4410 CCTW
PHASE TRAINING MANUAL
COURSE 104102 Z

PILOT

C1AC - 47

AUGUST 1967

TACTICAL AIR COMMAND

FOREWORD

The venerable C-47 is still being used for a wide variety of combat missions. Probably no other aircraft has demonstrated such versatility in adapting to the changing demands of the military mission. Phase I of this training is intended to develop in you the skill necessary to fly the aircraft, to make precise approaches with the somewhat antiquated equipment available and to land within a reasonable distance under any combination of circumstances likely to be encountered. Those of you who have had tail wheel experience will find it helpful. Those who have spent all of their time on tricycles and bicycles will find their coming experiences educational. All of you should bear in mind the axiom that the flight is never over until the wheels are chocked.

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GENERAL INFORMATION

1. Course Title: Special Air Warfare Training Course, C-47/AC-47 Pilot.

2. Course Number: 104102Z.

3. Purpose: To qualify pilots in the fundamentals of C-47/AC-47 combat operations.

4. Location: Hurlburt Field, Eglin AF Aux Field No. 9, Florida and England AFB, Louisiana.

5. Duration: Twenty-five (25) training days.

6. Status Upon Graduation: Upon satisfactory completion of this course, each pilot will be awarded a combat capable crew member and will be awarded a certificate of proficiency in accordance with AFR 53-15.

PHASES OF TRAINING

MSN NO.	FLYING PHASE I	SORTIES	TIME
I-1	Familiarization and Orientation	1	4:00
I-2,3,4	Transition (Day)	3	12:00
I-5	Instruments	1	4:00
I-6	Transition (Night)	1	4:00
I-7	Transition Proficiency Evaluation	1	4:00
		7	28:00

MSN NO.	FLYING PHASE II (AIR COMMANDO)	SORTIES	TIME
II-1	Low Level Navigation & Cruise Control (Day)	1	4:00
II-2	Air Drops	1	4:00
II-3	Gunnery (Day)	1	4:00
II-5	Gunnery & Flare Drops (Night)	1	4:00
II-8	Psychological Operations (Tactical Navigation & Leaflets)	1	6:00
II-10	Sod Field Operations & Speakers (Day)	1	4:00
II-11	Low Level Navigation & Assault Landings (Night)	1	4:00
II-13	Tactical Proficiency Evaluation	1	4:00
		8	34:00

MSN NO.	FLYING PHASE II (AC-47)	SORTIES	TIME
II-3,4	Gunnery (Day)	2	8:00
II-5,6,7	Gunnery & Flare Drops (Night)	3	12:00
II-10	Sod Field Operations (Less Speakers)(Day)	1	4:00

MSN NO.	FLYING PHASE II (AC-47) CONT'D.	SORTIES	TIME
II-12	Tactical Navigation/Assault Landings (Night)	1	4:00
II-13	Tactical Proficiency Evaluation	1	4:00
		8	32:00

MSN NO.	FLYING PHASE II (PSY OPS)	SORTIES	TIME
II-8	Psychological Operations (Tactical Navigation & Leaflets)	1	6:00
II-10	Sod Field Operations & Speakers (Day)	1	4:00
II-9	Psychological Operations (Tactical Navigation Assault Landings & Flares/Night)	1	6:00
II-13	Tactical Proficiency Evaluation	1	4:00
		4	20:00

NOTE: Upon completion of Phase I or IA Training, a pilot will enter one of the three Phase II courses. The course he enters will depend upon his subsequent assignment, i.e. AC-47, Psyops or Air Commando.

FLYING PHASE IA **	SORTIES	TIME
Familiarization and Orientation	1	4:00
Transition (Day)	4	16:00
Instruments	2	8:00
Transition (Night)	1	4:00
Transition Proficiency Evaluation	1	4:00
	9	36:00

FLYING PHASE IIA **		
Transition and Instruments	1	4:00

*INSTRUMENT GROUND SCHOOL	PERIODS	TIME
Synthetic Trainer	4	4:00

*Required only for those students who are unfamiliar with the C-47 Fluxgate Compass System, ID-249, and low altitude instrument procedures.

**Phases I and II are designed for the average, experienced pilot with at least 500 hours first pilot time. Phases IA and IIA are designed for the pilot with less than 500 hours first pilot time. Phase IA is in lieu of Phase I for such a pilot, while Phase IIA will be flown in addition to that Phase II course which applies to the pilot's end assignment. Phase IIA will be required only for the student receiving a Minimum Satisfactory grade on Mission IA-9. The Phase IIA mission will always precede the Tactical Proficiency Evaluation.

PHASE I

TRANSITION TRAINING

BRIEFING GUIDE

II Purpose and Description of Mission

II Operations

a. Forms

1. Clearance
2. Weight and balance
3. T. O. L. D.
4. Flight Information Publications Kit

b. Aircrew Position Times

1. Station time
2. Start engine time
3. Taxi time
4. Takeoff time

c. Aircraft Location and Taxi Information

d. Backup Aircraft

e. Emergency Procedures

III Navigation

IV Weather

a. Existing
b. Forecast

V Communications

a. Frequencies

1. Ground control
2. Tower
3. Command Post
4. Approach control

VI Personal Equipment

VII Questions

VIII Flying Safety

IX Instructor - Student Briefing

INTRODUCTION - PHASE I

Students are normally scheduled in pairs on four hour missions during Phase I. On the first ride the instructor pilot will conduct a walk around inspection of the aircraft pointing out those items which should be checked prior to flight. He will also brief the crew on the mission and emergency procedures. Students will ride in the right seat and perform co-pilot functions in order to become familiar with the checklist and the conduct of the various checks. On subsequent flights, students will perform the inspections, briefings and left seat functions; except that pilots with less than 500 hours first pilot time will fly at least 50 per cent of all training sorties in the right seat.

Notice while the instructor taxis out that the rudder is quite effective even at very low speeds and that corrections must be made before heading changes become noticeable. Rudder, power and brakes are used, in that order, except during tight maneuvers. During run up, checks are made on the right engine first. For those having no experience with recip engines, remember that the immediate corrective action for inadvertently turning the mag switch off during the power and ignition check is to do nothing. There is plenty of time to pull the throttle back and wait until the RPM is down below 1000 before turning the switch back on.

During the flight to the transition area the instructor will point out emergency air fields, traffic patterns, instrument approach pattern and conspicuous landmarks in the local area while the student flies the aircraft. Notice the aircraft response to control pressure in initiating turns. Aileron alone will cause an uncoordinated entrance to the turn and control pressure will be rather heavy for the rate of roll established. Use of the rudder will maintain coordination and will markedly decrease the aileron pressure required. The C-47 is definitely a rudder aircraft.

PRIMARY MISSION DETAILS

FAMILIARIZATION & ORIENTATION:

a. I.P. will demonstrate aircraft preflight and crew briefing.

b. Student will read checklist, becoming familiar with proper challenges and responses.

c. Proper taxiing techniques will be demonstrated.

d. Runup procedures will be demonstrated and student will perform all co-pilot duties.

e. Student will perform co-pilot duties on takeoff.

f. Local procedures will be demonstrated and will include the use of auxiliary airfields, traffic patterns and instrument approach patterns.

g. I.P. will orient student in the transition area. Student will fly the aircraft while approaching stalls, slow flight and simulate engine loss at low speed and high power. Student will use checklist to shutdown and restart an engine.

h. I.P. will demonstrate touch and go landings and go-arounds until student is proficient in co-pilot duties.

i. Student will make landings from right seat.

j. Postflight procedures will be demonstrated.

TRANSITION (DAY)

a. Student will preflight aircraft, brief emergency procedures, start, taxi, takeoff.

b. Student will make touch and go landings at all flap settings until proficient.

c. Simulated engine out, stop and go landings will be practiced until student is proficient.

d. Student will develop proficiency in all emergency procedures.

INSTRUMENTS:

a. Student will perform all procedures.

b. Basic instrument work will be practiced until student is proficient.

c. Student will practice track interception, holding, ADF, VOR, TACAN GCA & ILS approaches, missed approaches and low visibility approaches.

TRANSITION (NIGHT)

a. Student will perform all procedures. Lights will be checked during preflight.

b. I.P. will orient the student in the local area.

c. Student will practice touch and go landings at all flap settings until proficient; emergency procedures will not be practiced at night.

d. Student will make instrument approaches as time and facilities permit.

e. Normal Landing and termination.

TRANSITION PROFICIENCY EVALUATION:

a. Student will perform all procedures including crew briefing.

b. Flight will include evaluation of student's ability to perform all procedures, both normal and emergency, that are required to safely operate the aircraft.

GENERAL INSTRUCTIONS

Phase I training is designed to produce qualified C-47 pilots who will be capable of progressing to Phase II training with minimum difficulty. Student proficiency, as determined by the instructor pilot, will be the sole standard for progression. A student current in the aircraft on arrival and demonstrating adequate proficiency can progress through all of the Phase I lesson plans by completion of mission I-8 on the first flight. Students with no previous experience will probably require several flights to progress through the lesson plans. At the completion of Phase I, pilots should be able to make precise approaches and good landings on short runways.

All lesson plans will be initiated with a thorough mission briefing and will conclude with a critique of the student's performance. Instructors will review preceding lessons prior to each mission to insure that all items are covered.

For training purposes, the normal traffic pattern airspeeds will be 100 knots turning base, 95 knots on base, 90 knots on final regardless of flap setting or number of engines operating. Patterns will be kept in close, final approaches will be fairly steep with low power. Touchdowns will be power off and at a designated point. Emphasis will be placed on proper use of checklists, precise control of airspeeds and altitudes. Students with recent experience on flight director systems may need extensive review of instrument interpretation. For training purposes airspeeds will be 120 knots for cruise and descent, 105 knots for holding and circling approaches, 95 knots on GCA and ILS final. Climb airspeeds will be in accordance with T.O. 1C-47-1.

Stall approaches will be practiced above 5000' absolute along with slow flight and single engine practice maneuvers.

The landing gear has no effect on the stall other than to cause more rapid deceleration when it is extended. The aircraft is completely honest in power off stalls, falling straight through with no tendency to roll. The approach is marked with light buffeting which starts about 10 knots above the stall and gradually increases in intensity. Extending flaps will decrease the stall speed and reduce the buffet zone somewhat. Power on stalls are approached but never practiced. Approach with 18" MAP, gear and flaps down. If the airplane is actually stalled, it will probably roll violently one way or the other and unless immediate corrective action is taken, will progress into a spin. The corrective action is to instantly chop the power off and relax back pressure, thereby eliminating both the cause of the roll and the forces that sustain it. The buffet prior to the stall will be quite obvious. Wing heaviness may develop just before the stall--a sure indication that more exciting things are imminent.

Slow flight is done at about 70 knots. Notice the amount of power required to maintain altitude and the rudder displacement necessary for coordination. Engine loss at this speed will cause a turn which can be stopped only by reducing power on the good engine. Engine loss at any airspeed will usually be first detected by the abrupt yaw into the dead engine. The only exception to this would be a failure during let down at low power which might be detected only by the drop in cylinder head temperature.

The airplane will not maintain altitude with one engine windmilling. It can hold altitude at light weights with the gear down and one engine feathered. It flies like a manhole cover with the gear down and one engine windmilling. In practical terms this means that an engine failure during takeoff requires rapid reaction from the pilot. Don't get in the habit of reaching for the rudder trim first. This has proven fatal in the past.

Engine failure will normally be simulated by pulling a throttle back. Feathered condition is simulated by a power setting of 1500 RPM and 15" MAP. The instructor will set this up after the student has indicated which engine he wants feathered. The rate of descent with the dead engine windmilling and the good one feathered is about 1000 FPM. So get the right one!

TAKEOFF

There are about as many ways to launch a C-47 as there are pilots flying it. There are, however, certain factors which must be controlled on every takeoff.

First, line up with the runway. This sounds a bit elementary but you may be surprised when you try it. The problem arises from the angles formed by the window, the curvature of the nose and the off center position of the pilot. Put it in the center of the runway and let it roll forward to make sure it is going to stay in the center.

Consider the wind. If there is a crosswind, roll the aileron into it before applying power, otherwise put the wheel in neutral and keep it there. Your directional control problems will be reduced considerably.

Release the brakes and apply the power--respectfully. Those of you who have been driving the more modern equipment must remember there is no black box between your throttle and the engine on this one. The engines aren't too sensitive as recips go, but they will object if needled too hard and the prop governor needs a little time to catch up when the RPM gets up to 2700.

Make immediate corrections with the rudders at the first indication of a swerve. DON'T USE THE BRAKES. Get the tail up around 40 knots and expect a swerve as it comes up. Hold approximately a level flight attitude (and keep that aileron in there) until the speed gets to 76 knots, then ease in a little back pressure and at the same time neutralize the ailerons or correct if a wing is low. When airborne, let it weathervane but maintain a track over the runway. Check the engine instruments, consider the runway remaining and call for gear up when you are committed to fly. Hold a gradual climb and let the speed build up to 104 knots. Call for METO power. Continue to accelerate. After attaining climb speed and enough altitude to get around the field without dodging the TV antennas, call for Climb power.

In case you didn't catch it the first time by, you steer with your feet, not the wheel, and stay off the brakes.

Once in a while you will find a crosswind the rudder can't take care of. Then you use differential power. The tech order says to retard the throttle and re-apply as necessary. This is the proper technique for correcting a swerve into the wind but you'll find with a little practice that leading the upwind throttle two or three inches as you apply power in a stiff crosswind will help you avoid swerving to start with and makes for smoother operations.

LANDINGS

The two most difficult maneuvers to accomplish with this airplane are good landings and smooth taxiing. Since the period from final touchdown to parking brakes set is actually a continuously varying problem in directional control, we'll cover the whole works in this section.

First the traffic pattern. Yours is probably too big, tighten it up. Why? In the first place this is not a rapid aircraft and in the second place, people shoot at pilots that fly wide downwinds and long finals in SEA. If a fighter pilot can make a continuous turn from downwind to final, so can you--if you want to. With that as a basis we'll press on.

Downwind airspeed is optional. You should have 100 knots turning base, slow to 95 on base and 90 on final. Normally put down ¼ flaps prior to turning base, ½ flaps on base and full flaps on final. Make the final flap setting early, aim for the touchdown point and control the airspeed with the throttles. Pull the power off when you get down near the runway and touchdown slightly tail low. Don't start flaring out way up in the air-- the airspeed dissipates rapidly. Trim it when you are established on final and suit yourself on the flare. Some airplanes need it, some don't.

Power control. As a ballpark rule, in closed traffic, leave the props at 2350 RPM, set about 23½" MAP when reaching downwind altitude, and the airspeed will take care of itself. Drop the gear about half way down the runway, $\frac{1}{4}$ flaps abeam touchdown (104 max IAS), reduce to 20" as you turn base and about 12" to 13" for a full flap final. Power off finals are all right if desired and are recommended for no-flap finals.

