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AIR TRAFFIC CONTROL TRAINING SERIES

Simulator Operators Manual

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LAST REVISION: November 1989

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Prologue

The yellow 'vette careened around him on the empty Pensacola boulevard, gathering speed as it passed. Their glances met, but he already knew what the other driver would look like -- close-shaven, leather jacket, small but tight build. The Naval officer's cap on the dashboard and vanity license plate "Burner" clinched it.

Mike Richards, already late for his 0600 shift, sighed under his breath as the other car accelerated away. "Fighter jocks. Wonder if they ever grow up." Then he floored it and raced to Eglin Air Force Base, situated just east of Pensacola, Florida.

Glenn Dumax greeted him at the RAPCON door. "Whata matter, buddy? Had to wait for some Krispy Kremes?" The donut shop had just switched from a 24-hour operation. Its new six am opening time was everyone's latest excuse.

"Yeah, maybe. Never been any good at getting up before dawn, though."

"And you joined the Air Force? Real smart, buddy." With that banter, Glenn left, and Mike signed into the facility.

He was assigned to handle his usual arrival sector which covered low altitude airspace southeast of the field. Although light just now, the flightstrips coming off the FDEP indicated that the usual training missions were just now departing and would get him hopping in an hour or so.

He watched the flights depart: Cider-15, -16, -17, -18, and -19, each a T-38 on a training mission. Sitting next to him, Melissa Holt worked the departure sector, assigning each trainer a specific block of airspace in the Military Operating Area (MOA) about 30 miles off the coast in the Gulf of Mexico. She was an old hand at this, punching in each operating area on her PIDP console as it was taken. Soon each of the rectangles drawn on his scope contained a maneuvering target.

Each target consisted of a smudgy primary radar return, overdrawn by a letter indicating the control position working that target. A leader line connected the target with its associated data tag which displayed its callsign, current altitude, computed ground speed, and transponder "squawk" code. With each five-second sweep of the radar beam, the primary and then secondary targets moved across his scope, fanning out into their individial operating areas.

An assistant handed him a paper flightstrip just as that aircraft announced itself over the comm.

"Eglin Approach, Seneca Three Niner Seven Sierra Zulu, with you, level at five thousand."

The Aero Club's light piston twin. Wonder what it was doing up so early?

"Seneca 397SZ, Eglin Approach Control. Radar contact. Descend and maintain three thousand. Turn right heading two six zero for vectors to visual approach, runway one two, Eglin. Mighty early for a sight-seeing spin this morning, isn't it, guys?"

"Roger, Eglin. Right to two six zero and down to three... Getting an early start on another multi rating."

So that was it. All these jet jockeys were leaving the Air Force to work for the airlines with thousands of hours of fighter time, but because of the placement of the engines, they had a "centerline thrust" restriction on their Commercial pilot licenses. They went straight to the Aero Club for the required five or so hours in the little twin to qualify for an unrestricted multiengine rating. That kept the Seneca busy all hours.

As the Seneca's datatag showed it beginning the descent, Mike's assistant pointed at the weather readout on the CRT above his head. Where before it had listed a visibility of five miles with clear skies, the display now read one mile in light fog. Dewpoint and temperature were both reading 71 degrees, wind calm.

"Seneca Sierra Zulu, weather has gone down here. Visibility now one mile in fog. Expect an ILS approach, runway 30, Eglin. Descend and maintain one thousand, five hundred."

"Sierra Zulu, roger. Out of four thousand, one hundred for one thousand, five hundred."

As his single inbound continued its descent, he noticed an increase in activity over on departure. Looks like the training squadrons were trying to launch as many flights as possible before the fog closed in. Pilot reports from the MOAs out over the Gulf showed the weather to be just fine out there -- CAVU (ceiling and visibility unlimited) -- but here along the coast, the fog continued to build.

"Seneca Seven Sierra Zulu, visibility now three-quarters, fog. Turn right heading two eight zero to intercept the localizer. Cleared ILS runway Three Zero approach. Contact Eglin Tower now one one eight point two."

"Roger. Sierra Zulu over to tower. Looks like I'm home just in time this morning!"

After he noted that the Seneca intercepted and was tracking the localizer inbound, Richards turned his attention to the flightstrips that were beginning to be tossed at him by his assistant. Some of the training missions were starting back home and would be entering his sector shortly. Switching his radar display out to a long-range view to get a good situational awareness before the traffic hit, he noticed numerous untracked targets about thirty-five miles offshore. He pressed an interphone button, linking his mike with a MOA sector controller across the room.

"Hey, John, what's going on in Six Low?"

"The Lex, I think. I've got one in there now, but they showed up about ten minutes ago. Didn't they coordinate?"

How did this happen, he thought as he began checking through the communications records Glenn had left behind from his shift. The U.S.S. Lexington, a WWII-vintage aircraft carrier, was steaming back and forth offshore between thirty and a hundred miles south of Pensacola conducting its own training exercises. She did this to keep a relative wind of at least twenty-five knots on her bow, the minimum required to launch and recover aircraft. New pilots from Pensacola NAS would fly out there for carrier qualifications -- shoot a touch-and-go or two, then at least three traps, then return to the Naval Air Station.

Eglin "owned" the airspace out to forty miles south of the beach in that area, so the Lexington was required to coordinate with them whenever she launched her birds that close to shore. Today, something had fouled up, because she was obviously there working aircraft yet no one here at the RAPCON knew about it until they noticed the extra targets in their MOAs. Maybe she had checked in and they had lost it; maybe she hadn't checked in at all. It didn't matter now -- they had a coordination problem.

Mike punched into that sector's radio channel. He overhead his friend John Markham talking almost nonstrop.

"Cider One Niner, Eglin. Traffic twelve o'clock, four miles, multiple targets, same altitude. Looks like the Lexington is out there."

"Cider One Niner, roger. No joy."

"Cider Two One, Eglin. Traffic nine o'clock, six miles, multiple targets, three thousand, three hundred."

"Cider Two One, roger. Thought we were alone out here?"

"Heads up, buddy. I'm trying to get you a new area. Navy came to town. Cider Two Two, you've got company, too. All aircraft on this channel, we're got Navy flyboys all around you. Stand by for new area assignments."

John punched the interphone. "Mike, can you get the Lex guys on the line? We've got too many aircraft up here to clear 'em all out. Cat-see's gotta help us on this one."

Looking across the room, Mike caught John's eye and merely nodded as he began attempting to contact the Lexington's Carrier Air Traffic Control Center (CATCC). He had just punched up the frequency when Cider One Niner interrupted. Warning horns could be heard in the background.

