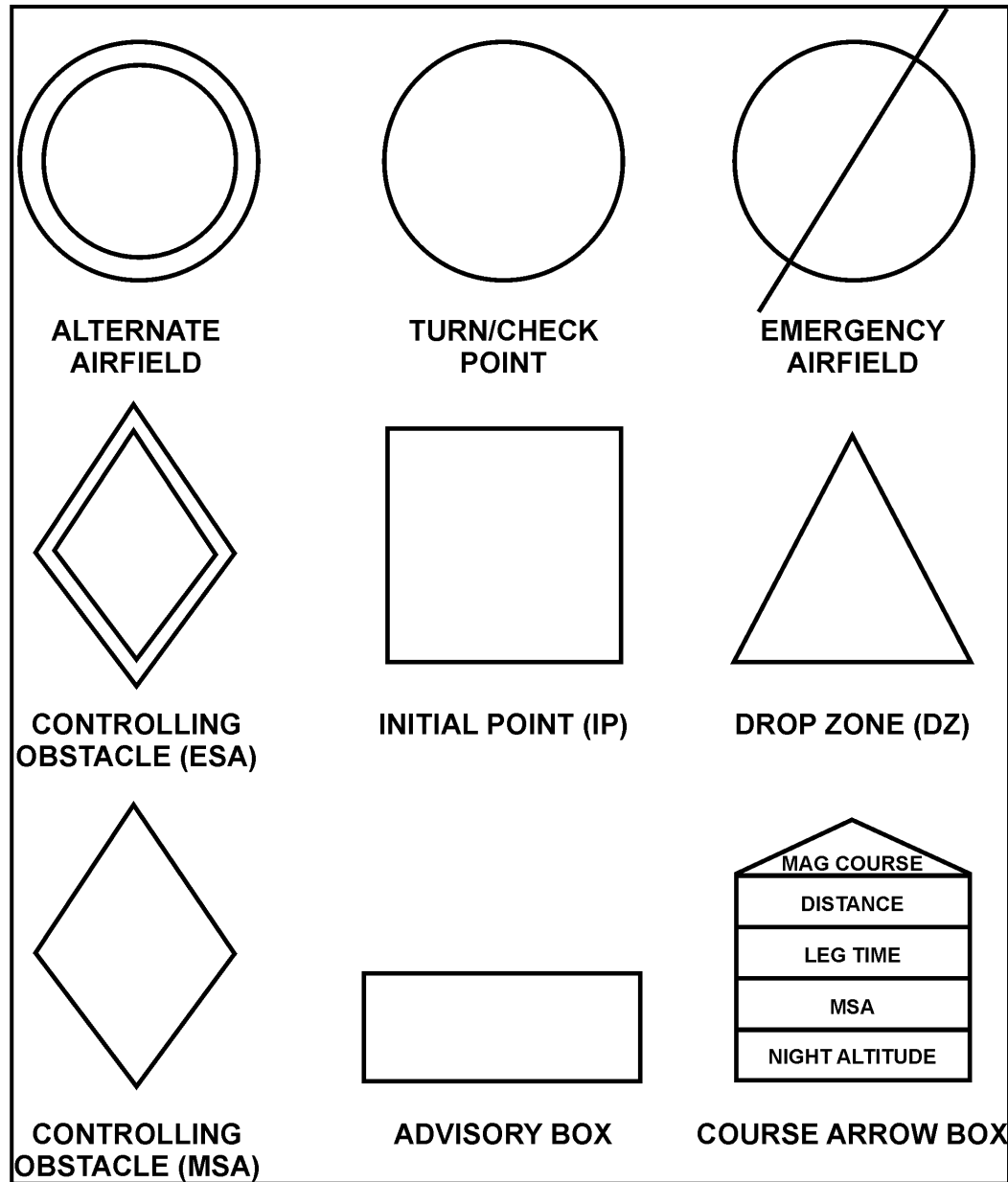


Figure 1-5 Required Chart Symbols

**NOTE**

The Drop Zone symbol is the same for Landing Zone

**Determine Headings, Minimum and Maximum Altitudes, Times, and Continuation Fuels.**

1. **Headings.** Use a plotter to measure true course (TC). Adding (west) or subtracting (east) variation finds the magnetic course (MC) from TC. Place the MC in the course arrow box, but this is not necessarily the heading you will fly in the aircraft. Each time you fly this low-level route, you will spin the winds to compute your wind-corrected magnetic heading (MH). On the



day of the flight, your drift correction (DC) or MH can be placed just above the MC on your map. MH is what will be flown in the aircraft.

2. **Minimum Altitudes.** Low-Level navigation is flown at an altitude of 500 to 1500 feet AGL.

- a. **Day VMC.** Plan a minimum of 500 feet AGL using visual reference and the radio altimeter. Modified Contour flight is defined as flight in reference to a base altitude (500 feet AGL) above terrain with momentary deviations above and below the base altitude for terrain depressions and obstructions to permit a smooth flight profile.
- b. **Night VMC.** Prior to slowdown, fly each leg or segment of the route at an indicated altitude of 1000 feet above the highest man-made obstacle or terrain feature and spot elevation within 5 NMs of route centerline to include the aircraft turning radius over each turnpoint. **If the altitude for the next leg is higher than the current leg altitude, the climb will be completed prior to the turnpoint. If the altitude for the next leg is lower than the current leg, do not initiate descent until over the turnpoint.**
- c. **Minimum Safe Altitude (MSA).** MSA is an initial VFR altitude which provides terrain clearance while the aircrew analyzes situations that require interruption of low-level operations (route disorientation and equipment malfunctions or when either pilot must leave the seat during low-level operations, etc.), yet limits threat detection. A MSA may be computed for each leg, route segment, or entire low-level route.

The MSA is calculated by adding 500 feet to the highest man-made obstacle or terrain feature within 5 NMs of course centerline. Calculate an MSA for each leg of the low-level route. Do not fly lower than calculated night altitude on night low-levels until the drop zone is positively identified.

- d. **Emergency Safe Altitude (ESA).** This altitude is calculated (and rounded to the next highest 100 foot increment) to ensure terrain clearance in the event a crew must abort an MTR when the weather is insufficient to continue the route, or an aircraft malfunction requires termination of the low-level route. It provides 1000 feet of clearance (2000 feet in mountainous terrain) from the highest obstacle within 22 NM on either side of course for the entire low-level route. Under normal circumstances, you exit the route under VFR conditions or on an IFR clearance. However, due to a delayed pilot decision, an aircraft malfunction, becoming lost or disoriented, or rapidly deteriorating weather, you may have to perform an emergency climb through the weather to the computed ESA. You are expected to plan ahead and make timely decisions concerning the need for route aborts. If the need arises, do not hesitate to transition to instruments, roll wings level, and initiate a climb to this altitude. The acceleration can give you a feeling of excessive pitchup; it is vital you crosscheck your attitude indicator. **Do not attempt to reenter the route once you initiate the route abort.** Proceed to your destination and analyze what happened and why.

3. **Maximum Altitudes.** You must comply with a maximum altitude on your low-level routes. FLIP AP/1B defines the vertical limits of your route corridor. Ensure you do not exceed the published vertical limit of the route when correcting for obstacles. If required, go around the obstacle instead of over it. There is not a maximum altitude for non-MTR routes.
4. **Times.** Plan to fly an indicated airspeed that gives you 180 knots groundspeed considering the predicted winds enroute.

Place one-minute timing marks between all turnpoints. Arriving at a preplanned Time over Target (TOT) is the desired techniques for low-levels and here are two techniques to help you arrive at your TOT:

- a. **Leg Time.** This is the amount of time from one turnpoint to the next. Hack the clock at the first point and again at each turnpoint along the way. You may find leg time useful for locating individual turnpoints because it eliminates the cumulative error of running time.
  - b. **Estimated Time of Arrival (ETA).** This is the time you compute on the clock at each turnpoint. In-flight GS corrections are based on your planned ETA.
5. **Compute Indicated Airspeed for Each Leg.** Using preflight winds, calculate the necessary indicated airspeed to maintain 180 knots groundspeed. Use NATOPS or the wind side of your whiz wheel (or CR-2) to determine headwind/tailwind corrections.
  6. **Calculate Continuation Fuels for Each Turnpoint.** Continuation fuel is the minimum amounts of fuel required at each turnpoint to be able to continue with the flight planned route and proceed to the destination with required reserves. Compute continuation fuel by starting at the destination and working backward. Add the amount of fuel required to fly each portion of the flight plan from the destination all the way back to initial takeoff. If you arrive at a turnpoint below your calculated continuation fuel, modifications will need to be made.

An immediate abort is not necessarily required. Modifications to the escape/recovery may be made or you may terminate the route early and fly direct to the destination. Compare fuels while straight and level (i.e., before or after the turn, NOT DURING THE TURN).

7. **Determine Your Entry and Exit Route.** Plan an appropriate route of flight to and from the low-level route. Plan your entry onto the route carefully. You will find that crossing your hack point on heading, airspeed, and altitude will make the rest of the low-level go smoother. The following techniques should help you get to your entry point easily:

Use your chart to allow room to maneuver so you approach the entry point on the heading you have planned for your first leg. In most cases, you will be descending from an IFR altitude onto the route. Plan the descent carefully by allowing distance from an IFR altitude onto the route and allowing distance for smooth clearing turns while descending on course. Carefully study the terrain surrounding the entry point to ensure your route altitude provides adequate terrain clearance for the entry area.

When flying a VR route, squawk 4000 and report entering the route to FSS. Monitor 255.4 on the route. While on an IR route, squawk your assigned code and monitor your assigned frequency. Squawk 1200 and monitor 255.4 to the max extent possible while flying a SR route.

Ensure both crewmembers hack their clocks at the entry point. Carry a stopwatch as a backup to the aircraft clock. One crewmember will give a verbal “Ready, Ready, Hack!” command over the entry point. This will ensure both pilots are using the same timing throughout the route.

Carefully plan the exit from the MTR. Know what altitude to climb to, what heading to fly, what frequency to be on, what NAVAID to tune, who to contact, and what to say. Be prepared to fly your flight-planned route via the VFR map. Due to your low altitude, you may not be able to receive NAVAIDs.

8. **Complete a DD Form 175.** General Planning and AP/1B explain how to fill out a DD Form 175 for a typical low-level. The format for completing the DD Form 175 differs for different types of routes (i.e., IR vs. VR).

9. **Obtain Weather Information.** Weather conditions can have a major, and sometimes tragic, impact on low-level operations. Before you fly, get the best weather briefing you can. You may wish to supplement your information by phoning a FSS near your route and ask for a local observation. Obtain all possible weather information and always keep the abort option in mind.

## 105. MISSION BRIEFING

1. **Perform a Route Study.** Once the mission planning is complete and the charts are constructed, it is time for a thorough route study before actually briefing the mission. The route study itself should be a detailed examination of the LL route and its surroundings. By reviewing the chart, note whether the area is flat, mountainous, coastal or inland. When studying the route, consider the direction of hills in ranges, steepness of slopes, ground elevations, and valley characteristics. If the route shows water features or coastlines, look for distinct features of lakes, inlets or islands. Wooded areas and farmland may be good landmarks if the shapes are distinctive. Keep in mind that some areas could easily change with increased industry or changing seasons. Similarly, railways and roads should be examined for distinguishing features. Note any special features (towers, power lines, etc.) and their relationship to your route. A common route study technique, referred to as “big to little,” starts by identifying the largest terrain features, such as mountains along the route left or right of course centerline. Systematically narrow down the terrain features to the smallest such as riverbeds. During your route study you should interpret the contours for each leg of the route to form a mental picture of the terrain. Identify those features that will most probably stand out, particularly those that will help you identify your turnpoints. Note any hazards. This is also a good time to get in the habit of using proper identification techniques. You can do this by using positions of towns and other checkpoints instead of names. For example, use “the two o’clock town” versus the name of the town. A good technique is to identify three checkpoints along each leg during the brief.

You must know how to read a chart and interpret terrain contours. If you do not, you will end up “thumbing the chart” - continuously referring to the chart to determine your position along the route by attempting to identify terrain features, roads, or towns you are flying over or have already passed. This completely contradicts the purpose of DR navigation. To avoid thumbing the chart, identify checkpoints by the **clock to chart to ground** method. This technique requires you to locate your position on the chart using elapsed time, choose a landmark confirming your position and find it on the ground. An example of this thought process would be: “At four minutes on this leg (clock), I should be crossing a road (chart) coming out of a town 3 miles off my left wing. There is a road at 11 o’clock coming from a town to my left (ground)”. Repeat this process step by step, and work your way to your destination. Do not pick points too far ahead or too far to the side. Generally, at low to medium altitudes, you should be looking for points 2 to 5 minutes ahead - depending on your aircraft speed and altitude - and have them in sight and identified by 1 minute out. You must have confidence that you do not need to identify every road, river, and town along the way to arrive at the drop zone on time. Again, if you plan and study the route correctly and do no more than fly heading, airspeed, and time, you will get to the drop zone on time. **FLY THE PLAN!** Thumbing the chart keeps your head inside the cockpit and has you looking over your shoulder at where you have already been. Not only is this ineffective, it is also dangerous. By thumbing your chart, you have negated your crosscheck and are not clearing your flight path.

Good LL preparation is a must. Thorough **preflight** study of the route (before you come in for the brief), good knowledge of timing and tracking correction techniques, and proper chart management will give you confidence in DR and get you to the drop zone on time.

2. **Brief the Mission.** Be ready for the brief. Use approved briefing guides and visual aids, as appropriate. Have charts ready, both enroute and run-in, stick diagrams, Form 280 (for formations), weather, NOTAMS, and airfield information completed prior to the brief.

## 106. LOW-LEVEL NAVIGATION FUNDAMENTALS

### Dead Reckoning and Pilotage

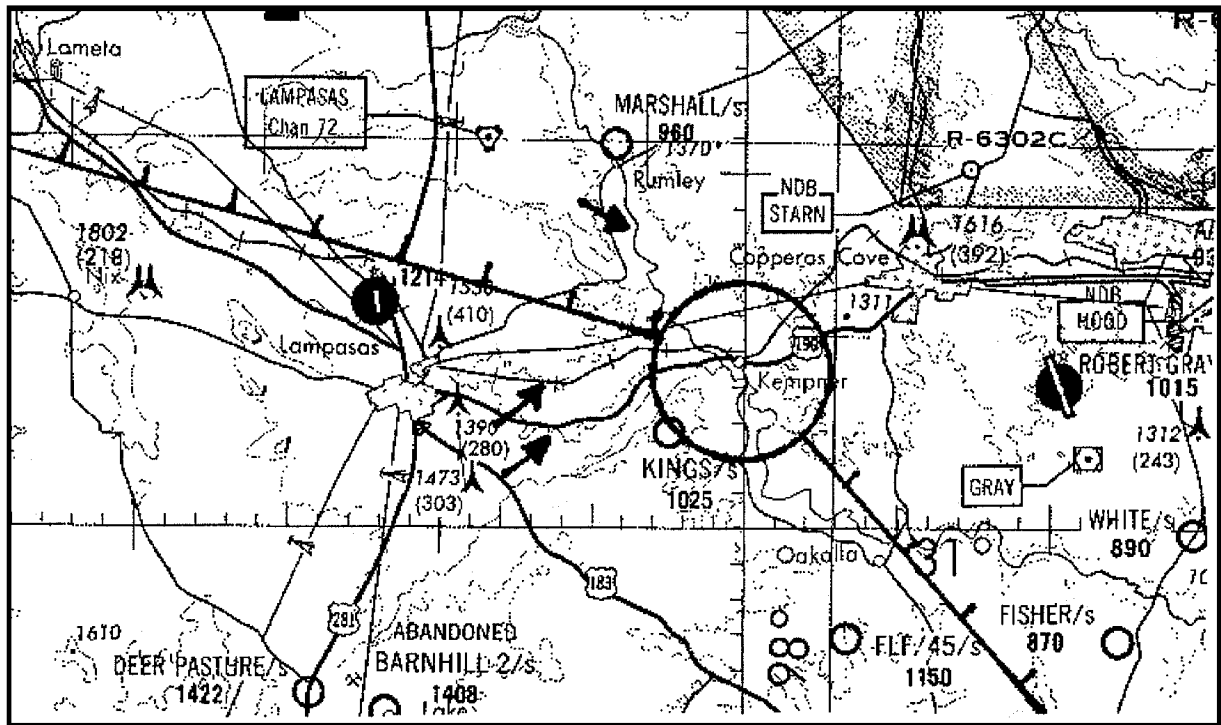
1. **Dead Reckoning (DR).** DR navigation using airspeed, time, and heading is your primary means of low-level navigation. It is simple, reliable, and requires only a clock, navigational charts, and compass. Although internal and external devices are great aids to navigation, they cannot be totally relied upon. Even with modern technology, a pilot must master the basics of DR because other means of navigation may be lost or degraded. A NAVAID requires ground stations and a line of sight to the station to establish a fix. The only other means of navigation available in the T-44/TC-12 is visual. However, since lateral and forward visibility is limited when flying near 500 feet AGL, visual checkpoints and ground references are often difficult to locate and confirm.

Precise DR navigation requires flying an exact heading, for an exact time, at an exact airspeed and then turning with a precise bank angle to the next heading. Heading control allows you to navigate from one point to another. Precise airspeed control results in the correct time between two turnpoints; if you are unable to locate your turnpoint, you must turn to the next heading at

the calculated time. Nothing else should be done during or immediately after the turn; concentrate on clearing and completing the turn.

Pick a point or feature in the direction of your next leg, turn to that feature, and then fine-tune your new heading. High speed, high bank-angle turns are not the time to be checking fuel or trying to read your chart. Fold the chart so the track is easily followed. Ensure usable features off track are not hidden and that chart creases occur in midtrack after a checkpoint and not at a high workload time. Try to arrange folds so you simply turn the chart over or refold only once.

If there is not a good reference for a turnpoint, you must fall back to pure DR navigation and turn on time. Conditions sometimes exist that make chart reading extremely difficult (for example, flight over an extensive area of featureless land or water). Continue to adjust your IAS until aircraft position and lapsed time coincide. Remain on track by making frequent crosschecks at predetermined points. When landmarks are identified that show you are off track, immediately correct back to your desired ground track to avoid having to make a large heading change later.



**Figure 1-6 Funneling Features**

2. **Orientation.** Because an aircraft travels in three dimensions, it does not take long to lose your positional awareness. Although it is easier to become disoriented when flying over featureless terrain, it is also possible in a heavily populated area where there are a number of roads and small towns that look alike. Therefore, you must study your chart to get a good idea of what you will see from the air.

Knowing the approximate time of day and location of the sun can help you keep track of the direction of flight and the turns you have made. Your instructor knows the terrain you will be

flying over in great detail, but will leave orientation matters up to you as much as possible. Your instructor will teach you to recognize the checkpoints along your route or ground references in the training area. You should be able to get to any of the nearby airports and know the main roads, cities, hills, rivers, etc., of your local training areas.

3. **Positive Identification.** Before you use a checkpoint, make sure it is the right one. Before the mission, learn what you can expect to see by studying the chart and its legend. While flying, use DR to determine when you will reach the next checkpoint. Look for features that will help you locate the point as far out as possible. Remember, if you are looking for a point on course, you will not be able to see it once it goes under the nose of the aircraft. Do not forget **clock to chart to ground**. If the timing is not right, it may not be the correct point.

Hold the chart so your course points toward the nose of the aircraft. If the checkpoint is to the right of course on your chart, it should be to the right of the aircraft. Always fly “up” the chart. Get the approximate position of the aircraft by DR. Select an identifiable landmark on the chart at or near the DR position.

When you are uncertain of your position, check every possible detail before identifying a checkpoint. The relative position of roads, railroads, airfields, and bridges make good checkpoints. Intersections and bends in feature, such as a major city, select a small prominent checkpoint within the large landmark to fix the position of the aircraft (like an outdoor theater, oval running track, etc). Look for funneling features to help take you to your turnpoint or checkpoint. A funneling feature is any item that leads you to the turnpoint. An example is shown in Figure 1-6. Note how the railroad, road, and river help lead you toward the turnpoint.

4. **When a landmark is not available as a reference at a scheduled turnpoint, make the turn at the estimated time of arrival (ETA)!** Extend the DR position to the next landmark, and fix the position of the aircraft to make sure course and GS are being maintained.

Be sure to adjust your timing if you know you are ahead or behind timing due to airspeed deviations or wind effects. It is easy to talk yourself into erroneously matching points on the ground with similar points on the chart. Most point recognition involves shape or pattern matching. Look for distinctive bends in rivers or shapes created by their intersections. When looking for streams or rivers, only the largest will have water visible. In many cases there will be foliage hanging over the stream and you will have to find the stream or river by changes in coloration, density, or size of the foliage growing along the water.

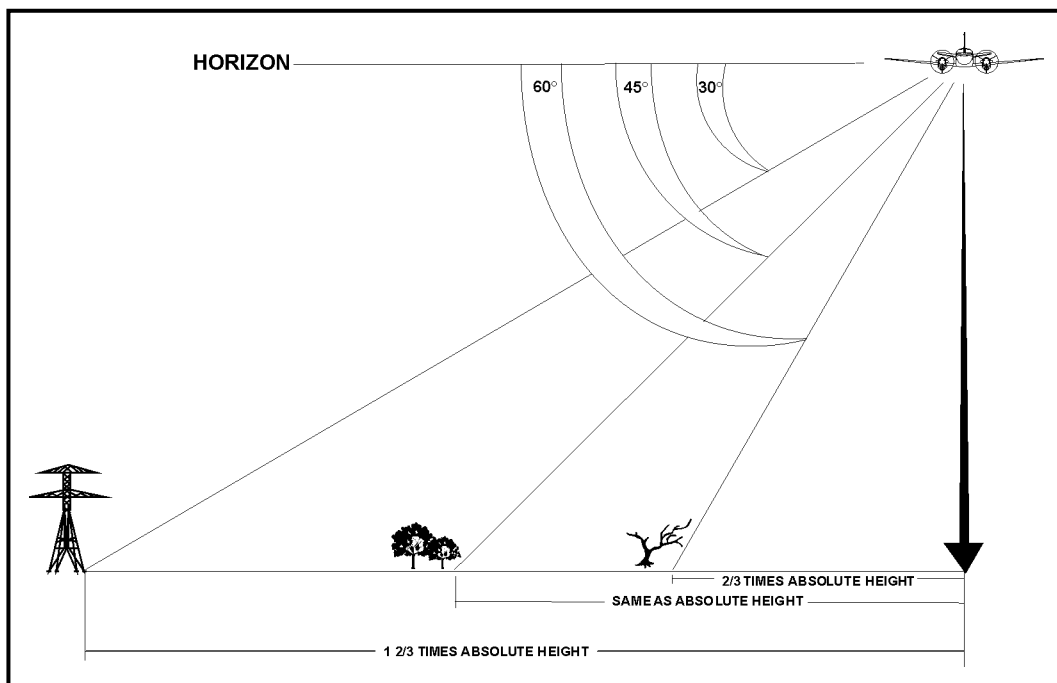
5. **Contour Map Reading.** Contouring is the most common method of showing relief features on a chart. Contours are lines that, at certain intervals, connect points of equal elevation. To understand contours better, think of the zero contour line as sea level. If the sea were to rise 10 feet, the new shoreline would be the 10-foot contour line. If the water continues to rise, the 20-, 30-, and 40-foot contour lines could be seen.

Contour lines are closer together where the slope is steep and farther apart where the slope is gentle. Within the limits of the contour intervals, the height of points and angle of slope can be determined from the chart.

Military operations require the analysis of contour-labeled charts to visualize the land. In operational planning, this is of the utmost importance, whether it is planning a route for a safe flight or determining the best escape route from enemy territory. In pilot training, you may use roads and towns as checkpoints.

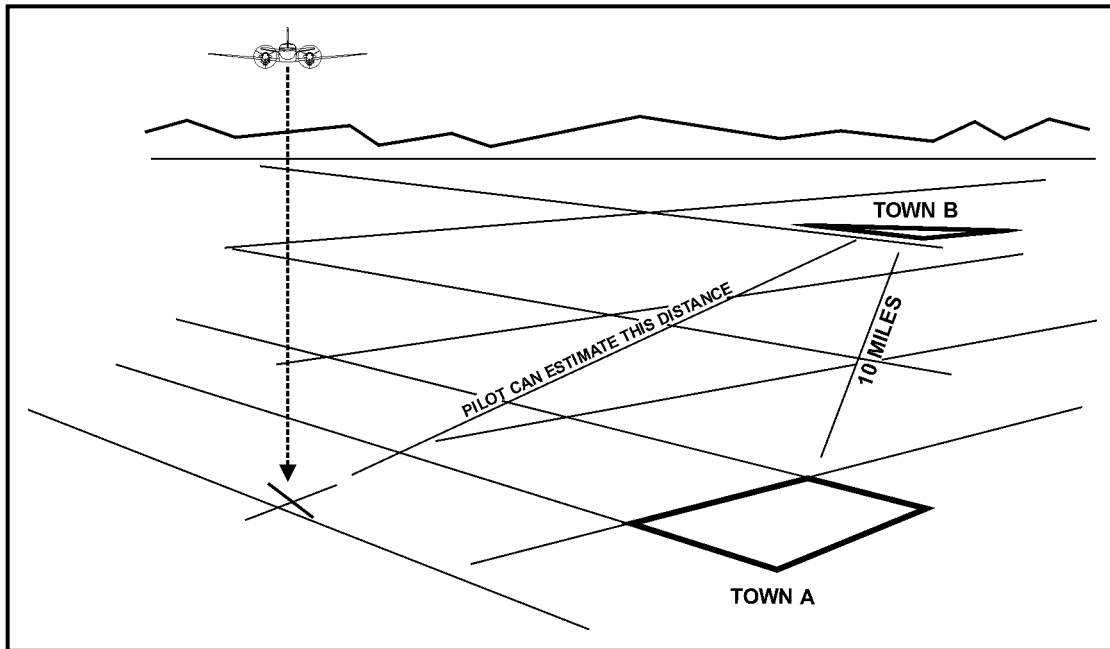
6. **Estimating Distances.** After you have positively identified the checkpoint, you may have to estimate your distance from it. Learning to judge distances comes mainly through experience. Here are some techniques you can use:

If a checkpoint is  $45^\circ$  below the level of the horizon, the distance from the aircraft position on the ground to checkpoint is equal to your altitude above ground (AGL). Other angles and approximate distances are shown in Figure 1-7.