The theory behind our pattern is (1) that a consistent pattern makes for better landings in a training situation. Flying the same pattern with the same airspeeds and the same final approach angle regardless of variations in flap settings and number of operational engines will reduce the variables the student must cope with and result in more rapid improvement. (2) The pattern is very useful in actual operations since it is easily adapted to crosswinds, engine failures and "grease jobs."

Most pilots get to the point of touch down with minimum difficulty. Then the problems start. First, the bounce. You flare out, or start to, or maybe hold it too high. There is a squawk from the tires, an instinctive jerk of the wheel and there you are--40 feet in the air with no airspeed, a desperate feeling of inadequacy and suspicion that your instinctive corrections aren't right because the I.P. is doing something else.

The first mistake was that instinctive jerk. If you had just let go of everything about then, the airplane probably would have stayed on the ground. (Assuming it was trimmed on final). What you needed was a touch of forward pressure at the moment of impact--and you'll need it again when you get down from the 40 foot bounce--or the one after it. If it does leap into the air, you use forward pressure to reduce the altitude, back pressure and perhaps a little power to keep the impending crash within structural limits and then forward pressure at touchdown to stay down. You have to break the habit of trying to hold the nosewheel off.

Perhaps you hit going sideways. Pay attention to the way the world looks as you taxi out and charge down the runway. There aren't many reference points out in front to help show the way so check what you have closely. This airplane gets downright unfriendly when landed sideways. Directional control problems multiply and the gear falls off in severe cases.

Directional control. The airplane is afflicted with dynamic directional instability. The center of gravity is behind the center of resistance (the main gear) and any little deviation from straight line movement develops forces which will, if not checked immediately, cause the beast to swap ends--rapidly. The means of control is a barn door sized object on the back end known as a rudder. Those of you who have been instructed to, "Keep your feet on the floor" in previous aircraft will now have to learn what they are for. You will probably be firmly convinced that directional control is a hopeless mystery in short order because you can't see the changes in heading the I.P. is unhappy about. The secret is that he <u>feels</u> them. Pay attention to the seat of your pants--the most sensitive instrument in the airplane. It is unusual for the average pilot to use too much rudder during the landing roll but it is probable that he will leave the correction in too long. Bear in mind that a swerve toward the side of the runway not only must be stopped, it requires a swerve back to line up with the runway again and that second swerve, deliberately induced, usually requires more corrective action than the initial error.

Stay off the brakes during gyrations in takeoff and landing. When you hit the stops on the rudder, it is time for asymetrical power. Brakes are the last resort. Leave them to the I.P., he may need them to get both of you out of trouble.

When you have the speed down to about 55, its time to put the tail wheel down. Smoothly put it down and continue to hold back pressure on it until you get down to taxiing speeds. Pressure on the tail wheel acts as a stabilizing influence by shifting the center of resistance rearward and thus assists in maintaining direction. Get the speed down to about half what you think you can handle before turning off the runway and come in with a little power on the inside engine to stop the turn. Taxiing with a cross wind will require more power on the upwind side than on the down wind side. The only alternative is excessive use of the downwind brake. Use the rudder all the time. During takeoff and landing, keep the aileron rolled into the wind all the time the plane is on the runway and don't try to use the wheel as a steering wheel--it doesn't work unless you happen to be ski equipped and operating from deep snow.

As a final word, don't break the airplane trying to stay on the runway. When things get that bad, you are better off rolling to a stop out in the boondocks. Stuck perhaps, but usually not broken.

INSTRUMENTS

Basic instruments are not hard to handle. The airplane responds fairly well. Climbs take quite a bit of power. A standard rate turn only requires about 18 degrees of bank at normal cruise, less at holding and approach speeds. Just don't forget to use the rudder for starting and stopping the turns.

In turbulence don't fight the excursions too much, sort of herd things along in the general direction desired and it will hang together through nearly anything.

In icing conditions, get alcohol on the props before you get into the stuff and keep them clean. With clean props you can lug an awful lot of ice around. Carburetor ice isn't much of a problem. It is relatively rare and heat will take care of it unless it is out of hand before you wake up. If carb ice presents a hazard on takeoff or landing, the alcohol should be used.

Approaches are fairly standard but they provide a wonderful opportunity for analytical thinking before commencing. The first rule, of course, is to use all available radio aids. Secondly, consider the approach itself. At C-47 airspeeds, it often takes quite a while to get from low station to the field and the landing is frequently made out of a circling approach. In such cases there isn't much point in dragging gear and flaps in from the low station. They could just as well be extended when the field is sighted. On the other hand, a short, straight-in approach obviously requires that you be ready to land when the field is sighted. The point is that a "by the numbers" approach is not necessarily a professional approach.

The airspeed selected for the approach should be based on the situation. Approach charts give time required for 90, 105, and 120 knots, all within C-47 capabilities. The short, steep, straight-in approach might be best performed at 90 knots, gear and flaps down. The long circling approach could be done at either 105 or 120 clean. If done this way, all items except gear and flaps on the Before Landing Checklist should be accomplished prior to reaching minimums. This will set the airplane up for an easy missed approach (just push the throttles up to 36" and go) or a landing. (gear down, flaps as desired).

Holding should be done clean at 105 indicated. If fuel might be a problem, the RPM should be 1700 to 1750. (According to the Douglas tech reps, the two best RPM settings are 2050 and 1750 for smoothest operation).

GCA patterns are laid out to handle much faster aircraft. Life becomes difficult for the controller who has to mesh a 175 knot T-33 and a 104 knot C-47. There is no requirement to maintain a specific airspeed on the downwind leg. High cruise will hurry things up and considering how quickly the airplane can be slowed down, it can hardly get you in trouble. When the controller calls for the before landing check, the slow down can be started. 100 knots is the target speed for base leg, 95 knots on final. Flap setting is optional, either $\frac{1}{4}$ or $\frac{1}{2}$ flaps for normal finals, more if desired on $4\frac{1}{2}$ degree glideslopes. Glidepath interception is accomplished by lowering the nose about one bar width and smoothly reducing power to about $17\frac{1}{2}$" M.P. Power corrections will normally not exceed an inch either way unless there is a singificant head or tail wind.

The most difficulty is usually encountered with directional control. Precise control cannot be maintained with ailerons, it can only be done with rudders. Use them to make the one and two degree heading changes and forget about the ailerons.

NIGHT TRANSITION

Night flying presents no particular problems. Lights are checked during the preflight inspection. Landing lights are used for taxiing, takeoffs and landings. There are no restrictions on the ground use of the lights. Landings are normal with about the same perspective as long as both lights are working. The lights are focused at two different points, one fairly close and the other about twice as far down the runway. If one light quits, the picture changes quite a bit so it behooves the pilot to notice where the lights are pointed and perhaps experiment a bit to see what the runway looks like with just one light on.

EMERGENCIES

The C-47 is very reliable but there are certain failings worth noting and certain philosophies of operation worth thinking about.

First, engine failure. This is not too common, but it happens. Consider a failure on takeoff. Under certain conditions there will be a mile of runway in front of you if the engine fails soon enough to give you problems. If you haven't been too hasty with the gear, there will be plenty of room to land. This is a lot easier than fighting a heavy bird all the way around the pattern.

If it fails in flight, don't mess up your own traffic pattern. The great majority of single engine go-arounds, some successful, some not, occur because the pilot was overly concerned about falling out of the sky when he dropped the gear--so he held it to the base leg and ended high and hot on final. Face it, your normal pattern has a descending base. If you have normal airspeed, pattern altitude and a reasonable pattern, there is no reason why you can't drop the gear the same place you have been doing it all along--and the same goes for the flaps. If your pattern is where it should be, you can punch out the other engine and still make the field.

To feather or not to feather. Generally speaking, if in doubt, don't. If it will run, run it. Engines are cheaper than airplanes. Exceptions: prop problems that are erratic--cage 'em while you can. Fire hazards; get the airspeed and altitude you need and punch them out unless you have a long way to go. Fire warning light: on this airplane the odds are you have a fire whether you can see it or not....

Gear malfunctions. You can see the gear. You can usually feel it hit the locks when it goes down. If you have a red light in spite of this evidence, the odds are it is a micro switch problem. If you can't hold pressure on it but you have a green light, don't sweat it, the locks will hold.

Hydraulic problems. Consider the use of the hand pump and its reserve in case of damage to the system. The gear will free fall and doesn't require pumping. You can land without flaps, but it is nice to have brakes. Save the reserve for the brakes.

Crash landings. The props have a tendency to break loose from the engines. The left prop will smash into the cockpit and, if there was any power on the engine, may kill the pilot, You. The more power the more likely it is to be fatal. Recommend feathering the left prop prior to touchdown. (Feathering takes 12 to 15 seconds). If you want to get fancy, you can shut it down in the pattern, use the starter to point one blade straight up, have the co-pilot do the same to the right one after you have your field made and make a gear up landing with practically no damage. (With flaps at slightly less than ½ down and a reasonably smooth surface, you'll lose the ADF antenna. Period.)

PHASE II

FOREWORD

With the completion of Phase I you are prepared to learn the methods of tactically employing the C-47. The following portion of the manual summarizes the practical experience of those who have done the job under fire. It is oriented more toward the combat mission than the training mission.

However, summaries of experience have the unfortunate characteristic of outlining only that which has happened. They can never adequately cover what is happening right now. This particular failing is somewhat more obvious in those areas which are relatively new. However, the procedures set forth here have been used for an extended period with success and have generally stabilized.

PHASE II

TACTICAL TRAINING

BRIEFING GUIDE

I Purpose and Description of Mission

II Operations

- a. Forms
  - 1. Clearance
  - 2. Weight and Balance
  - 3. T.O.L.D.
  - 4. Flight Information Publications Kit
- b. Aircrew Position Times
  - 1. Station Time
  - 2. Start Engine Time
  - 3. Taxi Time
  - 4. Takeoff Time
- c. Aircraft Location and Taxi Information
- d. Back-Up Aircraft
- e. Emergency Procedures

III Navigation/Range Information

IV Weather

- a. Existing
- b. Forecast

V Communications Frequencies

- a. Ground Control
- b. Tower
- c. Command Post
- d. Approach Control
- e. Range Control

VI Personal Equipment

VII Questions

VIII Flying Safety

IX Instructor - Student Briefing

PRIMARY MISSION DETAILS

LOW LEVEL (DAY)

a. Mission will proceed as normal flight to the start of the low level route.

b. Low Level will commence at 500 feet absolute in order to orient student to map reading at minimum VFR altitude. Altitude will be reduced slowly to 50 feet above obstructions in order to gradually accustom students to the problems of map reading at minimum altitudes.

c. Pilots will assist navigator at all times in spotting check points and keeping track of position.

d. Constant awareness of wind direction and velocity will be stressed. Hazards of wind in relation to various terrain features will be emphasized.

e. Aircraft performance will be demonstrated in terms of "pull up" capability, turn radius and climb performance.

f. Visibility limitations will be demonstrated.

g. Low level will normally terminate with a simulated or actual air drop. Pilot will assist the navigator in attempting to control the target time to within plus or minus two minutes.

AIR DROPS

a. Range procedures will be demonstrated.

b. All currently used air drop methods will be demonstrated and practiced. The sequence of drops will be at the discretion of the instructor. All drops will be made at 105 IAS.

c. Personnel drop will be made using the inverted L, panel marked, drop point. Drop altitude is 1250' absolute.

d. Cargo drops will be made using the same system at 500' absolute. This may be either single bundle or roller conveyor.

e. Eyeball paradrops will be made at altitudes from 100' to 200' absolute depending on the type of parachute and bundle used.

f. Eyeball free fall drops will be made with sandbags at 50' absolute. Accuracy is stressed. Freefall drops may also be made at higher altitudes to reduce scattering if the type of cargo makes it necessary.

GUNNERY (DAY)

a. Range procedures will be demonstrated.

b. Lessons will start with dry firing practice which will continue until student is capable of acquiring the target and bringing the guns to bear. Adjustment of sight for various conditions will be demonstrated and practiced.

c. Live firing will be conducted over a water range. Initial altitude 2000' MSL. Smoke markers will be used as targets. Crew coordination will be demonstrated and practiced. Varation of impact points in relation to pipper under different conditions will be demonstrated. Student will make initial attempts to apply "Kentucky Windage." Wind effects will be noted. Slant range variation effects will be noted. Perspective errors will be demonstrated.

d. Dry firing practice will be conducted as time permits to practice target acquisition on single, multiple and area targets.

e. Students will be cautioned to make short bursts and avoid double bursts at all costs.

f. If mission number 4 is conducted on a land range the student should practice working with a forward air controller and working with restricted areas and angles of fire.

GUNNERY AND FLARE DROPS (NIGHT)

a. Flare emergency procedures will be briefed.

b. Night gunnery will normally be conducted over a land range. Targets will be man-made markers or natural objects selected by the instructor.

c. Students will be cautioned to be alert for vertigo.

d. Flares will be dropped to illuminate the target. Wind drift problem will be solved. Student will experiment with various methods of arriving at proper release point to determine which method he can handle best.

e. Student will practice dry firing, live firing and maintaining illumination.

f. Student will note difficulty of range estimation under flares due to disorientation and the corresponding adverse effects on accuracy.

g. If mission can be conducted over a land range student will practice providing illumination for fighter aircraft.

FLARE OPERATIONS (FOR OTHER THAN AC-47 CREWS)

a. Students will provide flare support for other aircraft or ground operations.

b. Wind drift problem will be solved. Flares will be released so as to maintain constant illumination of the target area. Orbit will be short enough to provide overlap of flares, as required.

PSYCHOLOGICAL OPERATIONS: (SPEAKER/LEAFLETS)

a. Speaker operation will be practiced over a radio equipped ground party. Each run will be critiqued immediately.

b. Wind corrections and variables of pattern altitudes will be demonstrated and practiced.

c. Leaflet drops will be practiced. Variations of coverage due to wind and temperature effects will be noted. Procedures for different sized targets will be demonstrated and practiced. Drops will be made according to data computed by a navigator from Standard Leaflet Charts.

CRUISE CONTROL

a. Mission will normally be in support of navigation training. Flight time and route will depend on navigation requirements. Mission will be flight planned in cooperation with the navigator.

b. Cruise speeds somewhat above the maximum range speeds are recommended in order to provide more realistic training.

c. Power settings and expected fuel consumption will be computed and the total entered in the student lesson plan prior to take-off. Fuel tanks will be dipsticked before and after flight to obtain actual fuel used for comparison with the planned consumption.

d. Complete records of power settings, altitudes, CAT, CHT, IAS, OAT, fuel readings and gross weights will be kept on an hourly (or at each change) basis for post-flight critique by the instructor.