"Cider One Niner, mayday, MAYDAY, MAYDAY! Gotta problem here... clipped my wing... losing hydraulics... no control... punching out..." Perhaps two seconds had elapsed.

"Cider One Niner, Eglin. How do you hear me?...Cider One Niner, come in please," John called, but they both knew better than to expect a reply.

"Eglin, this is Cider Two One. Cider One Niner splashed about five miles east of my position. Possible midair. One chute. We can see the Lexington... let's see... make it about ten miles southwest of here. Can you get a 'copter over there? We're circling..."

"Cider Two One, Wilco. Hold your position and stand by."

A new voice in his headset told Mike that he had reached the Lexington's CATCC. Sounded like all hell had broken out, based on the shouting in the background of the radio channel.

"Eglin, Lexington Cat-see. We've had a mid-air. We got a crippled A-4... Wait... Someone says they see a chute... Stand by..."

"Roger, CATCC. Eglin here. One of ours, I think. A T-38 Talon trainer with one aboard. Can you send the rescue 'copter, heading zero six five, about fifteen miles from your position?"

"Wilco, Eglin. Rescue One already on the way. He reports an ELT on guard. No voice contact with downed flyer yet. They see a raft, though. Stand by..."

Mike motioned to Melissa. "Can you handle arrival for a minute while I deal with this?" Her departures had about cleared out, and she readily accepted, since the Seneca was long gone and Mike had only two actives. He turned his attention back to the Lex.

"CATCC, what have you got on the Navy flier our guy hit?"

"Eglin, it was an A-4 Skyhawk. He rolled ninety degrees to evade just as they clipped and sustained some underbelly and flap damage, but he's still flying. Hook broke. We've sent him back to Pensacola."

"Eglin, Pensacola." The interphone light from Pensacola blinked.

"Go ahead, Pensacola," Mike answered.

"Pensacola just went zero/zero in heavy fog. Shuttling other aircraft inland, but we've got a damaged A-4 coming in. Heard about him?"

"Roger, he clipped one of ours. Our guy is in the water, but Lex rescue is picking him up now." At least he hoped they were.

"OK. Well, we've got another problem. Bantam Niner is limping home with bingo fuel, limited flap and aileron travel from the midair. You still got a half mile? Can you take him?"

"Stand by."

"Affirmative, Pensacola," he said over the landline. "Weather still reports visibility at one-half mile; send him to me."

He touched Melissa's shoulder, who pointed out a target just south of the coast in response. The stricken A-4.

"Thanks, Eglin. He's about two zero south now. Got him?"

"Affirmative. Radar contact." Melissa responded, even as the target started blinking to indicate that the automated handoff procedure has been initiated. She slewed the cursor on her scope to the A-4's target and stopped the blinking by accepting the target. A few seconds later came an uneven radio call.

"Eglin Approach, Bantam-9. How copy?"

"Bantam-9, Eglin Approach. Loud and clear. Radar contact one seven miles south of Eglin. Say status."

"Uhhh, we've got real problems up here. Only one comm radio working, don't know about nav. I've tried cycling the flaps -- no joy -- and not too sure about the gear either."

"Roger, Bantam Niner. Turn right heading zero three zero. Vectors to ILS approach, runway three zero. Descend and maintain one thousand five hundred. Weather one-quarter variable one-half mile in fog, wind calm, altimeter Two Niner Niner Seven. Hang in there, buddy."

Melissa frowned to Mike, who was leaning over her shoulder watching. "I'm not too sure about his guy, Mike. Sounds awfully rattled. Kid glove treatment."

"Yup," was all Mike said. Let's just get him down, he thought.

"Eglin, Bantam Niner. How far out am I?"

"Bantam Niner, fives miles from Final Approach Fix. Turn left heading three three zero. Say altitude -- your mode C is intermittent."

"We're at twenty-nine hundred."

"Bantam Niner, confirm descending to one thousand five hundred."

"Bantam Niner is descending now."

Melissa was pure concentration now. "Bantam Niner, you are three miles from outer marker, right of course. Turn left heading three zero zero to intercept, say altitude."

"Seventeen hundred. In and out of fog. Weird."

"Bantam Niner, you are one mile from Final Approach Fix. Check wheels down, continue left turn to a heading of two eight zero, one mile right of course. Contact Eglin tower Two Three Six Point Six. Good luck." Melissa relaxed, but only slightly, her gaze still locked on the target as it went down the ILS Final towards the runway.

To Mike she commented, "He's too far right and staying there. I don't think he's got course guidance." Just as the aircraft's target went into a "coast" mode as it descended below radar coverage, their interphone from the tower woke up.

"Approach, tower. Bantam Niner missed approach. Coming around again."

And there the target was again, in a right one-eighty turning onto downwind.

"Approach, Bantam Niner. On fumes, guys, and I don't know about this nav. How far are we from the coast if I have to punch out?"

"Bantam Niner, Eglin Approach, radar contact. Recommend you go for a PAR before you head for the water. How 'bout it?" Melissa radioed back to the pilot.

Mike took the hint and looked two consoles away at a completely different radar display. The Precision Approach Radar was designed to give a controller both vertical and horizontal glidepath information so that he could talk down an aircraft all the way to the ground if necessary. No excercises involving it had been scheduled for this morning, but when he saw its twin sweeps moving, he knew that it was warmed up and ready. Thank you God for small favors, he muttered, as he moved into position in front of it. Mike did a quick check of the alignment...everything checked out OK.

"Yeah, I guess. Tell Hap he can have the yellow 'vette if I buy the farm," replied Bantam Niner.

And at that moment Mike saw his face up there, that face that had so casually screamed by on the way to work, that now scared, sweating face of a young kid praying that he had enough fuel and control of a sick broken airplane to make it back one more time.

As Melissa turned the target onto final just outside the final approach fix, Mike took the handoff and heard the radio call.

"Eglin Final Controller, Bantam Niner. Let's do it."

"Bantam Niner, Eglin Final Controller. Radar contact, seven miles from touchdown. This will be a PAR approach to runway 30. Do not acknowledge further transmissions. If no transmissions heard for five seconds on final approach, attempt contact Eglin Tower two three six point six and proceed VFR."

"Five miles from touchdown, wheels should be down. Begin descent.

"Turn left heading two niner five.

"Slightly above glideslope; slightly right of course.

"Turn left heading two niner zero. Slightly right of course, correcting slowly. Four miles from touchdown.

"On glideslope, slightly right of course, correcting slowly.

"Going below glideslope. Three miles from touchdown." Things were starting to move quickly now, as the logarithmic scale on his display made the aircraft's twin targets appear to move quicker and quicker down to touchdown.