**Figure 1-7 Estimating Distance by Angles Below the Horizon**

You may also estimate distances by first measuring the distance between two checkpoints on the chart. Use this reference as a guide for estimating other distances. For example, in Figure 1-8, towns A and B are measured on the chart to be 10 miles apart. You are about twice that distance from town A (or about 20 miles). Some parts of the country have section lines spaced approximately 1 mile apart. To determine a distance, simply count the section lines.



**Figure 1-8 Estimating Distances by Comparison**

7. **Position Fixing.** Checkpoints are used to determine a fix. A fix is a definite position or point on the ground indicating the position of the aircraft at a definite time. You establish a fix by noting the relationship of the aircraft to one or more checkpoints. There are three basic types of fixes. The simplest type of fix is flying directly over a checkpoint. A second type of fix is distance and direction from a checkpoint. An example of this type of fix is knowing that your aircraft is 5 miles north of a small town. The third type of fix is establishing aircraft position by its direction from two checkpoints. An example of this type of fix is placing the aircraft north of a town and west of a lake.

8. **Turnpoints.** Fly directly over turnpoints unless deviating for known threats or when making timing corrections. When approaching the turnpoint, ensure the PAC positively identifies the correct point. Over or abeam the point say “ready, ready, turn” to ensure that everyone knows it is a turnpoint and not a checkpoint.

9. **Corrections to Course and Time.** You will find you can get very close to a target simply by using DR navigation. Use the chart for course control and timing accuracy. Occasionally, you will find it necessary to make an in-flight correction to course or airspeed because of improper heading control, improper power control, faulty flight planning, winds stronger than forecast, etc. Making in-flight corrections to course and time are simple, however you must know how far off course you are before determining a correction. Making a correction without knowing your exact location typically results in greater error!

- a. **Course Corrections.** Use the following techniques, in the following order, to correct course deviations:

Aim for a feature in the distance that is on course. Before selecting your point, ensure you are on course and have rechecked your heading system for accuracy. This



will keep you on course. As you get closer to your selected point, recheck your heading system and select another feature that is on course.

Keep doing this until you find and positively identify your turnpoint or turn on time. Use funneling features between 10 and 2 o'clock to steer back to course. You may find roads on either side of you that converge on your checkpoint. A valley between two ridgelines may lead you directly to your checkpoint. Funneling features are relatively common, but they might not be obvious. Study your chart for possible funneling features prior to flight. Again, make sure you know where you are and where you should be before making a course correction. A good technique is to confirm your current position by at least two other references before making a course correction.

If you cannot find any features between 10 and 2 o'clock, use a technique known as Standard Closing Angle (SCA). SCA is calculated by dividing 60 by your GS in NM/min. This results in an SCA of  $20^\circ$  for 180 knots GS. The SCA is then applied to your planned heading and held one minute for every mile you are off course. You could also apply double the angle for half the time ( $40^\circ$  for 30 sec per mile off course) but as you increase the heading corrections, you will increase the timing error your correction induces. Making too rapid or too acute a correction may affect your timing. For instance if you were 2 miles left of course and chose to turn  $90^\circ$  right for 2 miles and then  $90^\circ$  left on course, you would increase your overall running time by 40 seconds at 180 knots GS.

An example of a course correction follows: you confirm you are 2 miles left of course and want to correct to course minimizing timing errors. You cannot find a feature in the distance that is on course and you cannot find any funneling features to steer back to course. You decide to use the SCA to correct. With 180 knots GS you would turn  $20^\circ$  right for 2 minutes (or  $40^\circ$  right for 1 minute). The correction you choose depends on the length of the leg on which you are making the course correction. A short leg may not allow you to make a 2-minute correction. When back on track, analyze why you got off track. Were you holding the desired heading or did you let your heading drift? Is your RMI/HSI working properly or do the winds appear different than planned? Whatever you determine, apply the appropriate corrections to avoid repeating your mistake.

- b. **Timing Corrections.** Timing corrections are simply a matter of changing your GS for a period of time or off-course maneuvering. Off-course maneuvering will change the distance you fly which will affect your timing. All timing corrections should be made prior to the IP. No timing corrections shall be made from the slowdown to the DZ/LZ. The following methods are recommended:
  - i. **Off-Course Maneuvering.** Off-course maneuvering works well on routes that are circular (semicircular) or have turns of more than a few degrees between legs.

If a route has three legs that are 90° to each other, as in Figure 1-9, you can adjust your turn to either lose or gain time. Think of it as a parallelogram. For example, if you have confirmed you are one minute early at a previous checkpoint you can simply turn 30 seconds past your next turnpoint. At 180 knots GS you will travel 1.5 miles in 30 seconds so if you parallel your course 1.5 miles to that side and turn abeam your next turnpoint you will lose 1 minute. The same technique will work if you are late - you just turn 30 seconds early at your turnpoint.

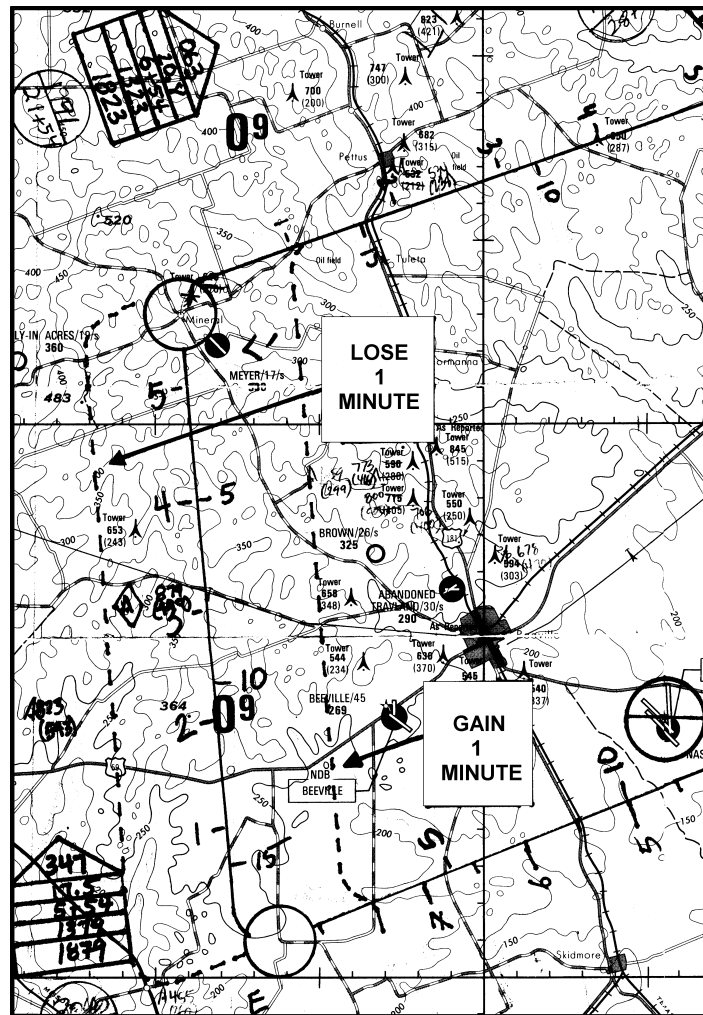


Figure 1-9 Timing Correction

A circular or semicircular route allows you to cut off part of the route to make up time. You can just skip one turnpoint or turn prior to reaching a turnpoint. When you skip a turnpoint, estimate the distance to the new turnpoint, calculate the time it will take you to cover that distance, and then add up the time it would have taken to fly the two legs you skipped. The difference in time between the original route and the new route is the time you saved. The same theory is used if you turn early at a turnpoint as in Figure 1-10 and intercept the

next turnpoint. Just take the difference of what you are going to fly and the original track. Be sure that if you maneuver off-course more than 5 miles you figure a new MSA for your new course.

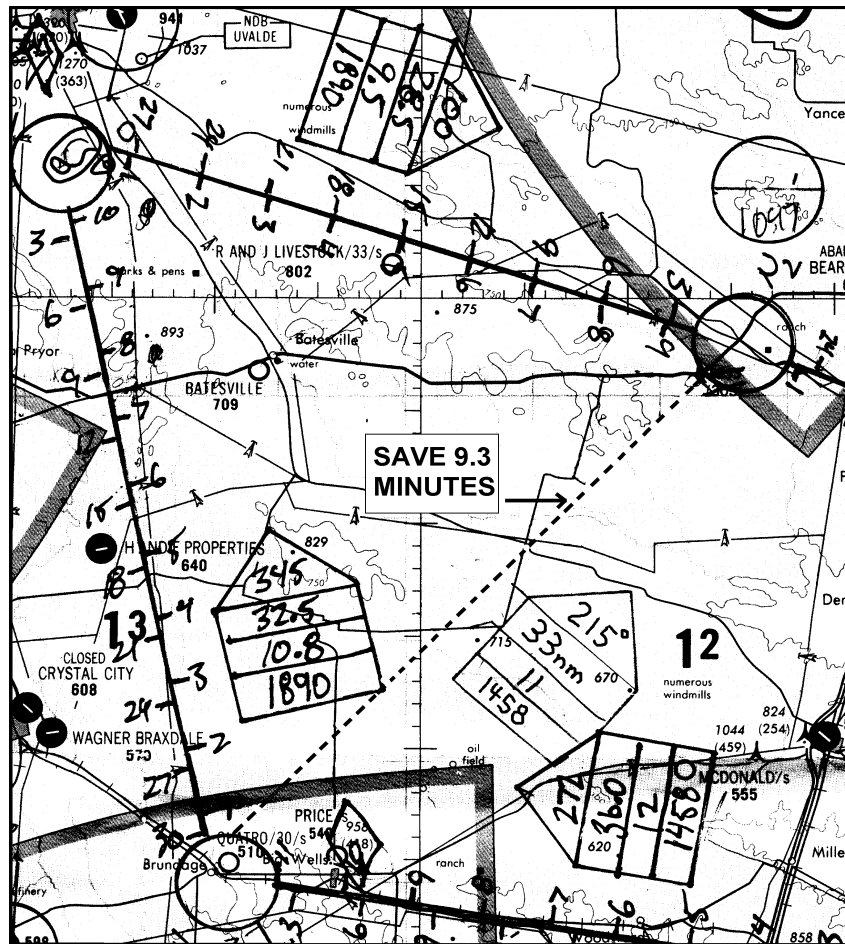


Figure 1-10 Timing Triangle Corrections

- ii. **Proportional Method.** For every second off of your planned ETA, change your IAS by 1 kt and hold this new airspeed for the number of minutes equal to your GS in miles per minute. For example, you are traveling at 3.0 NM per minute at a 180 kts GS. If you arrive at a checkpoint 10 seconds early, decrease your airspeed 10 kts for 3.0 minutes. This relationship can be modified to optimize timely corrections. You may decrease your airspeed 30 kts for 1 minute or 15 kts for 2 minutes. Again, the amount of time you spend making the correction depends on how quickly you want the correction to occur.
- iii. **Ten Percent Method.** To use this method you will need to know the amount of time to gain or lose. This amount is calculated by taking 10 percent of the flight-planned GS ( $10\% \times 180 \text{ kts} = 18 \text{ kts}$ ). The rule states that holding the 10 percent increase or decrease in flight-planned GS for 10 minutes gains or loses

1 minute. This also means you can gain or lose 6 seconds for every minute the adjustment is made (Figure 1-11).

Time ahead or behind (seconds)	Time to hold speed change (minutes)
6	1
12	2
18	3
24	4
30	5
36	6
42	7
48	8
54	9
60	10

**Figure 1-11 Ten Percent (10%) Method**

- iv. **Incremental Method.** To determine the increment, first find your groundspeed in nautical miles per minute (180 kts = 3.0 miles per minute). Multiply this by 10 to get the increment (3.0 x 10 = 30). Divide your time ahead or behind (in seconds) by 10 to determine the number of minutes to hold the correction. For example, if you are 50 seconds late, you must hold the 30-kt correction (increment) for 5 minutes (50 sec/10). Note that you will gain or lose 10 seconds for every minute that you hold the increment (Figure 1-12).

Try to have your overall timing corrections accomplished by the time you arrive at the IP. Likewise, when back on time, analyze why you got off time. Also check that you are now maintaining the correct or new IAS (if one was required).

#### NOTE

If you are close to continuation fuel, beware of increasing your speed too much. The increase in fuel consumption may force an early return to base. In this situation, it may be better to accept and allow the timing error.

Time ahead or behind (seconds)	Time to hold speed change (minutes)
10	1 min
15	1 min 30 sec
20	2 min
25	2 min 30 sec
30	3 min
35	3 min 30 sec
40	4 min
45	4 min 30 sec
50	5 min
55	5 min 30 sec

**Figure 1-12 Incremental Method**

**107. FLYING THE ROUTE**

**Route Entry.** This is probably the most difficult part of low-level training. Get your chart out and begin DR right after takeoff (complete your checklists before you pull out the chart). You will be more successful if you begin with a known point (your departure base) and then chart read continuously to the route entry. If possible, have a radial/DME backup for the entry point. This will help you locate ground features and prevent you from becoming temporarily disoriented prior to route entry. Try to identify the entry point as early as possible to allow for time to get lined up, coordinate with the appropriate agencies, etc.

Call “ready, ready, hack” at the entry point and hack both clocks. Broadcast entering the route and route flying on base frequency. Notify FSS on 255.4 when entering an IR or VR route. Give them your call sign, route, entry point and time, and exit point and time. Because your route probably has alternate entry and exit points, be sure to announce the points you will be using to the applicable agency. There is no requirement listed in FLIP AP/1B to contact any ATC agency when entering an SR route, but FLIP does state that you should monitor 255.4 if it is not detrimental to your mission. Work hard to achieve a smooth route entry so you do not start behind the power curve.

**On the Low-Level. Clearing (outside scan) cannot be overemphasized!** Typically, most student pilots will be guilty of “thumbing the charts.” It is very unlikely you can effectively clear with your head down, thumbing your chart. A thorough route study on the ground must include an examination and explanation of how the terrain is laid out, both on and to either side of the route. A proper understanding of DR will maximize training and flight safety. Update points should be replanned; they should not just occur every half-mile.

Now that you are clearing, the navigating should be easy. After your thorough route study, you should not have to spend much time determining that the little squiggly line is really a railroad. Instead, you will be navigating by DR and position identification. Initially, students tend to “chart read” behind the aircraft. Your instructor will teach you how to anticipate and predict what lies ahead. You should know the distinguishing features of landmarks ahead so you can make a quick positive identification as they pass. This skill prevents you from watching a feature go under the nose and then attempting to confirm it against the chart. Additionally, timely position verification is the only basis for using all those nifty time and course correction techniques. Do not forget clock-to-chart-to-ground navigation. This method helps you stay ahead and prevents the normal student pilot procedure (ground-to-chart-to-ground-to-IP). Remember, DR is what flying low-level is all about.

### **DZ Transitions**

**Slowdown.** Since we will be simulating an airdrop at times, we need to slow from the enroute groundspeed, to the drop airspeed. We also need to be stabilized at drop altitude over the DZ for the airdrop. Drop altitude is determined by adding 1000 feet above the highest point on the DZ. The highest point on the DZ can be found on the DZ survey. Slowdown should be planned to allow time to stabilize on airspeed and altitude at least one minute prior to green light (TOT). Slowdowns will be accomplished in one of the following two ways depending on the initial altitude.

1. **Ascending Slowdown.** Typically for a day low-level, we will be flying at 500 feet AGL. This will necessitate a climb to drop altitude (1000 feet AGL) during slowdown. To execute an ascending slowdown, notify the PAC “30 seconds to slowdown, 5 seconds to slowdown, slowdown, slowdown, now.” The PAC will reduce power to 400 ft-lbs and initiate a climb at 1000 FPM. When the airspeed is below approach flap limiting airspeed, extend flaps to approach and continue to slow to a drop airspeed of 120 KIAS (T-44)/130 KIAS (TC-12) while leveling at drop altitude. Maintain drop airspeed and altitude until the escape maneuver is initiated.

2. **Descending Slowdown.** For a night low-level, we will normally be at an altitude higher than drop altitude. To execute a descending slowdown, notify the PAC as in the above paragraph. The PAC will reduce power to idle and maintain altitude. When airspeed is below approach flap limiting speed, extend flaps to approach and continue slowing to a drop airspeed of 120 KIAS (T-44)/130 KIAS (TC-12) while maintaining altitude. After slowdown, when the DZ is in sight and will remain in sight or when a positive position is identified and adequate terrain clearance is assured, the aircraft may descend to drop altitude. Stabilize at drop airspeed and altitude until the escape maneuver is initiated.

### **NOTE**

No timing adjustments shall be made from the slowdown to the drop zone.

**Simulated Airdrops.** We will be simulating airdrops on several drop zones. A drop zone is a geographic location that has been surveyed by a team and approved for airdrops.

Actual drop zones will have some kind of marking to identify the drop zone and define where the load should impact (Point of Impact, PI). The markings are briefed prior to the flight and will consist of a Block Letter, Raised Angle Marker (RAM), smoke, flares, mirrors, etc., or any combination of these. Rectangular drop zones will be marked towards the front, while circular drop zones are marked at the center. The drop zones we simulate will not have markings.

One minute prior to reaching the point of impact (PI) on the drop zone, call "one minute advisory". Five seconds prior to reaching the PI on the drop zone, call "5 seconds". Call "green light" when over the PI to simulate the airdrop. Green light time is defined as the amount of useable time over the drop zone during which the load may be dropped and still land on the drop zone. Red light denotes the end of green light time and will be called at the expiration of green light time. Our simulated drop zones have been determined to have a green light time of 7 seconds.

**Escape.** At red light, retract the flaps, turn to escape heading, accelerate to enroute airspeed and climb or descend as required.

### LZ Transitions

**Slowdown.** Prior to any slowdown, accomplish the approach checklist, check WX, and make traffic advisories. If traffic exists at the airfield enter a standard civilian pattern or abort the approach attempt and continue on with the next part of the mission.

For landing zone transitions, slowdown is accomplished in one of two areas depending on your planned airfield entry. For tactical arrivals that involve anything other than a straight-in, slowdown is typically accomplished once in the airfield environment by executing an energy dissipating maneuver to get the aircraft configured to land. For straight-ins, slowdown must be done at a point prior to reaching the landing zone. The straight-in approach is the more challenging of the two types. Wait too long to configure and you will have to go around exposing your aircraft to possible enemy fire as you maneuver to get back to the airfield. If you configure too soon, now your aircraft is moving slow and exposed on a straight line, making an easy target for enemy forces to shoot at. For a basic idea on approach types available, see Appendix E section 103 and ask your instructor about their experiences doing these types of approaches.

Once slowdown has occurred, configure the aircraft as airspeed permits, complete the landing checklist and back the PAC up by monitoring airspeed, aim point, and watching for any traffic. Either a touch-and-go or a go-around may be accomplished depending on runway lengths/widths available.

**Escape/Transition.** Once airborne, hack your clock, clean up the aircraft, turn to your next course, and accomplish the climb checklist.

## 108. LIMITATION OF CHART READING

When used within its limitations, chart reading is the most dependable DR aid. If you have unrestricted visual contact with the terrain and a reliable chart of the area, map reading is limited only by your ability to read and interpret the chart. Other limitations can be grouped under one heading, restrictions to visibility. These can be caused by weather phenomena, altitude, darkness, or physical construction of the cockpit. When selecting suitable checkpoints, consider these variables:

### Weather Restrictions

1. **Clouds.** If they are below you, clouds can restrict visibility by obstructing checkpoints. If they are above you, they will change the amount of light you have available to identify checkpoints.
2. **Haze and Smoke.** When the fine dust, salt particles, or other impurities that are normally dispersed in the atmosphere are trapped and concentrated in a limited layer, the resulting restriction to visibility is called haze. The greatest restriction to visibility in haze usually occurs when you look directly into the sun. The best visibility in haze is when you look straight down. Smoke from industrial areas and forest fires often create smog; visibility in haze is similar to smoke and smog.
3. **Blowing Dust, Sand, and Snow.** Blowing dust occurs in several regions when the air is unstable and winds are relatively strong. The strong winds and vertical currents can spread dust over wide areas and lift it to great heights. Surface, flight, and slant-range visibilities are greatly reduced in blowing dust. Sandstorms are more local and occur where loose sand is found in desert regions. Blowing sand is seldom lifted above 50 feet. When the wind is strong, blowing snow reaching a few feet above the ground can be as troublesome as ground fog over snow-covered regions.
4. **Precipitation.** Precipitation in the form of rain hinders visibility as it streaks over the canopy. Drizzle and snow can reduce visibility even more.
5. **Altitude.** Your altitude poses a problem in determining how far and how well you can see. At low altitudes, vertical differences in cultural and topographical features are more apparent than general shapes viewed from above. Good low altitude checkpoints are tall buildings, grain elevators, mountain peaks, radio towers, road crossings/bends and bridges. However, because your range of vision is severely restricted at a very low altitude, your checkpoints must be close together and close to course. This is something you should consider when initially planning a low-level mission. You can use charted AGL tower heights to help determine your altitude above the ground. For example, if you know you are flying abeam a 400-foot tower and the top of the tower is even with the horizon, you know you are too low if you are supposed to be at 500 feet AGL.



As your altitude increases, your ground-range visibility increases. Features such as roads, railroads, and fence lines all look alike. Small towns become difficult to identify and you must rely on large, prominent landmarks. Pinpoint fixing becomes more difficult.

### **109. NIGHT CHART READING**

Night navigation is primarily done using DR. Fly the planned heading for the planned time at the planned airspeed. Ground references are used to make corrections to DR navigation. The primary altitude reference at night is the barometric altimeter while the primary reference during the day is the RADALT. During darkness an unlit landmark may be difficult or impossible to see. Lights can be confusing because they appear closer than they really are. Fixing on points other than those directly beneath the aircraft is very difficult. Objects are more easily seen by scanning or looking at them indirectly. This uses the portion of your eye best suited for night vision. The pilot should preserve night vision by working with red lights or very dim white light. Keep the cockpit lights as dim as possible and still see everything inside the cockpit. The dimmer the interior lights, the better your outside visibility will be.

In moonlight, some prominent unlit landmarks are visible from the air. Coastlines, lakes and rivers can be seen without difficulty. Sometimes reflected moonlight causes a river or lake to stand out brightly for a moment, but this is usually too brief for accurate fixing. By close observation, roads and railroads may be seen after the eyes are accustomed to the darkness. Lighted landmarks, such as cities and towns, stand out more clearly at night. Large cities are often be recognized by their shapes, but many small towns are darkened at night and are not visible. Airfields with distinctive light patterns may be used as checkpoints. Military fields use a double white and single green rotating beacon while civilian fields have a single white and green beacon. At night, busy highways are discernible because of automobile headlights. The key to night navigation is to choose very obvious, distinctive checkpoints (big picture) and keep an eye on your timing.

### **110. DISORIENTATION**

The seriousness of becoming lost is actually relative to the weather and terrain conditions encountered during flight. It may not be serious to be 3 miles off course over flat terrain and in an area of excellent visibility; but in mountainous terrain with poor visibility, being off course as much as 2 or 3 miles can kill you.

If you are not completely sure where you are, but you know you are near your course, you should start a climb to a higher altitude (ESA is a good choice) until you can positively identify your position. Climbing will give you more references and help you get terrain clearance in case you cannot figure out where you are. Try to climb at your enroute airspeed and turn on time. Realize that winds in the climb and winds where you level off will be different from those at your original altitude. If you are able to positively locate your position, take a serious look at your fuel and remaining route to determine if you should resume your route at the original altitude or stay higher for increased fuel range.

If you elect to continue the route, select a specific point, preferably a turnpoint, and positively identify it. Then descend to the point and try to arrive over the point on the heading to the following point. Make sure to hack your clock so you will be able to maintain positional awareness for the remainder of your route.

If you realize you are totally lost, stay on your original heading, establish maximum endurance airspeed, and climb to an appropriate VFR altitude that will give you terrain clearance. Attempt contact with a FSS or ARTCC for the area you are flying in. A simple memory aid is “climb, conserve, confess.”

### **111. COMMON ERRORS**

You should be able to locate a visual fix without a doubt in your mind that it is the right one. Some common map reading errors include:

1. Not holding desired heading and airspeed.
2. Trying to find ground features on the chart; always go from the clock, to the map, to the ground.
3. Selecting points too far apart; select the closest feature or landmarks you think you will see.
4. Attempting to look for points too close to the aircraft.
5. Overflying points due to underestimating speed.
6. Continuing on a route when lost.
7. Not turning on time if turnpoint is not found.
8. Misreading the time and losing positional awareness.
9. Not considering all factors to allow best observation of ground features.
10. Not properly backing up the pilot on aircraft control (e.g., altitude, airspeed, and heading).

## **CHAPTER TWO**

### **TACTICAL FORMATION**

#### **200. INTRODUCTION**

Tactical Formation (TF) is designed to teach basic pilot/copilot skills required for Tactical Low-Level Formation Missions. TF will consist of either a two- or three-ship formation (“LEAD”, “TWO”, and/or “THREE”) with the two ship formation the standard. If a third aircraft is employed, it will fly in the “traditional” C-130 formation as part of the element. Tactics employed here are based on C-130 tactics taught at Little Rock and used operationally worldwide.

#### **201. PROHIBITED MANEUVERS**

1. **Night Formation Flight is prohibited.**
2. **Fan Breaks** (all aircraft execute break at the same time).
3. **Intentional Formation Flight in IMC.** This does not prevent a flight, if adequately briefed, from flying an IFR clearance in VMC. The only situation that would warrant IMC formation flight is a recovery with a wing who has lost communications and/or the radio instruments necessary to execute an instrument approach, and is unable to continue in VMC. If formation IMC flight is required, both IPs shall be at the controls.