SOD FIELD OPERATIONS

a. Airstrip markings will be briefed.

b. Landings will usually be accomplished on the Pollock strip but any other suitable sod runway will suffice if support equipment is available.

c. Traffic patterns are normally rectangular. Altitudes are optional and variation is encouraged where possible.

d. Final approach is at 75 knots, full flap, low power.

e. Accurate control of touchdown point is mandatory.

f. All landings are full stop and taxi backs.

g. Take-offs are obstacle clearance type. Flaps will be set prior to roll. Full power set prior to brake release; Lift-off at 65, Climb at 76 to clear 50' obstacle.

h. Proper ground handling will be stressed. Aircraft will not be allowed to pivot on one wheel during turns or allowed to stop moving on soft surfaces. Turns should be made into the wind if possible.

i. Students will be cautioned to hold the wheel full back when applying power to take-off. After brake release tail will be raised for better directional control and positive control of lift off speed.

j. Airstrip inspection from the air will be demonstrated and practiced.

LOW LEVEL & ASSAULT LANDINGS (NIGHT)

a. Mission planning to include altitude selection techniques.

b. Normal altitude flight to start of low level route.

c. Low level navigation, 200' above obstacles.

d. Night sod and assault operations using same techniques detailed under "SOD FIELD OPERATIONS."

GENERAL INSTRUCTIONS

Phase II training is designed to provide the pilot with the basic skills required to perform any combat mission he is likely to encounter. It is entirely possible that some of these skills will never be used by a given individual, but the ability will be available if needed.

Each lesson is designed for a two-hour block of instruction, but proficiency remains the criterion for completion.

The subjects covered in this section include almost the entire range of C-47 activities. Certain operations have been ignored in order to avoid security classification.

GENERAL INSTRUCTIONS (CONT'D)

You, as a pilot, will probably not fly all of the different types of training missions available because your assignment has, to a certain extent, limited the variety of actual missions you can engage in.

The training missions are, in general, not profiles of actual combat missions due mostly to the difficulties of scheduling range times and partly to the flight restrictions in this area. The resulting loss of realism in training is recognized but the training itself remains valid. We expect of you the ability to integrate the lessons learned and apply the knowledge in performing the combat mission.

LOW LEVEL

This lesson will develop skills needed to avoid getting shot full of holes while operating under adverse weather or avoiding radar survellience. The low level mission to be flown will usually be an introduction to low level for a student navigator as well as the pilot. The mission will start at 500' absolute and over a period of 30 minutes to an hour will descend to the normal operational altitude of about 50 feet above the tree tops. Navigation is strictly by map reading. Pilots assist the navigator at all times in spotting checkpoints and keeping track of position. Pilots must develop a constant awareness of wind direction and velocity in order to safely cope with low level wind effects on the aircraft. Common errors are: disregarding wind direction when choosing flight paths through hills, overestimating the "pull up" capability of the aircraft, underestimating the radius of turns, insufficient coordination with the navigator and flying the center of valleys.

Low level operation at first glance seems to be a simple proposition. Just get low and stay there. That, however, is buzzing. Low level is more complicated. The complications arise mostly from the mission requirements. which make low level flying necessary and partly from the characteristics of the airplane itself.

In Viet Nam the current situation makes low level operation a "last resort" type of thing which becomes necessary when weather gets bad or the aircraft is crippled. Normally, cruise to and from target areas is done above 5000' if possible. Once in a while the weather will not allow this much separation from Viet Cong small arms fire. When the ceiling forces the plane closer to the ground the hazard of small arms fire increases rather slowly until you get down to about 1500'. Then it increases abruptly, and from there down to about 100 feet or so above the trees or bushes, the hazard is very high. Below that band of airspace there is another relatively safe area where the airplane will be shot at but usually missed simply because it is a difficult and fleeting target. Just how safe are you on the tree tops is difficult to determine but experience has shown that it is generally safer there than at any altitude from there up to at least 1500' and in the presence of .50 caliber weapons, perhaps to above 3000'. In Vietnam then, the sole purpose of low level is self preservation when low ceilings or aircraft damage preclude the use of higher altitudes.

In other situations low level may be necessary to avoid **RADAR** and/or visual detection. The requirements for this type of operation are somewhat different from those of avoiding small arms fire and the procedures are, therefore, sometimes different.

To avoid effective small arms fire one becomes a difficult target. One of the easiest of targets is a C-47 lumbering along at 120 knots 500 feet in the air. You can see and hear it coming for a mile, get your guns all ready and---zap! On the other hand, the same airplane at the same speed will appear as a startling surprise if it goes by just above the tree tops. The sound doesn't carry very far ahead, the airplane becomes visible only at the very moment it can be shot at, giving no time for preparation, and is gone in seconds. In this situation the pilots can frequently hear the rattle of guns but very rarely the more uncomfortable sound of strikes. The primary requirement for the pilot is to stay close to the foliage without picking any of it up. Around 20 to 30 feet of clearance works pretty well until a turn is needed. Then you require a bit more to take care of the wing. The usual mistake in bad weather is to stay too high when the visibility is poor. The tendency is natural but a compromise must be made between obstacle clearance and gunfire avoidance. The sneakiest problems will be antennas, power lines and dead snags, none of which can be seen easily and all of which can be disconcerting.

For avoidance of **RADAR** the first requirement is to know where the sites are--a problem for the intelligence branch to solve for you, and then to plan your flight so as to keep either distance or terrain between you and the sites at all times. The only time this becomes really difficult is when you must come in over water to penetrate a RADAR guarded coastline. It is possible to get under most screens between dawn and dusk by flying low and staying as far away as possible. Get down between five and ten feet, no closer than 30 miles and the average site won't see you but there are some well located sites that can track a rowboat at 40 miles. The best way to surmount this particular problem is to arrange for RADAR jamming during your penetration. Airplanes intended to be used for penetration should be equipped with their own detection units so as to avoid unknowingly getting into RADAR range.

Inland valleys can be used to stay out of sight in mountainous country. The usual tendency is to fly down the center of the valley, staying as low as possible. This is wrong for several reasons. First, the center of the valley will have the most people and the lines of communication. Flying over this area will expose you to more visual observation and reporting. Second, if you have a sudden need to do a quick 180 it must be a climbing turn--and if the need is generated by an engine failure this may not be possible. The best place is about half way up the hills on the downwind side of the valley. The wind will blow the sound away from the populated center and, as it rises over the hills, will give the advantage of a constant updraft--allowing reduced power or higher airspeed as desired. Emergency turn arounds can be made downhill and into the wind from this position. The plane should be kept in close to the side of the hills to avoid being seen from the hill top lookouts as much as possible. This technique works well both for RADAR and small arms fire avoidance.

In hilly terrain the wind becomes extremely important to a low flying C-47. The airplane is, performance-wise, in the light plane category. It just doesn't have what it takes to fight downdrafts, especially when loaded. With this constantly in mind a pilot can stay out of trouble by using the updrafts on a windy day. Avoid low approaches to ridge lines when flying into the wind and stay away from the downwind sides of hills when flying crosswind. Stay to one side of the lowest spot when going through passes to allow for a downhill 180. Don't be surprised by slowly rising terrain — it can trick you into gradually losing airspeed. Always keep in the back of your mind the knowledge that wind is potentially much more powerful than anything you can oppose it with. If you should get trapped the only way to walk away from the inevitable will be to go in under control in an attitude parallel to whatever surface is remotely usable. It takes a lot of guts to accept the fact that you aren't going to get away with something, but when the situation arises there will only be split seconds to accept it and switch to the only possible solution. If you aren't mentally prepared you probably won't hack it.

Navigation at low level is a unique problem. The average individual can't do it without considerable practice - and that doesn't mean practice at 500' or 200', it means practice on the deck. Map reading and D.R. will get you there but you'll find that map reading when your effective visual range is around a mile is completely different from what it is at higher altitudes. You will also find that surface winds cannot be accurately forecast and corrections must be made constantly from visual indications of local conditions. Watch for ripples in ponds, the way the grass is blowing and so on. Flights are normally planned to utilize those features which can be seen from the expected operational altitude. When a low level requirement develops during a mission planned for normal altitude, crews must deduce the location of map features from clues rather than by direct observation. A stream for instance, may be deduced from the existance of a line of trees or from a line of deciduous trees in the midst of a forest of evergreens, or perhaps just by the lay of the land. The map must be followed constantly. A few minutes devoted to logs, forms or sightseeing can be disastrous as far as keeping track of a pinpoint position is concerned--especially when unplanned low level is required because of bad weather. Unless the position is pin pointed continuously, low level at night or in bad weather is not really safe. The ability to navigate with the required accuracy is achieved only through practice.

Pilots who haven't had experience on low level generally tend toward common mistakes. They will overestimate the climb capability of the airplane, underestimate the distance required to change the flight path and ignore wind direction. This leads to starting climbs too late when approaching hills or ridges, allowing the airspeed to dissipate before adding power, and attempting to climb through downdrafts. Other errors are: getting too low over tree tops--not realizing that there are about ten feet of miscellaneous airplane parts below the eye level, getting too low over calm water where depth perception is impossible, not getting low enough over the ocean where the waves seem to be awfully close long before they really are, not planning ahead to go around isolated areas of trees and brush which might be VC strong points and not going around houses, people and boats which are also potential hazards. Another common error is the tendency to set a higher RPM and rich mixtures for low level cruise. Lower RPM will make less noise, giving less warning you are coming. A rich mixture with less than 600hp doesn't do anything but increase Uncle's fuel bill for no good reason. Cockpit distractions must be ignored by the pilot doing the flying. The other pilot can monitor fuel, power settings, instruments and position. He should have a map with a course line and no wind headings on it in a thin pencil line and in fine print so as to not cover up the useful information on the map. Maps can be more completely annotated if desired but there is a rather common tendency to obscure checkpoint details with annotations.

Night low level is a somewhat different proposition than day low level since the pilot generally can't see the obstructions. The burden of terrain avoidance falls on the navigator who, with good maps, can determine the altitude required for a specified clearance above the ground on each leg of the proposed flight. The pilot then flies this altitude as closely as possible. This procedure works only as long as the maps are accurate, the position of the aircraft is pin pointed and the barometric pressure remains close to the forecast. It is more adapted to planned missions than to in-flight re-planning but it can be used in flight if more terrain clearance is allowed. 200' is normally allowed during training missions.

Long range night low level penetrations are feasible providing the flight is planned to utilize moonlight and good weather. Aircraft intended for this use should be equipped with radio altimeters to allow more positive terrain separation. Check points must be selected for their visibility. Water/land contrasts are the most reliable checks at night providing the body of water is large enough to show up well.

AIR DROPS

This lesson is intended to develop proficiency in all of the various types of aerial delivery in current use in the C-47. Cargo to be air dropped is generally loaded on a plywood base, called a "pallet", which serves as a foundation for building up a package. The package is manually pushed out the cargo door at the pilot's signal and, if all goes well, arrives intact in the vicinity of the intended recipient. Preferably the closer the better. Breakable material is lowered by parachute.

There are two general ways by which the pilot determines when to release a paradrop. The release point can be determined by people on the ground and indicated by the location of panels, lights, or electronic signals, which are placed so that bundle trajectory and wind drift will combine to put the impact where they want it. Cargo drops on this system are usually made at 500' absolute. Personnel drops are usually made at 1250' absolute. Accuracy may be termed adequate at best.

The other type of drop, the "eyeball" type, is made at lower altitudes and depends on pilot judgement. The pilot judges his release point and altitude so as to deliver the bundle to a specified point on the ground. The altitude is generally as low as possible to eliminate the wind drift problem. Students will make at least one personnel drop (normally simulated) and one cargo drop on the panels. They will then make seven to ten "eyeball" drops and about five free fall deliveries to achieve accuracy. A. C. E. of 30 yards or less is expected.

Personnel Drops

Two types of personnel drops are in common usage at this time. The static line troop drop and the HALO drop. The most interesting from the pilot's standpoint is probably the static line troop drop since it involves more pilot judgement if done properly than does the HALO type of drop.

In theory the troop drop is a cut and dried procedure. The pilot flies 50 meters to the right of the inverted L and signals for the drop when abeam the flank panel. See sketch.

The only problem, in theory, is to establish an exact altitude, airspeed and track over the drop point and hold it until the troops are clear. In actual practice things are usually different.

First the army will frequently insist that the flight path of the airplane should be immediately above the stem of the figure. Second, the figure itself will vary considerably from the standard. See sketch for samples and Army track.

Third, the drop altitude will be subject to discussion. The TAC standard for training drops is 1250' absolute. 1000' is allowed under some conditions and actual combat jumps are made at 750'.

The major problem will arise when the airplane arrives over the drop zone (assuming a suitable compromise has been reached on the preceding points). In theory the ground control party has placed the panels in such a position that if the drop is done according to the book the personnel will land at a pre-selected landing zone someplace downwind of the indicated release point. In practice this is rarely the case. The most common error is that drift is calculated on the basis of surface wind with no reference to winds aloft. Parachutes drift with the wind aloft, obviously, and this is usually different from surface wind. No matter what the cause of the error the pilot will get blamed if anyone lands in the trees. The only solution is for the pilot to compensate for the wind, if possible, so as to put the troops into the desired DZ. This is made doubly difficult when the panels are displaced from the DZ to compensate for surface wind since it requires the pilot to locate the probable desired impact point during the very short time it can be seen on the inbound run and then correct his track so as to hit it. This frequently cannot be done on a strange DZ and in such cases the only possible courses of action are to either drop on the panels and hope for the best or correct so as to avoid any obvious hazards in the area.

Occasionally a drop will be made in combat without any panels. This is the case when the combat control team goes in. The responsibility is then placed on the pilot to use every source of information available in order to position the aircraft properly over the selected DZ. Such drops are customarily made at lower altitudes so that wind drift is reduced somewhat and jumpers usually have steerable parachutes which will take care of small errors.

Why not use Computed Air Release Point? Actually the pilot is trying to mentally compute a release point on the basis of any information available. CARP is computed on the basis of the wind at drop altitude on the way into the DZ and is, therefore, subject to perhaps more error than computations based on surface wind at the drop point. Local effects have frequently made CARP worse than useless. A good column of smoke in the target area is much more helpful. Actual drift can be determined only by dropping a wind dummy and seeing what happens. (Wind dummys above the rank of Captain are generally referred to as "Wind Evaluators.") Experience is the only teacher in this process; a pilot who has a lot of it can frequently make a very good guess as to the proper release point under given conditions.

The other type of drop will be some version of a HALO. (High Altitude, Low Opening.) The most common approach to this is to drop a wind dummy from the altitude the jumper plans to open his chute and thus determine the drift he will encounter. The airplane is then flown into the effective wind, across the landing point, over the target and straight ahead. The jumpers time the distance between the impact point and the release point and exit the aircraft the same distance upwind of the desired landing point. During the run-in the jumpmaster will give the pilot course corrections in terms of turns a number of degrees right or left in order to arrive exactly where he wants to get out. The pilot must make the corrections quickly, smoothly and accurately while keeping the airplane as level as possible. Any bank angle tends to distort the jumpers view of the situation and causes him to ask for erroneous corrections. If a wind dummy cannot be dropped, the jumpmaster will have selected a point he wishes to be at opening time on the basis of forecast winds and the vectoring procedure will be the same, except the run-in will be on a previously determined and agreed upon track.