"Below glideslope. On course. Two miles from threshold.

"Slightly below glideslope, correcting. Going left of course, turn right heading two niner five.

"On glideslope, on course. One mile from touchdown." About time for you to see the runway, Mike thought. Melissa checked -- yes, the approach lights were at maximum.

"At decision height." Please see the runway.

"Over the approach lights." No miss. He was continuing the approach below decision height!

"Going right of course." The target was merging with the ground clutter. No time... go around. Go around!

"Runway!... Left!... Down!..." Was that Bantam Niner?

The tower interphone came alive. "There he is! Can just make him out through the fog. Looks like he went off the righthand edge of the runway. Roll the equipment!"

Still on his channel, the A-4 pilot pressed his push-to-talk switch. "...stopped. Sorta hung up on a runway light over here." He paused. "Mr. RAPCON, whoever you are, thanks. I was about to lose it up there."

"Any time, Burner. Just doin' my job." And with that, Mike stretched, then turned to help handle the other Air Force training missions now being handed off to his Arrival sector.

Section 1. Installation and Equipment/Training Requirements

1.1 General Introduction

RAPCON is the most complete simulation ever of a military Radar Approach Control facility. Using RAPCON, you will enter a world of almost unimaginable authority and responsibility, a world where the lives of fighter pilots and many others depend on your skill and ability to "look-ahead" in time and anticipate aircraft flight paths in four dimensions.

You have probably listened in on air traffic control conversations using a scanner, at the movies, or through your headset while sitting bored at 35,000 feet. Much of what was said might have been unintelligible to you, yet the verbal exchanges communicated precise command and control information between pilot and controller. With RAPCON, you can enter into this mysterious world and learn what those verbal conventions mean. You can actually experience the problems and solutions that air traffic controllers must deal with every minute they are on duty.

RAPCON's world is the airspace surrounding a major United States airbase and its satellite airports:

* Edwards Air Force base, the famous flight test facility in the Mojave desert;
* Miramar Naval Air Station, the Navy's "TOP GUN" fighter base outside San Diego;
* Nellis Air Force base where the "Red Flag" exercises are held annually in the desert near Las Vegas;
* Eglin Air Force Base, where several TAC wings are based; and
* Pensacola Naval Air Station, from where the Navy sends pilots out for carrier qualifications on the USS Lexington aircraft carrier.

A sweeping radar beam continuously scans the skies, pin-pointing each aircraft target and reporting its altitude and groundspeed with each scan. Airports, airways, TACAN radio beacons and fixes, and ILS instrument landing systems are all depicted faithfully from actual government airspace charts. Significant ground markings such as coastlines are also shown, as well as airspace boundaries of Military Operating Areas and sector limits.

Using this radarscope and the automated flightstrip display plus the communications channel shown along the bottom of your screen, you must handle all the aircraft in your sector, keeping them oncourse, vectoring them into and out of the airports there, and handing them off to the adjacent facility controllers. If you choose, you can take arrivals all the way to touchdown using your Precision Approach Radar (PAR) scope.

This job is complicated by pilot errors, unreliable equipment, and weather. Missed approaches are common in bad weather, so even though you think you have finally finished with some turkey, he may pop up announcing a missed approach, which in turn throws all your other careful sequencing off, and generally turns a "good day" into a nightmare.

You control these factors, though, and can gradually progress through the ranks from controller trainee to seasoned veteran. Helping you in this process are demonstration scenarios in which prerecorded instructions are played back for you to watch. And always the *Communications* section translates each keystroke command to the official controller/pilot vocabulary, using the proper commands and responses that real air traffic controllers and pilots use every day to keep the skies as safe as they are.

1.2 Read This Manual!

If you have some controller or IFR pilot experience, or have used Wesson International's **TRACON** program before, you can probably just fire up the program and muddle through. But the real job of a RAPCON controller typically takes many years of training -- you are not going to master it in a couple of minutes. We have painstakingly composed this manual to take you step-by-step into this incredibly rich but complex world, and you will be wasting your time if you do not at least scan its high points first. Besides, there is an on-disk demo at the end of this chapter, so you can just sit back and enjoy reading, watching, and listening to this fascinating world. You'll get your chance sooner than you think.

This training manual adheres to all known government printing specifications, including but not limited to typestyle, paragraph numbering, and section headings. Obscure bureaucratic phrases have been substituted for normal English wherever required by government regulations.

1.3 Documentation Organization

If you are not an instrument pilot or controller, you should absolutely read through the second chapter which introduces you to this complex arena. And even if you have substantial knowledge of air traffic control, you should probably skim this chapter and look over the elements of this environment which are simulated here and which are not. Section Two ends with instructions about running the audio tape demo.

After this brief introduction to the general world of air traffic control, RAPCON's basic display setup and controls are described. By the time you have read through Sections Three, Four, and Five, you will begin to feel comfortable with the environment of RAPCON; without this "sense" of RAPCON's world, you will probably be powerless to prevent the inevitable mid-air collision.

Sections Six and Seven are optional but useful for achieving high performance using RAPCON. Section Six distills information from various air traffic control procedures and describes how to best utilize the resources available to you: altitude, speed, and heading. You might call it a "Hints" chapter. It also points out the errors that can occur and what you should do to prevent them.

Section Seven discusses how to vary the simulation once you have mastered the initial configuration. For instance, RAPCON comes delivered with the Edwards sector standard and a modest level of aircraft generated for each scenario. As your expertise grows, you can edit its initialization file to routinely generate far more aircraft over a shorter period of time and really stretch your abilities.

After the chapters come maps and charts of each of the control sectors included with the program.

1.4 Conventions

In this manual, we will consistently use *italics* to indicate one-word commands you should type at the DOS prompt (ending it with the **Enter** key, of course), and:

```
this typestyle
```

when we break out a multi-word DOS command line. We will boldface the names of keys (like the reference to the **Enter** key above) when we discuss them.

Additional instructions for using a mouse with RAPCON will be enclosed in this type of box and highlighted with a little mouse symbol like you see here.

1.5 About the Designer and Programmer

RAPCON was designed primarily by Robert B. Wesson, Ph.D. Dr. Wesson's thesis involved applying artificial intelligence techniques to the problems of air traffic control. In 1977, he created a program running on a mainframe (which had little more power than today's '386-based microcomputers!) which not only simulated an Air Route Traffic Control Center's sector, but also solved separation problems in that environment and issued appropriate ATC commands to the aircraft in the sector. This program was judged by professional controllers at Houston Center to perform better than human ATC personnel handling the same traffic in the same sector. RAPCON derives from the simulation component of that program.