#### **202. FORMATION BRIEF**

The formation brief will be attended by all formation members and shall be given by students designated by the mission commander. Briefers will show a minimum of one hour prior to formal brief time to prepare the briefing slides or the briefing book. The brief shall include, but is not limited to the following:

1. Aircraft BUNO/side-numbers/call signs/parking positions/initial position assignments.
2. Communication:
  - a. Callsigns
  - b. Internal (interplane) frequency
  - c. External frequencies
  - d. Maneuver commands/terminology
  - e. Chattermark

3. Forecasted weather.
4. Sequence of events.
5. Departure procedures.
6. Airspeeds, climb/descent rates.
7. Route, min/max altitudes, obstacles, threats.
8. “ON-TOP” rendezvous points/Orbiting rendezvous altitudes.
9. Recovery: Brief the type of recovery, when to use ground idle, when to use brakes and reverse, and when to clear the active runway.
10. Formation holding procedures.
11. Abnormal procedures:
  - a. Aborted Takeoff
  - b. Midair Collision
  - c. Lost COMM
  - d. Systems Failure
  - e. Engine failure
  - f. Inadvertent IMC
  - g. IMC Breakup
  - h. “KNOCK IT OFF”
12. Remarks and modifications.

Following the formation brief, each aircrew will individually discuss crew coordination/responsibilities and complete a thorough route study and NATOPS brief.

### **203. CREW COORDINATION/RESPONSIBILITIES**

Flightcrews need to exercise extreme vigilance throughout all phases of flight. Safe formation flight requires exact crew coordination not only between the lead aircraft and wingmen, but also within each cockpit. A thorough brief is the basis for good crew coordination. Crewmembers

## **2-2 TACTICAL FORMATION**

should not hesitate to communicate any unsafe condition and take the appropriate action required to prevent a mishap from occurring. Flight crew responsibilities are:

**Mission Commander.** A Mission Commander will be assigned (via annotation on the flight schedule) for each formation flight. The mission commander is responsible for the safe and orderly conduct of the flight, and makes decisions for the flight regarding weather, departure/recovery, fuel requirements, operating areas, etc. This responsibility is held by the same pilot for the duration of the event and does not change with in-flight lead transfer (i.e., the mission commander may fly either LEAD or WING positions).

**Formation Leader (LEAD).** The formation leader is the PIC of the lead aircraft. The formation leader changes with every lead change. Responsibilities include:

1. Conduct the flight in the briefed sequence.
2. Keep the flight clear of other aircraft (clearing), including any other low level traffic (local or MTR) as well as identifying and avoiding terrain, birds, and manmade obstacles.
3. Maintain flight in VMC.
4. Ensure the flight remains on the assigned route (in compliance with course rules and ATC clearances).
5. Initiate climbs, descents, turns, slowdowns and recoveries.
6. Ensure aircraft is flown precisely, giving wingman a stable platform to follow using the following guidelines:
  - a. Climb and descend at 1000 fpm.
  - b. Lead will use a maximum of 1200 ft-lb (T-44)/2000 ft-lb (TC-12) and a minimum of 400 ft-lb.
  - c. Lead will plan to make all turns using 30° of bank. This does not prevent lead from using 45° of bank if needed.
7. Ensure all necessary communications are accomplished.

**Wingmen (WING).** The primary duty is to maintain formation position relative to LEAD. Additional responsibilities include:

1. Inform LEAD of any deviations from brief.
2. Acknowledge all interplane frequency changes and all required interplane radio calls.
3. Execute frequency changes.

4. Functions as the weather ship during the flight (i.e., radar and radio calls to METRO/FSS) and makes UNICOM voice reports.
5. Maintains overall SA and is prepared to assume the lead if needed.

**Copilot (LEAD and WING).** Primary duty is to back up the pilot during all phases of flight. Additional responsibilities include:

1. Read and perform checklists when called for by the Pilot.
2. Monitor flight and engine instruments.
3. Enroute navigation (map reading, terrain avoidance and time control).

#### **NOTE**

During low-level operations, attention should be focused outside the aircraft, emphasizing threat detection and situational awareness.

### **204. COMMUNICATIONS (COMM)**

COMM procedures shall be briefed and may be modified as required. Good COMM procedures are essential for maintaining formation integrity. Aircrews shall minimize radio calls to reduce frequency congestion. The two types of COMM are:

1. **Internal COMM (Interplane).** Internal COMM is communication between LEAD and WING aircraft and is referred to as interplane. It is normally accomplished on a prebriefed discreet VHF frequency. In the event that VHF is unavailable, UHF may be utilized; however, UHF is normally used for External COMM (ATC communications). If acknowledgment of a radio call is required from WING aircraft, use “2” or “3” vice the term “Roger”. Attempt to maintain radio discipline as much as possible on interplane but do not hesitate to talk if necessary for safety or continuation of the mission.
2. **External COMM.** External COMM is communication between formation aircraft and ATC. It is normally accomplished on UHF with LEAD communicating for the formation. If acknowledgment of a radio call is required from WING aircraft, use “2” or “3” vice the term “Roger”. When directed to change to another frequency, LEAD replies “Roger, Montana/Stingray xxx flight, push button XX (e.g., four).” WING will change to the appropriate frequency; NO verbal response is required from WING.

In the event of an apparent breakdown in external COMM or a missed frequency change, resolve confusion on interplane if possible. If unable, the flight should return to the last good frequency to regain COMM. Appendix B has examples of the TACFORM COMMS.

**205. FORMATION EMERGENCY PROCEDURES**

Aircraft emergencies or any situation that could result in a midair collision must be handled quickly and safely. An aircraft with an emergency requiring immediate action will transmit “KNOCK IT OFF”. Any time “KNOCK IT OFF” is called, training is finished and the formation will return home, as this phrase is used to discontinue the training evolution. Upon hearing this call, all aircraft shall break off any aggressive maneuvering and return to the enroute position. Discuss the situation on interplane and stand by for lead’s direction. If necessary, emergency aircraft will then obtain a separate ATC clearance and depart the formation. To discontinue any type of maneuvering but continue on with the mission, the word “TERMINATE” will be used.

Following is a list of unsafe situations/emergencies and appropriate procedures that shall be briefed prior to each flight:

**Inadvertent Weather Penetration Procedures (If IMC is unavoidable):**

**Note:** The following procedure assumes in-trail position. If weather is entered while in fluid trail, **LEAD WILL BE DIRECTIVE**. It is incumbent upon wingmen to inform lead of their last position.

1. WING will advise LEAD if visual contact is deteriorating or is lost due to weather conditions. WING will do this by transmitting that he has lost sight and give his last position in relation to lead.
2. LEAD will transmit “Execute Inadvertent Weather Penetration” on interplane. LEAD will include base heading and a base altitude (normally ESA) with his radio call. LEAD will climb at enroute airspeed 1000 feet above base altitude. (Refer to Figure 2-1.)
3. TWO turns 45° away (normally right) from LEAD for 2 minutes while simultaneously climbing at enroute airspeed 500 above base altitude.
4. THREE turns 45° away (normally left) from LEAD for 2 minutes while climbing at enroute airspeed to base altitude.
5. If VMC is regained, LEAD will coordinate a rendezvous. If VMC is not regained, LEAD will coordinate with ATC for separate IFR clearances to a recovery base.

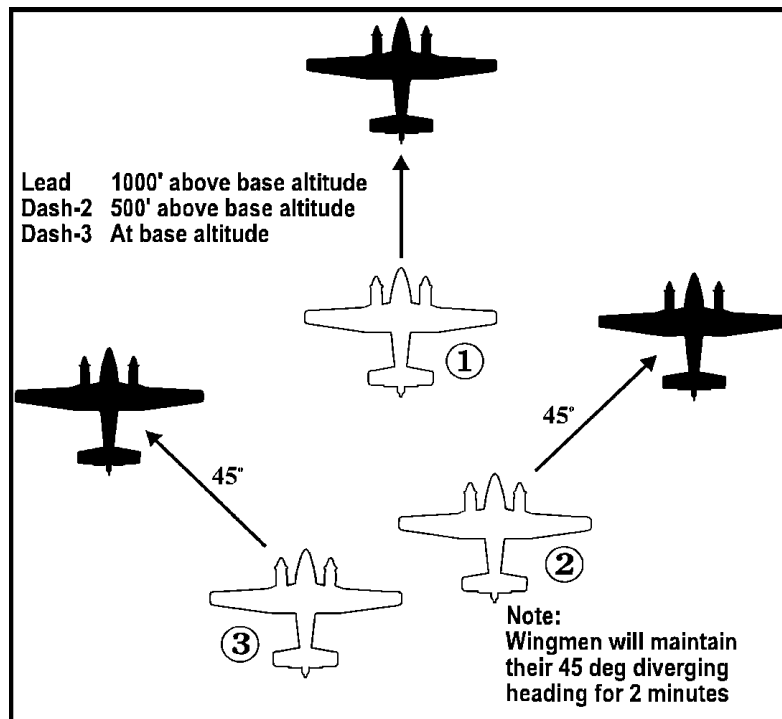


Figure 2-1 Inadvertent Weather Penetration Procedures

### WARNING

Inadvertent IMC procedure may not guarantee obstacle clearance. It is the responsibility of all pilots in the formation to be aware of terrain and obstacles along their flight path.

### NOTES

1. If the formation is flown with only two aircraft, in the event of inadvertent weather penetration, LEAD will still climb to 1000' above the base altitude and TWO will climb to 500' above base altitude, and the phantom THREE will be at base altitude.
2. This procedure will be modified for alternate formation geometries.

**IMC Breakup.** This procedure is used to transition from VMC formation flight to IMC single-ship flight for recovery in less than VMC. LEAD will coordinate with ATC for individual IFR clearances starting with the last plane in the formation. All aircraft will recover independently.

**Radio and equipment failures.** Any loss of internal or external communication ability, or the loss of any equipment necessary to continue the mission shall be reported to LEAD as soon as



practicable. The following procedures will be followed if any aircraft in a formation loses total COMM.

1. WING lost communications. WING will turn their rotating beacon and strobe lights off and cautiously assume a loose line abreast position. LEAD (or other WING if a 3-ship) should note WING's beacon/strobes off and "tail wag" to tell WING that LEAD knows he's NORDDO and to rejoin. After receiving no response from WING on interplane, inform ATC of NORDDO wingman, and lead the formation home. Normally, the affected aircraft will full stop while all others wave off (this will preclude having any other aircraft on rollout with the NORDDO aircraft).
2. LEAD lost communications. LEAD will turn his beacon and strobe lights off and "tail wag" by stepping lightly on the rudders. This should catch TWO's attention. TWO should assume a line abreast position. LEAD will signal that he has lost communications and clear TWO to take the lead. The former LEAD then turns his beacon/strobes back on to signal the completion of the lead change, exits the formation in the safest direction and rejoins at the end of the formation.

#### NOTE

TWO will always assume LEAD regardless of formation size.

If necessary, use hand or other signals as briefed or contained in Section A of the Flight Information Handbook.

**Engine failure.** The primary hazard during engine failure is a rapid loss of airspeed with accompanying yaw into the dead engine. WING must be prepared for emergency evasive maneuvering if LEAD loses an engine. Any aircraft with any sign of impending engine failure shall call "KNOCK IT OFF".

**Mid-air collision.** In the event of a mid-air collision, regain control and make a "KNOCK IT OFF" call. Follow NATOPS procedures to determine aircraft controllability. Lead will coordinate altitude assignments as necessary. If feasible, attempt to visually assess the other aircraft's damage as you regain separation. Do not reform, maintain well clear and recover as the situation dictates.

#### 206. PERTINENT CHARACTERISTICS OF THE T-44A/TC-12B

The T-44A/TC-12B does not have a speed brake or any other device designed to slow the airplane rapidly. The following is a brief discussion of various techniques to slow the T-44/TC-12, and their applicability to formation training:

1. Pulling the power levers to flight idle will not immediately slow the airplane. Anticipation (recognizing a closure rate on LEAD) and proper power reduction will decrease the probability of an overrun. This is the best technique to control airspeed and relative motion.

2. Although lowering the landing gear, extending the flaps, or placing the props full forward will increase drag and decelerate the aircraft, these methods are impractical and should not normally be used. If an overrun occurs, WING will notify LEAD (e.g., “TWO/THREE’s overrunning on the left/right”) and turn away from the formation. Once proper spacing is obtained, move back into the enroute position.

Visibility forward from and across the cockpit is limited due to the high glare-shield, windshield supports, small side windows and the windshield wipers. Compensate for this by moving your head to maintain visual contact with the other aircraft.

The side-by-side seating arrangement results in a slight difference (parallax) between the copilot’s and pilot’s sight picture. For standardization, fly the checkpoints as seen from the PAC seat.

Wingtip vortices may induce a strong rolling or pitching tendency. If encountering wake turbulence, add power and attempt to climb up and away from the preceding aircraft’s turbulence. You must exit the turbulence before you can fully regain control of your aircraft.

## **207. GROUND PROCEDURES**

1. Prior to the brief, students shall obtain aircraft assignments and parking location from Aircraft Issue.
2. During the “Before Start Checklist,” navigation lights should be turned ON to identify the aircraft as part of a formation flight.
3. Upon reaching “Avionics Master” on the “After Start Checklist,” check-in as briefed per your squadron’s standard. LEAD will initiate flight check-in and then change the flight to “Formation Common” frequency. When checking in, if wingmen need more time to troubleshoot a problem or complete the checklist, say “TWO/THREE needs a minute.” When ready, WING says “TWO/THREE’s ready.” LEAD will call for taxi: “Montana/Stingray XXX, flight of two/three, taxi with information Charlie, wingman’s side numbers are XXX, XXX.”

### **NOTE**

Minimum taxi interval is two aircraft lengths. It is WING’s responsibility to maintain proper taxi spacing.

4. In the run-up area, LEAD ensures sufficient room is available for WING to position their aircraft.
5. LEAD will obtain a clearance and squawk and pass to WING. LEAD will squawk the appropriate code for the entire flight. WING aircraft transponders shall be set to “standby”.
6. WING will check in when the “Takeoff Checklist” has been completed for C-12 or down to the last five items for T-44.

## **2-8 TACTICAL FORMATION**

7. When the flight is ready, LEAD will call for further taxi.
8. Secure navigation lights and switch to tower frequency when approaching the hold short line.
9. Ground Abort. If problems are encountered with your aircraft, inform the other aircraft of your problem(s) and intentions. The other aircraft may elect to abort or continue with an alternate mission. (If originally a 3-ship, the mission commander will determine if the formation may continue as a 2-ship.)

### **208. RUNWAY LINEUP/TAKEOFF**

1. LEAD positions on the left side of the runway. TWO positions on the right side of the runway allowing tail-to-nose clearance. THREE positions directly behind LEAD with tail-to-nose clearance from TWO.
2. After the formation receives takeoff clearance and all aircraft are in position, all aircraft will set power IAW appropriate NATOPS, scan engine instruments and other formation aircraft for loose panels and leaks. WING reports ready (i.e., “TWO’s in”, “THREE’s in”). LEAD releases brakes, advances power slowly and smoothly to takeoff power, and begins the takeoff roll.
3. Five seconds after LEAD commences takeoff roll, TWO releases the brakes and begins his takeoff roll. THREE will delay five seconds after TWO.
4. During the takeoff roll, all aircraft shall remain on their respective side of the runway.

### **209. ABORTS**

#### **Aborts During Takeoff**

1. The copilot immediately transmits an “abort” call on tower frequency using formation position number (e.g., “Montana/Stingray XXX, TWO’s aborting, TWO’s aborting, TWO’s aborting”).
2. Clear the runway as quickly as safety allows (i.e., taxi to the end of the runway).
3. WING aircraft not on takeoff roll will hold until the runway is clear.
4. If succeeding aircraft have already started takeoff roll, they shall also abort.

#### **Airborne Aborts**

1. Aircraft aborting during assembly will remain clear of departing traffic.

2. Maintain VMC if possible and notify LEAD of intentions.
3. Contact the appropriate controlling agency and RTB via course rules.

### **210. DEPARTURE/ASSEMBLY**

**VMC.** Assembly should occur as soon as practical after takeoff. On departure, LEAD maintains a stable platform at 150 KIAS. After positive identification of all preceding aircraft, WING climbs at speeds up to 180 KIAS to reach the in-trail position. TWO will remain below and slightly to the right of LEAD until in position. THREE will remain below and to the left of both LEAD and TWO. Once level at assembly altitude, WING may accelerate to 200 KIAS max to complete the rejoin. Each aircraft should complete the climb checklist prior to assembly.

**IMC.** LEAD and WING fly separate instrument departures. The departure is flown at the prebriefed airspeed and power setting. LEAD directs a rejoin once all aircraft are VMC and WING aircraft have reported visual contact with LEAD. LEAD will terminate with ATC prior to the rejoin.

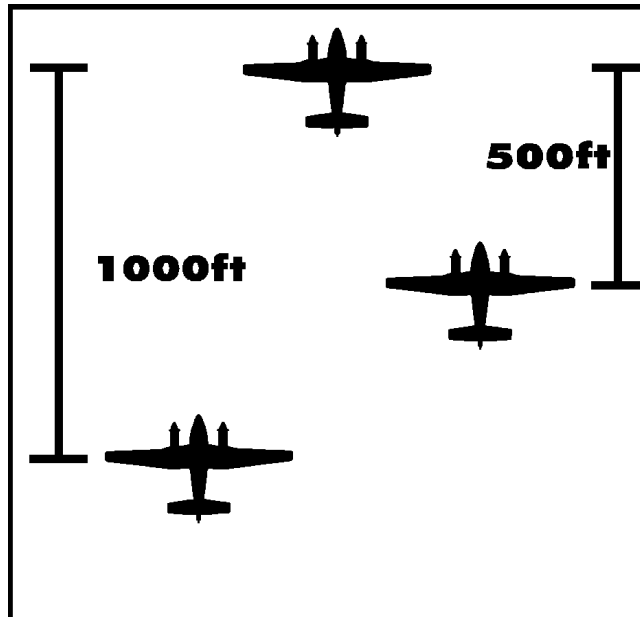
TWO should remain at least 1000 feet below LEAD's altitude until positive visual contact has been established. THREE will maintain 1000 feet below TWO (i.e., 2000 feet below lead until visual established with both preceding aircraft and cleared to rejoin).

**Rejoin.** Aircraft joining a formation enroute will contact LEAD and rejoin as briefed, or proceed single ship. Remain at least 500 feet above or below the formation until the formation is in sight and clearance to rejoin is granted.

### **211. VISUAL FORMATION GEOMETRIES**

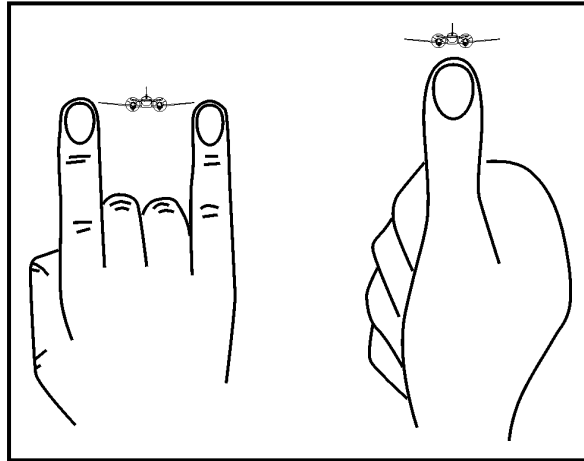
The purpose of formation flight is to permit the largest number of aircraft to drop supplies, equipment, or personnel, in the minimum amount of time, thus minimizing risk to aircraft and aircrews. Several types of formation geometries have been developed to enable large formations of aircraft to safely and effectively operate in a tactical environment. We will use some of these to familiarize you with the basics of formation flight.

**In-Trail Position.** The basic position is a rigid in-trail formation used primarily for formation departures, drops, and recoveries. It allows large formations to cross the drop zone in a minimal amount of time. Its disadvantages are that wingmen have to work harder to stay in the correct position and it makes maneuvering to avoid threats or detection more difficult and dangerous. It also allows enemy gunners to target each aircraft as they cross over.



**Figure 2-2 Visual In-Trail**

1. The in-trail formation position for TWO is right of LEAD, 500 feet behind, out of prop-wash, with wingtip overlap (see Figure 2-2). The in-trail formation position for THREE is left of LEAD, 1000 feet behind, out of prop-wash with wingtip overlap. In the in-trail position, each WING must stay on their appropriate side. Some good references for “in position” are LEAD’s right stab tip over his right nacelle for TWO, and left stab tip over his left nacelle for THREE (see TF picture book). When in position, LEAD should look approximately three inches wide from wingtip to wingtip (about the distance between an extended index finger and little finger) for TWO, and one inch (about the width of a thumb) for THREE (see Figure 2-3).
2. While in the in-trail position, LEAD should use a smooth, steady roll rate in and out of turns. Attempt to limit bank angle to 30° but do not exceed 45°.
3. WING will follow LEAD’s turn using visual references. All aircraft execute their turns over the same geographical point with WING maintaining LEAD’s general flight path.

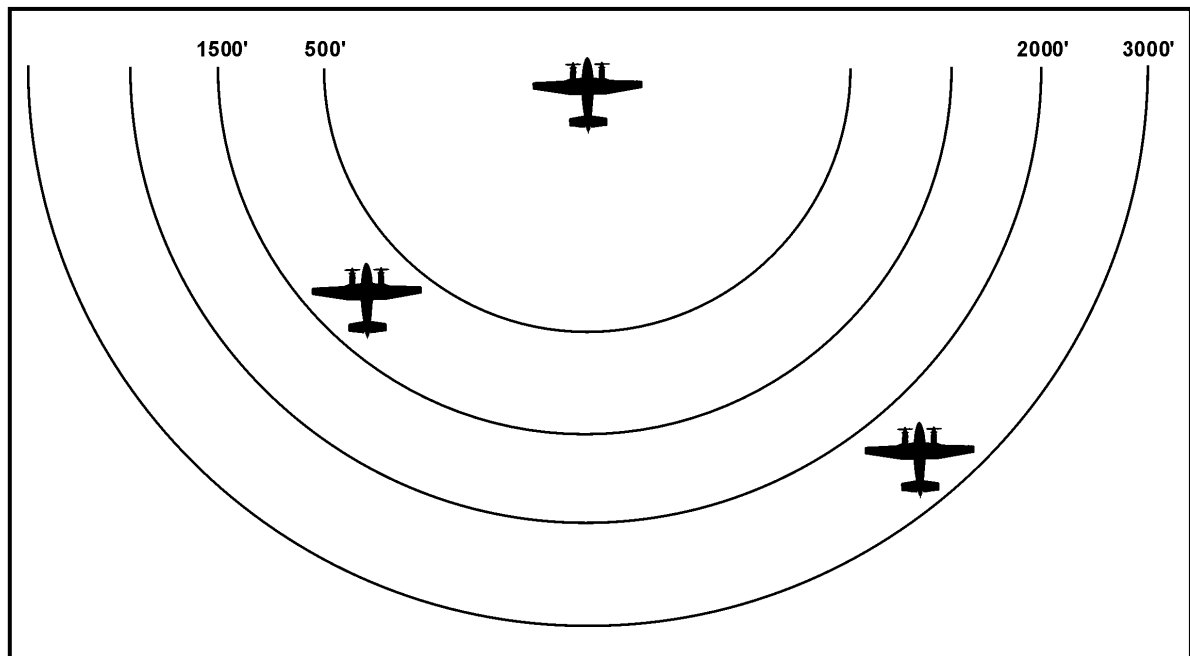


**Figure 2-3 Visual References for In-Trail Position**

**Fluid Trail.** Fluid Trail is a tactical formation and is the most flexible of the geometries we will fly. It allows wingmen to position themselves as needed to minimize threat exposure by using terrain masking or hard maneuvering. It also lowers LEAD's workload by allowing him to maneuver the formation as required with minimal regard to WING's position. In Fluid Trail, it is WING's responsibility to position themselves in the best tactical position.

Fluid trail for TWO is defined as a cone 500-1500 feet and from left abeam or right abeam of lead. THREE maintains the cone 2000-3000 feet and left abeam to right abeam of LEAD. This ensures a 500-foot minimum separation from all aircraft. Wingmen can position themselves anywhere in their respective cones to maximize threat avoidance and minimize detection (see Figure 2-4).

While extremely flexible, fluid trail demands WING's constant attention and understanding of how LEAD's maneuvering could affect them. This requires WING to constantly anticipate and adjust for LEAD's position. While aggressive maneuvering is fun, in a threat environment the wing flash that results will allow other aircraft or gunners to see and target the formation. WING must anticipate what LEAD will do to avoid threats, adjust timing, or maintain the route so they do not find themselves in an unsafe position.



**Figure 2-4 Fluid Trail Formation Position**

Several potentially hazardous positions exist in which WING could position themselves. Two of these will be discussed to illustrate how WING must anticipate LEAD's actions.

1. One position is directly abeam LEAD (similar to Line Abreast, which is discussed below). If LEAD begins a turn towards WING, a conflict exists. There are several things WING could do. The first is to simply turn away from LEAD; however, WING would first lose sight of LEAD and then actually pass LEAD. This is not a good option. The second is for WING to turn towards LEAD aiming to pass behind LEAD. This works as long as WING is not directly abeam. The third is for WING to initiate a turn towards LEAD while climbing to pass above LEAD. Once LEAD safely passes, quickly reverse the turn and descend to avoid being thrown out of the cone.

2. Inadvertent IMC presents another hazard since wingmen are not in a set position and therefore no set procedures can be established. If IMC is encountered, LEAD and WING must quickly communicate and decide the safest method to separate the flight. LEAD must be directive to prevent a serious situation from developing. For example, if both WING aircraft have maneuvered to the same side as LEAD, it would be appropriate for LEAD to direct TWO to fly straight, while LEAD and THREE fly 45° away from TWO for 2 minutes. It is imperative that all aircraft quickly communicate to ensure separation.

Fluid trail is usually briefed to begin at a point prior to entering a threat environment. It ends at the IP since WING must be back in the in-trail position for the run-in and drop.

**Line Abreast.** Line abreast is used to cross lines of communications or for coastal penetrations. It minimizes the amount of time a formation is exposed to sight since all three aircraft cross a

point at the same time. It also prevents ground threats from targeting each aircraft as they pass overhead.

Line abreast is defined for TWO as 500 feet right abeam, and for THREE as 500 feet left abeam (Figure 2-5). It is a rigid formation that does not allow LEAD to maneuver and is usually prebriefed for specific segments of the route. When executed, WING will move into position until safely past the threat, then move back to the previous formation position (in-trail or fluid trail).