Regardless of the type of drop the warning signals remain the same: 20 minute warning, 10 minute warning, 6 minute warning and 1 minute warning. Red light goes on at the six minute warning. Green light at drop time for static line drops or, for HALO, when the DZ appears safe.

Air Drop Tactics - Eyeball

The cardinal principle behind accurate cargo delivery in a hostile environment is that there must be no rigid rules. Rules ensure routine performance and a known routine is an open invitation to a shooting. Experience has shown that the following guide lines will keep you from getting shot up unnecessarily.

Survey each drop zone from a reasonable altitude in order to decide upon the best drop pattern to be used and possible variations that can be made. Don't accept a doubtful inbound track just because it happens to be specified on a frag order. You have your neck and your crew to look out for. The whole object of the pattern is to arrive over the release point with an airspeed of 105 knots and the minimum altitude commensurate with the type and number of parachutes attached to each bundle. Avoid trees, brush, houses and similar cover. If such cover must be overflown do so at absolute minimum altitude. This will reduce the time of exposure to any gun and make your airplane a more difficult target. Experience has shown that altitudes between 200 and 500 feet are the most hazardous. Strive to stay below this range at all times including the moment of drop.

Accurate cargo delivery can only be achieved with practice. Almost any pilot can hit within 150 feet on his first eyeball drop if given the opportunity to observe a drop or two with an IP. Improvement comes rapidly with practice as long as the crew practices as a unit. Accuracy within 20 feet is possible under favorable conditions and on some drops you'll need it. Two areas of judgement must be developed. First, determination of the correct amount of lead to compensate for crew reaction time and chute deployment time. Then follows altitude judgement to determine how high the drop should be made from. For maximum accuracy there should be just enough altitude for the chute or chutes to deploy fully and swing once before landing. This will reduce wind drift error to a minimum. A normally loaded, single, C-9 or G-1 chute will do this in about 100 feet or slightly less. Each additional chute will require another 30 to 50 feet. A single G-13 chute will need about 175 feet with 50 feet for each additional chute. Although bundles of nearly 1000 pounds have been dropped by our C-47's we don't recommend loading a pallet over about 750 pounds due to the difficulty in handling such loads in the air. The maximum number of chutes used so far has been three on one bundle. Occasional problems with second and/or third chutes streaming have been noted. Increased altitude up to 500 feet doesn't seem to noticeably affect the situation. The problem seems to be one of proper rigging.

Airdrops are much easier with heavy bundles if roller conveyors are installed down the center line of the cabin with a curved section running up to the door. Bundles up to about 100 pounds can be handled without the conveyors but the heavier they get the harder they are to handle and the more delay is encountered in getting them clear of the door.

Prior to launch on an airdrop mission all protrusions, crevices, etc., in the vicinity of the door should be taped up to eliminate any possibility of a bundle or its parachute hanging up. When the airplane is being loaded don't let the loading crew follow the natural inclination to load the heaviest pallets last. This can be disconcerting on take-off.

Crew coordination over the drop zone seems to work best when the pilot flies the aircraft and calls for the drop, and the co-pilot turns on the green light <u>and</u> the alarm bell. Kickers then get the load out, one of them watches the impact and relays over the interphone information as to where it touched down in relation to the target and whether the drop altitude should be higher or lower. (The light and bell are both used to avoid confusion. The light sometimes cannot be seen at the moment of drop due to various lighting conditions.)

The actual sight picture at the moment of drop will vary slightly with each pilot due to the variation in seating position. In general the airplane is lined up so the target will pass under the pilot's left hip pocket. The target will disappear under the curve of the nose about a second before the drop point is reached. The time between disappearance and drop varies with how high the pilot sits in the seat and can only be determined by practice. If there is wind the easiest way to compensate is to fly into the wind on the drop pass and delay the drop slightly. Cross winds are taken care of by passing to the right or left of the target as necessary. The key to consistent drops is consistent airspeed and altitude at the moment of drop.

Free fall drops are subject to variation of technique due to the type of cargo being dropped. The theoretical minimum impact will be achieved with release at about 35 feet but if the cargo is subject to scattering this type of drop will create a lot of work for the recipient. If the drop is made from a higher altitude the vertical velocity will be greater but the forward velocity will be lower. In the final analysis the drop altitude chosen for a given cargo represents an educated guess by the pilot and the more practice he has with assorted cargos the more educated he will be. The sight picture will be very close to the same as for parachute delivery (assuming the parachute is delivered from minimum altitude) except that no allowance is made for wind.

Conveyor Drops

Roller conveyors are used when a large number of supplies are to be dropped on a single pass over a drop zone. This is especially desirable when friendly forces may want their location to remain unknown to the enemy. By using the roller conveyor system it is possible to drop as much equipment on a single pass as could be dropped on five or six passes without it. Conveyor drops from the C-47 differ from other aircraft in that the load exits from the left side of the fuselage.

The conveyor, developed by the Special Air Warfare Center, consists of two straight section of five and ten feet in length and a curved section which carries the cargo out the door. All sections are 26 inches wide. When installed, the conveyor extends from the forward bulkhead to the edge of the forward cargo door. Before installing the conveyors they should be inspected for dents, warps, obstructions, and freedom of movement of the rollers. Install the conveyors with the five foot section forward, then the ten foot section and finally the curved section. They are secured to the cargo floor with tie-down ring fittings.

No single loaded pallet should exceed 500 pounds. The maximum number of pallets the conveyor will hold is ten. However, any number over eight is difficult to tie down. Pallets should be free of cracks, splinters and rough edges. The roller guides should operate freely.

All seats not required should be stowed to allow working room and prevent accidents. The overhead cable will be used with the turnbuckle safetied.

It is recommended that three "D" rings or any equivalent device, be looped thru the anchor cable for the purpose of attaching three or four static lines to each "D" ring. "D" rings travel along the anchor cable much more smoothly than the clip of the static line. This helps to prevent the static lines from becoming entangled during their transit down the cargo floor.

Target Acquistion and Tracking

First let's define some terms. When the pipper is between the target and the nose of the aircraft (pipper is on the right side of the target) it is ahead of the target. When the pipper is between the target and the tail of the aircraft (pipper is to the left of the target) it is behind the target. When the pipper is between the target and the horizon it is above the target, and when it is between the target and the aircraft it is obviously below the target.

The target may be approached from any direction. The airplane is positioned so that the target will pass between the left prop hub and the top of the cowling. For most pilots the target should be just above the prop hub but this varies with seating position. When the target reaches a point just ahead of the cowling, the airplane is rolled to the left, bringing the pipper down ahead of the target. The roll in should be a coordinated maneuver. The roll is stopped smoothly when the pipper is level with the bottom of the target and the pipper is allowed to slide back to the target. This maneuver should be done smoothly so that the pipper follows a "J" pattern. As the pipper reaches the target, top rudder will be needed to stop the movement and hold on target. The co-pilot should turn the master switch on as the roll in is begun. Firing is commenced as the pipper comes on target.

With .30 caliber guns caution should be exercised to avoid long bursts (five seconds and up) since they will cause "cook offs" a couple of minutes after the firing is stopped. The GAU-2B has a .5 second minimum and no maximum burst. Recoil will be noticed and is compensated for with a little more top rudder to hold the pipper steady. Recoil forces vary slightly with gun selected and become quite strong when all three guns are used.

When the airplane becomes excessively cross controlled, it is time to recover and re-acquire the target. It is not necessary to roll out completely to do this; a decrease in the angle of bank and a short period of coordinated flight will generally suffice to re-position the aircraft. During maneuvering the altitude should be held as constant as possible and the co-pilot should assist in setting the power so as to maintain 130 knots, TAS.

If, on the roll in, the pipper comes down behind the target, there is no point in trying to drag it forward with top rudder. The same applies if the roll in becomes uncoordinated in an effort to bring the pipper down in the proper place. Roll out, drive straight ahead for a short distance and start the roll in again. The most common error is rolling in too soon.

Kentucky Windage

Now that we have the pipper on the target, what next?

Since the gunsight on the AC-47 is fixed in azimuth and cannot be continuously varied in elevation as the firing pass progresses, there exists a need for the pilot to hold the pipper someplace off the target most of the time in order to compensate for the variables that affect the impact point of the bullets.

Let's look at some of those variables and bear in mind that ignoring them will result in hits that are frequently more than 100 feet from the target.

First, airspeed--or to be more accurate, groundspeed. The sight and the guns are harmonized for 130 knots TAS. Any variation will throw the hits either ahead or behind the target. High speed throws them ahead, low throws them behind. Going into the wind has the same effect as reducing airspeed and going downwind increases it.

Slant range. If the wind didn't blow there wouldn't be much problem. Unfortunately the wind plays a very definite part in establishing the slant range as well as the ground speed. Wind blows the airplane in on the upwind side of the firing circle and out on the downwind side. Long slant range will cause the rounds to hit short, short range will cause the hits to be high.

In effect, with just the variables generated by a light breeze we can miss the target no matter where we shoot from.

Now let's change the altitude. What happens to the impact point will depend largely on pilot technique. If the bank angle is held constant, (slant range is increased) the impact point will move below the pipper as the altitude increases. If, on the other hand, you do as most pilots do and increase your bank angle with increasing altitudes, the relation between pipper and impact may remain nearly constant. If you increase the bank angle more than usual, you may even cause the impact to move above the pipper as you increase altitude.

Suppose you allow the airplane to start a dive while you hold the pipper on target. The resulting increase in speed will pull the impact point forward and the decrease in slant range will move it up. Starting a climb will reduce the speed, moving the impact back and the increasing slant range will pull it below the pipper. It is also possible to climb over the target with increasing bank angle and thereby move the impact behind and above the pipper.

One last variable. When you increase the number of guns being fired, you increase the tendency for the pipper to walk back behind the target while the guns are firing. This increases the amount of top rudder required which in turn tends to reduce the airspeed—moving the impact point back and thus increasing the need for top rudder—which sounds very much like the start of a vicious circle, but you can break it by a slight reduction in burst length.

So, how do you ever hit the target?

A good question. First, reduce the variables to a manageable number. Learn to maintain a constant airspeed and level flight while looking through the sight. Learn the feel of the airplane in a level pass and pay attention to what your ears can tell you about the airspeed. Second, develop a judgement of slant range. Not in a specific number of yards but in a set distance. Be able to tell whether you are closer in or further out than normal. Find out what happens to your impact point when you increase altitude over a specific target so that you can make corrections either with the sight or by eyeball.

With those variables out of the way you can concentrate on correcting for wind. Your training missions will include quite a bit of time over a water range. Using short bursts and watching for the splash from about 2000 feet, you can develop an appreciation for the amount of correction necessary to compensate for wind effects. The only solution to the problem is to practice. See what happens when you fire with the pipper on target and then make appropriate corrections the next time you fire from the same position.

A word or two about optical illusions. The tracers will burn out before reaching the target. Since they are fired from your left and converge on the target, they appear to be short. Expect them to disappear about 20 mils to the lower left of the actual impact point.

When you look at the splashes and their relation to the target, remember that there has been a perceptible time since you pressed the trigger. The airplane is traveling around an arc and you are looking at a stationary spot. The result is that a bullet falling short and in line with the target will appear to have landed short and to the left due to your change in position. (You moved about the length of a football field while the bullet was in the air.)

Another point to keep in mind is that errors due to range variation will be greater in terms of distance between target and impact on the near side than they will on the far side. As an example, if you were 1000 feet too far out, you might have to hold 20 mils above the target whereas being 1000 feet too close might require holding only 10 mils low.

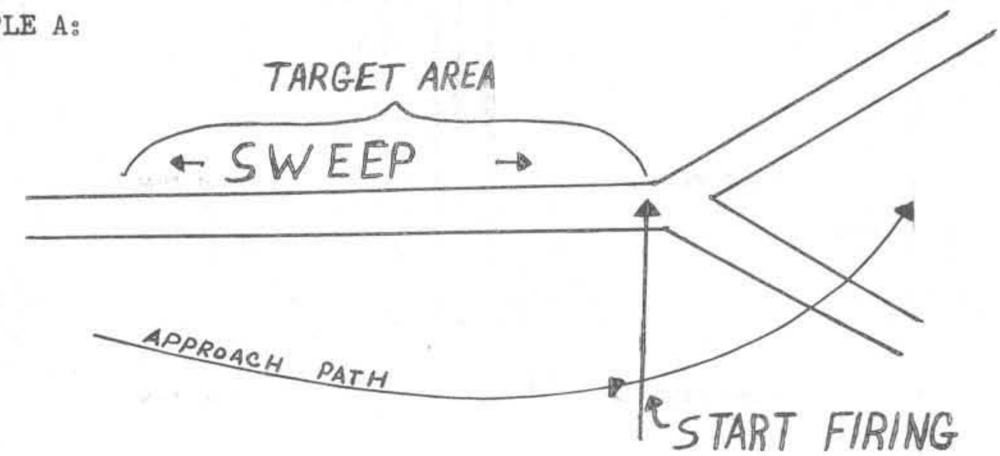
There is no easy solution or rule of thumb to the amount of "Kentucky Windage" needed any given moment. The direction of the needed correction can be predicted but the amount depends on much the same variables a paper boy handles automatically as he tosses a newspaper on your porch from his bicycle on a breezy day. You solve the problem the same way he did. Try it, see what happened, correct and try again.

You may find after some practice that the standard elevation adjustments don't quite work out for you. Don't be afraid to develop an adjustment factor to fit your own technique. Everyone does it a little differently, and if a shift of the pipper will put your hits in the target by all means shift. Increasing the mil setting moves the pipper down in relation to the impact and decreasing it moves the pipper up. A mil is one unit per thousand. Your firing range is about 4500 feet on the average so a one mil adjustment will move the pipper an apparent $4\frac{1}{2}$ feet.