During the late '70's at the Rand Corporation "think tank" in Santa Monica, California, Dr. Wesson led a research team which produced and evaluated scenarios for the evolution of the present-day en route ATC system to a modern computer-mediated control environment called AERA. This work helped guide the FAA's multi-billion dollar airspace and airway modernization program currently underway. Dr. Wesson moved back to Austin, TX in 1981 and is currently president of Zen Software, Wesson International, and Wesson Developments.

RAPCON was programmed in Microsoft C by Dale Young with the assistance of G. Graham Moore. Many of its most advanced, realistic features were suggested and tested by a number of professional controllers and training personnel at HQ Air Force Communications Command, the Air Force's ATC school at Keesler AFB, and Naval controllers based at Pensacola, Florida. Special thanks go to MSgt. David Warner, Keesler AFB.

1.6 System Requirements

RAPCON requires the following computer system:

* An *IBM PC or compatible computer with 512K* of random-access memory. Although RAPCON will run on regular IBM PC 8088 class machines, its performance improves significantly with faster processors such as the 80286 or 80386. A math chip such as the 80x87 and more memory also improve performace. In particular, the radar sweep works more smoothly and continuously on the faster machines and RAPCON will be more responsive during periods of heavy traffic loading.

* Any type of *graphics adapter and monitor*, including Color Graphics Adapter (CGA), Hercules Monochrome (sometimes called

"monographics"), enhanced Graphics Adapter (EGA), or Personal System/2 graphics system (MCGA or VGA). The higher the resolution of the graphics system, the better RAPCON will look. In particular, EGA and VGA screens are stunning compared to their monochrome counterparts. EGA and VGA screens are in full color, while CGA, MCGA, and Hercules are monochrome. Monitor configuration occurs automatically within the program.

Note: To achieve highest resolution, RAPCON must run in monochrome on your CGA system even if you have a color RGB monitor. Also, if you only have an original IBM monochrome adapter card, you will not be able to run RAPCON at all!

* At least one *floppy disk drive* (double-sided, low- or high-density). RAPCON is not copy-protected and may be installed on a hard-drive for better performance.

* IBM-DOS or *MS-DOS* (version 2.00 or later).

Optional equipment includes:

* A Microsoft-compatible *mouse*, although not required, may be used extensively to issue commands to the aircraft. It will be detected automatically if present. Whenever you double-click on an aircraft scope target, a mouse command box pops up just under the target and you may then select one of the items there. Some of the items, such as altitude changes, require another selection from a graphic representation of the parameter, and the mouse continues to be useful here. Overall, using a mouse can substantially improve the speed with which you can issue commands to the aircraft.

1.7 Package Contents

When you open this product, you should find enclosed its two basic elements:

* This manual, which you must look over before using the program; and

* The program diskettes (one 3.5" or two 5.25").

There are no hidden files or copy-protection.

1.8 Installation Procedures

As with any new microcomputer product, you should first make a backup of the distribution diskette and then install the program and all its data files onto your system. Do this by copying all the files onto a newly-formatted floppy disk, or use the DISKCOPY program that comes with DOS. Your DOS manual describes how to make copies of standard DOS disks.

Before even installing RAPCON, you should read the file READ.ME from the distribution disk, if one is present. Like all microcomputer products, RAPCON undergoes constant revision, and some things may have changed since this manual was printed, including the installation procedure. The READ.ME file documents these changes.

To see READ.ME on your terminal, simply enter the command

```
type read.me
```

at the DOS prompt (>) and watch the file scroll across your screen. Be sure to end the command by pressing the **Enter** key. Use the **Ctrl-S** and **Ctrl-Q** commands to stop and restart the scrolling if it is too fast to read. (**Ctrl-S** means to hold down the **Ctrl** key and press the 's' key at the same time.) To print the file to your printer, make sure your printer is connected and turned on, then enter the command

```
copy read.me prn
```

at the DOS prompt (>) and answer the question about what your printer device you are using if necessary.

Floppy-Disk-Only Systems

After backing up the distribution disk, you should make a working copy of the program and its associated data and voice files. If you are using 3.5" or 1.2 megabyte 5.25" floppy disks, all RAPCON files will fit onto a single working diskette; 360K 5.25" disk users must use two working floppies -- one for the program and sector files, the other for the voice files. If you want to run RAPCON from the same disk you use when you turn your computer on, you should copy all RAPCON files onto a bootable diskette. See your DOS manual for more information about making a bootable diskette and copying files to it.

To run RAPCON from a single working disk, simply insert this floppy disk into a disk drive and log into that drive by typing the drive letter followed by a colon and press **Enter**. Then type *rapcon* to DOS and the program will start. To run a RAPCON demonstration as described below, the general procedure is to enter

`RAPCON` *filename*

at the DOS prompt (>), where *filename* is the name of the demonstration file specified in the instructions. You do not have to enter *filename's* extention.

If you have 360K working diskettes, the digitized voice files are too large to fit onto a single working disk and you should have made a working copy of the RAPCON voice disk as well. You will have to do a little more work to configure your system for running RAPCON from these two working diskettes. (Other users may skip the rest of this section.)

Before running RAPCON from two working disks, always create a path to your second (B:) floppy drive by typing the DOS command:

```
A>path=b:
```

This command tells DOS that if it cannot find a file on the default drive/directory (drive A:), then search drive B: before failing.

The best procedure is to insert this command somewhere in your AUTOEXEC.BAT file so that it will be executed once when you startup each day. Then you won't have to type it in everytime you run RAPCON.

An alternative procedure is to put it into a batch file with a RAPCON command and use that command to invoke RAPCON instead. For instance, suppose you create the file VRAPCON.BAT by typing the following to DOS:

```
A>copy con vrapcon.bat
path=b:\
a:
rapcon %1 %2
^Z      hold down Ctrl and press 'z'
```

Then, instead of typing *rapcon demo* to DOS, you would type *vrapcon demo* and the above commands would be executed. Note, however, that we prefer putting the path statement into your AUTOEXEC.BAT file. It's a "cleaner" solution.

Then, to run RAPCON, insert both working diskettes into your computer -- the RAPCON *System* diskette into drive A: and the *Voice Disk* into drive B:. Startup RAPCON as documented before, making sure that you do not change the disk in either drive during its operation.

Hard Disk Systems

Follow this procedure to install RAPCON onto your hard disk:

1. Insert the RAPCON program disk into floppy drive A:.

2. Log onto the hard drive on which you want the simulator to reside. For example, to log onto hard drive C:, type *c:* and then press **Enter**.