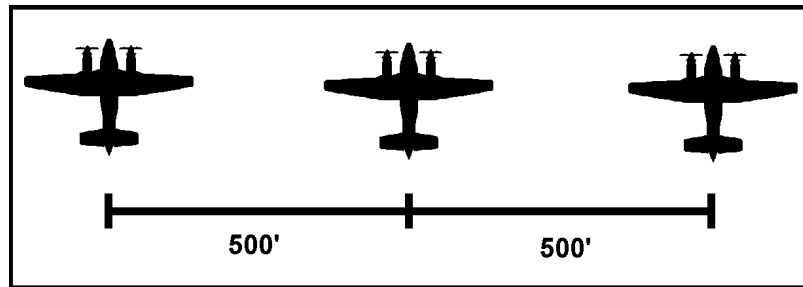


Figure 2-5 Line Abreast

## 212. LEAD CHANGE

During a training flight, lead changes will be made to allow formation members to fly several different positions within the formation. Where lead changes occur is left to the discretion of the mission commander and shall be thoroughly prebriefed.

1. If a lead change is briefed to occur at a turnpoint, lead may either continue straight ahead allowing the formation to turn at the point and then turn to rejoin at the end, or LEAD may initiate a turn to the next course and continue the turn until approximately 45° beyond course and allow the formation to pass. When TWO sees LEAD turn at the prebriefed point, he will turn to the new course and when abeam LEAD, transmit “two has the lead.” Once the formation has passed, old LEAD can rejoin the formation as TWO in a 2-ship or THREE in a 3-ship and the new LEAD takes the squawk (Figure 2-6).
2. If the lead change is briefed at the midpoint of a leg, LEAD transmits “stand by for lead change.” LEAD then turns left 45° and allows for formation to pass. When abeam LEAD, TWO transmits “two has the lead”. Once the formation has passed, old LEAD rejoins as TWO in a 2-ship, or THREE in a 3-ship and the new LEAD takes the squawk. The method selected depends upon the situation and is normally based on ensuring that visual contact is kept between formation members.



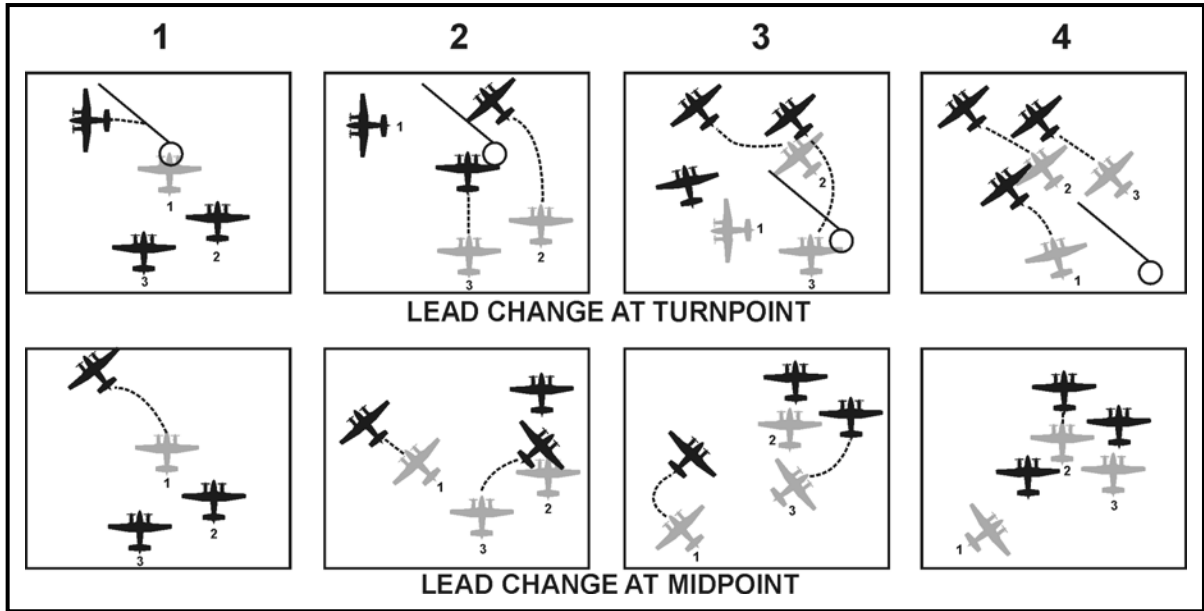


Figure 2-6 Formation Lead Changes

**213. ENROUTE**

LEAD is primarily responsible for navigation and terrain avoidance. LEAD maintains altitude by reference to the radar altimeter and terrain. WING uses a combination of the above and reference to LEAD. Five miles prior to each turnpoint, the copilot will brief the course and airspeed (and altitude if different than 500 AGL) for the following leg. Also include any additional information concerning the formation (i.e., upcoming lead change or transition to fluid trail).

**NOTE**

For wingman considerations, LEAD should use no more than 1200 ft-lbs (T-44)/2000 ft-lbs (TC-12) for accelerations and climbs. LEAD should use no less than 400 ft-lbs for decelerations and descents.

**214. SLOWDOWN**

Slowdown occurs at a prebriefed, identifiable, geographic point. Slowdown should be accomplished early enough to allow all aircraft to be stabilized at drop altitude and airspeed 1 minute prior to green light.

1. At the slowdown point, LEAD transmits “Stingray/ Montana xxx flight slowdown, now” over formation interplane.

2. The formation then executes the appropriate slowdown maneuver as described in Chapter One, page 1-28, Slowdown paragraph. LEAD should use wingman consideration techniques during the slowdown.

#### NOTE

No timing corrections will be made after slowdown.

### 215. AIRDROP

LEAD is responsible for guiding the formation to the drop zone. WING maintains the basic in-trail position but calls their own green light based on when they are over the drop zone. If encountering a strong crosswind (3° of drift or more), WING should adjust their position so as to maintain the same relative ground track as LEAD across the drop zone. This means that WING will literally follow LEAD across the drop zone as depicted in Figure 2-7.

1. The formation will stabilize at 1000 feet above the highest point on the drop zone and 120 KIAS (T-44)/130 KIAS (TC-12).

2. Each aircraft makes its own green light and red light call. (IAW Chapter One, page 1-29, Simulated Airdrop paragraph). The instructor pilot will call “load clear” after the student calls “green light”.

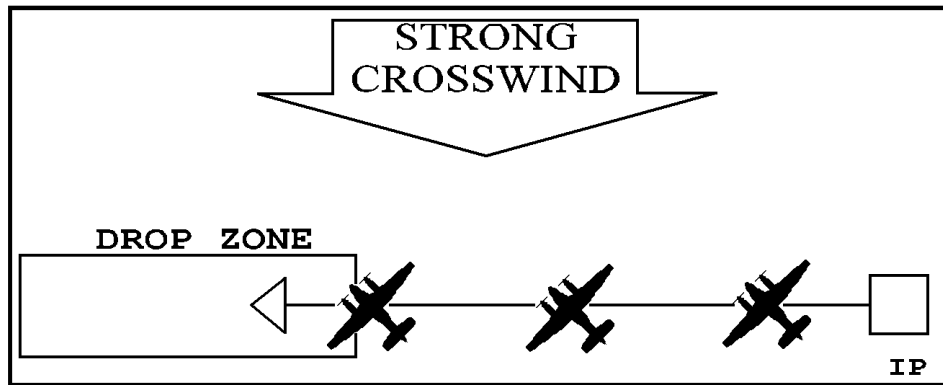


Figure 2-7 Crosswind Procedures for Airdrops

### WARNING

Attempting to regain position by reducing power and/or airspeed will cause a nose-high, low-power situation and may result in a stall.

### 216. DZ ESCAPE

Each aircraft will execute a combat escape. After the IP calls “load clear”, LEAD retracts flaps, turns to escape heading, accelerates to enroute airspeed, and climbs or descends as required. WING watches for LEAD's flaps to retract, waits for the IP to call “load clear”, and initiates escape by retracting flaps and accelerating to maintain/regain position.

### 217. RACETRACKS

A racetrack is a planned pattern to allow a formation to make multiple passes over the same drop zone. This may be desirable for dropping large numbers of jumpers on drop zones too small to accommodate all jumpers at the same time or for other considerations. Racetracks will be used at the discretion of the mission commander and will be briefed prior to flight. Formation racetrack procedures are as follows and as depicted in Figure 2-8.

Following LEAD's red light, LEAD will maintain drop run-in, altitude, and airspeed for one minute to allow WING aircraft to complete their green light time. At the end of one minute, LEAD will retract flaps, accelerate to enroute airspeed, initiate a climb or descent as appropriate and execute a 180° turn to parallel the run-in course to the drop zone. Slowdown, drop, and escape will be flown as previously described.

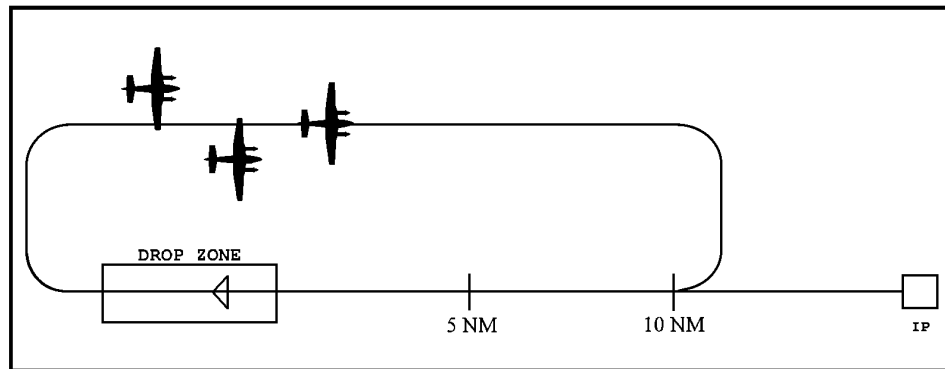


Figure 2-8 Racetrack Procedures

## 218. RECOVERY

**Overhead.** At initial, fly 1000 feet AGL or pattern altitude, whichever is higher, and 200 KIAS.

1. WING will fly the same ground track as LEAD and stack up slightly to avoid wake turbulence. Break using 45° of bank. Retard power to idle as 45° of bank is established. WING delays 5 seconds after previous aircraft before breaking.
2. Make a level turn to the downwind leg. Configure on speed and complete the landing checklist and reapply power as necessary to maintain 120 KIAS (T-44) or 140 KIAS (TC-12).
3. Succeeding aircraft commence final turn with sufficient spacing to provide a 20 second (15 seconds minimum) landing interval to ensure minimum spacing of 1500 ft between aircraft at touchdown. Maintain 120 KIAS (T-44) or 140 KIAS (TC-12) until established on final.

**Downwind Entry.** Enter a downwind leg for the active runway, maintaining 200 KIAS and 800 feet AGL or traffic pattern altitude, whichever is higher. Position the downwind to allow for a continuous turn to final.

1. WING will fly the same ground track as LEAD and stack up slightly to avoid wake turbulence.
2. LEAD will break approximately ½ NM past the approach end of the runway with 45° of bank. Retard power to flight idle after the bank is established.
3. Succeeding aircraft will break with sufficient spacing to provide a 20 second interval (15 seconds minimum). At 200 KIAS entry speed, initiating break approximately 7-9 seconds apart will generally result in 20-second spacing at landing. Complete the landing checklist as airspeed permits. Make a level turn until reaching 120 KIAS (T-44) or 140 KIAS (TC-12), then descend at this airspeed while completing the turn. Slow to 110 KIAS (T-44)/130 KIAS (TC-12) once established on final. Ensure minimum spacing of 1500 feet between aircraft at touchdown. **The downwind recovery will not be flown at NGP to prevent an extended pattern.**

**219. LANDINGS**

1. Land on runway centerline using approach flaps. Place power levers to idle and use beta and reverse as briefed (normally delayed until 1000 feet remaining).
2. Clear the runway without slowing or stopping in any position that would prevent succeeding aircraft from clearing the runway.
3. Landing Procedures. If a proper interval (minimum of 1500 feet or 15 seconds) has not been maintained, WING shall execute a go-around on final. The landing interval may be extended due to a strong crosswind, narrow runways, or other adverse conditions.

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## CHAPTER THREE

### TACTICAL/AERIAL REFUELING PROCEDURES

#### 300. INTRODUCTION

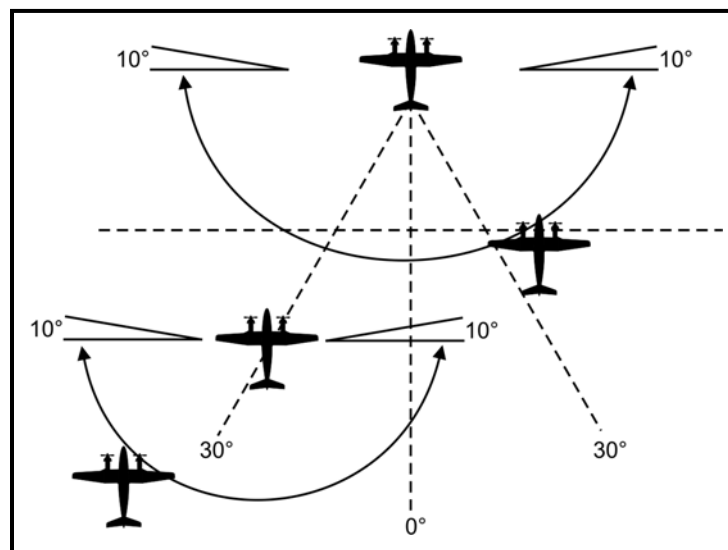
The objective of this Chapter is to introduce you to Tiltrotor MPTS Tactical/Aerial Refueling Procedures. These objectives are strictly for Marine Corps Intermediate Tiltrotor MPTS use only.

#### 301. TACTICAL FORMATIONS

These formations are designed to increase the flight leader's flexibility and should be utilized when there is a requirement for maximum maneuverability and aircraft separation. They also promote security by providing overlapping fields of view. From either tactical formation, nine basic tactical flight formation maneuvers can be used to control the flight. These maneuvers include tactical (TAC) turns, center turns, in-place turns, split turns, cross turns, break turns, the dig, the pinch, and cover. They give the flight leader maximum command and control of the flight while increasing flexibility and space for individual aircraft to maneuver. During tactical maneuvering, the wingman always has the ultimate responsibility for maintaining adequate clearance from lead.

##### Combat Cruise

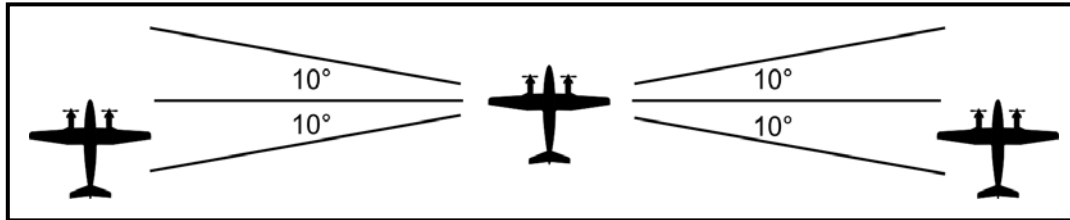
Combat cruise is a tactical formation designed to provide maximum flexibility to increase the capability to maneuver and to apply lookout doctrine and terrain masking. Wingmen can fly on a rearward arc with 500 - 1000 feet displacement from 10° forward of the abeam position on either side of lead. The optimum position for wingmen is on the 30° bearing in reference to lead.



**Figure 3-1 Combat Cruise**

### Combat Spread

Combat spread is not as flexible as combat cruise, but is a good technique to employ when crossing wide-open terrain and affords good defensive lookout ahead of the flight. It also maximizes the ability to employ forward weapons. Wingmen are to be  $\pm 10^\circ$  of lead's abeam.



**Figure 3-2 Combat Spread**

### TAC Turn

There are two types of TAC turns:

1. The TAC turn away from the wingman.
2. The TAC turn into the wingman.

These turns can be accomplished easily from the combat cruise or combat spread formation. They are used to change the direction of a formation from 60 – 120 degrees. With the command, Call sign, TAC left (right), a turn of  $90^\circ$  at  $30^\circ$  AOB is understood. If a smaller or larger change is desired, the tactical leader may elect to specify the new heading in the command. TAC turns enable aircrews to turn into an approaching enemy while maintaining formation integrity to facilitate mutual support and avoid presenting a linear target to an approaching enemy aircraft. The following should be understood:

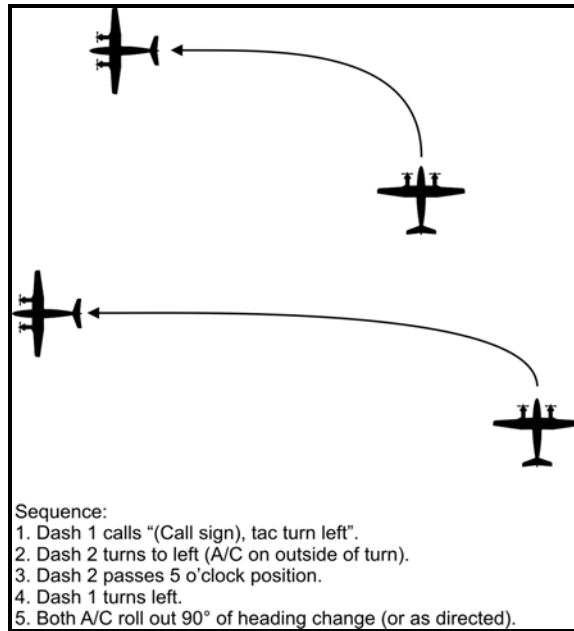
1. The wingman will always change sides in the formation.
2. The aircraft on the outside of the turn will always turn first.
3. The wingman is always responsible for clearance regardless of who initiated the turn.
4. When the aircraft turning first crosses the 5 or 7 o'clock position (of the other aircraft), the other aircraft should commence the turn.

### NOTE

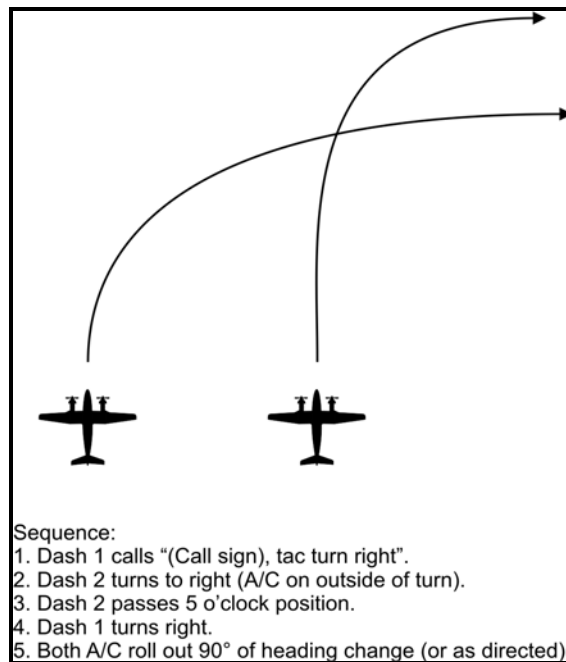
During TAC Turns into the wingman from a combat cruise position, the tactical leader immediately turns to the new direction and depending on the wingman position, either passes behind or in front of the wingman. This shall be communicated over the radio:



(Callsign), TAC turn right, crossing front. Otherwise, TAC Turns into the wingman (combat cruise or combat spread) will be executed by lead passing behind the wingman and making the call, “passing 5” or “passing 7.” For all TAC turns and subsequent maneuvers, -2 will maintain a covered (step up) position of +200 feet from lead for alt de-confliction.



**Figure 3-3 TAC Turn Away From Wingman (Combat Cruise)**



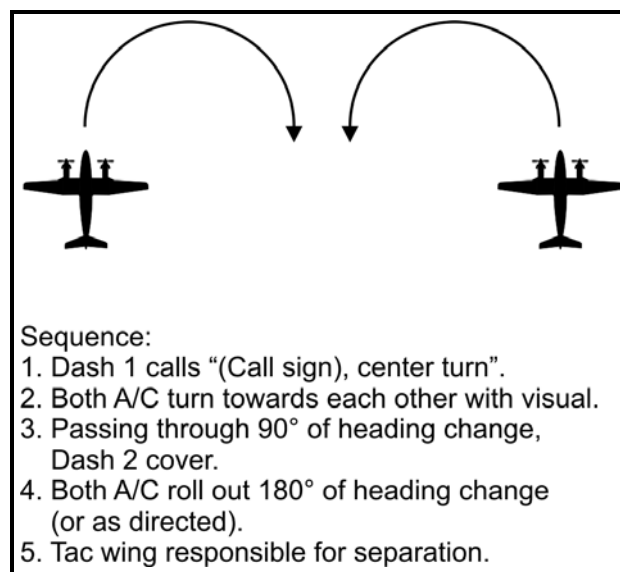
**Figure 3-4 TAC Turn Away From Wingman (Combat Spread)**

### Center Turns

Center turns are turns of 120 – 240 degrees of heading change that can be performed from either the combat cruise or combat spread formation. When aircrews receive the command, Center, both aircraft turn toward each other at 45°AOB while maintaining power. The turn is usually maintained for 180° until the aircraft roll out in the new direction. The center turn is normally executed when excessive separation has developed between a friendly section and a threat approaching from the rear hemisphere that dictates that aircraft separation be decreased in order to provide mutual support.

#### NOTE

Aircrews must take care to ensure that adequate separation exists between aircraft prior to commencing a center turn. In any case, the wingman is always responsible for clearance, and shall maintain a covered position of + 200 feet for altitude de-confliction.

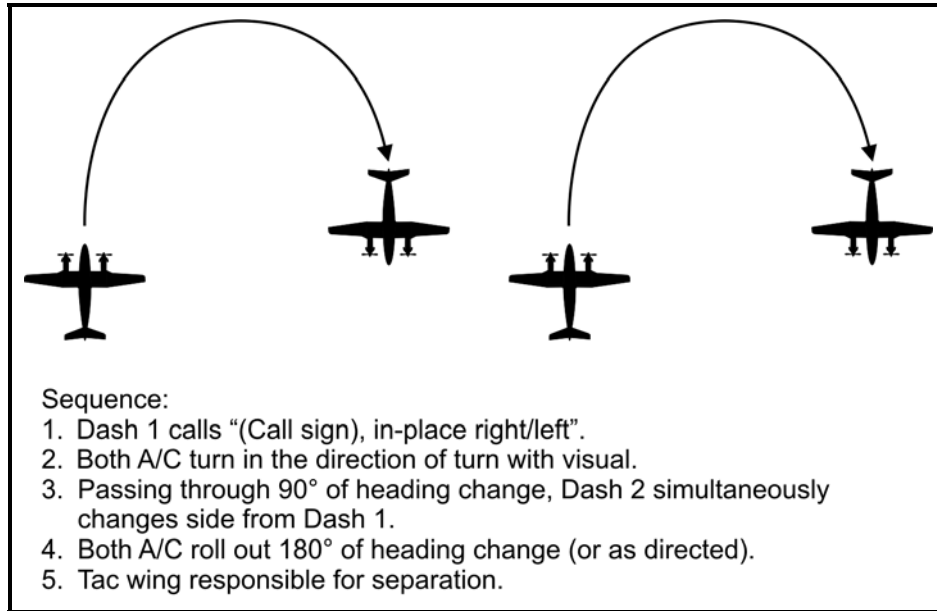


**Figure 3-5 Center Turn**

### In-Place Turns

In-place turns can be accomplished from either the combat spread or combat cruise formation. They can be used for small heading changes of 60° or less or for large course changes of 120 – 240 degrees. For small turns, the command includes the new degree of heading change (for example, (Call sign), In-place left, 030). When used in this way, the in-place turn allows the section to visually clear the rear hemisphere of a flight's axis of advance. For large turns, a change of 180° is understood on the command, (Call sign), In-place left (right). If a smaller or larger change is desired, the leader may elect to specify the new rollout heading (for example, In-place left, roll out 145). To initiate small turns, all aircrew simultaneously turn the appropriate

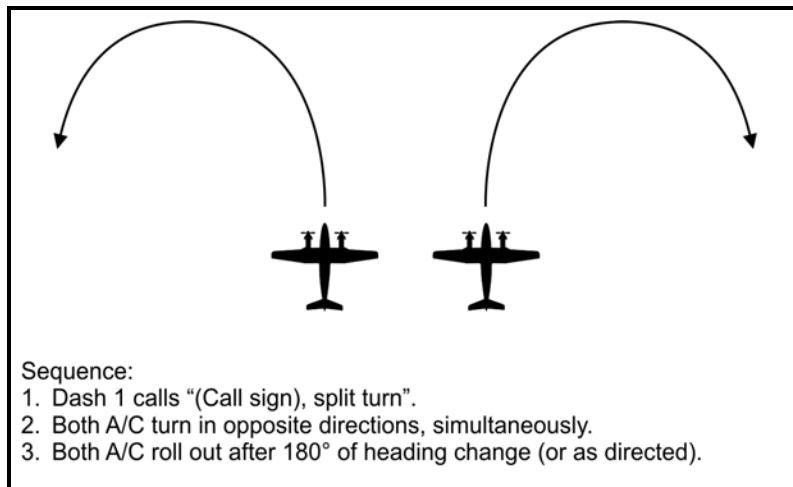
number of degrees in the direction specified in the command at 30° AOB. At the same time, they maintain their position relative to each other. To initiate large turns, aircrews simultaneously turn in the specified direction. As the flight continues its turn through 90° of heading change, the wingman will automatically change sides from the lead aircraft.