Tactics

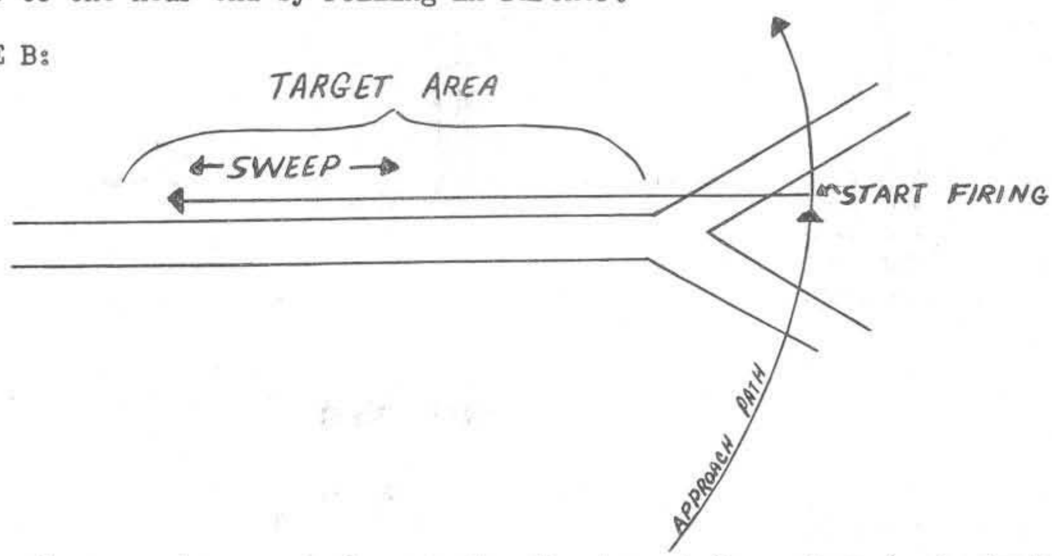
If the target is an elongated area it should be approached approximately parallel to the long axis if possible and the roll in should be planned to place the pipper on the far end of the target.

EXAMPLE A:



From this position the guns can be swept through the entire area easily by just relaxing some pressure on the top rudder. Similar results can be obtained with a little practice by rolling in as you cross perpendicular to a long axis. The pipper is placed on the far end of the target and then brought to the near end by rolling in further.

EXAMPLE B:



The procedure can be reversed, sweeping the target from close in to further away but it takes considerably more cross controlling.

The great majority of firing is done from a level turn, 2500 to 3500 feet above the target, but there are other possibilities which may be useful against specific targets. Fire can be directed at different angles to the target by varying the distance from the target at a given altitude. As higher angles are approached, the maneuver must be varied from the level turn to something approaching a lazy 8. Airspeed is gained in a shallow dive, then the nose is pulled up above the horizon and the airplane rolled to a near vertical bank as it passes over the target. Fire can be directed nearly straight down for a period of several seconds while going over the top by applying top rudder to hold on the target. This shouldn't be extended too long, however, or considerable altitude will be lost on the recovery. This maneuver would probably be needed only over a deeply entrenched unit.

Low angle strafing passes can also be made if the situation warrants the risk. This is done by flying parallel to the area to be strafed a thousand feet or so to the side and an altitude of 200 to 500 feet. Use the ailerons to put the pipper in the target area and rudder to hold the direction of flight or traverse the target as desired. The lateral distance and the altitude are interrelated. In general, the further out you are, the higher you can be and still hold the guns on target while maintaining straight flight.

The normal turning pass cannot be made below about 1200 ft absolute with undepressed guns or about 2000 ft with depressed guns because the pipper reverses its normal training direction.

The straight pass is sometimes the only pass that can be made at targets on the sides of mountains if the top of the mountain is high enough to interfere with the normal turn. Even if the turn can be made, it may not be advisable since the airplane would be very vulnerable to anyone firing from near the top of the mountains.

When using flares, the target should be evenly bracketed by the flare while it is burning. That is, the flare should be dropped upwind so that it will drift across the target, spending about the same length of burning time on each side. After the flare is dropped the airplane is brought back into the firing pattern as rapidly as possible. There will usually be time for about two orbits of the target before the flare goes out. When it quits or just before it burns out, another is dropped at the original point (or if the first one wasn't so good an adjustment is made) and the operation continues. This requires the pilot to make a conscious effort to remain oriented with regard to the target and the wind even after the light goes out. If there is little or no wind the flares can be dropped at random points around the firing circle as desired. If flares are released about two minutes and 40 seconds apart there will normally be enough overlap to keep the target lighted. Target acquisition under flares presents no particular problem as long as the reticle light is kept as dim as possible and the pilot maintains orientation.

While the pilot is concentrating on the target at night, the co-pilot has the responsibility of monitoring the aircraft attitude to ensure that it doesn't get dangerous. Caution should be exercised to avoid tumbling the gyros at night. Pilots must also be aware of the probability of vertigo during the period of transition back to the instruments after firing under a flare. Co-pilots must be alert to this probability and prepared to recover while the pilot is having trouble. Mild vertigo may be expected after most night firing passes. The pilot may not even be aware of it until he notices the ten to fifteen degree bank to the left that develops whenever he glances away from the instruments. This can be very troublesome when it is necessary to drop flares as well as fire the guns.

Caution:

Holding the pipper on target for an extended period during a firing pass will require heavy top rudder pressure. It is possible to push the rudder all the way to the stop and generate a stabalized condition in which the aircraft is in such a severe left slip that the rudder stops pushing back. Recovery requires firm bottom rudder and the recovery gyrations are rather abrupt.

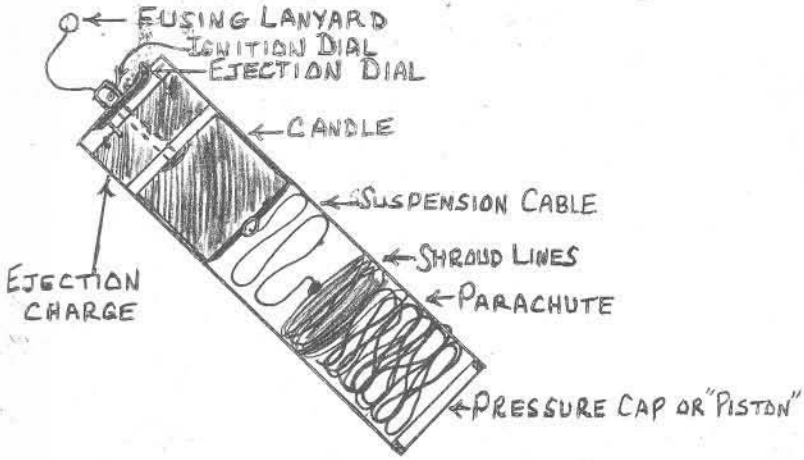
FLARES

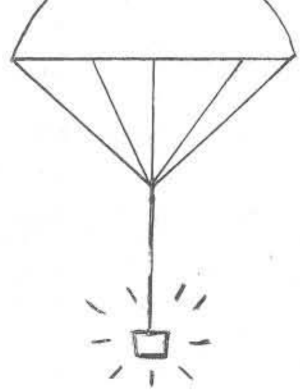
The most commonly used flare is the Mark 24 Mod 3. Each flare weighs 27 lbs, is parachute supported in operation, burns about three minutes and generates two million candlepower. Each flare has a dual timer which controls the length of time from ejection to parachute deployment and then the delay before the flare ignites. For training purposes we set our flares on 10 and 10. Ten seconds after the lanyard is pulled the parachute deploys and ten seconds after that the flare ignites.

Let's look at some of the safety features. A weather cap protects the fuzes and prevents accidental pulling of the lanyard. A thumb screw prevents accidental moving of the fuse dials from the safe position. A cotter pin through the ignition dial also prevents accidental pulling of the lanyard. The ejection fuze cannot be ignited with the dial on safe. The ignition fuze will not ignite unless both ejection and ignition timers are set. The cotter pin is removed just prior to launching from the aircraft. A fifteen foot static line is attached to the lanyard of the flare. When the flare is dropped, the static line pulls the flare lanyard.

More technically described (see figure below), the flare is simply a parachute supported magnesium composition candle. The parachute and candle come packaged in an aluminum cylinder about three feet long and four inches in diameter. One end of the cylinder is merely a pressed on cap that can best be described as a piston. In operation, the flare ejection charge generates pressurized gases that cause this piston to be forced out of the cylinder. This same pressure causes the parachute to follow through the opening left by the pressure cap or piston. The parachute becomes deployed and, with an assist from the remaining gases in the cylinder, the candle also leaves the cylinder, suspended under the parachute at the end of a steel cable. This cable is fastened to the riser lines of the parachute. The cylinder or cannister then falls free to the surface. Hence caution must be exercised when dropping flares over friendly troops. The cannister becomes a deadly missile when free falling from altitude.

The following illustrations depict a basic "cutaway" view of the entire flare package and the candle suspended in flight.





The flare can be de-armed by resetting the dials to safe after it has been set initially, but if the lanyard has been pulled it must be jettisoned immediately.

The flare must not be handled roughly, or exposed to moisture or to heat. Rough handling will disturb the powder trains in the timers and cause erratic operation.

When flares are used to support fighters in actual operations the pilot of the flare ship quite frequently has a lot to say about the patterns flown. Basically the flare ship flies a racetrack pattern with an inbound heading, and 30° off the fighter inbound heading.

Normally, the fighters use a left-hand pattern with (for instance) a strike heading of 090. The flare ship would then use an inbound heading of 060 and a right hand pattern. Flares are usually dropped in pairs and the pattern is adjusted to keep the time between flares to about two minutes and forty seconds in order to maintain continuous light over the target. The fighter pilots are essentially operating in day, VFR conditions under the flares so allowing the lights to go out can cause some pretty hairy instrument recoveries.

So far the problem is fairly simple. The hard part arises when the wind starts blowing. If at all possible, the flare ship should have the wind from the right or behind when inbound to the drop. This will prevent the overlap with the fighter pattern that will occur if the wind is from the other side or on the nose. The flares must be positioned so they bracket the target area while they burn.

The altitude selected can be almost anything above 2500 feet. Below that the flare will hit the ground burning even with minimum settings. Selection will be influenced by weather, ground fire and type of ordnance being delivered. Generally, the higher you fly the more difficult it is to put the flare where you want it.

Timer settings are influenced by the altitude flown and the desires of the fighters being supported. Fighters generally want the flares as low as possible so they will be in the light for as short a period as possible.

THE PEA PATCH

Eventually almost every C-47 pilot will have occasion to look upon some revolting piece of real estate and mutter--at least to himself-- that guy who expected him to land there was out of his head. Perhaps he was, but the real question is, "Can it be done?" There are ways of making an enlightened survey of the situation and coming up with a reasonably accurate answer.

The first question in potentially hostile territory is, who owns the air-strip at the moment? This can sometimes be determined by simply making a low pass and looking at the people who await your coming--if any. This won't do much good if you don't happen to know what the uniforms and flags of both sides look like. Such things call for a little study prior to departure. Perhaps recognition signals have been arranged in advance. If so, fine, maybe. A good recognition signal is no guarantee, nor for that matter is a bad signal necessarily meaningful. People tend to make mistakes and the more complicated the system the more mistakes will be made. There are some elements of risk to a low pass, of course, but bad guys will frequently hold their fire hoping that you will land. This means that just because they don't shoot doesn't mean they are friendly. Each situation is different. Each is potentially risky and a wrong decision will make things rough.

Assuming that a landing seems desirable, the next logical question is whether it is possible without breaking something. Field length, a critical factor, can be determined rather accurately by timing the low pass. Any airspeed and time can be worked out to field length, of course but 100 kts. has turned out to be a good speed. You can count on having a thousand feet of field for every six seconds and you are mooving slowly enough to take a pretty good look at the surface.

Surfaces have as many variations as there are airfields. We are interested primarily in hazards. Look down at the field from between 200 and 500 feet as you first come over to get an idea of the obstacles around it and within it. Rocks and stumps, hidden by grass at lower angles, can frequently be seen from above. If you can get in the right place relativeto the sun, you can see the glint of water through the grass quite often. Then the low pass at 30 to 50 feet looking for the smaller obstacles, timing the length of the field and checking on the welcoming committee. Cattle are frequently found on strips and a low pass will generally encourage their departure. (Watch out for the ones that circle back to their favorite pasture while you circle for your approach). If still in doubt as to whether or not the surface is hard enough, check for tracks. Any animal or vehicle that sinks in more than a couple of inches is bad news. If in doubt, make a touch and go, come back and look at your own tracks. After as many passes asyou need to determine the condition of the surface, planyour approach, touchdown spot and roll-out path. Then do it that way.

Considerations: If you are bringing a load in and going out empty, it is possible to get out of just about anything you can get into. If it's the other way around, take a good look at the obstructions and give yourself at least 2500 feet of runway. If the surface is soft, you'll stop with no problems but getting out can be tight. Snow up to about four inches won't hurt much on take-off but stopping takes more room. Deeper than that it's the other way around. Grass is slippery early in the morning and after a rain. Clay is the same but worse after a rain. PSP with grass growing through it is slippery all the time.

Tidal beaches that front on the sea or a large gulf are often excellent landing areas. But be very careful turning around. In fact, if there is enough room, don't turn around at all. During landing or takeoff roll the upslope of the beach will tend to turn the aircraft toward the upslope and the soft sand. If you catch one gear in the soft sand, abort immediately. A ground loop or cartwheel is virtually assured unless you can stop and regroup. Always examine a beach carefully before you land. Since the surface changes about twice daily, the nice runway you used this morning may be lethal this afternoon. Look for "leads" and moist spots. Leads are small streams that cut across the beach and run from the land side toward the sea. They are usually caused by water that was trapped during high tide or by a heavy rain or are the mouths of larger streams. From only a few feet in the air most look quite shallow and harmless. They are not, frequently are two feet deep with sheer sides or soft sand bottoms. Moist spots on an otherwise fairly dry looking beach are positive indicators of quicksand. Stay away from them. Plan landing and takeoff rolls as near the waterline as possible. This will generally be the best surface available. A crosswind exists almost always. During warm or hot weather the wind will be from the sea to the land during the day and should reverse at night. In cold weather the wind should blow from the land to the sea in the daytime and at night dies down but continues to move from land to sea. These are only general rules of thumb because weather systems and the geography of the land will cause variations. If hills are near the beach the winds aloft can be 180 degrees out of phase with surface winds. Tricky crosswinds combined with beach upslope can bring a wing tip awfully close to the sand. If at all possible fly a practice approach right down to touchdown point. You may find that you need slightly more power and half flaps for optimum control.

A note on engine run ups. Be logical. The engine and prop oil should be warmed up, naturally, but in many places an abort is ridiculous to even contemplate. In other places a mag check will tear up your elevators with rocks. On a gravel surface you'll have less grief if the mags are checked at 1700 RPM. This doesn't give you a power check but it will give as much or more of a mag drop indication in most cases.

Taxiing: Don't make it hard on yourself. If you plan all turns so that they start into the wind, you'll find it much easier to get around. Don't expect any help from people on the ground. Don't trust them when they give it. Don't trust the driver of any vehicle to have or use any sense at all. Don't try to taxi too slowly over soft or rough ground, keep it moving. Don't forget that on turns the wing will safely go over things which the tail has to go through. Don't wind up sitting someplace with a bent airplane. (And don't forget that under some circumstances you can't lose a thing by beating the bent section into a rough approximation of the original and giving it a try).

Short Field Landings

There are two basic techniques for landing the C-47 on short fields. The difference between them is considerable and the selection of the appropriate technique should be based on the mission, the field involved and the prevailing wind conditions.