3. Type *cd * and then press **Enter** to go to the root directory.

4. Type *md rapcon* and then press **Enter** to make a directory for RAPCON.

5. Type *cd \rapcon* and then press **Enter** to change directories.

6. Type *copy a:*.** and then press **Enter** to copy all RAPCON files from the floppy disk in drive A: to the hard disk. If you are using 5.25" disks, insert the *Voice Disk* and repeat the copy command once more.

To run RAPCON from your hard disk, do the following:

1. Log onto the hard disk directory set up for RAPCON. For example, to log onto the directory called RAPCON on hard disk C:, type *cd \rapcon* and then press **Enter**.

2. Type *rapcon* and then press **Enter** to run RAPCON.

3. To run a RAPCON demonstration as described below, the general procedure is to type

`rapcon` *filename*

to DOS, where *filename* is the name of the demonstration file specified in the instructions.

In case of difficulty: If RAPCON does not seem to display properly on your system, it may have autodetected your configuration improperly or your system might not be as compatible as hoped. You can probably fix the problem by changing the first line in the RAPCON.INI initialization file so that it matches your monitor exactly -- see Chapter 6 for more details.

1.9 Quick Reference Guide

For those of you who, in spite of our admonitions, are about to jump right in and try your hand at controlling aircraft, we have provided a handy quick reference guide to the screen displays and keyboard controls in RAPCON. After you have read through the rest of the manual, you can always refer to this guide for a reminder of the material detailed later on.

1.10 Exiting RAPCON

You can shut down RAPCON at any time and return to DOS via the command **Alt-X**. You issue this command by holding down the **Alt** key on your keyboard and pressing the 'x' key at the same time. If you issue this command from the startup dialog box (see Chapter 2), RAPCON will immediately exit to DOS. If you are running a simulation when this command is processed, RAPCON will popup a dialog box with the first entry -- Exit -- highlighted. Simply press **Enter** at that point and your usual DOS prompt should greet you.

1.11 Quick-Start Demonstration

Now for the fun part. Let's run a simple demonstration of RAPCON's capabilties. It will take about 15 minutes, and you don't have to do anything but sit back and watch! This demonstration is a good way to become familiar with many of the program functions documented in the rest of this manual.

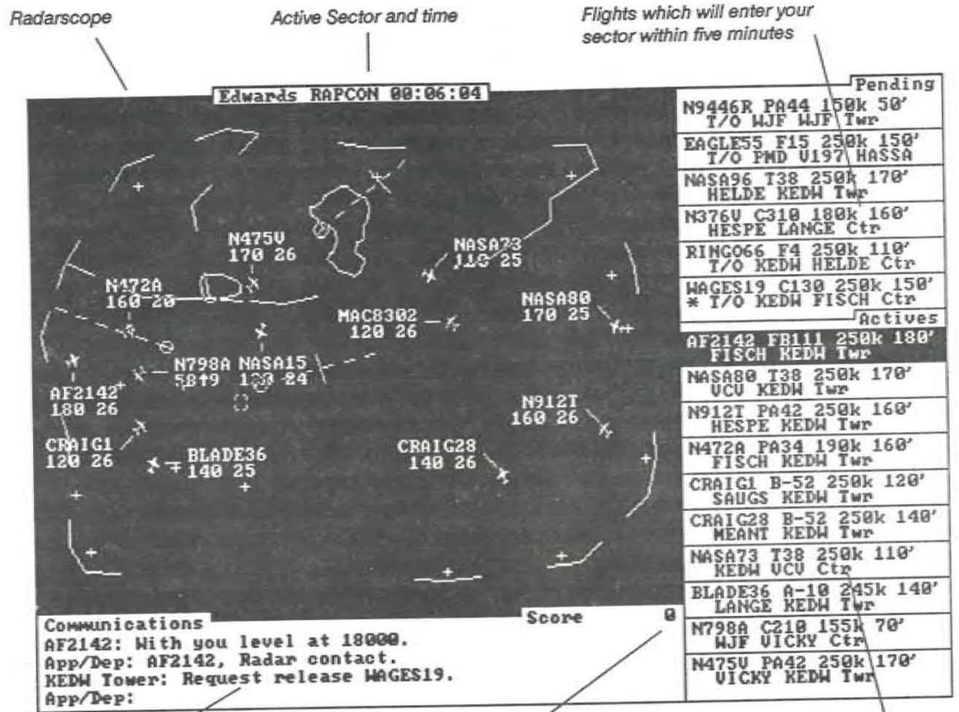
To run the demonstration, simply activate RAPCON as described above for either a floppy-disk or hard-disk system, except append the word "demo" to the command you type to DOS. Assuming you are in the RAPCON directory or have the RAPCON floppy disk in your default drive, please type now:

```
rapcon demo
```

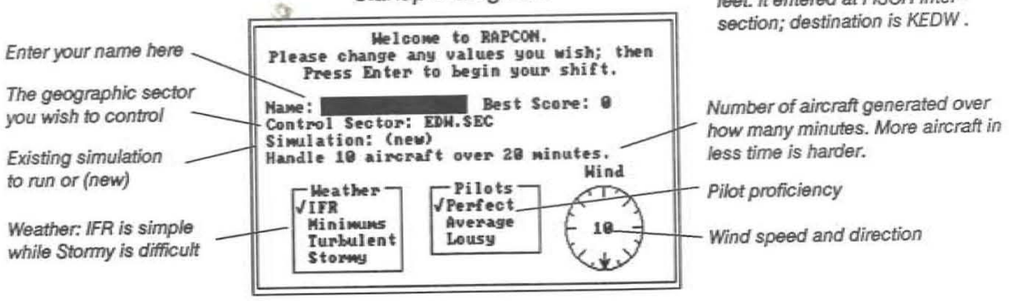
to DOS (ending with the **Enter** key, of course). RAPCON will load and display its usual start-up dialog box. Don't touch anything. Instead, look at the lower righthand screen area and you will see a small "Post-it"-like notepad which is "talking to you." Simply sit back and watch this notepad area, which will direct your attention around the screen and generally run through a simple scenario in which a couple of arrivals and departures are handled correctly. This little demonstration should give you a flavor of RAPCON. It repeats continuously until you stop it.

End the demonstration at any time using the **Alt-X** command as described above. Then, you should probably read through the next two chapters and begin to control aircraft yourself directly.