**Figure 3-6 In-Place Turn**

**Split Turns**

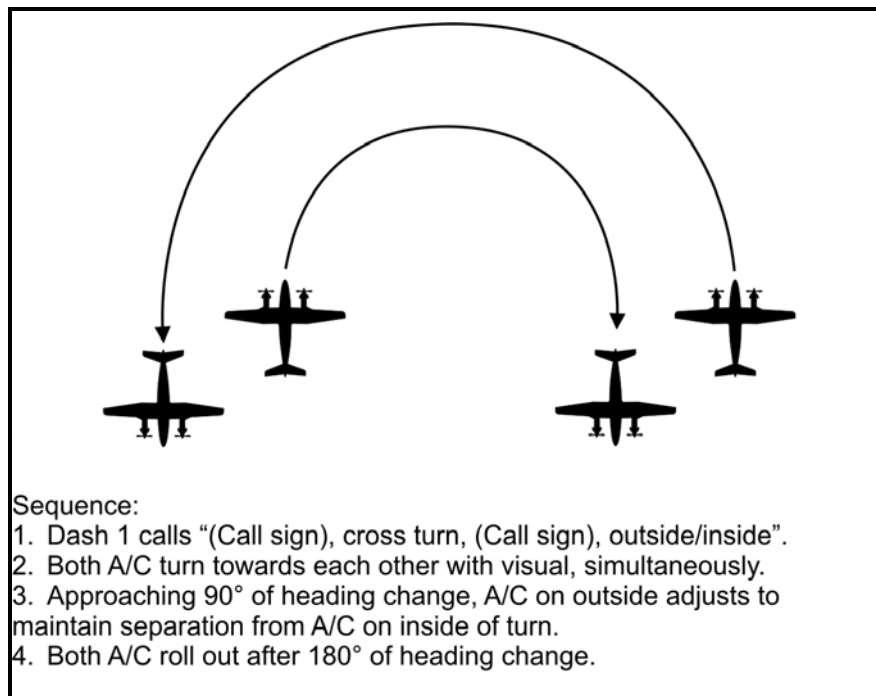
Split turns can be performed from either the combat cruise or combat spread formation. They involve making heading changes of 120 – 240 degrees. With the command, Split turn, 180° of change is understood. If a different heading change is desired, the new heading will be specified in the command (for example, (Call sign), Split turn, roll out 145). When aircrews receive the command, they turn away from each other while maintaining power until rollout in the new direction.



**Figure 3-7 Split Turn**

### Cross Turns

Cross turns can be performed from either the combat cruise or combat spread formation. They involve making heading changes of 120 – 240 degrees. With the command Callsign, Cross turn, 180° of change is understood. If a smaller or larger change is desired, the leader may elect to specify the new heading in the command (for example, Cross turn, roll out 145). It is understood that lead will turn inside on a cross turn, though should still be stated. The cross turn should not be used in situations where an aggressor might deliver ordinance at the apex of the turn since both aircraft are closely aligned at this point. If terrain dictates the use of a cross turn during an engagement, the wingman should climb or descend in order to break the horizontal plane. For training purposes, the wingman shall climb +500ft for alt separation and both a/c will turn at 45° AOB.



**Figure 3-8 Cross Turn**

### Break Turns

Break turns are maximum aircraft performance maneuvers that orient the flight toward an enemy aircraft that has penetrated within weapons engagement parameters or that orient the flight away from hostile ground fire. Against fixed-wing aircraft, break turns are normally used when the attack comes from near the abeam position. The aircrew that initiates the maneuver gives the command, (Call sign), break right, bandit 2 o'clock, level, rolling in. The aircraft on the right side of the formation will make an immediate turn to face the enemy head-on or with a small aspect angle. The aircrew on the far side of the formation will also turn toward the enemy, but will continue to maneuver in order to break plane/phase and provide mutual support. The aircraft with the best tactical situational awareness will assume the role as lead. Additionally, if the section is engaged by a single aggressor, the aircraft engaged assumes the lead.

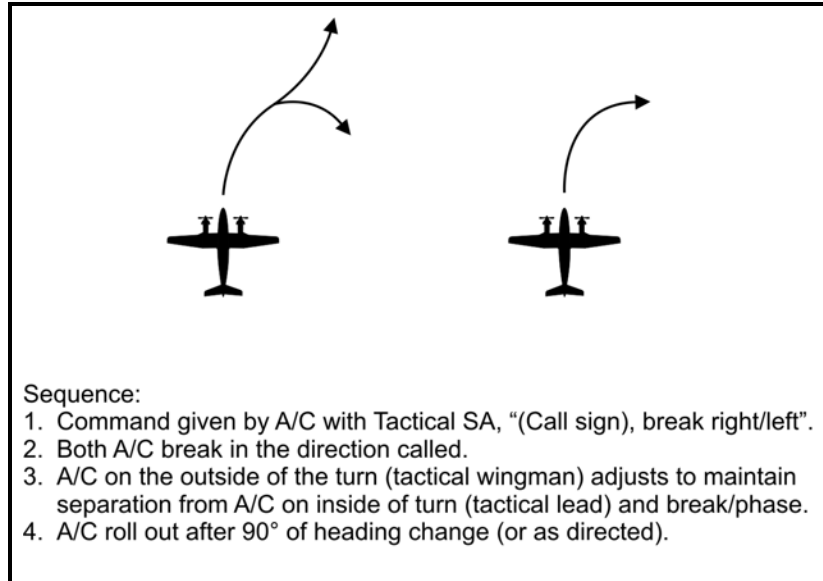


Figure 3-9 Break Turn

**Dig and Pinch**

Lead uses these dig and pinch maneuvers to adjust the separation of the flight while the flight moves in a constant direction. They are separate maneuvers; the dig increases separation of the flight while the pinch decreases it. Aircrews begin the dig or the pinch while flying a constant heading in either the combat cruise or combat spread formation. When lead commands, (Call sign), Dig, aircraft simultaneously turn away from each other for 45° of heading change at 30 degrees AOB. When lead commands, Pinch, the aircraft simultaneously turn toward each other for 45° of heading change. When the aircraft are the desired distance apart, the lead commands, (Call sign), Resume, and both aircraft once again return to the original heading.

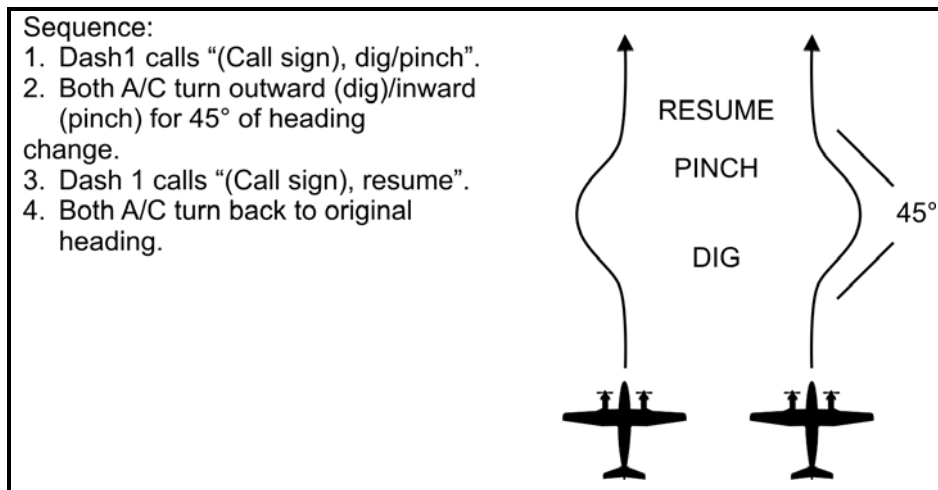


Figure 3-10 Dig and Pinch

## Cover

The command, (Call sign), Cover, can be added to any of the other formation maneuvers to tell the wingman to break the horizontal plane with lead by either increasing or decreasing altitude. For example, the command, (Call sign), Crossturn, Cover, if given in the low-altitude regime, would tell the wingman to increase altitude to break the horizontal plane with lead. This command is particularly useful in crossturns and break turns since it is often difficult to avoid creating a linear target when executing these turns during an engagement. For purposes of training, the wingman shall always maintain 200 feet of step up during tactical maneuvers.

## Scatter Plan

A scatter plan is a planning tool devised for use on a mission if a threat is unable to be suppressed and affects the primary route of flight. It provides an alternate route(s) and appropriate re-join procedures for the formation. The scatter plan must be thorough and extensive and be able to be utilized with minimum confusion. Formations should plan to scatter in sections (2 aircraft). Typically, this involves rejoining the formation at the last known safe checkpoint on ingress to the objective area or at the next checkpoint along the route of flight on egress.

## LZ Transition

When making a transition from the IP (initial point) into a landing zone (LZ), planning is key. In-depth knowledge of the LZ and the objective area is imperative to operate safely. You should know what markings will be present to properly identify the LZ. Also, you should know what approach you will employ upon reaching the zone or airfield and be prepared to fly an alternate approach if needed. Your approach to the LZ should be tactical in nature, limiting your exposure in the area. Emphasis should be placed on being fully briefed on all specific procedures for a particular LZ and arriving at the zone at a pre-planned target time (within +/- 1 minute). Also, it is imperative that ingress and egress are fully discussed in regards to vulnerabilities to the enemy and probable point of first enemy contact.

## 302. AERIAL REFUELING

In this syllabus, aerial refueling procedures will be simulated. However, the training accomplished will lay a foundation that will assist in your training in the MV-22.

Aerial refueling may be divided into four stages of operation: rendezvous, join-up, contact/fuel transfer, and post air refueling. All refueling operations require thorough planning and coordination to address communications, lighting, navigation, position reporting and airspace. Here at Navy Corpus, communication between the simulated tanker and receiver must be maintained on the interplane frequency at all times and proper coordination must be made with ATC. Typically, refueling procedures will be simulated in the Seagull or Delta Working Areas. Try and be established in a working altitude block that provides 2000 feet of vertical maneuvering space. With the refueling altitude in the middle of the block, this will allow plenty of altitude to appropriately accomplish a safe breakaway if necessary. As the student, you will

## 3-8 TACTICAL/AERIAL REFUELING PROCEDURES

be playing the role of the receiver. All aerial refueling simulation training shall be conducted in VMC and aircraft shall remain well clear of clouds. VMC rendezvous require 5 NM visibility.

### **Definitions**

**Air Refueling Initial Point (ARIP)**-A point established prior to the ARCP. This point is part of the Air Refueling (AR) track and aids in identifying the receiver and determining their heading. Receivers should be at the ARIP prior to ARCT and inbound to the ARCP. This will assist in placing both aircraft in a position for rendezvous at the ARCP. Receiver aircraft shall be established at the joinup altitude at the ARIP.

**Air Refueling Control Point (ARCP)**-The planned point where the tanker arrives abeam the receiver and assumes formation lead.

**Air Refueling Control Time (ARCT)**-A specified time coordinated between the tanker and receiver(s). The receiver(s) will arrive at the ARCP at the ARCT or earlier and the tanker will arrive at the ARCP at the ARCT or later. An effort should be made to arrive at the ARCP within 2 minutes of the ARCT.

### **Rendezvous**

The tanker will normally accomplish all required maneuvering during rendezvous with the exception of the tanker orbit rendezvous. A minimum vertical separation of 1000 feet shall be maintained between the tanker and receiver during rendezvous until positive visual contact has been established. Also, the tanker and receiver(s) shall not close within 1 NM of each other until positive visual contact has been established. The aircraft conducting the rendezvous, normally the tanker, is responsible for this separation. The altimeter setting will be the nearest station altimeter. Minimum visibility for a VMC rendezvous is 5 NM. After initial radio contact has been established between the tanker and receiver, the tanker will assume radio control of the rendezvous. Refueling airspeed will typically be 170 KIAS. The different types of rendezvous that will be practiced in this syllabus are: 1) Strategic Tanker Modified Point Parallel, 2) Tactical Tanker Head-On Offset (low speed), 3) Tanker Orbit (VMC only), and 4) Enroute (overtaking). These procedures are somewhat modified from what you will be accomplishing in the MV-22 due to TC-12 restrictions, but are very similar.

#### **Tactical Tanker Head-On Offset Rendezvous (Low Speed)**

During this rendezvous, the receiver(s) will maintain 1000 feet below the refueling altitude while inbound from the ARIP to the ARCP at 150 KIAS. The tanker will be at refueling altitude at 170 KIAS and will roll in directly over, or slightly offset from, the lead receiver. The receiver(s) will normally be in a left echelon and stepped down. When the tanker is in sight and gives the clearance, the receiver formation will climb/close to the observation position (45° bearing off of tanker, 200 feet aft and 200 feet out) and accelerate to 170 KIAS. Prior to join up, the tanker airspeed will be 210 KIAS and the receiver's airspeed will be 150 KIAS outside the ARCP. The tanker approaches the receiver(s) on the reciprocal of the air refueling (AR) track with an approximate 3 NM offset from the track. Normally, the tanker will plan to make a left, standard

rate, 180° turn toward the receiver(s). This rendezvous may be done electronically using Radar and IFF range and bearing in formation or by utilizing Air to Air TACAN; however, due to equipment limitations in the TC-12, we will practice the rendezvous by using standard rate turns at certain speeds/times (approximate offset achieved by flying 210 KIAS is 2.5 NM). The tanker will plan to be abeam the ARCP with the 3 nautical mile offset on a reciprocal track heading at refueling altitude approximately 5 minutes prior to the ARCT. The receiver will be at the ARIP 3 minutes prior to ARCT 1000 feet below refueling altitude. The tanker should plan to make a standard rate turn back to the AR track 3 minutes prior to ARCT. (At this time, the distance between the tanker and receiver should be 2 NM) After completion of the turn, the tanker should be 1 NM in trail of the receiver(s) on the AR track. The tanker should overtake the receiver(s) 4 NM prior to the ARCP. Upon overtaking the receiver(s), the tanker will slow to the refueling airspeed of 170 KIAS while the receiver(s) accelerates to 170 KIAS in preparation for maneuver and climb to the observation position. The receiver(s) will maintain 1000 feet vertical separation until the tanker passes overhead or abeam and clears the receiver(s) to the observation position.

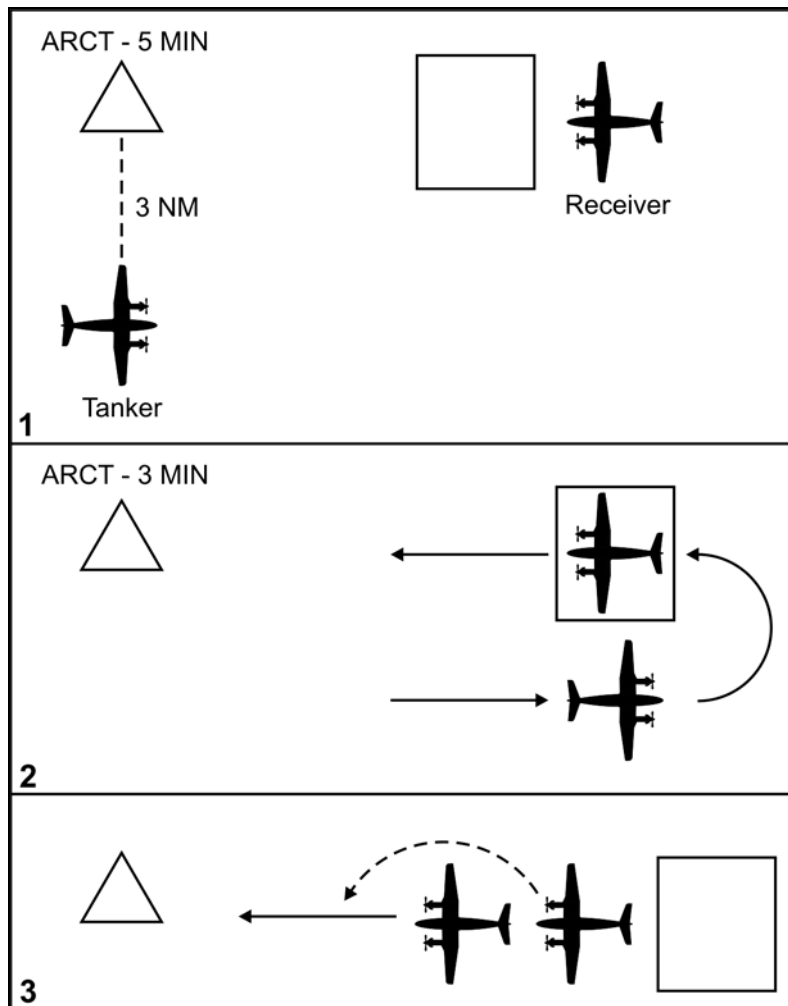
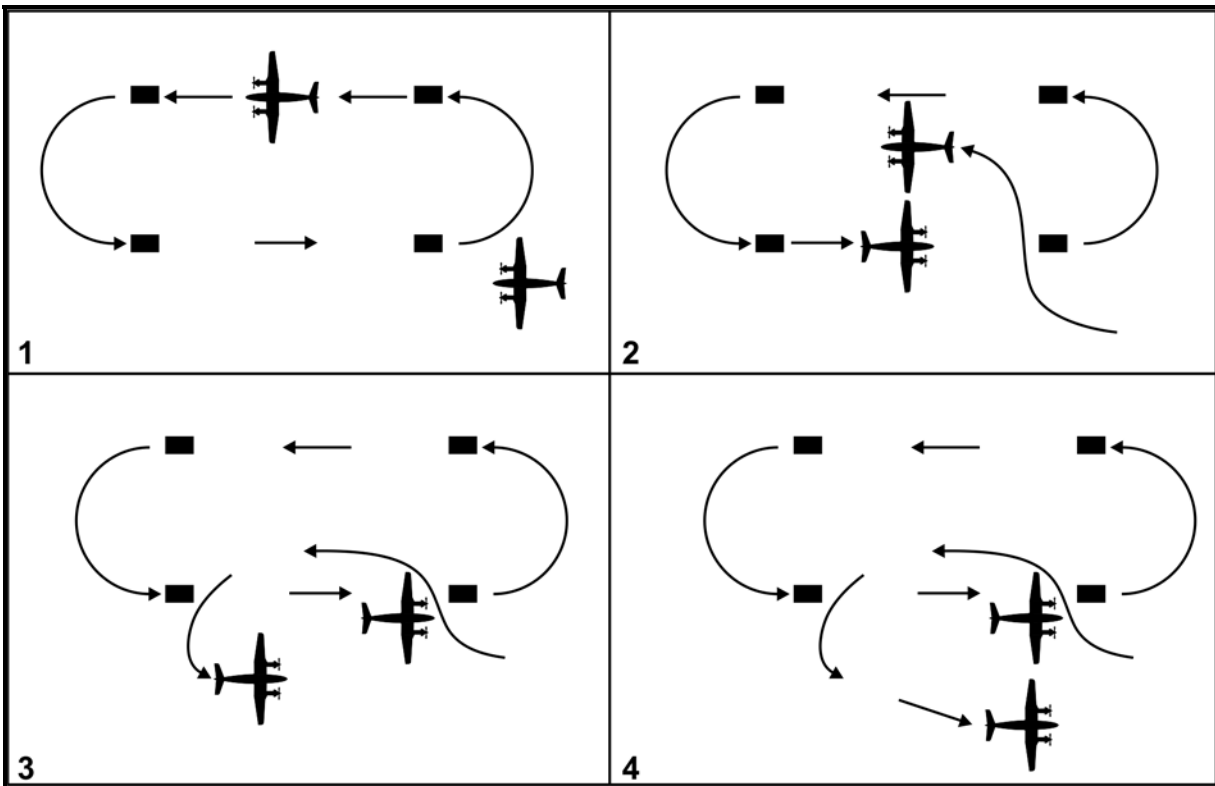


Figure 3-11 Tactical Tanker Head-on Offset Rendezvous



**Tanker Orbit Rendezvous**

This is the only rendezvous in which the receiver maneuvers his aircraft to affect the rendezvous and join-up. The receiver is responsible for maintaining the required 1000 feet of vertical separation from the tanker until visual contact is established. The tanker will maintain an orbit at the refueling altitude, at a specified location and allow the receiver to maneuver for rendezvous. Prior to join-up and at least 5 minutes prior to ARCT, the tanker slows to refueling airspeed and establishes the refueling altitude. The receiver will approach the tanker position from 1000 feet below the refueling altitude maneuvering to 1 mile in trail and will then climb to the observation position when cleared by the tanker.



**Figure 3-12 Tanker Orbit Rendezvous**

**Tanker Enroute (Overtaking) Rendezvous**

The tanker aircraft approaches the receiver(s) with 1000 feet of altitude separation and establishes radio contact well in advance to confirm exact position of the receiver formation. The receiver formation will be at 170 KIAS. When in visual contact with the receiver(s), the tanker pilot maneuvers to overfly the receiver(s) and communicates to the receiver formation the refueling heading to be maintained. Once ahead of the receiver(s), the tanker will slow to 170 KIAS and clear the receiver(s) to the observation position.

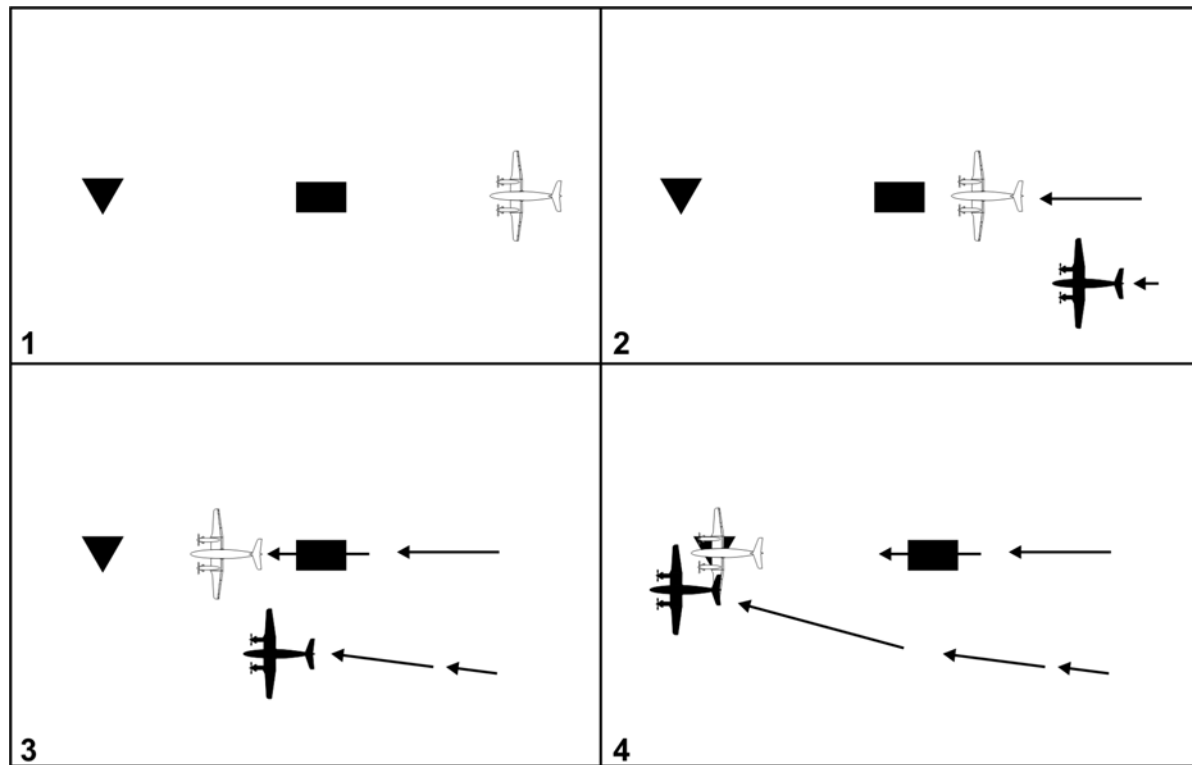


Figure 3-13 Enroute Overtaking Rendezvous

### TACAN Rendezvous

A TACAN rendezvous is a visual circular rendezvous employed to rendezvous a flight above the weather after takeoff or during the mission if the flight is separated. The TACAN rendezvous is normally executed in a left-hand turn tangent to the briefed TACAN fix (radial/DME) at a specified airspeed, altitude, and direction (inbound or outbound). Figure 3-14 illustrates points around the rendezvous circle are numbered from 1 to 4, with point 1 located at the TACAN fix and sequential positions located at 90° intervals around the circle. Upon reaching the TACAN fix, the Lead simultaneously calls his "call sign, point 1" and commences a 30° AOB turn in the briefed direction. Passing each 90° position, the Lead transmits his position number until the Wingman acquires a visual. The Lead must adjust the rendezvous turn to compensate for wind, ensuring point 1 is always at the briefed TACAN fix. The Wingman will fly toward the point 1 fix, 500 feet below the briefed rendezvous altitude and will remain 500 feet below until the Lead is in sight. At night, the Wingman will remain 500 feet below the lead until established on bearing. The Wingman will transmit his position and initiate a turn in the briefed direction using AOB as necessary. Each flight member will report his position, as required, in the rendezvous circle as he passes a numbered position. From position reports, the Wingman establishes an idea of the Lead's relative position, narrowing his visual search for the Lead. When the Wingman sees the lead, the Wingman will call "visual" and fly to the rendezvous bearing line, climb to the Lead's altitude, and proceed with a standard CV rendezvous. Initially, if the Lead's aircraft is behind Wingman's wing line when a visual sighting is attained, then Wingman should proceed to the center of the circle and maneuver aircraft in the lead/lag manner. The concept of lead/lag

### 3-12 TACTICAL/AERIAL REFUELING PROCEDURES

should be used to initiate a position from which the bearing line can be attained. If the Lead is cross-circle from Wingman's position, the Wingman should maneuver to put his nose just in front of the Lead's nose in order to close the distance on the Lead. Once the Lead has moved approximately 30° beyond Wing's nose, maneuver to put Wingman's aircraft nose in front of Lead's aircraft again to continue closing. Once Wingman has closed to a suitable distance, the Wingman should maneuver to attain fuselage alignment. If the Lead gains visual contact first, he will call "visual" and radio the Wingman the Lead's relative position from the Wingman to help gain sight of the Lead. Angle of Bank during the day may vary as necessary and is limited to 45° at night.