The most commonly used technique is similar to that which is outlined in the C-47-1. This involves a tail low attitude at touchdown. The type of approach used to get to the touchdown will vary with individual pilot proficiency and preference but should generally be a fairly steep, low power approach with full flaps. The steep, low power approach is much safer due to the power-on stall characteristics of the airplane which generally involve a snap roll one way or the other and a relatively short stall warning. A high power, flat approach can more easily be terminated with a touch down at a given spot but it also involves the very definite risk of a power on stall precipitated by a wind shear. The steep approach can also run into a wind shear stall, but the power-off stall will fall straight through and give the pilot some margin for recovery. Another disadvantage of the flat approach is that many back country strips are laid out across the tops of ridges and thus come equipped with a built-in down draft right at the approach end. The pilot with a flat approach will frequently find himself looking up at the runway quite suddenly with only a few hundred feet to go. This is disconcerting.

For training purposes an airspeed of about 75 knots on final with anything from power off to 12-15" manifold pressure to about 50 feet from the runway (vertically), followed by a power off round out and touchdown on the wheels at the selected spot will work out rather well. The airspeed has a small margin built into it for the benefit of the I.P. and with increased student proficiency can be lowered a bit more if desired. However, with the heavier loads likely to be encountered during operational use, 70 knots is about as low as you want to go on final unless you know the individual airplane pretty well. The touchdown on the wheels rather than three point is usually preferred because the touchdown point can be more precisely controlled by pilots with relatively low experience. In addition, when the airplane is carrying a load, the wheel landing is less likely to overstress the tail wheel. Generally speaking, the wheel landing will also use up less total distance (air run plus ground roll) from the last obstacle cleared to the final stop even though the ground roll may be less with a three point landing. This last point can be argued either way, however, since there are enough variables to make an individual landing go either way.

The length of the ground roll is mostly determined by the conditions of the brakes, the type of surface, its slope, and of course, the weight and speed at touchdown. The most critical controllable factors are the speed and the condition of the brakes. Anyone who intends to use a C-47 on short runways should be thoroughly indoctrinated in how to taxi with absolute minimum use of the brakes and maintenance facilities should check brake adjustments on a daily basis. A pilot who sets his throttles at 1000 RPM and rides the brakes to control his taxiing can effectively wipe out a set of brakes just getting out for takeoff on the average airfield. Unfortunately it usually seems to be the next pilot to fly who winds up in the boondocks on the short field.

Assuming good brakes and a good touchdown speed there remains the question of runway surface and the possibility mentioned in the T.O. of digging in and nosing over. Judging by rather extensive experience, the possibility appears to be rather remote under most conditions. A stubborn individual can nose the airplane over by locking the wheels on a strip with good braking action, but full up elevator will counteract maximum braking on hard dirt down to between 25 to 30 miles an hour and the tail will promptly drop when the brakes are released. Grass fields allow the airplane to slide and you usually can't get the tail to even start up. A very soft surface does not present the possibility of digging in and nosing up, but when the surface is soft enough to present a hazard, there isn't much need to use brakes in the first place. In two cases, at least, the airplane has been landed on fields that allowed it to sink in over the tops of the wheels and in both cases full up elevator prevented the nose from striking the ground, although in one of the two cases it did bend the pitot tubes. Total "roll" in both incidents was about 300 feet without brakes. An uneven or unprepared surface presents the major hazard. Dropping a wheel into a hole or ditch while braking hard will almost certainly result in disastrous gyrations of one kind or another. Pilots should always drag unfamiliar strips before landing to locate such hazards.

Assuming reasonably good braking action, it isn't difficult to stop a 30,000 pound airplane in about 1500 feet of ground run. On the other hand, a grass field with morning dew still on it might take 2500 feet with the brakes locked all the way. The same field an hour or so later might be done in 1500. A rainstorm on a clay strip can double the required stopping distance. The question of whether the brakes should be locked will probably have occurred to pilots accustomed to hard surface operations. Rolling friction is greater than sliding friction on hard surfaces but on most dirt fields a sliding tire will be plowing a shallow trench and as a result will usually be generating more resistance than a rolling tire. A second consideration is that C-47 brakes are incapable of generating the optimum 20% rolling skid for any significant distance but can keep the wheels locked if they are locked before the full weight is on them. Average pilots in average conditions can operate safely on 2000 feet of runway with gross weights up to about 30,000 pounds. Proficient pilots can do with less under favorable conditions but the question is not how much runway is used as it is how much margin of safety you wish to allow. A good deal of uncommon sense must be exercised to avoid committing people to untenable operations especially when the determining factor, such as weather, is is not under the control of the commander.

The second technique for getting into short fields has a rather limited practical application since the airplane can be put into fields it can't possibly be flown out of without the use of RATO. The basic idea is to make a power off approach at about 5 knots above power off stall, terminating the approach with a rather abrupt flare out which places the airplane in a three point or slightly tail first attitude just above the ground. Done properly the resulting touchdown will usually be rather firm. If the flare is started too high, the plane will fall through to a solid impact on the gear; and if the flare is started too low, the results are guaranteed to loosen teeth, but if the gross weight is under 26,000 it takes a really bad one to damage anything other than the pilot's ego. This procedure will get the airplane on the ground in an absolute minimum distance after passing over an obstacle but it is not for the novice and there is almost no room for an I.P. to recover an error. Air run from over fifty foot obstacle to touch down can be as low as 300 feet with no wind, and stopping distances with maximum braking and a good surface will be between 500 and 800 feet with the average around 700. Braking techniques are important on this. Best results are obtained by locking the wheels immediately, before the weight on them can prevent it, and allowing the airplane to slide until it starts to swerve, then releasing and reapplying as hard as possible. This can't be practiced on hard surfaced runways of course--the tires blow--but on dirt they don't even skuff much. Flap retraction is unimportant since the airplane will be almost stopped by the time the flaps get up and retraction does slightly reduce the hydraulic pressure available for braking.

Under some conditions a combination of the two techniques can be used to advantage. A low power approach to a three point landing will allow a slightly lower speed at touchdown and result in a somewhat shorter ground run under slippery conditions, for instance. Wheel landing advocates frequently tangle with the exponents of the three pointer technique over what gets the shorter landing. The touchdown point is easier to control with a wheel landing. Stopping distance is shorter with a three point touchdown due to lower speed. If the pilot is proficient enough to make a three pointer just where he wants it, he can stop sooner than if he touched down on the wheels at the same place, but if he floats a hundred feet trying to get the three pointer, he has thrown away all his advantage and then some.

A note on takeoffs. The procedure in the T.O. has its disadvantages. The tail low attitude will give noticeably less effective rudder control than can be obtained with the tail up. It will also yield more stone damage to the elevator fabric on gravel fields and gives pretty marginal lateral control at lift-off in cross winds as well as some rather interesting moments in gusty conditions. A more satisfactory performance can be obtained by setting the flaps in advance to a little over ¼, (on <u>rough</u> fields any setting made at 39 knots is a guess) running up to full power with the wheel held full back, releasing the brakes, getting the tail up near level ASAP and rotating at a selected airspeed. There is rarely any need to select an airspeed under 60 for the rotation but this is dependent upon the airfield. With this technique, the airplane breaks ground cleanly with positive control and the ground run won't be measureably different from the T.O. procedure. Initial climb out is usually done at 76 knots for obstacle clearance. Lower airspeeds may be used as necessary of course, but engine failure below minimum control speed is a hazard that must be considered. There is also the possibility of forcing the airplane into a power on stall if the nose is brought too far up too soon. This is rare but it can be done if rotation is accomplished around 55 knots and the nose is pulled up past a three-point attitude. Aileron reversal may also be encountered below 55 knots- a wing low attitude should be corrected with rudder.

The T.O. technique has its place on very soft ground where the lift generated by the tail low attitude helps get the bird out of the mud so it can accelerate faster. On <u>really</u> soft ground starting a deliberate bounce on the roll will sometimes let you pick up enough speed between impacts to stay airborne but you better have a lot of field to run on if it takes that technique. While on the subject, it is worth noting that there is probably more hazard of nosing up on take off than there is on landing. All it takes is a hole, a ditch, a pile of dirt, snow or something of that sort to make the nose bob enough to catch the props. It doesn't take much of an impact to cause the props to separate from the engine at max power. The left prop usually comes through the cockpit in such cases and kills one or both pilots.

Loudspeakers

Several different types of loudspeaker installations are in current use. The most common varieties mount in the main cabin door, projecting sound to the left and slightly downward. Some other types are mounted beneath the aircraft. Of these, one type projects the sound to the rear and others have movable installations which may be adjusted to direct the sound in any direction. This discussion is primarily concerned with the door-mounted installation which has achieved favor through its minimum drag penalty, easy installation and relative effectiveness.

At least three varieties of door-mounted speaker systems are being used. From the pilot's point of view the major differences are largely confined to variations in the maximum altitude at which the system is still effective. Basic flight techniques remain the same. The aircraft is flown around the target area in a left turn which will keep the speakers pointed at the target and within effective range. Airspeed has little if any effect on the outcome other than to establish the angle of bank required for a given radius of turn. Any errors can usually be compensated for by cross controlling to keep the speakers on target while following the desired flight path.

Altitude selection is dependent on several variables. If the natives are restless--and armed--the pass should be at the maximum effective altitude and preferably after dark. The maximum effective altitude can be determined most accurately by a series of trial runs over a man equipped with a radio. He can give you a direct reading on your effectiveness at various altitudes and distances as well as helpful criticism of voice technique.

Since it is rarely possible to put a man in the actual target area, the pilot must make allowances over the target for several factors. Surface wind, for instance, will reduce the height from which you can speak effectively. The stronger the wind the lower your altitude must be. Wind at flight altitude will shift the reception point as well as messing up the flight path. You must come in closer on the downwind side and move out further on the upwind side--directly the opposite of what the wind will normally do to your flight path. Trees, houses and traffic will also reduce the effective altitude. In general, the small speaker systems can usually get through at from 800 to 1200 feet in the average target area with light winds (up to about 8-knots). The larger systems can punch through from 1500 to 2500 feet in average conditions with winds up to about 15 knots. In ideal conditions the big ones can be understood from over 4000 feet but operational targets are rarely ideal.

The selection of material to be broadcast is not generally up to the flight crew but the crew has some responsibility for guidance of the psyops types who do the selection. The gray flannel suit boys frequently come up with something ridiculous and subsequently blame the crew for poor performance. An extreme example was the order to broadcast an entire presidential speech to the city of Santo Domingo.

The basic requirement for successful communication with this system is that the message be short and to the point. "Short" means a maximum of about 45 seconds at a slightly slower than normal rate of speaking. Shorter messages are even better. With a short message the pilot has the capability of reducing the aircraft noise to an absolute minimum by reducing power while the message is being broadcast, sacrificing airspeed to maintain altitude. Repetition of the message will insure delivery even though an occasional word is lost to extraneous noise or garbling. The meaning of a long message will inevitably be degraded by uncontrollable factors.

In practice, after the speaker system is checked out sufficiently to give the pilot a good idea of its capability, he will approach the target area at or slightly above the altitude he judges will be effective. The path of flight will be between $\frac{1}{4}$ and $\frac{1}{2}$ a mile to the right of the target, aircraft clean, and with minimum RPM. Airspeed is optional; normal cruise is adequate, slower if desired. When the target is off the left wing, the pilot rolls into his turn and tells the operator to start talking. Speakers are kept pointed at the target until the message is finished--and that is about it. Actual effectiveness over the target is impossible to determine but there will be clues if people are visible. If they stop and look up, you are getting something through. If they don't react, get lower. If they start shooting--well, you can't win 'em all.

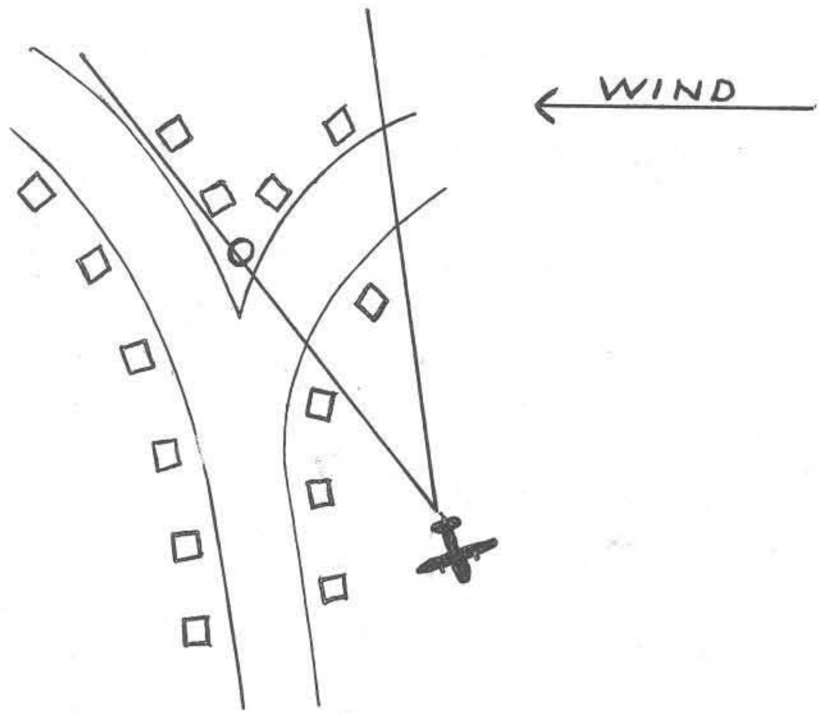
Leaflets

Leaflets are usually distributed by hand from the passenger door and/or the emergency hatches. Hatch doors may be removed prior to flight or they may be unlatched in flight and allowed to "fly". Airflow will hold the hatch door out at about a 30 degree angle. When the passenger door is opened for drops, several cargo straps rigged across the opening will tend to prevent inadvertent departure of crew members.

Villages can usually be covered adequately with a single pass at 50 to 100 feet (Example A). Larger areas will require multiple passes, normally in a creeping line pattern (like crop dusting) to insure coverage (Example B). Generally, drops made at minimum altitude are the most accurate. Over hostile territory night drops can be used but accuracy is degraded since the pilot cannot determine the drift. Day drops over hostile towns are rather hairy propositions but if the pilot avoids flying down streets and stays at or below rooftop level the number of bullet holes acquired from small arms fire will be kept to a minimum. Towns with heavy weapons are out of the question.