Quick Reference: Screen Display

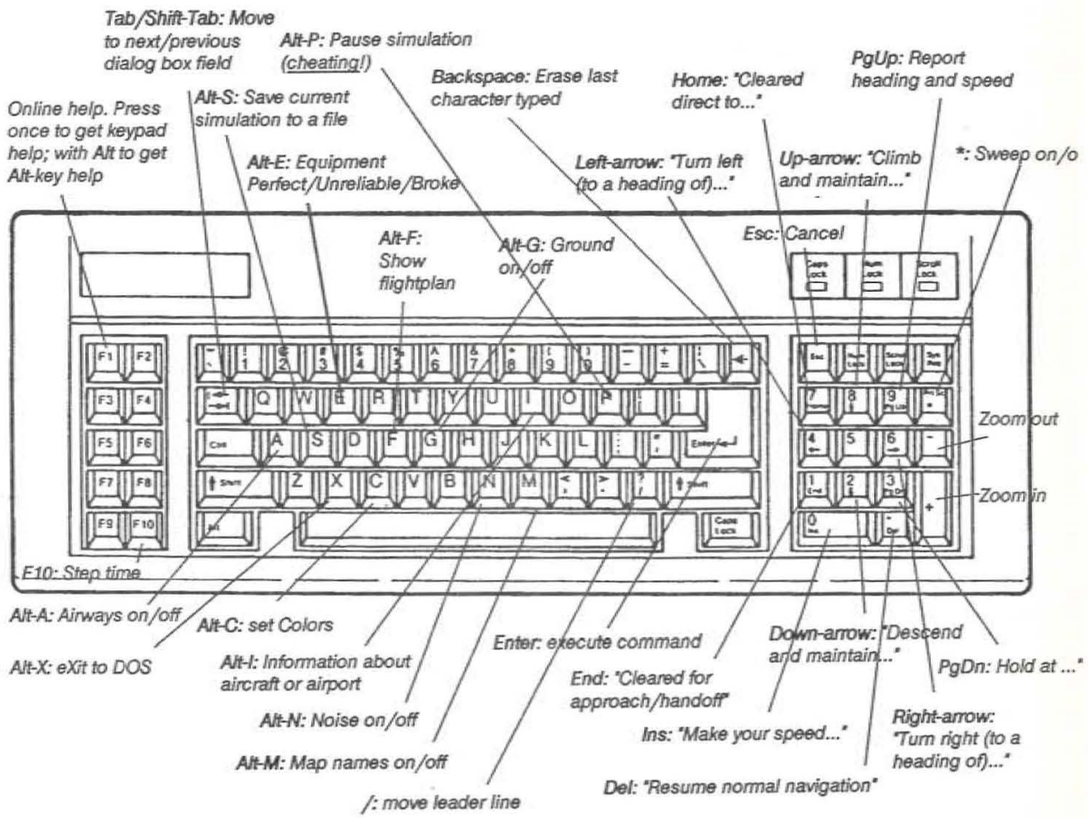


Startup Dialog Box



Quick Reference: Commands

General Command Format: Select an aircraft, <keypad command> <parameter (if necessary)>
To select an aircraft, type in the last few characters of its ID, highlight its flightstrip, or click using the mouse.



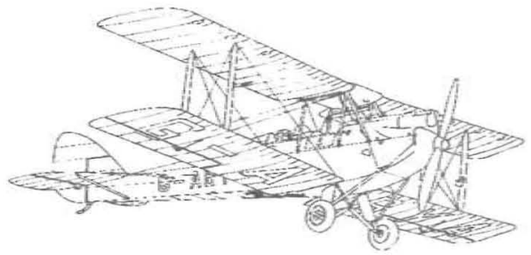
Mouse Operations

* Click on flightstrip or aircraft icon on radarscope to select an aircraft.
* Double-click on aircraft icon to select that aircraft and popup a mouse command menu. Then click to select command and parameter.

Section 2. Introduction to Air Traffic Control

2.1 Historical Perspective

You have probably heard the expression "flying by the seat of his pants." This characterizes the way early airplanes and their pilots took to the air. They flew by looking ahead at the physical horizon and navigated by looking over the side at landmarks. Seat of the pants flying has a severe drawback, of course, because clouds frequently obscure both the horizon and the ground.



The increasing requirement for reliability in the budgeoning mail and passenger flying services led to the development of *instrument* flying, in which control of the aircraft is achieved using inboard artificial horizons and other instruments coupled with the use of radio navigational beacons along standardized routes of flight. As more and more aircraft began using these routes, however, some method of cordinated control became necessary and the government-based air traffic control service was born.

During these early days, air traffic control was performed using time as the basis for control. Each aircraft was given precise take-off and fix-crossing times. Aircraft flying the same routes were tracked using plastic indicators moved manually across large horizontal maps in the ATC control rooms. These indicators were called "shrimp boats" and continue to be the worst-case backup mechanisms available in many control rooms even today.

The use of ground-based radar to provide more precise position information for this tracking function is really only a few decades old. As frequently happens with government, this concept was a response to a critical catalytic event. In 1956, two airliners, both flying under existing instrument flight rules of the day, crashed over the Grand Canyon. One was climbing and the other descending. Congress mandated that "something has to be done about this!" and so radar-based ATC was created. The type of radar used to display aircraft geographic location in the vicinity of an airport is called *Airport Surveillance Radar* and abbreviated *ASR*.

With radar control, ground-based centralized controllers can monitor an aircraft's flight and execute their basic safety mandate: maintain separation between aircraft. In RAPCON, as in real life, that separation requirement is three miles horizontally or one thousand feet vertically. This constraint will form one of your primary goals in RAPCON.

RAPCON controllers naturally do many other things in the course of their job. Although every airport equipped with an *instrument landing system* (ILS) has a published approach procedure, most

pilots never actually fly it. Instead, the air traffic control authority issues guidance commands to position the inbound aircraft at a point from which an abbreviated approach can be successfully completed. In RAPCON, as in real life, you will be required to perform these activities as well.

Finally, some RAPCONs have an additional piece of radar equipment called *Precision Approach Radar* (PAR) which enables the controller to guide one aircraft at a time down the approach path. This equipment gives the controller a vertical glidepath screen representation as well as a horizontal view. Although the ILS has become the standard approach these days, PAR approaches are still practiced and used at many military bases, especially when either ground-based or airborne ILS equipment fails. RAPCON (unlike its sibling product TRACON) duplicates this PAR function as a secondary screen that you will be able to call up instead of merely handing off an arriving aircraft to the appropriate tower controller.