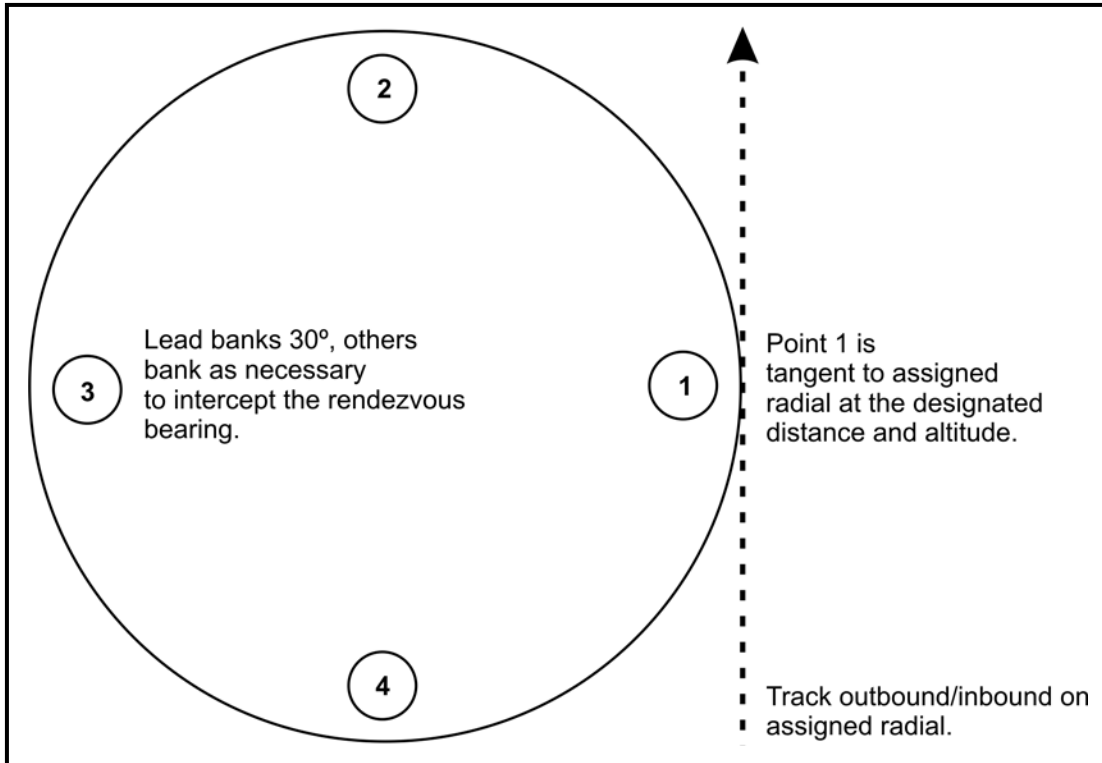


Figure 3-14 TACAN Rendezvous

**Join-Up/Observation/Contact/Fuel Transfer**

Join-up begins with the tanker clearing the receiver(s) to the observation position. When cleared by the tanker, the receiver will establish the observation position, which is at approximately a 45° bearing off the tanker 200 feet aft and 200 feet out and at level altitude. The observation position should allow the tanker's observers to monitor the receiver formation and observe the receiver's movement to the precontact position. After the receiver reports the observation position, the tanker will clear the receiver into the precontact position, which is approximately 50 feet below the tanker's altitude and 100 feet aft behind either wingtip of the simulated tanker. The receiver will maintain this position for approximately 1 minute to stabilize. The tanker will clear the receiver to the contact position, approximately 50 feet low and 50 feet aft slightly offset to the left or right of the tanker's wingtip directly behind the tanker's wingtip. If movement behind the tanker is required, a crossover or crossunder will be executed as appropriate. After

fuel transfer is complete, the receiver will reduce power and fall back 500 feet and rejoin into the observation position.

### **Post Air Refueling**

When the last receiver has completed refuel procedures, he will fall back into his receiver formation in the last position. Once the receiver aircraft are all back in the observation position, the tanker will clear the receiver formation to detach. The tanker will maintain the refueling altitude and accelerate ahead of the receiver(s). Another method of separating the refueling formation is for the tanker to maintain his altitude while the receiver formation descends below the refueling altitude.

### **Breakaways**

When any crewmember aboard either the tanker or receiver determines that an unsafe environment exists, he will transmit on the refueling frequency the breakaway call. The call will consist of the tanker's call sign and the call "breakaway, breakaway." Excessive rates of closure, receiver overrunning, or aircraft fire/malfunctions are all examples of situations that warrant a breakaway call. Once a breakaway call has been made the following will occur: the tanker will immediately accelerate and climb to the top of the block while the receiver will immediately reduce airspeed by moving the throttles to idle (if safely able) and descend to the bottom of the block. If there are multiple receivers in formation, then the receiver in the wingman position should be prepared to immediately turn to a heading away from the other receiver as well if an overrun situation develops. This should be thoroughly briefed before the flight. Another rendezvous can be re-coordinated or the refueling mission can be terminated.

### **Lost Contact Procedures**

If at any time the receiver loses sight of the tanker, a breakaway will immediately be called and executed. If receivers lose sight of each other in formation then the lost sight procedures per the squadron joint form procedures shall be executed. If receivers in formation enter IMC, then the squadron inadvertent IMC procedures for formation flights shall be executed. In any case, Lead shall always be directive.

### **Example A/R Communications:**

TANKER = Stingray 323      RECEIVER = Stingray 330.

Let's assume the requested working area is 5000 - 7000 feet.

### **Establishing Radio contact (otherwise known as the 15 minute call):**

Stingray 323-Tanker, this is Stingray 330 and flight.

Stingray 330, this is Stingray 323-Tanker. Altimeter is 2986. Go ahead.

Roger. Stingray 330 is a flight of 2 climbing to 5000 feet with altimeter 2986.

Stingray 323-Tanker copies. A/R altitude 6000 feet. We are established 6000 feet with altimeter 2986 and ARCT of 1605.

**During the Rendezvous:**

Both Tanker and Receiver should call traffic in sight:

Stingray 323-Tanker has receivers in sight - Stingray 330 flight has Tanker in sight.

**When executing the turn range/offset join up:**

Stingray 323 - Tanker in the turn.

Stingray 323 - Tanker halfway through the turn.

Stingray 323 - Tanker rolled out.

**When receiver sees tanker pass overhead/abeam and in front:**

Receiver: Tally Ho, tanker 3 o'clock-Stingray has the lead.

Tanker: Roger, Stingray 323 has the lead.

Receiver: Stingray 330 flight request port observation position.

Tanker: Roger, Stingray 330 cleared port observation position.

Receiver: Stingray 330 Dash 1 established port observation.

Tanker: Roger. Dash 1 is cleared to pre-contact.

Receiver: Dash 1 is established pre-contact. Request contact.

Tanker: Dash 1 is cleared to contact.

Receiver: Roger, cleared to contact.

Tanker: Dash 1, your offload is complete.

Receiver: Request disconnect, re-position to port/starboard obs position

Tanker: Roger, Dash 1 cleared disconnect port/starboard obs position.

(Then next receiver moves in)

**\*\*Receiver must acknowledge all calls from Tanker!\*\***

**AR/Tactical Maneuver Safety Commands:**

“Knock it off” - Cease all training and proceed as briefed or return to base.

“Terminate” - Conclude current maneuver or line of training. All A/C must acknowledge in order.

**APPENDIX A**  
**GLOSSARY**

**A100. Not applicable**

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**APPENDIX B**  
**TACFORM COMMUNICATIONS**

**B100. INTRODUCTION**

Communication procedures shall be briefed and may be modified as required to maintain formation integrity. Aircrews shall minimize radio calls to reduce frequency congestion.

**NOTE**

Each aircraft will make an independent initial radio check with Montana Base. For C-12s, Lead will check in with Stingray Base for the formation.

**1. INITIAL CHECK-IN**

{on Montana/Stingray Base frequency or interplane}

LEAD - *"Montana/Stingray XXX, check"*

TWO - *"Two"*

THREE - *"Three"*

{on Montana/Stingray Base frequency or interplane if required}

LEAD - *"Montana/Stingray XXX, go (chattermark for interplane)"*

TWO - *"Two"*

THREE - *"Three"*

{on Interplane if required}

LEAD - *"Montana/Stingray XXX, check"*

TWO - *"Two"*

THREE - *"Three"*

**2. TAXI**

{on Navy Ground}

LEAD - *"Navy Corpus Ground, Montana/Stingray XXX Flight of Three, taxi across from hangar 57, with alpha. Wingman side numbers are XXX and XXX."*

**3. COMPLETION OF RUN-UP**

{on Interplane}

TWO - *"Two's ready"*

THREE - *"Three's ready"*

{on Navy Ground}

LEAD - *"Navy Corpus Ground, Montana/Stingray XXX Flight, further taxi"*

#### 4. TAKEOFF

{on Navy Tower}

LEAD - *"Navy Corpus Tower, Montana/Stingray XXX flight, holding number one, Portland Low on request"*

{on Interplane}

TWO - *"Two's in"* (in position on the runway with checklist complete and engine instruments checked)

THREE - *"Three's in"* (in position on the runway with checklist complete and engine instruments checked)

#### 5. DEPARTURE

{on Interplane}

LEAD - *"Montana/Stingray XXX, go (chattermark for Corpus Departure)"*

{on Corpus Departure}

LEAD - *"Corpus Departure, Montana/Stingray XXX flight, off Navy Corpus, At 500 feet on the Portland Low"*

#### 6. ENROUTE

{interplane}

LEAD - *"Montana/Stingray XXX go (chattermark for Enroute freq, i.e. 255.4 or ATC)"*

#### 7. ARRIVAL

{interplane}

LEAD - *"Montana/Stingray XXX go (chattermark for Corpus Approach)"*

{on Corpus Approach}

LEAD - *"Corpus Approach, Montana/Stingray XXX flight, on the CRP 360/25, request traffic advisories to Shamrock"*

{on Corpus Approach}

LEAD - *"Corpus Approach, Montana/Stingray XXX flight, terminate"*

{on Interplane}

LEAD - *"Montana/Stingray XXX flight, go (chattermark for tower)"*

{on Navy Tower}

LEAD - *"Navy Corpus Tower, Montana/Stingray XXX flight, Point Shamrock, full stop"*

{on Interplane}

TWO- *"Two's down and locked"* when the aircraft is configured and the checklist complete

THREE- *"Three's down and locked"* when the aircraft is configured and the checklist complete

{on Tower frequency}

LEAD - *"Navy Corpus Tower, Montana/Stingray XXX left 180, three down and Locked for three aircraft, full stop"*

## 8. AFTER LANDING

{on Navy Ground}

LEAD - *"Navy Corpus Ground, Montana/Stingray XXX flight, clear of the active on Echo, taxi my line"*

{on Interplane}

LEAD - *"Montana/Stingray XXX, go (chattermark for Peg/Maintenance Base)"*

TWO - *"Two"*

THREE - *"Three"*

{Peg/Maintenance Base}

LEAD - *"Montana/Stingray XXX check"*

TWO - *"Two"*

THREE - *"Three"*

{Peg/ Maintenance Base}

LEAD - *"Peg/ Maintenance Base, Montana/Stingray XXX flight, back, all aircraft up, request parking"*

{Peg/Maintenance Base}

LEAD - *"Montana/Stingray XXX, go (chattermark for Montana/Stingray Base)"*

TWO - *"Two"*

THREE - *"Three"*

{Montana/Stingray Base}

LEAD - *"Montana/Stingray XXX check"*

TWO - *"Two"*

THREE - *"Three"*

{Montana/Stingray Base}

LEAD - *"Montana/Stingray Base, Montana/Stingray XXX flight is back, all ups."*

## APPENDIX C

### NAVIGATIONAL CHARTS

#### C100. INTRODUCTION

An aeronautical chart is a pictorial representation of a portion of the earth's surface upon which lines and symbols in a variety of colors represent features that can be seen. In addition to ground images, many additional symbols and notes are added to indicate additional information necessary for navigation. Aeronautical charts are vital aids to navigation. Because of their great importance, you must be thoroughly familiar with the wide variety of aeronautical charts available to you and their proper use.

**Scale.** The ratio between any given unit of length on a chart and the true distance it represents on the earth is the scale of the chart. The scale may be relatively uniform over the whole chart, or it may vary greatly from one part of the chart to another. The charts you will use will normally have a uniform scale. Charts are made to various scales for different purposes. If a chart shows the whole world, it is drawn to a small scale; otherwise it would be too big to be useful. If a chart needs to show a lot of detail, it needs to be drawn to a large scale. Remember: "Large area=small scale and small area=large scale" (Figure C-1). The scale of a chart may be given by a simple statement, such as, "1 inch equals 10 miles." This means 10 miles on the earth's surface is shown as 1 inch on the chart. On aeronautical charts the scale is indicated as a representative fraction or graphic scale.

1. **Representative Fraction.** The scale may be given as a representative fraction, such as 1:500,000. This means that one of any unit on the chart represents 500,000 of the same unit on the earth. For example, 1 inch on the chart represents 500,000 inches on the earth. A representative fraction can be converted into a statement of mile to the inch. Thus, if the scale is 1:1,000,000, 1 inch on the chart stands for 1,000,000 inches or about 68.5 NM. Similarly, if the scale is 1:500,000, 1 inch on the chart represents about 13.7 NM. Thus, the larger the denominator of the representative fraction, the smaller the scale.

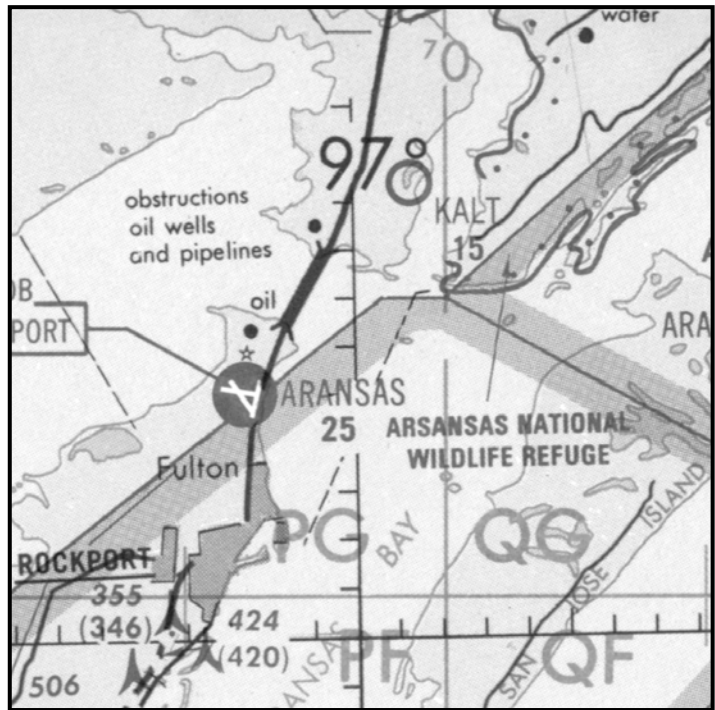
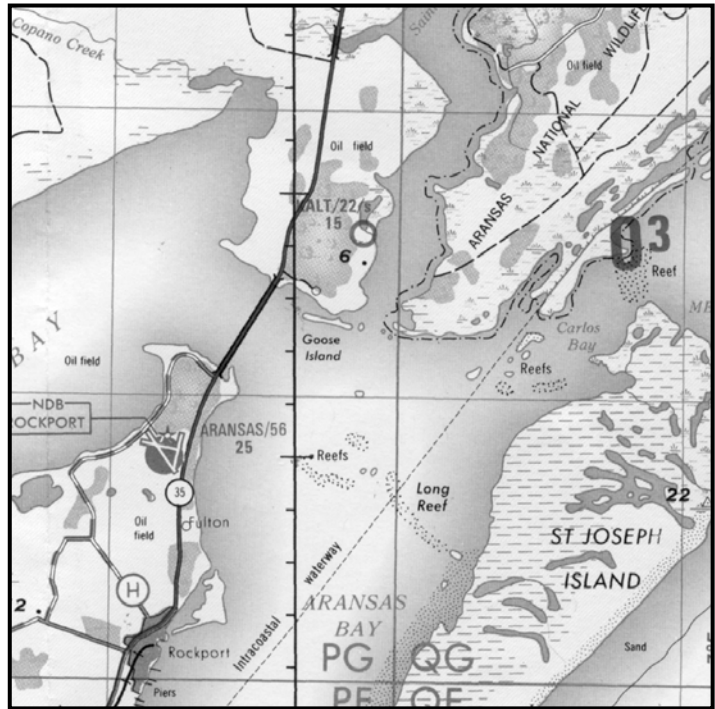


Figure C-1 Scale Comparison

2. **Graphic Scale.** The graphic scale may be shown by a graduated line. It is usually found printed along the border of a chart. Take a measurement on the chart and compare it with the graphic scale of miles. The number of miles the measurement represents on the earth may be

C-2 NAVIGATIONAL CHARTS

read directly from the graphic scale on the chart. The distance between parallels of latitude also provides a convenient scale for distance measurements. One degree of latitude always equals 60 NM, and 1 minute of latitude equals 1 NM.

**Types.** The charts we are most concerned with are the Operational Navigational Chart (ONC - 1:1,000,000 scale), Tactical Pilotage Chart (TPC-1:500,000 scale), and Joint Operations Graphic Chart (JOG-1:250,000 scale). The ONC is used for high altitude long distance missions; the TPC and JOG are used for low altitude VFR navigation.

**Chart Symbols.** Charts have standard symbols for easy identification of information. While these symbols may vary slightly between charts, the variation is slight and once the basic symbol is understood, all symbols are easy to identify. The chart legend explains the meaning of the relief culture, hydrography, vegetation, and aeronautical symbols (Figure C-2).

1. **Relief.** Chart relief shows the differences in elevation of the land surface. These include features such as mountains, hills, plateaus, plains, depressions, etc. Standard symbol and shading techniques are used in relief portrayal on charts. These include contours, variations in tint, shading to represent shadow, and spot elevations.
2. **Contour Lines.** These are lines connecting points of equal elevation. Figure C-3 shows the relationship between contour lines and terrain. Notice that on steep slopes the contour lines are close together; on gentle slopes they are farther apart. The interval of the contour lines usually depends on the scale of the chart and the terrain depicted. In the illustration, the contour interval is 1000 feet. Depression contours are regular contour lines with spurs or ticks added on the downslope side. The ONC shows basic contour lines at 1000 feet while the TPC and JOG show basic contour lines at 500 feet and 100 feet, respectively. Some of these charts occasionally have contour lines at other heights so you will need to check each time you use.
3. **Gradient (or Elevation) Tints.** The relief indicated by contours is also emphasized on charts by a system of gradient tints. Different tints designate areas within certain elevation ranges.
4. **Shading.** Perhaps the most obvious portrayal of relief is supplied by a graduated shading applied to the "southeastern" side of elevated terrain and the "northwestern" side of depressions. This shading simulated the shadows cast by elevated features, lending a sharply defined, three-dimensional effect.

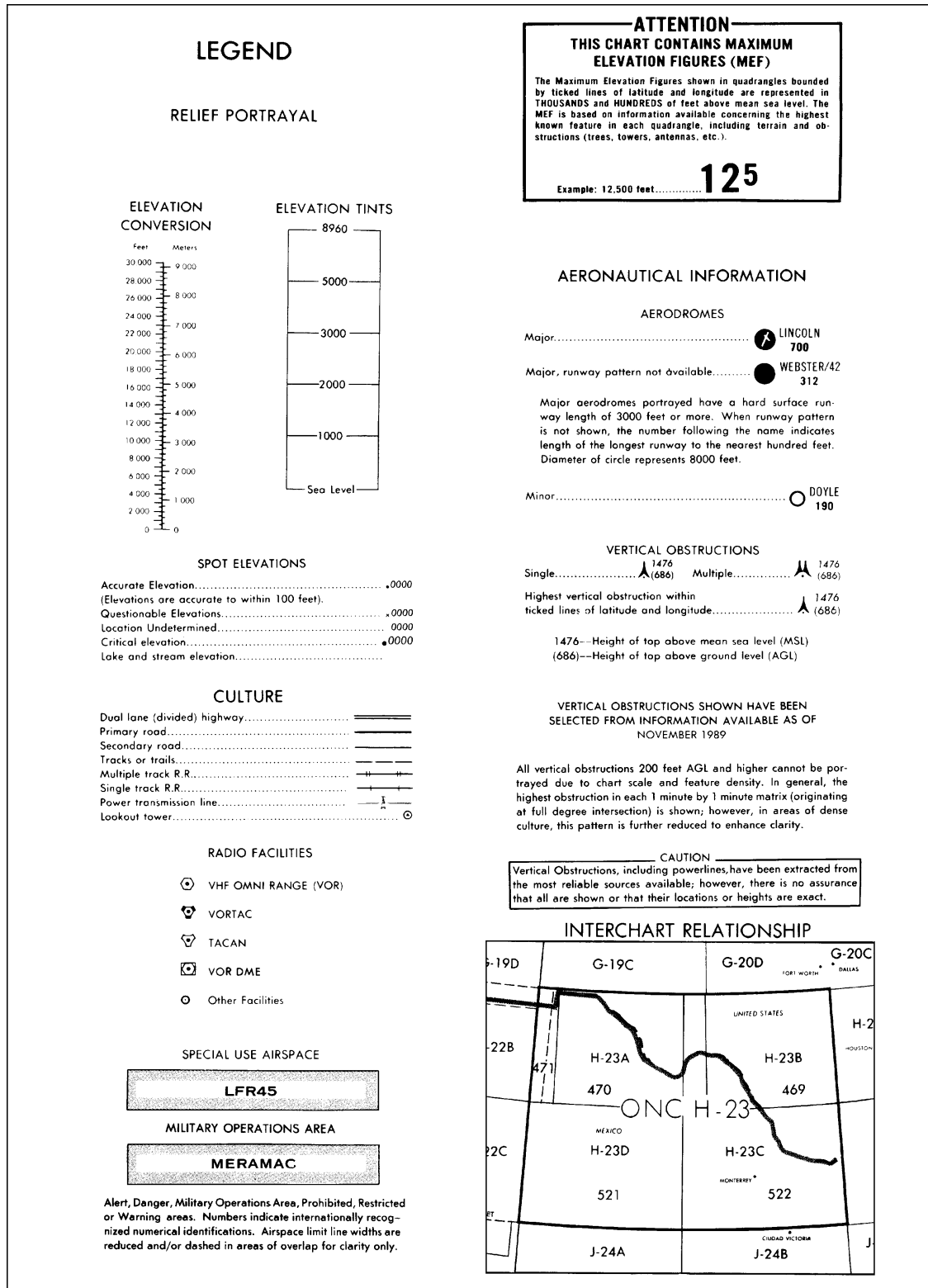
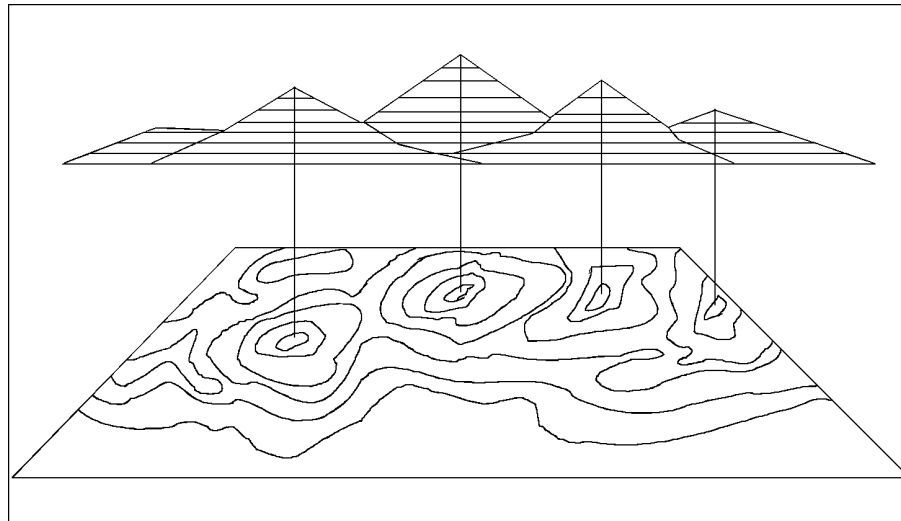


Figure C-2 Sample Chart Legend





**Figure C-3 Contour Lines**

5. **Spot Elevations.** Spot elevations are the heights of particular points of terrain above an established datum plane, usually at sea level. Spot elevations are identified on the ONC, TPC, and JOG. Accuracy to within 100 feet is indicated by black numbers preceded by a dot, which indicates the exact location of the elevation (.000). Approximate elevations are shown in black numbers preceded by a small x (x0000). Undetermined locations are indicated by omission of the point locator (0000). Critical elevations (mountain peaks) are indicated by heavy black numbers and dots (.0000).

6. **Maximum Elevation Figure (MEF).** The MEF is based on the highest point, natural or man-made, within a given grid square (Figure C-4). The MEF is determined by adding a 200-foot safety margin, plus a vertical accuracy factor, to the highest point in the grid square, and then rounding up to the next 100-foot increment. If you fly at the MEF, you should have at least 200 feet of obstruction clearance.

7. **Cultural Features.** All man-made structures appearing on a chart are called cultural features. The following three factors govern the amount of detail: the scale of the chart, use of the chart, and geographical area covered. Population centers, roads, railroads, towers, power lines, dams, and bridges are some of the many kinds of cultural features portrayed on aeronautical charts. The true representative size and shape of larger cities and towns are shown. Standardized coded symbols and type sizes are used to represent the smaller population centers. Although most symbols denoting cultural features are keyed in the legend, some are self-explanatory. Examine cultural features with caution; if the chart is several years old, man-made features have certainly changed.

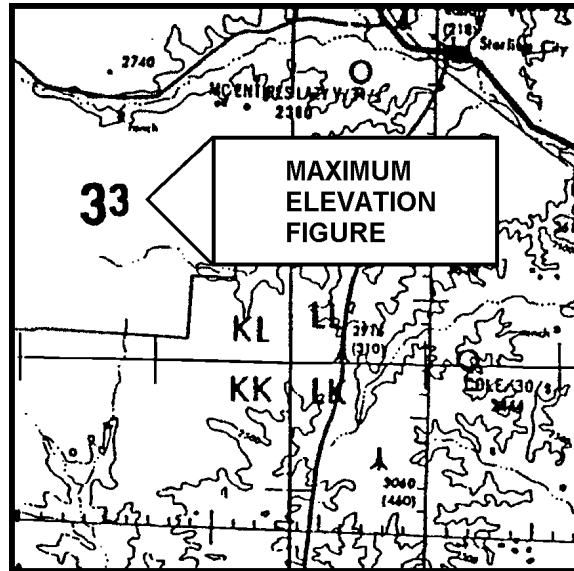


Figure C-4 Maximum Elevation Figure

8. **Hydrography.** This category includes portrayal of oceans, coastlines, lakes, rivers, streams, swamps, reefs, and other hydrographic features. Open water is either left blank or is portrayed by some type of tinting or shading.
9. **Vegetation.** Vegetation is not shown on most small-scale charts (JNC). Forests and wooded areas in certain parts of the world are portrayed on some medium-scale charts. Park areas, orchards, hedgerows, and vineyards are shown on some large-scale charts. Portrayal is by solid tint, or by various shading patterns.
10. **Aeronautical Information.** Notice that the aeronautical information is similar on ONCs, TPCs, and JOGs. All major aerodromes show runway diagrams and a 6000- or 8000-foot diameter circle, depending on the chart. The center of the circle represents the actual position of the field. A star near or in the circle shows the position of the rotating beacon. If runways are not shown, the length of the longest runway will follow the name of the aerodrome. This applies to major aerodromes only.