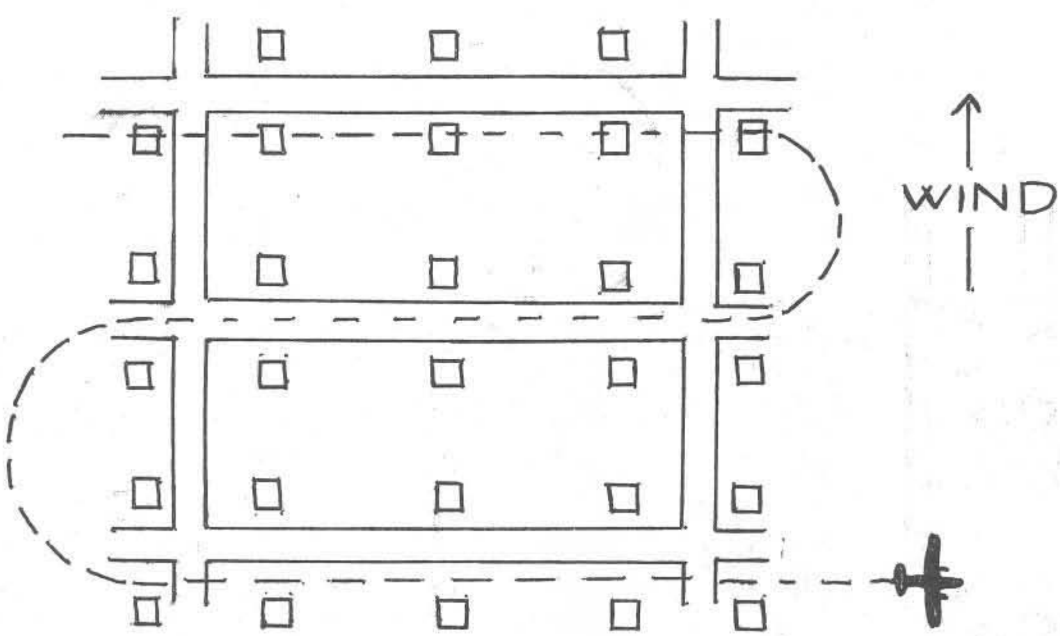
Very large areas requiring thin distribution are most easily covered by high altitude drops. The drop point can be approximated by using the forecast wind and the supposed rate of fall of the leaflets to be dropped.

EXAMPLE A:



Larger areas will require multiple passes, normally in a creeping line pattern (like crop dusting) to insure coverage.

EXAMPLE B:



Wide distribution is guaranteed, target coverage is not, but unless the wind is very erratic, results should be adequate if enough leaflets are dropped.

Another procedure is the DOL system. This is a method for delivering bundles of leaflets from any desired altitude. The bundles are fuzed to open up a set time after an igniter is pulled. By careful altitude control, the pilot can cause the bundles to open and scatter the leaflets at any selected altitude. From that point on the leaflets are scattered by the wind. Precise control of leaflet coverage is more difficult with this system than with low level distribution but it does have the advantage of allowing the aircraft to remain out of effective ground fire range.

In practice, leaflet drops are essentially cut and try operations. Due to the vagaries of winds, variation in leaflets and varying thermal conditions over the varying types of targets, the only way to really find out where the proper release point should be is to try a sample drop and see what happens.

Wind is probably the most significant single factor. Unless it is caused by a definite weather system, wind is a wild variable at low altitudes. 180 degrees shifts over a distance as short as five miles are common in light wind conditions. At the rate a leaflet falls, one or two knots will make a considerable difference in the release point. Target wind conditions can be determined from smoke, ripples on water, flags, laundry, etc. Smoke is the most helpful if it can be found in the area.

The leaflets themselves have a lot to do with the coverage. Heavier paper will fall faster, naturally. Leaflet size will normally range from about 5" to 8" up to tabloid newspaper size. If they are all on the same paper, they seem to settle at about the same rate regardless of size. Several charts showing leaflet fall rates have been developed and are currently in operational use. The navigator computes a release point over the ground from the charts, and the pilot simply drops when over that point.

Thermal conditions over the target can make or break the whole operation. On a hot day a leaflet released more than 200 feet above a city with paved streets just isn't going to land in the city. Thermals over the paved areas will keep it up until the wind drifts it out over the country. Leaflets released below 200 feet have a better chance of being read but don't be surprised to see leaflets released just above the roof tops on the first pass still airborne and gaining altitude after the last pass. Such conditions are common--and frustrating. The only solution is an early morning drop before thermals get started. When a mission requires drops on several different targets, the planners should remember that thermals are slower to start and don't get as healthy over smaller towns. Get the big ones first and the smaller ones later.

MISCELLANEOUS OPERATIONS

Mixed Loads

There are certain factors that require special consideration and planning when airlifting both cargo and passengers. The cargo MUST be placed forward of the passengers. The obvious reason for this is that in the event of a rapid stop on takeoff or landing (crash landing, ground looping, etc) danger to passengers from possible shifting of cargo is minimized. In the event that loading of all cargo forward is impractical due to weight and balance requirements or other factors, it is permissible, though not recommended, to load the cargo along one side of the fuselage and the passengers on the other. Remember that passenger safety is always paramount, and if final load configuration would compromise safety, redistribution or reduction of cargo or passenger load may be necessary.

Dangerous Cargo

Dangerous cargo falls into many categories and utmost precaution must be observed when handling or transporting it. All dangerous materials must be stowed in such a manner that they will be easily accessible for jettisoning in flight without moving other cargo. It is recommended that all dangerous materials be loaded on the C-47 in "F" compartment if weight and balance requirements can be met.

The principles of loading dangerous cargo in all aircraft are practically the same. The following safety precautions are required:

1. Proper ventilation
2. Aircraft placarding
3. No smoking
4. Fire extinguisher availability
5. Aircraft electrical grounding
6. Thorough inspection of cargo
7. Stowage away from heater outlets, and other heat or electrical sources.
8. Medical personnel notified in case of damage to radioactive material.
9. Utilization of protective clothing and equipment as required when handling dangerous materials.

Litters

Medical evacuation by air is the quickest and often the only method for transferring ill or wounded troops from the field to hospitals where they can get proper attention. In order to insure the safety, and as far as possible, the comfort of patients being air lifted, a medical corpsman or nurse should accompany patients during flight. The loadmaster will see that each litter is installed properly and the patients secured with their heads to the front of the aircraft, (due to the $7\frac{1}{2}$ degree slope of the cargo floor). This will help to prevent abnormal blood flow to the head during ground operation and takeoff.

The C-47 has provisions for carrying 15 to 24 litter patients, depending on what modifications have been made on the aircraft. The litters are installed by means of litter straps and litter brackets. When needed, the 2" cotton straps are secured between the overhead litter support tube and fittings on the cargo floor. The litter brackets are mounted permanently on the fuselage.

It is usually easier to rig the litters prior to loading the patients than it is to load and rig at the same time. Emergency evacuations of three or four litter patients can be more rapidly accomplished by securing the litters to the cargo floor with tiedown straps as they are loaded aboard.

FAC

As a C-47 pilot you may at times be called upon to perform Forward Air Controller functions or to work for a FAC. In either case the communications problems inside and outside the aircraft are multiplied. Generally it is best to delegate most of the communications functions to the co-pilot. This will enable you to devote more of your attention to the operation at hand.

You may also serve as a communications relay between a ground unit and a flight of fighters. Army units generally use FM radios and most fighters only have UHF. In such cases you must remember that the capture of a radio will allow the opposition an opportunity to call in fighter strikes on friendly forces. If there is room for doubt--authenticate.

A FAC will mark targets for you by using verbal directions, smoke grenades, smoke rockets or high explosive rockets. Rockets are carried under the wings of the O-1E and fire forward in a conventional manner. Accuracy varies from one pilot to another and shouldn't be criticized--the guy doesn't have a sight. Smoke grenades are eyeballed in--usually from at least 1000 feet. Targets will be called a given distance and direction from wherever the marker lands. You must maintain directional orientation in order to work with a FAC.

In order to work as a FAC you must not only know your own aircraft, you must know the capabilities of the strike aircraft, the effectiveness of different types of ordnance and the delivery procedures utilized by the strike aircraft. In addition you must know, thoroughly, the rules of engagement.

As a FAC over a target you should note the prominent check points and select an orbit point for strike aircraft. The orbit point should be a well-defined geographical point which can easily be seen by the strike aircraft, and one from which the strike can be started. Orbit location is affected by such factors as known or suspected anti-aircraft fire, other tactical operations in the area, weather conditions and the need to minimize observation by enemy ground forces in order to attain the element of surprise. Study the target area for the best directions of attack and break-away from the target using the following criteria:

a. Break should be toward the most suitable terrain, considering obstacles and emergency landing areas.

b. Direction of attack and break should avoid areas of concentrated ground fire from known or suspected enemy positions.

c. Attack should be in the direction which will afford the target the least protection from terrain or protective cover.

d. Attack and break should be in a direction which will not endanger friendly forces in case of runaway guns or hung ordnance.

Landmarks and terrain features can be used as reference points from which to locate targets. Using these reference points, compass direction and distance to the target may be relayed to the strike aircraft. The clock method of identification using your aircraft as a reference can also be used if the strike aircraft can see you. When these are not adequate, colored smoke grenades or rifle smoke grenades may be used as a reference point from which to locate targets.

The smoke grenade discharges white or colored smoke for approximately two minutes but it must be dropped from a relatively low altitude since it ignites the smoke immediately after being thrown. Once the pin is pulled, the handle must be held to prevent discharge. An advantage of this grenade is that strike aircraft are able to follow the smoke trail to the target.

The rifle smoke grenade is not set off until it hits the ground. It may be dropped from any altitude with the assurance that the smoke will be discharged at ground level. (Avoid striking the aircraft after the pin is pulled).

When the strike aircraft arrive, determine the call sign, type of aircraft, type and amount of ordnance and the time the flight can remain in the area.

Brief the flight leader on the target--what is it made of, its location, elevation, any obstacles around it, surface winds, how it will be marked, flak location, location of friendlies. Recommend the attack and breakaway you have selected.

If you mark the target with smoke, as soon as the marking device has been dropped turn to observe its impact point and adjust the fighters to the target. EXAMPLE: "The target is 20 meters north of my smoke," or "The target is my smoke." Use compass heading to target and distance in meters.

Have the fighters confirm your smoke color and the target. When the fighters have the target and you have the fighters in sight, clear them in HOT, but do not clear them unless you have them in sight. Up until this time it has been the responsibility of the fighters to maintain separation from you but when you clear them in, it becomes your responsibility to stay out of their way. Remember that even if they have accepted your recommended attack heading they will be varying around that heading on their attacks.

(When there is sufficient distance between friendly and enemy forces, the strike aircraft are free to attack on any heading. This allows more variation of attack patterns and decreases the effectiveness of enemy ground fire. Strike aircraft which are free to attack on any heading will normally use a moving figure eight pattern.)

Strike aircraft will also vary their pull out from the target to reduce their susceptibility to ground fire. It behooves you to make every effort to avoid being in front of a fighter coming off a target due to the hazards of runaway guns or hung ordnance.

Delivery Methods

Incendijel: The aircraft releases in a level attitude approximately 50 feet above the ground. The method of reaching this point is varied by the pilot depending on terrain and the extent of ground fire. If severe ground fire is encountered, the aircraft may approach the release point in a fairly steep dive and will frequently be strafing the target during the dive.

Bombs: Normally released by dive bombing. The roll in is initiated 4000 to 5000 feet above the terrain, the aircraft dives at a steep angle and recovers at about 1000 feet.

Rockets: Usually fired from a 20 to 40 degree dive when the aircraft is about 1500 feet above the terrain. Can be fired in salvos or by intervalometers.

Guns: Strafing can be accomplished using either shallow or steep angles of attack. Runs can be initiated from almost any altitude but the average roll in is between 2000 and 3000 feet.

Mixed Loads: An effective tactic used by strike aircraft to reduce losses to ground fire is the use of mixed ordnance loads. To illustrate this, consider the following theoretical flight of four aircraft:

Lead Acft - 500 lb bombs, 260 lb frag bombs, guns

#2 Acft - Incendijel, rockets, guns

#3 Acft - 500 lb bombs, 260 frag bombs, guns

#4 Acft - Incendijel, rockets, guns

Lead aircraft bombs on his first pass; #2 aircraft allows just enough time for the bomb fragments to settle and then delivers incendijel on his first pass; #3 aircraft has already rolled in on his first pass (dive bombing) as #2 aircraft releases, and as #2 pulls off, releases his bombs. The attack is continued in this way, so that one aircraft is constantly delivering ordnance on the target. This method tends to keep the enemy's heads down and prevents him from firing during the extremely susceptible period when the strike aircraft is pulling off the target.

Ferrying

Pilots assigned to long range ferrying missions will discover there are weird ways of installing fuel systems in a C-47. For some reason, possibly a shortage of plumbing, several short cuts are frequently tried. Lines will be attached to the front ends of the tanks and led directly into the intergral fuel system, for example. Cross feed systems may not be installed. Dump lines will be too small and too far forward. Vent lines will be on the wrong ends of the tanks. Non-flying types will be very difficult to convince when arguments start. The best approach is a flight test--with the non-flying types on board. Fuel fumes, the deafening silence of a dead engine--such things are the most convincing arguments and can easily be demonstrated with a little forethought.

A safe installation can, and must be demanded by any pilot assigned to a ferry mission. To be safe the fuel supply to the engines must come from the aft (low) end of the tanks. There must be a crossfeed arrangement which will allow feeding either or both engines from each tank individually or together. The dump system must be of adequate capacity and dump lines should run back near the tail before venting overboard to avoid fumes in the tail during dumping. The tank vent lines must be placed at the high end of the tanks. The valves in the plumbing should be quick acting types rather than fugitives from a water line.

All other arrangements are inadequate, hazardous or both, regardless of who approved them.

Assuming a safe, versatile fuel system, the actual conduct of a ferry mission is quite simple. The only really vital things to remember are: first, when cabin tanks are turned on, the wing tanks must be turned off, because otherwise the fuel will drain from the cabin into the wings until the wing tanks are full and will from then on be lost overboard. Second, the fuel must be managed so that fuel will be available in the wing tanks for the approach and landing. All tanks should have some slosh fuel remaining unless it becomes absolutely necessary to run them dry.

We recommend that takeoff and climb be accomplished on the main tanks. Cruise for the first half hour or so on the aux tanks and then go to one of the cabin tanks. Running both engines from the same cabin tank will produce a more accurate record of fuel consumption than running them from separate tanks. Wing tanks should be checked hourly to detect any overflow due to unusual carburetor return flow. After both cabin tanks are used, wing tanks are selected on the basis of trim and the flight continues in normal fashion.

One problem remains--the selection of power settings and airspeed for cruise. The 4440th will provide the pilot with cruise charts. These charts are drawn from the -1 and will get the aircraft to its destination. The only objection is that the basic information in the -1 pertaining to cruise speeds is wrong. Anyone can demonstrate this with a little work. For instance, if the cruise charts are plotted out for a no wind flight to Hickam from McClellan, the time required will be over 17 hours and the maximum acceptable headwind will be about 4 knots with a legal reserve. If the same charts are then used to plot the same flight using 135 knots TAS instead of the "max range" speed, the time required will be nearly an hour less, the aircraft will burn 50 gallons less fuel and the allowable headwind is nearly tripled. 135 knots may not be the best possible speed, but it is demonstrably better than the -1 speed.