2.2 A Complex System of Interlocking Parts

Air traffic control is not a uniform system -- it is comprised of a multitude of overlapping rules, control facilities, and personnel. This section introduces you to that system as a whole, and discusses the part that RAPCON simulates. Aircraft in this country may fly under two sets of rules and regulations: *visual flight rules* (VFR) or *instrument flight rules* (IFR). The majority of "Sunday-pilot" flights occur VFR out of uncontrolled fields, where "see-and-be-seen" constitutes the primary traffic control mechanism. But whenever the weather turns cloudy, and always in congested airspace around major commercial airports and military bases, aircraft must file flightplans and be guided by ground-based controllers. All military flights are conducted under IFR regulations.

In order that these controllers have sufficient information to anticipate the movements of these IFR aircraft, pilots file a *flightplan* before actually taking off. This is filed through a Flight Service Station (or the military pilot's flight ops section) and entered into a networked nationwide computer system and fed as required to the various control authorities which will oversee the flight.

A flightplan consists of (at least) an aircraft's type (so the controller will have some idea of its performance capabilities), its true airspeed, the altitude it wishes to cruise at, its destination, and its intended route of flight to reach that destination. (Much other information may also be required, depending on the area to be traversed, but for our purposes this is enough.)
Various navigational beacons called *fixes* have been established over the years, along with Victor (low-altitude) and Jet (high-altitude) airways which form a complex spiderweb connecting these beacons. Aircraft flying IFR carry radio transmitters and receivers which allow them to track along these airways and maintain continuous communication with the ground at all times. In the absence of a specific instruction from a ground controller, each IFR pilot must maneuver his aircraft according to the flightplan he filed before taking off.

Once an aircraft is airborne, it is continuously monitored by ground-based controllers during each phase of its flight. There are different controllers for each phase of flight.

Before taxiing from the gate, the pilot must call *Clearance Delivery* to get his actual flightplan instructions. Depending on traffic, weather, and delays, the route of flight he is given may or may not be what he requested.

Once he accepts the clearance, he calls *Ground Control* for taxi instructions from the gate to the active runway. Ground Control "owns" all the airport real estate except the active runway(s).

Once positioned in line at the active runway, the *Tower* clears him for takeoff, and after a takeoff roll he lifts off. Once his transponder (a radio beacon device which uniquely identifies him to the radar site) can be seen on the controller's scope, the tower hands him off to the local RAPCON (Radar Approach CONtrol), which houses both *Departure* and *Approach* Controls for the surrounding airspace. His transponder reports his altitude as he climbs out, and the RAPCON's computer system matches the transponder return with the aircraft's identifier and displays it all onscreen. As you would expect, this program simulates the environment of a RAPCON facility.

After climbing to his requested cruising altitude, Departure control (that will be you!) hands off to the first of a series of Enroute or *Center* Controllers who monitor the more-or-less level flight's progress from an Air Route Traffic Control Center (ARTCC) until it reaches the vicinity of its destination.

For the descent to the airport, the flight is handed off to Approach Control (that's you, again), who issues turn and descent commands to line up the aircraft with the instrument approach into its destination. This process is generally called *vectoring* the aircraft, and usually results in maneuvering the aircraft until it is positioned at the correct altitude a few miles outside of the *Final Approach Fix* (FAF) for the destination airport.

At that point, the aircraft is cleared to perform an approach to the airport. Usually, this approach can be flown by the pilot solely by reference to his instruments and ground-originated precision navigational aids which constitute the ILS for that runway at that airport. Less precise approaches are usually available in conjunction with a nearby TACAN (or VOR site for commercial users) or Non-Directional Beacon (NDB). If the weather is VFR at the destination airport, the pilot is cleared to perform a visual approach, a procedure used as frequently as possible because separation restrictions can be relaxed under such conditions and more traffic can be handled.

However, some instrument approaches are conducted in concert with a controller manning the PAR position. Here, a special type of radar shows the controller not only the aircraft's geographic location, but also displays its altitude and distance from touchdown graphically. The PAR controller watches the aircraft on his split-screen scope, issuing advisory instructions about its position relative to the optimal approach path. The pilot needs to do nothing but listen to the controller and follow his instructions -- he does not need an ILS receiver aboard. Sometimes, PAR approaches are used when the weather deteriorates so much that an aircraft must be "talked" all the way to touchdown, but normally a PAR approach terminates when the pilot either sees the runway and can proceed visually or reaches decision height and must abort.

At the completion of the instrument approach, the aircraft is handed off to the destination tower, who clears it to land and finally turns it over the the local ground controller who has responsibility until it is safely parked on the airport ramp.

2.3 Hand-offs

Since there are so many sectors in the ATC system, coordination between and among them is critical. Who has control of an aircraft at a particular point in time must always be unique and known to everyone involved with the aircraft. Transitions of control from one sector or facility to another are called *hand-offs*. In RAPCON, since you control

no airports directly (their respective Tower controllers do that) and are surrounded by the Center's en route airspace, you will use a handoff procedure for every aircraft you handle.

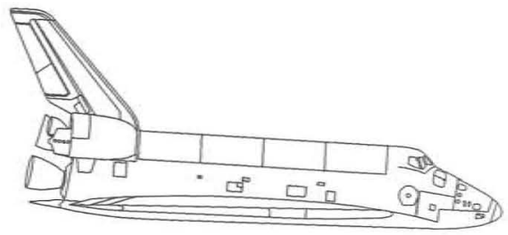
Inbound aircraft entering your sector will be at their cruising altitude (or level at some intermediate altitude, having been sent there by the Center controller already). Their target on the scope will immediately begin blinking, indicating that the Center controller wishes to hand them off to you. These aircraft may not proceed into your sector until you accept them -- that is one of the tenets of the absolute control regime of ATC. If you do not or cannot accept an aircraft, the Center controller has no choice but to hold the aircraft in his airspace until you can accept it. Once you accept the handoff, the aircraft can proceed normally under your control.

Similarly, departing aircraft are not released for takeoff by their tower until you say so. They hold on the ground (easier and more efficient than holding in the air, but burning precious fuel anyway). If the hold becomes protracted, they will start to complain about fuel use, but you have absolute discretion about when to let them depart.

As overflights or departures reach the edge of your airspace, they must be handed off to the adjacent Center controller. Likewise, after you have lined up an arrival so he will arrive at the FAF at the proper altitude and heading, you hand him off to the Tower, who takes him the rest of the way in. If he misses the approach because of pilot error or bad weather, the Tower will hand him off to you again once he has attained sufficient altitude to be seen on your radarscope.

2.4 Types of Flights

In RAPCON, as in real life, you will deal with three basic types of flights:



1. *Overflights* are the easiest to handle. These aircraft enter your sector at one of its edges at a cruising altitude and wish to exit your sector at another edge straight and level at the same cruising altitude. If there were no other traffic, you would have to do nothing other than accept the handoff from one Center controller and then hand him off to another Center controller. Of course, life is rarely like that, and you might have to change his altitude or vector him around conflicting traffic in your sector. The key constraint in RAPCON is that an overflight must be back at his original altitude when he exits the sector, or you will get an error generated for not adhering to the flightplan that Center expects.