Radio aids to navigation are depicted the same on all charts. We are interested primarily in the first four shown on the legend of the chart: VOR, VORTAC, TACAN, and VOR with DME.

Special use airspace is clearly marked. The list of special use airspace is located in FLIP. The numbers indicate internationally recognized numerical identification. All special use airspace is portrayed on the ONC except those activated only by NOT.

If you look at the interchart relationship box, you will find which chart you will need if you run off the edge of the chart you currently have. Near the bottom of the chart legend, you will also find a blue-lined box labeled CAUTION. This box indicates how current your chart is and where to find information not shown on the chart.

## APPENDIX D

### FLIGHT PREPARATION

#### D100. INTRODUCTION

Congratulations on making it to the LOW-LEVEL/TACFORM phase of pilot training. You will be attending LL/TF academics classes sometime during late Instrument stage and prior to your first LL/TF flight. It is imperative that you read the FTI prior to attending these classes! This phase of flying will be both exciting and fun, but it requires a great deal more preparation than Contact or Instrument flights. You must show up prepared for class and for each of your flights. Being unprepared will not be tolerated.

You must bring fully prepared charts for every route you will fly. During the academic classes, you will be required to draw 2 routes. These charts take approximately 4-5 hours each to draw so it is important to plan accordingly. It is tedious work but doesn't take a lot of brainpower! Get the blank charts from your academics instructor or the chart locker. If more than one chart is needed for the route, tape them together. If the route is drawn on a TPC chart, you will also need to draw the run-in (IP to DZ) on a JOG chart. Remember to have your charts cover the entire route, i.e., you need to have charts to cover the flight from takeoff to landing.

**Using previously drawn charts:** If you are going to fly different routes than the ones you drew in class, you will have to check out a route chart from the chart locker and make sure it's chummed and up to date (annotate a new date on the back of the chart) before flying with the chart. Upon completion of the flight, put the charts back in the folders where you got them. Keep the charts in good shape since other students will have to use them. Don't wait until the last minute to get your chart...if there are no charts available, notify your IP or the squadron LL/TF stage manager immediately!

**Using Falconview charts.** After you have drawn low-level charts in the academics class, other charts can be prepared using the Falconview program. Chart requirements remain the same for hand-drawn charts and Falconview charts with one exception, use the MTR overlay function to put conflicting MTRs on your chart.

**Chart Preparation.** Use the following table to determine required charts for your assigned routes to draw. Get charts from your academics instructor. Route/Chart combinations are listed in figure D-1.

<u>BIG MAC</u>	<u>LOU ONE</u>	<u>MELLON</u>	<u>SHINER</u>	<u>VR-151</u>	<u>SR-166</u>
TPCH-23B	TPC H-23C	JOG NH 14-12	TPC H-24A	TPC H-24A	TPC H-23C
TPC H-23C	JOG NG 14-2		TPC H-23B	TPC H-23B	JOG NG 14-2
JOG NH 14-11			JOG NH 14-12	JOG NH 14-12	
<u>SILVER</u>	<u>AIR FORCE</u>	<u>GO HOME</u>	<u>F4390</u>		
TPC H-24A	TPC H-23B	TPC H-23B	TPC H-23C		
JOG NH 14-3	TPC H-24A	TPC H-24A	JOG NH 14-11		
JOG NH 14-6	JOG NH 14-6	JOG NH 14-12			

**Figure D-1 Table for Local Routes**

**Chart Construction.** If more than one chart is required, trim the margins from the charts and tape them together. It is recommended that you tape the backside of the charts. Tape on the front will interfere with drawing the course lines and other information. Draw the route using an indelible, black, fine point marker. Once drawn, information can be highlighted using colored highlighter markers. Use red markers to identify MSA and emergency information on the charts.

1. Using the information in the Tactical Aircrew Flimsy, Route Way Point Library, locate the Drop Zone (DZ) and the Initial Point (IP). Using the TAC Plotter, mark these locations IAW Figure 1-5 of this FTI.
2. Draw a line connecting the IP and DZ. Do not mark inside the square or the triangle.
3. Locate the remainder of the turnpoints, including the escape route, using the Way Point Library and mark IAW Figure 1-5.
4. Draw a line connecting the first and second points, again not marking inside the circles.
5. All other turnpoints will be made using the radius-of-turn technique.
  - a. Using the TAC Plotter, find the radius-of-turn circle that would approximate 180 kts at 30°. This will vary depending upon which plotter is used and the scale of the chart.
  - b. Draw the line from the tangent of the arc to the next turnpoint. Do not draw inside the circles. Erase any pencil marks used for the radius-of-turn.
  - c. Continue this process for all the turnpoints leading to the IP.
  - d. Using the proper scale along the TAC Plotter straight edge, draw mileage distance marks along the left side of each course leg. Mileage numbers start at the total mileage of each leg and count down to zero from one turnpoint to the next indicating distance-to-go.

## D-2 FLIGHT PREPARATION

- e. Using the same scale on the Plotter, draw time ticks on the right side of the course line that show minutes from the previous turnpoint. These time ticks start at zero at one turnpoint and count up to the next one indicating time elapsed on the leg. Flights are planned for a constant indicated airspeed of 180 kts or 3 NM per minute (no wind).

**Chart Updating Manual. (CHUM).** This is the most time consuming and tedious step in chart construction. It is also one of the most important. It allows you to compute accurate MSA, ESA and night altitudes and ensures that we will maintain clearance from all obstacles. TPC and JOG charts are published from information from many years ago. All obstruction data (towers, powerlines, etc.) added since the publication of the original charts is published in the CHUM. This information must be manually drawn, in ink, onto your charts. Only the obstructions that will affect the route of flight within 22 NM need to be CHUMed.

#### NOTE

**For TRARON 31 and TRARON 35 use only.**

The first way to get CHUM is through the National Imagery and Mapping Agency website. NIMA's website (<http://www.nima.mil>) provides Electronic-CHUM or ECHUM. Click through the following as applicable:

1. Products and Services
2. **Aeronautical Information Homepage,**
3. **Electronic Chart Updating Manual ([ECHUM](#)),**
4. Go to **ECHUM** and choose current edition by month and year,
5. Choose **Flight Corridor** or **MTRs** (for SR166 or VR151) as applicable.

ECHUM allows you to specify a route and the distance either side of the route that needs to be CHUMed. The work of chumming the chart is still there, but the CHUM retrieved through ECHUM is limited to only what is requested.

1. It is recommended that you enter all the points found in the two routes that you are building. Many routes overlap and requesting the routes separately will cause you to re-CHUM many points. Save yourself time and get all the points at one time. Use the picture provided on NIMA to make sure that what you entered looks like the route are building! Do not forget to include the escape routes in the CHUM searches.
2. If you have checked out an older chart and you need to update the CHUM, then use ECHUM. Go the page and enter the information as you would normally, but check the **Specify Additional Query Criteria** box at the bottom of the page. This will present a page with a number of options. The option **Specific Publication Query** will allow you to select, for

instance, only new CHUM since January 2002. Obviously, this option can only help you if the last CHUM was recorded on the chart you checked out.

### WARNING

The CHUM listed on ECHUM doesn't include power lines unless specific conditions are met. After using ECHUM, you MUST use the CHUM manual to plot the power lines. These are very important, especially when chumming hilly areas (a power line can extend into valleys at the altitude you will be flying). Additionally, if plotted correctly, they can help immensely in navigation.

### NOTE

Take some time to explore the NIMA homepage. It provides many services to include imagery that can be very helpful for getting familiar with run-ins and DZs. Also, two other websites that students have found helpful are <http://www.monkeyplan.com> and <http://www.baseops.net>. These are private websites tailored to military pilots.

### GOUGE:

1. From Monkeyplan, click on the ECHUM link.
2. Select the flight corridor query link.
3. Enter the number of points along the route to include the starting point up to the escape route.
4. Enter a 22 NM radius to determine ESA.
5. Click on the "Restrict Search Results" link and enter the type of chart you are using.
6. Click "continue".
7. Enter the latitude and longitude of each point. Watch out for putting extra zeros in front of the numbers. Additionally, enter the minutes instead of decimal points (for example, .7 minutes is 42 seconds).
8. Click "OK".
9. Be sure to check the ECHUM chart date at the top of the chumming points to ensure the chart you are using is current.

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10. If you are just updating the CHUM on a previously completed chart, click on the "Specify Additional Query Criteria" box at the start of the ECHUM web page.

- a. Page down until you get to "Specific Duplication Query".
- b. In this box, place the date of the last CHUM for the chart you are using.

11. If you are chumming a military route (e.g., SR166/ VR151), then from the main page select your route in the "Select MTR Route" box. Continue as above. You will not have to enter coordinates for your route.

The second source of CHUM data is provided automatically through the Falconview program. The computers used to plan a Falconview chart are updated on a regular basis to maintain a current database of obstructions that would affect the route you are planning.

A third source is from the CHUM books located in the chart locker/ LL TF cabinet. They are sent to the squadron every six months with smaller, monthly updates. These are the same books you were exposed to during VNAV ground school.

**Completing the Chart.** The following items are required on all charts you prepare for LL and TF stages.

1. Locate the highest terrain or obstacle within 22 NM of centerline of the entire route of flight. Mark the obstacle in red ink IAW Figure 1-5. Use this obstacle to calculate the route ESA (see Section 104).
2. Locate the highest terrain or obstacle within 5 NM of centerline of each leg of the route. This includes 5 NM before the first turnpoint to 5 NM after the second turnpoint. Mark these obstacles in red ink IAW Figure 1-5. Use these obstacles to calculate the MSA for each leg (see Section 104).
3. Locate and annotate emergency airfields IAW Figure 1-5.
4. Draw Course Arrow Boxes (doghouses) for each leg IAW Figure 1-5. Information for course, leg distance, leg time, and MSA can be found in the TAC Flimsy.

#### NOTE

The TAC Flimsy may not have the most current CHUM data and MSAs must be verified. For the check ride route, if Falconview is not available, this information must be obtained manually.

5. Reference the appropriate Sectional Chart to plot any airspace close to the route and any VR/ IR routes that will cross your course.

6. Trim the chart to no less than 10 NM from all course lines.
7. Write the name of the route on the front of the chart in a conspicuous place. Also, write the ESA in red on the front of the chart.
8. On the back of the chart, record your name, chart construction date, date of the latest CHUM, and chart number(s) and chart edition. Each time the CHUM is updated, the current CHUM date will be added. As a technique, tape the chart legend on the back of the chart.

**Stick diagrams.** The stick diagram is a one-page information sheet that displays all pertinent data needed to fly the LL without reference to the low-level chart. It is used by the pilot flying the plane to back up the pilot navigating the route. Incomplete stick diagrams are located in the TAC Flimsy. The stick diagrams must be completed prior to brief time.

1. On the day of the flight, get 500 foot altitude winds from the weather forecaster (1500 foot winds for night flight). Get wind information at NGP and from at least one other airfield along the route of flight.
2. Using the CR-2, or "whiz wheel", calculate the leg time based on 180 knots groundspeed, the preflight winds, and the distance for each leg of the route. Determine drift corrections necessary for each leg of the route and calculate the Magnetic Heading (MH). Write this information beside the printed route information on each leg of the stick diagram.
3. For your continuation fuels, start at NGP and work backwards through the entire route. We need to land with 530 lbs plus 200 lbs for an alternate. Estimating 125 lbs for the approach from Shamrock, we must have 855 lbs over Shamrock (530+200+125). Now calculate the leg time from Shamrock to the point immediately before Shamrock. For T-44s, multiply this time by 10 (burn rate is 10 lbs per minute). For TC-12s, multiply this time by 12 (burn rate is 12 lbs per minute). Keep up this entire process until you get to the entry point for the first route. These fuel calculations are placed next to each point in the route timing box on the lower left side of the flimsy. Extra spaces are available to account for transition between the routes and for the recovery to NAS CC.
4. To calculate **times** at each point, start with your takeoff time. In the sample flimsy, the takeoff time is assumed to be 1200. It takes about 8 minutes to get to the entry point (point B), so the time over that point would be 1208.00. You must now use your CR-2 to get each leg time based on 180 knots groundspeed. Take this total and add it to 1208.0. This no wind example has us arriving at the DZ at 1300.1 (1208.0+52.1=1300.1). Now subtract this ".1" from the entry point and takeoff time. This has us taking off at 1159.9 and getting to the entry point at 1207.9. Now go to the route timing block and locate the time it takes to get from B to I (7.0). Add this to the B time of 1207.9 to get 1214.9. Put this in the block next to point I. Continue this process for the entire route. We now have to calculate the entry point of the next route. In the recovery block of the stick diagram, calculate the times to arrive at each point after the DZ/LZ (note that the third point is the entry point into the LOU ONE route). Once you calculate your time at point L, transfer this to the LOU ONE stick diagram and do the same process for that route.



There will be a timing mismatch between the two routes, however we can adjust our speed on the BIG MAC recovery to arrive at the entry point at the time depicted on the LOU ONE flimsy.

5. Use the stick diagram to record any other information that will enhance SA in the low-level. Examples include calculated takeoff time, locations of required frequency changes, and drop zone altitude. On Tac Form flights, include threat locations, fluid trail legs, line abreast leg, lead changes, etc.
6. Once completed and checked for accuracy, make enough copies for each pilot in the flight and formation.

**AF Form 280 Preparation.** Similar to the stick diagram, the Form 280 is a one-page information sheet that displays all pertinent data to conduct a safe and effective formation sortie.

Be sure you are using the correct Form 280 (VT-31 / VT-35). There is a sample AF Form 280 and a blank 280 included in this handout. More blank 280s can be found in the LL/TF supply lockers. The Form 280 should be completed prior to the mission brief. If you make any changes after handing out the final copy, make sure to collect all the old copies and replace them with the correct version!

Assign chattermark to all the frequencies. Don't forget to fill in a frequency (TWR or CTAF appropriate) and assign a chattermark for the transition field. Chattermark terms will follow themes. The first theme will include all ATC frequencies; the second will include all interplane frequencies. As a technique, many students use a common theme (beer, sports teams, etc.) for their ATC chattermarks. It is not required, but standard practice, to assign the UHF interplane 303.0 as "winchester". For example, give primary and secondary VHF interplane and peg base firearms names to go with "winchester" 303.0.

The right side of the Form 280 will be filled in as follows.

### D101. FIRST ROUTE

1. **Formation callsign:** Choose the side number of the airplane that will be LEAD on the initial takeoff (it may not necessarily be the mission commander's airplane). Fill in the "**route**" and the "**type of drop**" blocks (your options for type of drop are personnel, heavy equipment or CDS). Make stations time 30 minutes prior to takeoff, start 25 minutes prior and taxi 20 minutes prior.
2. **Formation lineup diagram:** Fill in the IP/student, BUNO/side # and parking spot in the order you will take off from NGP.
3. **Remarks section:** "Autoswitch from ground to tower ..." is standard; make sure you have it there.
4. **Fluid trail block:** Fluid trail is the standard formation geometry employed. This geometry will be used from route entry to the IP except when a LOC is directed by threat

location. Consideration must also be given to terminating fluid trail if weather is marginal, wingmen loose sight, or you are unaware of your current position. You will decide where threats are located, but try and make it within 5NM of centerline near a recognizable geographic point. Use unclassified threat rings to identify a threat; we will assume that we will get shot down if we get within the threat ring.

5. **In-Trail block:** In trail is used on departure to route entry, IP thru the DZ, thru the recovery, and during the lead change.
6. **Line abreast:** This is where we simulate flying over the "Line of Communication" or LOC in line abreast formation. Have exactly one per route. Make it no closer than 5nm from a turnpoint and try to make it coincide with a major highway on our route. List the highway name and the turnpoint boundaries for the line abreast leg.
7. **Lead change:** If it is a two ship, make the lead change after the low approach at the transition field on the leg to the next route. If it is a three ship, have each crew lead for approximately 1/3 of the total sortie. Crew "B" will take lead for the first drop and low approach at the transition field. Crew "C" will take the lead after the low approach and lead the second route through the second drop. Crew "A" will retake the lead after the second drop and lead the instrument approach back to NGP. Therefore, in the "lead change" block list the one turnpoint for the lead change for a two ship and the turnpoints corresponding to the two lead changes during the first route for a three ship.
8. **Assembly:** This is the assembly right after takeoff at NGP. Use 500' MSL and 150 kts.
9. **Drop:** List the MSL altitude that corresponds to 1000' AGL for the drop and the airspeed. For example, if the highest point on the Mellon DZ is 51' MSL put "1051' M/120 KIAS" (T-44) or "1051' M/130 KIAS" (TC-12).
10. **Recovery:** Pick a runway that is most nearly aligned to the forecast terminal winds (the runway does not have to be long enough as we are planning a low approach). It can be a downwind or an overhead. If you choose a downwind entry, make sure you list either a left or right downwind and the direction makes sense based on the heading we are entering the pattern. Keep in mind that we must fly left hand patterns/turns at uncontrolled airports unless right hand patterns are specified (per FAR 91.126 & 91.127). Specify the airport and which runway (L or R) if there are parallels. Put the MSL pattern altitude that corresponds to 800' AGL for the downwind or 1000' AGL for the overhead.

## D102. SECOND ROUTE

1. **Mission Cmdr/Dep:** Don't forget to list the mission commander (the IP listed as mission lead on the schedule). Designate another IP in the formation as the deputy.
2. **Route, type of drop:** List the name of the second route and specify a type of drop.

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3. **Station, start, taxi, takeoff:** List "N/A" for the second route.
4. **TOT, DZ/LZ:** List the second route TOT/TOA and DZ/LZ name.
5. **Formation lineup diagram:** List the IP/student lineup to start the second route.
6. **Remarks:** "Autoswitch from TWR to GND..." and brakes and reverse 1000' prior to where you plan to exit the runway at NGP are standard.
7. **Fluid trail:** Have exactly one fluid trail segment for the second route. Same rules as before.
8. **Lead change:** If it is a two ship, you have already accomplished your one lead change prior to the second route. Therefore it is "N/A". If it is a three ship, list the turnpoint for the third lead change. Make it after the second drop unless specified otherwise.
9. **Assembly:** This is to reassemble the formation after the low approach. List a MSL altitude that corresponds to 500' AGL after the low approach. Example: the field elevation at VCT is 115' MSL therefore assembly should be 615' MSL. The airspeed is always 150 KIAS.
10. **Drop:** Same as before.
11. **Recovery:** Normally, course rules from Shamrock / Lima to an Overhead for a Full Stop recovery at NGP.

### D103. BRIEFING PREPARATION

**NOTAMS** (1 per plane). Have a set of NOTAMS for each IP. Include NGP, CRP, and the transition field (TF only) and any other significant fields along both routes which could be used as emergency divert fields.

**Weather.** Get a DD175-1 from the weather office and have a copy for each plane. Weather for our locally developed routes must be 1500-3 for day low-levels and at least 1000 feet above the highest MSA for night low-levels with at least 3 miles visibility.

**Time Hack.** Call the US Naval Observatory at DSN 762-1401.

**Conflicts** (1 per plane). Check the VT-35 and VT-31 flight schedules for other formations or low-level flights. Get call signs, routes, and IP names. List these in the remarks section of the 280 for TACFORMS, on the stick diagrams for low-levels, or if needed on separate paper. Also, deconflict all MTRs affecting your route of flight by calling the controlling agencies.

**TACFORM Transition Field Info** (1 per plane). Print out information about the transition field from the internet ([www.monkeyplan.com](http://www.monkeyplan.com) or [www.airnav.com](http://www.airnav.com)). Make sure to include ATIS/ASOS/AWOS frequencies as well as tower/Unicom frequencies.

**What to Know.** Know the FTI and the LL/TF brief. Know the "inadvertent weather penetration" and "descent to night drop altitude" as if they were memory items. Pay particular attention to the annex on radio calls as they can be difficult to master.

**TACFORM Formation Brief.** Use the TACFORM Briefing slides on the computer in the student lounge and update all appropriate information on the slides. The student giving the brief will brief from the front of the room using both the slides and the briefing binder. At the completion of the brief, students will delete their specific information from the slides. If pages or slides are missing, notify the LL/TF Stage Manager.

## **D104. LL/TF DEPARTURE AND ARRIVAL PROCEDURES**

### **Departures**

When flying the Portland departures for LL routes, all T-44 / TC-12s will transit at 500' AGL (if operationally feasible) and will fly directly to Portland once cleared for the turn out from NGP tower. Upon arrival at Portland, fly northwest of Gregory and stay northwest of the road leading to the Bayside Bridge. T-34s will be conducting low-level operations southeast of the road. In order to ensure separation, it is imperative you stay to the northwest! As soon as practical, after takeoff, set VHF on 122.7 (McC Campbell Unicom) and UHF on button 13 (once terminated on button 5) and monitor these frequencies. These are the frequencies the T-34s use in the vicinity of the airfield. Once you reach the Bayside Bridge you can revert to normal comms.

### **Enroute**

Monitor button 13 (337.8), T-34 common, for the Delta area (along most of the eastern portion of the routes you are under/in the Delta area).

### **Arrival**

For North recoveries, proceed to Mission Bay then to Shamrock. Altitude should be 1000' once over Mission Bay. Monitor Rockport UNICOM and Delta area common once you are in the vicinity of Mission Bay. When you are clear of Rockport, switch to McC Campbell UNICOM. Stay north of the red drainage ponds located to the north of McC Campbell airfield and announce your intentions to fly past the airport. T-34s often work near the drainage ponds and also monitor 122.7.

# LOW-LEVEL AND TACTICAL FORMATION

# APPENDIX D

CALLSIGN	AGENCY	UHF	BREVITY	VHF	BREVITY
<b>INTERPLANE FREQUENCIES</b>					
PRIMARY	VT-31/35	303.00	WINCHESTER	140.45	COLT
SECONDARY	VT-31/35			140.525	RUGER
<b>GROUND OPS / TERMINAL AREA</b>					
ATIS	NGP	1	Cowboys	138.6	
CLNC DEL	CLNC DEL	2	Aggies		
GROUND	NAVY GROUND	3	Rangers	118.7	
TOWER	NAVY TOWER	4	Mavericks	134.85	
<b>ENROUTE</b>					
DEP/ARR	CRP DEP/APP	5	Sooners	125.4	
APPROACH	CRP APP	6	Skins	120.9	
APPROACH	CRP APP	7	Huskers	124.8	
APPROACH	CRP APP	8	Broncos	127.5	
C3	BASE			140.325	Eagles
MX CONTROL	PEG BASE	358.8	Packers	138.775	
	AEGIS BASE	358.8			
OPS	NAVY OPS	346.8	Orangemen		
METRO	NGP METRO	344.6	Lions		
<b>ENROUTE</b>					
HOU CTR (RKP)	HOU CTR	350.3	Blue Devils	128.15	Tar Heals
HOU CTR (SAT)	HOU CTR	322.5	Tide	132.8	Tigers
HOU CTR (VCT)	HOU CTR	353.6	Irish	135.05	Trojans
INGLESIDE	T-34 COMMON	12	Wolverines	124.65	Spartans
DELTA AREA	T-34 COMMON	13	Cornhuskers		
VFR FSS	RADIO	255.4	Red Sox	122.55	Yankees
	UNICOM			122.7	Jay Hawks
	UNICOM			122.8	Cyclones
	UNICOM			122.9	Bears
REMARKS		THREAT INFO			CONFLICTS
		TYPE	CODE	LOCATION	
Auto switch GND-TWR-DEPT/TWR-GND #2 Makes Advisory calls					

MISSION INFORMATION											
FORMATION CALL SIGN				MSN CDR/DEP				DATE		SR/SS	
Stingray 316				RIPKEN/GEHRIG							
ROUTE	LOAD TYPE	ROUTE	LOAD TYPE	ROUTE	LOAD TYPE	ROUTE	LOAD TYPE	ROUTE	LOAD TYPE	ROUTE	LOAD TYPE
MELLON	PERS	SHNER	CDS								
STATION	START	STATION	START	STATION	START	STATION	START	STATION	START	STATION	START
1030	1035	NA	NA								
TAXI	TAKE-OFF	TAXI	TAKE-OFF	TAXI	TAKE-OFF	TAXI	TAKE-OFF	TAXI	TAKE-OFF	TAXI	TAKE-OFF
1040	1102.7	NA	NA								
ASSEMBLY (IAS/ALT)	DZ	ASSEMBLY (IAS/ALT)	DZ	ASSEMBLY (IAS/ALT)	DZ	ASSEMBLY (IAS/ALT)	DZ	ASSEMBLY (IAS/ALT)	DZ	ASSEMBLY (IAS/ALT)	DZ
150/500	MELLON	150/500A	MELLON								
<p style="text-align: center;">RIPKEN</p> <p style="text-align: center;">505 D1</p> <p style="text-align: center;">S 316</p> <p style="text-align: center;">GEHRIG</p>			<p style="text-align: center;">GEHRIG</p> <p style="text-align: center;">205 D2</p> <p style="text-align: center;">S 315</p>								
TOT	LEAD CHANGE	TOT	LEAD CHANGE	TOT	LEAD CHANGE	TOT	LEAD CHANGE	TOT	LEAD CHANGE	TOT	LEAD CHANGE
1200	VCT - S	1330	NA								
DROP	AL	HDG	IAS	DROP	AL	HDG	IAS	DROP	AL	HDG	IAS
1051M		132	130	1051M		210	130				
ESCAPE	ALT	HDG	IAS	ESCAPE	ALT	HDG	IAS	ESCAPE	ALT	HDG	IAS
500A		357	180	500A		205	180				
RECOVERY				RECOVERY				RECOVERY			
VCTR DW 12R				OH 13L NGP							