In practice, at level off power is set at 600 hp, the maximum auto lean power setting. With normal ferrying gross 31,000 plus this will produce about 132 knots TAS at the optimum altitude of 7500 feet. RPM is reduced and MP is held at max BMEP as the aircraft gets lighter to hold 135 TAS. When minimum RPM is reached, (1700), the MP is reduced gradually to about 28". By this time the consumption line on the fuel graph is usually far below the required line so the airspeed can be allowed to increase in order to reduce the flying time required. Using this procedure will result in a fuel graph that starts above the maximum line for the first few hours, drops steadily to the point below the required line where power reductions are stopped, then roughly parallels that line to destination.

UNCONVENTIONAL WARFARE

This chapter is concerned with tricks of the trade which have proven successful in the past and may again be useful to someone.

Hand Grenades: These little bombs can be delivered effectively in several different ways. The original method was to pull the pin and slip the grenade into a Skippy peanut butter jar. The jar keeps the handle from flying out to arm the grenade. Several grenades thus pre-packaged can be carried along carefully. Dropped from any altitude, the glass breaks on impact, the grenade goes off about five seconds later. The glass jar method has been largely superseded by the Dixie cup method which seems to work just as well. Pick the appropriate size of a cup and work the same way but don't try to pre-package them. If you don't happen to have a cup or jar handy, a grenade dropped from 300 feet will go off just as it gets to the ground but this has the disadvantage of exposing you to effective ground fire. Dropping from a low pass works too, although the effective radius of the grenade is reduced in a ground level blast and you have to guess at how far it will roll.

Twenty-five gallon drums of napalm, properly fused, can be eyeballed into a target just like any other eyeball drop. A Goon can carry a mess of napalm.

A .30 cal. Browning on a bipod mount can be very effective through the open back door against vehicles, boats, etc. Works best with 1 in 4 ammo, at 200 to 300 feet.

A Thompson .45 cal. sub machine gun can be used to fire forward against appropriate targets. Slide the co-pilot's weather window and his side window open. Stick the Thompson out the weather window and the co-pilot can hold it in the normal manner. The expended brass neatly disposes of itself out the side window. Tracers are not needed; the slugs are big enough and slow enough to be watched all the way into the target. Point the airplane at the target and the co-pilot makes the final adjustment. It really isn't very effective, but it's fun.

Smoke grenades are useful things to have along on just about any flight. They aren't used too often but when you need one there isn't any good substitute. They can be used to determine the surface wind on an airstrip where there just isn't any other clue. They save a lot of talking when you want to point out the location of someone who is shooting, so your escorting fighters can shoot back. Even if you don't drop the thing right on the s.o.b., it makes a dandy reference point.

With skill and cunning you can use a regular parachute flare to light your own landing area if need be--but use discretion, it's embarrassing to have the flare land on the airplane after you get parked. There are several ways to do the job but essentially all you need to do is drop the flare where it will light up what you need and then make a quick traffic pattern.

It seems to work out fairly well if you drop from a high downwind leg upwind of the field.

For emergency evacuations of people you can get the most on board by folding the seats down out of the way and having the customers sit on the floor facing aft. First row against the bulkhead and the rest packed neatly in succeeding rows against the knees of the ones further forward. Roughly 75 to 85 can be accommodated this way depending on their size. Watch out for the sneaky ones that hide in the tail cone and up in the wheel wells. With this load it is a good idea to use $\frac{1}{4}$ flaps on takeoff and run up to full power before releasing the brakes--no telling how much you'll weigh.

If the opposition has "fighters" in your operational area, (that means anything from an armed T-6 on up), the only place to be is on the deck with a man on interphone watching out the astrodome. You are harder to spot down there and getting on the deck covers that big blind spot underneath. If you do get spotted, don't just sit there and take it. You can turn inside just about anything simply because you can do it at a lower airspeed. Silly as it seems, it pays to be aggressive. Any time you can spend on the tail of someone's glorified trainer is time he can't spend on yours. A sharp fighter type won't let you get away with it for long but many of the jocks from the smaller countries don't have the air-to-air experience they should have. Stay on the deck and play the terrain--he might swing wide and run into it, you know. Remember that head on passes are better for you than for him and be gutsy about it--better to take him with you than let him off free in the first place and secondly, if you can shake him up, you have something else going for you. You'll need METO RPM at least and every combination of flaps and power you can come up with plus a lot of luck. You can outperform an armed T-6, match a T-28, turn inside A-1E's and P-51's. Most jets can be dodged if you see them coming, but they can get to you sooner or later if they have the fuel to mess around. The secret of success with any of them is to suck them into your game--a turning contest on the deck.

APPENDIX - - ORDNANCE INFORMATION

A variety of weapons may be carried by strike aircraft as standard alert loading combinations. When the target is known to be personnel in frame or jungle type houses, the ordnance will be incendiary and fragmentation in addition to the machine guns or cannon normally carried. Aircraft placed on alert to support a specific operation will be configured to provide the best capability against the preplanned target. The following paragraphs provide a brief description of the various ordnance and ordnance dispenser types available and the distance that the FAC or friendly troops should be from the center of the impact area for safety. The safety distance indicated is based on criteria contained in Air Force Manual 51-44, dated July 1963, and 400-5, dated October 1959, (no longer in print) and Tactical Air Command Manuals. Specific safety distance information is not available for all ordnance items; however, research is now being conducted to provide this data.

Guns and Cannon

(1) M3, Caliber .50 aircraft machine guns are high speed, recoil-operated link-belt-fed air cooled weapons. Caliber .50 gun ammunition is loaded as specified for the mission. Types available are:

- (a) Armor piercing M2.
- (b) Armor piercing incendiary M8.
- (c) Armor piercing incendiary tracer M20.
- (d) Ball M2, M33.
- (e) Incendiary M1, M23.
- (f) Tracer M1, M10, M17.
- (g) Tracer headlight, M21.

7.62 mm Machine gun (mini gun). This gun works on the gatling gun principle (6 rotating barrels) and is externally mounted in a SUU-11/A gun pod. Ammunition includes a tracer and an armor piercing round.

M3, 20 mm automatic gun. This air cooled weapon is a combination blow back and gas operated aircraft weapon. It is fix mounted and has a rate of fire of 650 to 800 rounds per minute. Ammunition types available are:

- (a) Armor piercing tracer, M95.
- (b) High explosive incendiary, M97, with fuze, point detonating, M75.
- (c) Incendiary, M96.
- (d) Target practice (ball) M99.

XM75, 40 mm gun. gun fires ball and high explosive anti-personnel ammunition.

Rockets

(1) 2.75 inch folding fin aircraft rocket (Mighty Mouse). The 2.75 inch FFAR is a high velocity aircraft rocket which, with the appropriate head for the purpose, serves as an air to air, air to ground or practice weapon. It is generally fired from clustered rocket tubes. Various warheads include:

(a) Inert, practice ball.
(b) High explosive (HE).
(c) High explosive anti-tank (HEAT).
(d) Improved frag head. Cast iron warhead of 10 lbs weight with a super quick, graze impact fuze for specific anti-personnel capability.
(e) Flechette head. Improved frag head contains an ejection charge which deploys flechettes (arrows) at a pre-determined time on its trajectory.

(2) 5.0 inch high velocity aircraft rocket (HVAR)(Holy Moses). A high velocity rocket with fixed fins and a variety of warheads. It is fired directly from the wing pylon. Various warheads include:

(a) Inert, practice (MK 6-1)
(b) Proximity HE (MK 6-4)
(c) High explosive, anti-tank (HEAT) - (MK 32-1)
(d) Armor piercing (MK 2-2)
(e) Smoke PWP (MK 4-1)

Bombs

(1) General Purpose (GP) Bombs. This type bomb is designed to meet the requirements of the great majority of bombing situations. The various models range in weight from 100 to 2000 lbs and the explosive in this type averages 50% of the total weight. General Purpose bombs may be used for blast, fragmentation or mining effect. They are designed for use with both nose and tail fuzes. Nose fuzes produce more efficient surface effect and tail fuzes produce more efficient deep (mining) effect. Both fuzes are generally installed and the aircrew can select the proper fuze prior to drop to give the effect required on the specific target.

(2) Fragmentation bombs and clusters. Fragmentation bombs are designed to produce their effect through projection of the fragments of the case body and are intended for use against personnel and materiel. Varying sizes of bombs are available and are selected based on specific requirements of the target. Target identification information should specify the type of vehicles or armor and the number of personnel and their disposition to assure that the proper ordnance is loaded for the mission. The following are examples of fragmentation ordnance available:

(a) M1A2, Frag Cluster contains 6-20 lb frag bomblets which disperse automatically when released from aircraft.

(b) M28A2 Frag Cluster contains 24-4 lb bomblets.

(c) M88 (220 lb), M81 (260 lb). Fragmentation bombs primarily designed as anti-materiel weapons.

(d) BLU-3B. These fragmentation bomblets are designed for anti-materiel use but have an anti-personnel application. The bomblets are housed in an SUU-14/A (6 tube) dispenser. Each dispenser tube holds 19 bomblets.

(e) BLU-17B white phosphorous bomblets housed in SUU-14A dispenser. 14-16 bomblets per tube.

Bomb Anti-Personnel and Materiel (Bomb Anti-PAM).

(1) 750 lb M116 A1/A2, 750 lb BLU-1B, 500 lb BLU-11/B, 250 lb BLU-10/B. These bombs are non-stabilized, cigar shaped, thin skinned aluminum tanks filled with a jellied gasoline solution formally referred to as napalm, now called incendijel. These bombs have either vane or electrical fuzes with white phosphorous igniters. Bombs come in 750, 500, or 250 lb sizes (called Red Dog 750, 500, 250) to provide flexibility and compatibility with aircraft and target.

(2) 100 lb WP/PWP (M47A4). A tin plate bomb with an explosive filled booster tube and a simple nose fuze for dispersion of contents. PWP has a plasticizing agent added to give better dispersion and greater adhesive qualities to the white phosphorous chemical which produces smoke and burning particles.

(3) M-31/M-32/M-35/M-36 Incendiary Cluster. These bombs contain individual bomblets which are separated by the action of a mechanical type fuse spilling the bomblets.

(a) M-31, 500 lbs, 38 bomblets, PT-1 ("GOOP" a type of incendijel).

(b) M-32, 500 lbs, 108 bomblets, thermite.

(c) M-35, 750 lbs, 57 bomblets, PT-1.

(d) M-36, 750 lbs, 182 bomblets, thermite.

(4) Fuse information. Various fuses are available for bombs and are used dependent upon the target and the result required.

(a) Nose fuses are generally impact or short time delay fuses (0.1-0.025 second delay).

(b) Tail fuses are generally time delay fuses designed to allow penetration of the bomb prior to detonation (0.025-0.15 second delay).

(c) Proximity fuses (VT) are used to provide detonation at a selected height above the terrain and are always used in conjunction with a tail fuse.

(d) Special long time delay fuses are available providing time delays from one to 144 hours and incorporating an anti-withdrawal device.

Separation Distance Criteria

The separation distance from Center of Impact in the following chart are for aircraft, and give a Safe Probability Distance that provides an operationally acceptable risk factor. It does not include the operational considerations of urgency of requirement (proximity of enemy) and the degree of protection available to friendly troops (fox hole, earth barricades, etc).

In all instances, it should be recognized that the degree of risk is a mathematical computation of hit probability and as such is only relatively safe. Protective cover is desirable in all instances. The distances are not safe for demonstrations.

GUNS	Recommended Combat Separation Distance
(1) 50 Cal Machine Gun*	500'
(2) 7.62 mm Gun*	500'
(3) 20 mm Automatic Gun*	
High explosive incendiary, M97	1900 ft
All other	500'
(4) 40 mm Gun*	
Ball	500 ft
HE Anti-personnel	1900 ft
Rockets	
(1) 2.75 Rockets	1900'
(2) 5.00" High velocity rocket	1900 ft
Bombs	
(1) General Purpose (GP)	
100# GP	800 ft
250# GP	1200 ft
500# GP	1900 ft
750# GP	2300 ft

Bombs Cont'd

	Recommended Combat Separation Distance
(2) All Fragmentation Bombs	2000 ft
(3) Bomb, Anti-Personnel and Materiel	
M116 Bomb, Anti-PAM	500 ft
BLU-1B (Red Dog, 750)	500 ft
BLU-11B (Red Dog, 500)	500 ft
BLU-10B (Red Dog, 250)	500 ft
100# WP/PWP (M47A4)	2000 ft
M-31/M-32/M-35/M-36 Incendiary Clusters	2000 ft

*Ricochets from non-exploding ordnance (50 cal, 7.62 mm and ball 20 mm) are unpredictable. Positive safe distance criteria are difficult to establish. The recommended separation distance may be drastically reduced when the friendly troops are protected by foxholes or earth barricades and the tactical situation warrants.

Artillery Adjustment

The following procedure can be used by the FAC to adjust artillery fire onto the target.

(1) Give target location, normally by coordinates. Order No. 1 marking round.

(2) To establish gun target line give range correction only. "Drop 400 meters, fire No. 2 round." This will establish direction of fire. If gun line is known, step #2 is not required.

(3) Give correction to target. "Right 50 meters, add 200 meters, fire No. 3 round."

(4) Give next correction by splitting range in half. "Drop 100 meters, fire No. 4."

(5) Then fire for effect. "Add 50 meters and fire for effect - on target." Things to remember:

(1) Make a bold first adjustment.
(2) Correct deflection and range one half of previous correction.
(3) Give deflection correction first, then range correction.
(4) Command to fire for effect is given when adjustment is within 50 meters.

	TYPE WEAPON	PRIMARY TARGET	SECONDARY TARGET
GUNS	Cal .50 20 mm	Aircraft-Vehicles Personnel-(entrenched and open) Light Armor Locomotives	Road Blocks - Gun emplacements - Small boats - POL
ROCKETS	2.75"	Tanks - Armored vehicles-locomotives and rolling stock	Pillboxes - POL
ROCKETS	5" HVAR	Pillboxes - ships - tanks - gun emplacements - concrete buildings warehouses	POL - runways and track cuts - personnel
BOMBS	GP	Hangars - runways - road and rail cutting - bridges - marshalling yards-tank bivouacs - buildings - ships - gun emplacements	Locomotives - personnel vehicles
	SAP and AP	Warships - Shipping - bridges - steel and concrete buildings	as GP when GP not available
	Incendijel	Personnel entrenched - tanks-pillboxes-road blocks - inflammable stores and buildings	Gun emplacements - POL-ground aircraft and hangars POL - Vehicle convoys
	FRAG	Convoys - Personnel in open - parked aircraft - pontoon bridges - gun emplacements - bivouacs - hangars	Pontoon bridges - supply stores and buildings
	INCENDIARY	POL - steel or wood installations	

Recommended weapons vs. T--get Selection for Strike Aircraft