**APPENDIX D**

CALLSIGN	AGENCY	UHF	BREVITY	VHF	BREVITY
<b>INTERPLANE FREQUENCIES</b>					
PRIMARY	VT-31/35	303.00	WINCHESTER	140.45	COLT
SECONDARY	VT-31/35			140.525	RUGER
<b>GROUND OPS / TERMINAL AREA</b>					
ATIS	NGP	1		138.6	
CLNC DEL	CLNC DEL	2			
GROUND	NAVY GROUND	3		118.7	
TOWER	NAVY TOWER	4		134.85	
<b>DEP/ARR</b>					
DEP/ARR	CRP DEP/APP	5		125.4	
APPROACH	CRP APP	6		120.9	
APPROACH	CRP APP	7		124.8	
APPROACH	CRP APP	8		127.5	
<b>C3</b>					
C3	BASE			140.325	
MX CONTROL	PEG BASE	358.8		138.775	
	AEGIS BASE	358.8			
<b>OPS</b>					
OPS	NAVY OPS	346.8			
METRO	NGP METRO	344.6			
<b>ENROUTE</b>					
HOU CTR (RKP)	HOU CTR	350.3		128.15	
HOU CTR (SAT)	HOU CTR	322.5		132.8	
HOU CTR (VCT)	HOU CTR	353.6		135.05	
<b>INGLESIDE</b>					
INGLESIDE	T-34 COMMON	12		124.65	
<b>DELTA AREA</b>					
DELTA AREA	T-34 COMMON	13			
<b>VFR FSS</b>					
VFR FSS	RADIO	255.4		122.55	
	UNICOM			122.7	
	UNICOM			122.8	
	UNICOM			122.9	
<b>REMARKS</b>		<b>THREAT INFO</b>			<b>CONFLICTS</b>
		<b>TYPE</b>	<b>CODE</b>	<b>LOCATION</b>	
Auto switch GND-TWR-DEPT/TWR-GND #2 Makes Advisory calls					

**D-12 FLIGHT PREPARATION**

**LOW-LEVEL AND TACTICAL FORMATION**

<b>MISSION INFORMATION</b>											
FORMATION CALL SIGN				MSN CDR/DEP				DATE		SR/SS	
ROUTE		LOAD TYPE		ROUTE		LOAD TYPE		ROUTE		LOADTYPE	
STATION		START		STATION		START		STATION		START	
TAXI		TAKE-OFF		TAXI		TAKE-OFF		TAXI		TAKE-OFF	
ASSEMBLY (IAS/ALT)		DZ		ASSEMBLY (IAS/ALT)		DZ		ASSEMBLY (IAS/ALT)		DZ	
-----				-----				-----		-----	
-----				-----				-----		-----	
-----				-----				-----		-----	
<b>TOT</b>		<b>LEAD CHANGE</b>		<b>TOT</b>		<b>LEAD CHANGE</b>		<b>TOT</b>		<b>LEAD CHANGE</b>	
<b>DROP</b>	<b>AL</b>	<b>HDG</b>	<b>IAS</b>	<b>DROP</b>	<b>AL</b>	<b>HDG</b>	<b>IAS</b>	<b>DROP</b>	<b>AL</b>	<b>HDG</b>	<b>IAS</b>
<b>ESCAPE</b>	<b>ALT</b>	<b>HDG</b>	<b>IAS</b>	<b>ESCAPE</b>	<b>ALT</b>	<b>HDG</b>	<b>IAS</b>	<b>ESCAPE</b>	<b>ALT</b>	<b>HDG</b>	<b>IAS</b>
<b>RECOVERY</b>				<b>RECOVERY</b>				<b>RECOVERY</b>			

**D105. F 4790 SCENARIO INFORMATION**

You will plan and fly your own "Checkride Route" on F4790. Ask schedulers 2-3 days prior to your checkride who your flying partner is. Decide who will go first. Student A will need to develop a 50-60 minute route starting after the PORTLAND departure and ending at the CANYON DZ (see below). A short escape and recovery to any suitable airfield (uncontrolled, less than 5000 ft, unpaved, etc. are all suitable) should be planned to allow time for a lead change. Student B will also need a 50-60 minute route from entry, to drop, and recovery. If your wingman consists of 2 IPs, plan the first route as a BIG MAC to the BIG MAC DZ, followed by a VFR recovery (to a suitable airfield) leading into your checkride route. You may draw your F 4790 routes on the Falcon View flight planning program located in Bldg 1824. You are responsible for having copies of all routes being flown as well as preparing the AF Form 280, stick diagrams, and formation brief. Show your planned route (not necessarily completed charts) to a mission commander for approval one day prior to your checkride. On the day of your checkride, remember to bring in all the charts you have drawn so that they can be added to the VT-31 chart library. F 4790 flights are usually long and hot and are the last flights in the program, so it's recommended that you bring in refreshments (beverages of your choice) for the debrief!

Consideration must be given to careful route planning for F4790, and points must be approved by an IP on F4202. For day VMC enroute, plan a minimum of 500 feet AGL **modified contour** altitude above the terrain using visual references and the radar altimeter. **Modified contour** is defined as flight in reference to base altitude (500 feet AGL) above the terrain with momentary deviations above and below the base altitude for terrain depressions and obstructions to permit a smooth flight profile.

1. Natural terrain features are preferable to man-made features.
2. Do not plan to fly over built-up, populated areas.
3. When unable to avoid hostile areas, select specific tactics, such as terrain masking (utilizing ridgeline and valleys to mask aircraft from both airborne and ground threats).
4. Avoid being skylighted--go around hills rather than over them. If a ridge must be crossed, do so at a low-level point and, ideally, at a 45° angle.
5. Plan to fly to shadows whenever possible and place the aircraft's shadow in the terrain shadows. Hide your shadow in the ridgeline, ridge shadow, cloud shadows, or dark vegetation if possible.
6. Turns should not be made into significantly higher terrain or other hazards without thorough analysis of aircraft engine-out climb performance.

### Two Days Prior to Checkride

1. "Yesterday it was reported that IRAQI MIG 29s attempted an attack on the USS EISENHOWER in the Persian Gulf. USN F-14s were launched to intercept. Preliminary report indicated 3 or 4 were destroyed."
2. "Late last night, intelligence sources confirmed that 3 were destroyed, however, the 4<sup>th</sup> one was damaged and lost control while attempting to return to Baghdad. The aircraft impacted in a busy shopping district, reportedly killing approx 150 IRAQI civilians."
3. "Early this morning, IRAQ publicly condemned the attack, placing all blame for the casualties on the US and vowed revenge. Within one hour of the news broadcast from IRAQ, multiple bomb threats were made against various targets across the United States."
4. "Throughout the day, heightened security measures have been implemented across the country. National Guard Units have been activated and are preparing for possible terrorists activity. We have been tasked to support the US Army and Texas National Guard at their deployed south Texas location if required."

CANYON IP COORDINATES:	28 48.0` N 98 45.4` W	(Mandatory IP)
CANYON DZ COORDINATES:	28 30.5` N 98 26.4` W	(Mandatory DZ)
DZ SIZE:	500 yds. X 1000 yds.	
RUN-IN COURSE:	129° MC	(Mandatory Run-In)

### One Day Prior to Checkride

"So far there have been 5 bombings across the US. Several terrorist groups have claimed responsibility for each one and promising more to come. In our region, a truck bomb placed at the Diamond Shamrock refinery at Three Rivers killed 37 people and critically injured 96 more. INTEL reports that possibly as many as 50 terrorists are located in and around Three Rivers and suspects that they are being resupplied through the Gulf of Mexico via Corpus Christi Bay. The Texas National Guard has made a request for an air drop of supplies at their command post near Canyon DZ".

### During Formation Brief

"The ATF and naval intelligence has confirmed that an undetermined number of terrorists have managed to sneak in through the bay. The USN has now successfully blockaded the bay but it is believed that large numbers of anti-tank rounds, 20mm cannons, and stingers made it through and are in the possession of terrorists throughout the region. Twelve Marines were killed south of San Antonio when an anti-tank round hit their Bradley fighting vehicle. Two Army AH-64 Apaches were damaged by gunfire while on patrol northwest of Beeville. Highway 281 is currently closed due to reported sniper fire."



**VT-31 / VT-35 Squadron Interfly Procedures**

VT-31 and VT-35 can plan and fly squadron interfly missions to assist in scheduling requirements and to validate training standardization between the two squadrons. The following procedures will apply.

**Mission Planning**

The Mission Commander will be agreed upon among the Instructor Pilots involved and annotated in each squadron's respective flight schedule.

The formation briefing will be held in the respective Mission Commander's squadron briefing spaces. Student Pilots involved will coordinate accordingly to assist each other in the flight planning process. The formation call sign will be from the MC's squadron.

Both squadron SDOs (CDOs) will be aware of the formation call sign for flight following purposes.

**Enroute**

All flight training will be IAW the CTW 4 Low-Level Tactical Formation Flight Training Instruction with the following exceptions:

The takeoff call will address both squadron SDOs, i.e., "Stingray, Montana Base, Stingray 321 airborne on the Mellon Shiner".

Formation recoveries will be flown at 200 KIAS. Final approach airspeed will be 120 KIAS.

**On Deck**

Each aircraft will contact their respective maintenance control with aircraft status and parking instructions.

Each aircraft will contact their respective squadron ops with aircraft landing time and student status.

**D106. TRAINING WING FOUR MULTI-ENGINE LOW-LEVEL/TACTICAL FORMATION STANDARDS**

1. Due to the high number of Aviation Safety Reports of near mid-air collisions during Advanced Multi-Engine Low-Level and Tactical Formation training, the following procedures will be utilized by all TRAWING FOUR multi-engine aircraft while performing subject training.
2. All aircraft will continuously monitor UHF/guard and utilize VHF to make position reports on low-level routes when not in contact with Corpus Approach. While operating below the Delta MOA, aircraft will monitor 337.8. Otherwise, monitor 255.4 or the frequency specified in the Tactical Flimsy. This restriction is not meant to preclude Tactical Formation aircraft from monitoring other UHF frequencies as formation interplane when transiting airfields for VFR formation approaches. Do not hesitate to use UHF Guard to resolve critical conflicts.
3. IPs and mission commanders are responsible for ensuring compulsory reports are made 10 NM prior to the following points: Woodsboro, Eagle Lake, Chase Field, and the Bayside Bridge and when crossing MTRs. The reports should include the cardinal direction and distance from the reporting point, direction of flight and altitude (when crossing MTRs calls will be made only on 255.4).
4. VT-31 and VT-35 will maintain a common Tactical Flimsy. The stick diagrams of the local routes will have both local and AP-1B crossing routes depicted. Compulsory reporting points will be underlined on the stick diagrams. The T-44 and TC-12 low-level stage managers are responsible for maintaining a standardized Tactical Flimsy.
5. Cross the Bayside Bridge at 500 feet if departing Navy Corpus and 1000 feet if returning. If weather precludes crossing the Bayside Bridge at 1000 feet, remain well clear of the area and contact Corpus Approach for an IFR clearance.
6. "LEAD" designation will be placed on the flight schedule and shall be either the senior ranking member of the formation or the most experienced member of the formation.
7. During squadron interfly, the following standards will be maintained:
  - a. Marshall shall take place in the engine run-up, the brief shall be conducted in the squadron of the lead aircraft.
  - b. C-12s will make Unicom calls for the formation, T-44s will maintain the interplane frequency.
  - c. Overheads will be flown at 200 KIAS with C-12s breaking 10 seconds after T-44s to gain required spacing, T-44s will break as normal following a C-12.
  - d. Downwinds will be flown at 200 KIAS.
  - e. Drops will be flown at 130 KIAS.

- f. Stick diagrams will include separate sections for continuation fuels for C-12s and T-44s.
8. These standards are a minimum to ensure deconfliction on low-level routes. Low-level stage managers are encouraged to develop squadron standards to supplement this document.
9. The PIC and/or the Flight Lead of all aircraft flying LL or TF shall inform the respective squadron CDO/SDO of the routes to be flown the day prior for planning purposes. All aircrews shall coordinate/call the sister squadron SDO/CDO to determine which routes are in use and at what times to avoid possible conflicts.

### **D107. STINGRAY/MONTANA FORMATION / LOW-LEVEL STANDARDS**

This guide is not meant to replace any regulations; it is only a supplemental source of information.

Number 2 Duties (LEAD may delegate to Number 3 when flying a three-ship):

#### **Enroute**

1. Make TP McCampbell UNICOM call (122.7) on Portland Low departure.
2. Monitor or make position reports on UNICOM frequencies if transiting within 5 NM of a field where the formation will not be conducting a tactical approach.
3. Obtain ATIS for the formation prior to all recoveries.
4. Act as weather ship.
5. Inform LEAD when your approach checklist is complete, and the GPWS is reset (TC-12).

#### **Landing**

1. Inform LEAD when your gear indicates three down and locked.
2. All Wingmen will inform LEAD if they experience a brake problem on landing, and LEAD will roll out to the end of the landing runway.
3. Landings on 13R will plan on brakes and reverse at the 5-board and exit on runway 4/22.
4. Landings on 13L will plan on brakes and reverse at taxiway Alpha and exit on Echo.

**Communications**

1. Use Chattermark procedures to the maximum extent possible on interplane.
2. Use formation callsign when speaking with ATC and formation position when speaking within the formation. When anticipating an IMC breakup for recovery, use the current LEAD's side number as the formation callsign, even if that aircraft started as number two.
3. LEAD will direct all frequency changes. Wingmen will respond to Interplane frequency changes, and will not respond to ATC frequency changes. Wingmen will acknowledge all LEAD instructions and directives with position number.
4. Students should check VT-35 and VT-31 duty offices for other low-level and tactical formation missions. IPs and mission commanders will ensure this information is obtained.
5. 99 calls should be made on Base, Formation Primary, and Formation Secondary at common choke points. T-44s only have one VHF radio, so VT-31 formations will not monitor Base frequency. Common choke points are Bayside Bridge, Woodsboro, and the run-ins for Mellon, Shiner, Go Home and Canyon DZ
6. Advisory calls should be made on 255.4 when crossing all MTRs south of San Antonio and prior to the IP on checkride routes. T-1s will have you on TCAS, but the T-38s from Randolph are a significant threat in these areas.

**D108. LOW-LEVEL BRIEFING GUIDE**

All low-level briefings will use the following guide to brief the mission. For those who prefer, 8-9 below (the run-in through drop) may be briefed out of order. For TF route briefs, brief only those items not already covered in the formal brief. When briefing a second route on the same flight, start with 3 below (Route name) and brief all applicable items.

1. Time hack
2. Weather (include preflight winds)
3. Route name/flying time
4. ESA and location
5. Times
  - a. Stations
  - b. Takeoff
  - c. Entry

- d. TOT
- 6. Drop zone/Landing Zone
  - a. Name
  - b. Size/shape/elevation
  - c. DZ magnetic course/run-in heading
  - d. Load type
  - e. Drop altitude
  - f. PI location
  - g. Green light time
  - h. Escape heading/altitude
- 7. Run-in (include 9 a-f, as well as slow down point)
- 8. Departure procedures
- 9. Enroute
  - a. Turnpoint description
  - b. Magnetic course/leg time/MSA/controlling obstacle (doghouse)
  - c. Significant course/time update point(s)
  - d. Crossing routes/Restricted areas/no fly zones/etc
  - e. Threats/locations
  - f. Time control/adjustments
  - g. Modified Contour (F4790 only)
- 10. Recovery
  - a. Brief 9 a-g, as applicable
  - b. Type (overhead/downwind/instrument approach)

## 11. NATOPS brief

The T-44/TC-12 uses approximately 600 lbs/hr and 720 lbs/hr respectively, at 500 feet AGL. Figure D-2 demonstrates how to estimate fuel for the LL route. Use NATOPS performance charts to determine time/fuel required to climb.

We frequently fly two local IR routes: IR 136 and IR 166. By a Letter Of Agreement (LOA) with Kingsville, we call them SR 136 and SR 166, but schedule them as VR routes. This eliminates the required two-hour prior notification to schedule them. We also fly one local VR route: VR 151. To schedule any of these routes, contact Kingsville Base Operations and ask if the routes are available (T-45s use them as IR and VR routes). Tell them you want SR 136/166/151 and schedule a block time for the routes. If Kingsville says you need to wait two hours before you can enter, remind them of the LOA and that we are treating them as SR routes.

You may enter the route any time during your scheduled block, however, you must abort the route at the end of the block (even if not completed) since Kingsville can schedule T-45s for the route at the end of our block. IR 147 is also covered by the LOA but is not flown by VT-31. (This includes IR 136/166 since we fly them as SR routes per the LOA.)

**NOTE**

For standardization, all TOTs will be whole times in multiples of five (i.e., 1000, 1005, 1010, etc.).

For T-44/TC-12 operations, use yellow arcs (530 lbs.) as required reserves and 125 lbs. for recovery and landing.

Since all routes that we fly are local routes, the flight schedule covers the requirement for a DD Form 175. *Ensure the duty office knows which routes will be flown prior to departure.*

## APPENDIX E

### COMBAT ENTRY/EXIT CHECKLISTS AND TACTICAL MANUEVERS

#### E100. INTRODUCTION

The objectives covered in this Appendix can be incorporated at the discretion of the IP on a low-level event or Mission Commander on a Tactical Formation event.

#### E101. COMBAT ENTRY (HOSTILE FIRE ENTRY)

Ensure the following checklist is completed prior to entering the threat environment (designate a combat entry point prior to the mission).

1. **Crew briefing-"Complete" (P)** Review airspeed, altitude, threat locations, aircraft configuration, and approach requirements.
2. **Survival Equipment-"Secured" (P, CP)** Ensure flight gloves, flak vests/armor, chemical defense ensemble and oxygen are immediately available as required. (If protective equipment is to be worn, don at this time.)
3. **Internal and External Lights-"Set" (CP)** Set interior lighting to a minimum and turn off all nonessential exterior lights.
4. **IFF-"Set" (CP)** As required.
5. **Radios-"Set" (CP)** Turn off all nonessential radios to reduce emissions.
6. **Radar-"Set" (CP)** Turn off radar if not required to reduce emissions.
7. **Radio Altimeter-"Set" (P).**
8. **Loose Items-"Secured" (P, CP).**
9. **Observers-"Clear to Position" (P).** (You will typically not have an observer in the training syllabus.
10. **Combat Entry Checklist-"Complete" (CP).**

#### E102. COMBAT EXIT

This checklist returns the aircraft to normal cruise configuration upon departing the threat environment (designate a combat exit point prior to the mission).

1. **Observers-"Clear to reposition" (P).**
2. **Battle Damage Assessment (BDA)-"Complete" (P, CP).** State specific problems/damage as determined.
3. **Survival Equipment-"Secured" (P, CP).**
4. **IFF-"Set" (CP).**
5. **Radios-"Set" (CP).**
6. **Radar-"Set" (CP).**
7. **Internal and External Lights-"Set"(CP).**
8. **Combat Exit Checklist-"Complete" (CP).**

### **E103. TACTICAL MANEUVERS (SINGLE SHIP)**

#### **1. Random Steep Approach**

##### **a. Limitations**

- i. Do not exceed 45° of bank
- ii. Minimum weather is VFR
- iii. Maximum speed is 200 KIAS
- iv. Minimum speed is 140 KIAS (No flap) or 130 KIAS (Approach flaps)

##### **b. Procedures**

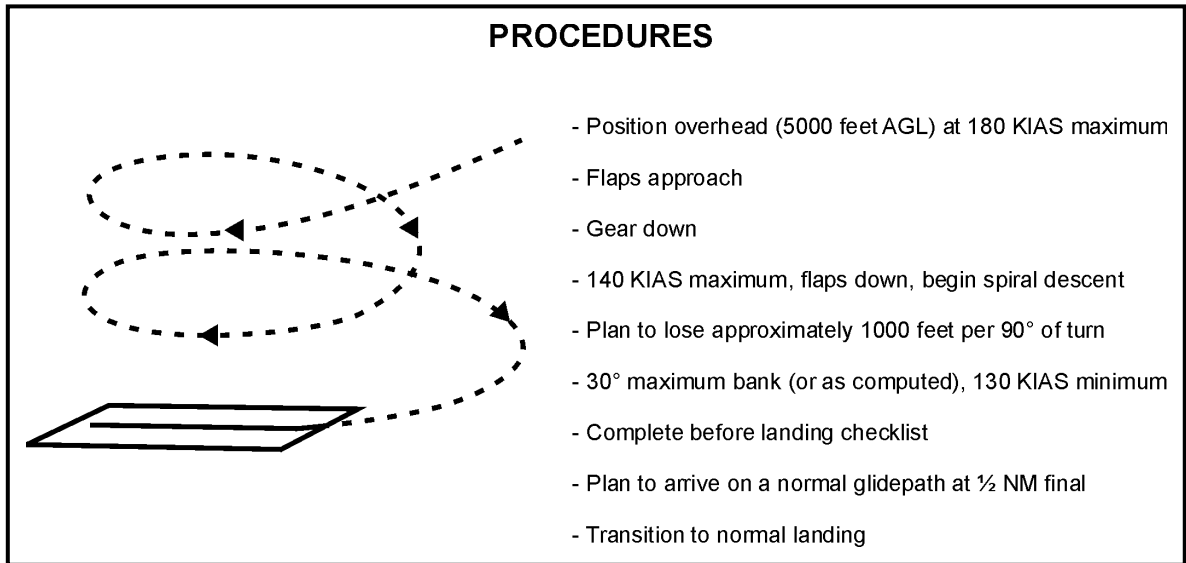
From any *planned* direction, fly towards airfield at 5000 feet AGL, 200 KIAS. Plan to arrive overhead the airfield at 180 KIAS. (See Figure E-1.) Overhead the field, select flaps approach, gear down/landing checklist, maintain level flight and continue circling. At 140 KIAS, select flaps full down and begin a spiraling descent (plan to lose approximately 1000 feet for every 90° of turn). Continue descent with 150 KIAS maximum, 140 KIAS minimum until rolling out on final. Do not exceed 15° nose low. Plan to arrive on a normal glidepath picture at 1/2 mile final approximately 150 feet AGL.

##### **c. Curvilinear Approach**

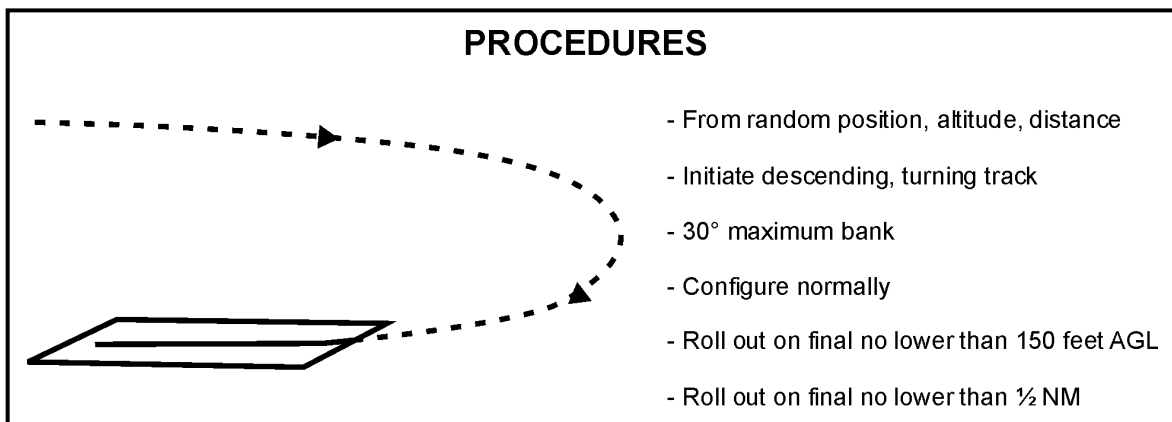
A curvilinear approach is a curving approach flown from any position other than a normal straight-in or downwind (see Figure E-2). Altitude, configuration, and



sequence of events will vary. However, in all cases, plan descent and flight path to arrive at a 1/2 mile final on a normal glidepath with the aircraft configured for landing and the Landing Checklist completed.



**Figure E-1 Random Step Approach**



**Figure E-2 Curvilinear Approach**

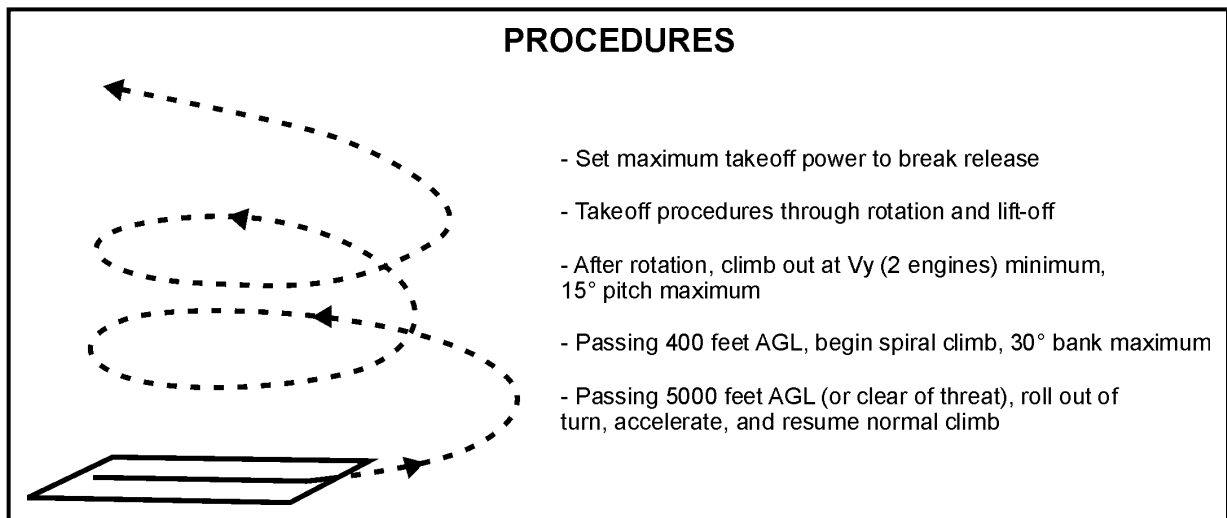
**2. Random Step Departure**

**a. Limitations**

- i. Maximum bank angle of 30°
- ii. Minimum weather is VFR

**b. Procedures**

Accomplish normal rotation and lift-off. Retract gear, select flaps up, engage yaw damper (200 feet AGL minimum), climb out at  $V_y$  (2 engines), 15° maximum pitch until above threat. Passing 400 feet, a turn may be initiated toward planned escape route. When above the threat altitude, lower pitch attitude slightly. Set climb power and resume normal climb schedule and complete climb checklist.



**Figure E-3 Random Steep Departure**

**E104. COORDINATION WITH AIR TRAFFIC CONTROL (ATC)**

In all cases, units should coordinate these procedures with the local ATC and any location where these maneuvers will be flown. Do not fly these procedures at uncontrolled fields when other traffic is in or will be entering the traffic pattern.