2. *Departures* are still relatively easy. Once you release an aircraft for departure, the tower clears it for takeoff and presumably it starts rolling. You do not immediately see it on your scope -- the aircraft must have some altitude before its transponder can be seen by your radar system. That takes time -- usually a minute or two. Then, if you do nothing, the aircraft will merely turn to intercept its outbound course and proceed to climb to its cruising altitude (or the top of your sector control, whichever is higher). Just before it reaches the edge of your sector, you must hand the aircraft off to the Center controller. Some departures are local training flights which must be vectored around for one or more practice approaches at their own field.

Problems arise when an aircraft's requested departure time conflicts with others at the same

airport, when it would conflict with an approach in progress, or when its normal climb-out would conflict with another overflight or climb-out from a nearby field. In this case, you would probably choose to either hold the aircraft or, more probably, release it for takeoff and then vector it or the conflicting one around each other.

3. *Arrivals* are the stickiest, mainly because they take so much of your attention. After accepting the handoff from Center, you must vector the arriving aircraft and also descend it so that it arrives at the destination airport's final approach fix at the correct altitude and heading from which to begin the approach. This usually involves intense concentration and great skill, since you must anticipate when to turn and descend the aircraft and alter the times you give these commands depending on the specific aircraft type, Handling arrivals with finesse requires the most experience of all in RAPCON.

2.5 Control Terminology

Each control environment has its own specific vocabulary. Most users will be familiar with the phrase "Cleared to land" -- tower terminology which means the subject aircraft will be the next arrival at the target runway and is guaranteed that the runway will be vacant when he arrives. RAPCON has a similar set of phrases that, used properly, guarantee that the target aircraft will perform to your expectations during flight.

Overall, an aircraft's flightplan governs its general operations and route of flight, and its performance capabilities govern the speed with which it accomplishes those operations. The flightplan specifies when it expects to takeoff, what altitude it desires to cruise at, how fast it cruises, the exact route of flight, and the destination airport. In the event of communications failure, in fact, the flightplan (as last modified by a control authority) and standard rules of interpretation are used by both pilot and controller as the sole guidance for the rest of its flight. Pilots file requested flightplans, and then Clearance Delivery, who has been working in conjunction with the other control authorities, either approves it and clears the aircraft "as filed" or modifies it and issues a modified actual flightplan.

Performance capabilities of an aircraft determine much of its behavior, An airplane will generally proceed as fast as its normal cruise capabilities allow (although supersonic jets will generally cruise subsonic over populated areas and to conserve fuel). Similarly, while small general aviation aircraft might be straining to climb at 500 feet per minute to their cruising altitude, you might see an F16 rocketing up at several miles per minute. IFR aircraft generally turn at three degrees per second, so heading changes are more easily anticipated.

ASR Commands

Overall, then, most of what an aircraft will do once he takes off is predetermined or outside of your control. You really only have three basic tools that you can use to separate aircraft:

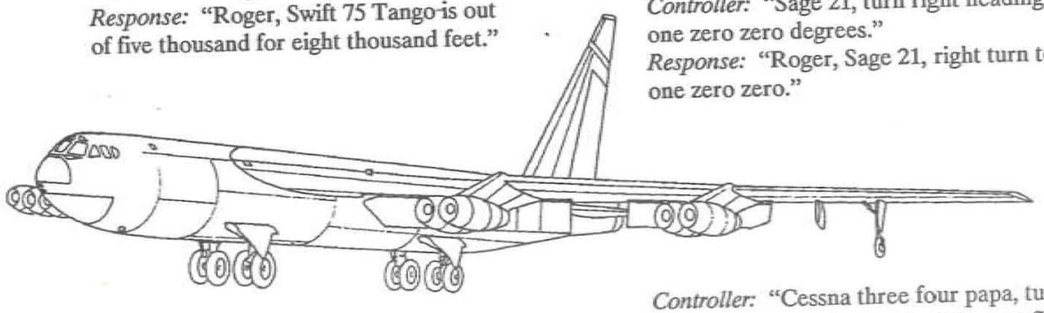
1. ***Altitude.*** "Descend and maintain three thousand feet...Roger, out of ten thousand for three thousand." You have probably heard such interchanges many times when you listened in on ATC frequencies.

Keeping planes apart with altitude seems simple, for it is, after all, a big sky up there. And indeed it is in "en route" airspace, where the traffic is generally boring holes through the sky flying straight and level. In fact, ARTCCs have evolved rules whereby aircraft travelling at certain headings or airways must travel at specified altitudes.

In the RAPCON environment, however, things are not quite so simple, because your aircraft will be continuously descending to land or ascending to their cruising altitudes. Thus, while altitude is always useful in separating aircraft, you will find using it more difficult than you might think in the transitory environment of RAPCON.

Sample vocabulary:

Controller: "November 3275 Tango, climb and maintain eight thousand feet."
Response: "Roger, Swift 75 Tango is out of five thousand for eight thousand feet."



Controller: "Eagle 34, descend and maintain three thousand feet."
Response: "Roger, Eagle 34 is out of one two thousand for three thousand feet."

2. ***Heading.*** If two planes are on a collision course, you can always turn one or both of them away. The process of issuing turn or heading commands to an aircraft is called "vectoring" in controller jargon. As a controller, you can command that an aircraft fly any particular compass heading from 001 through 360 degrees. Headings are specified as magnetic compass courses to fly. You should recall from your geography studies that 090 means East, 180 means South, 270 means West, and 360 (or 000) means North. You can also make fine relative heading changes by asking aircraft to "turn five degrees left."

Again, because of the rapidly-changing nature of the RAPCON environment, and because it is poor form to keep an aircraft on a heading significantly away from its destination, this tool is less useful than you might think. Your use of heading in RAPCON will mainly focus on lining up aircraft for their final approaches, just as your most frequent use of altitude might be meeting the FAF altitude requirement (more on that later).

Sample vocabulary:

Controller: "Sage 21, turn right heading one zero zero degrees."
Response: "Roger, Sage 21, right turn to one zero zero."

Controller: "Cessna three four papa, turn left about twenty degrees to intercept final approach course."
Response: "Roger, Cessna three four papa turning left twenty degrees."

3. ***Speed.*** A good controller is able to line up his approaching traffic on the extended centerline of the runway, tightly spaced, and the view from the tower, especially at night, has produced the descriptive jargon for this feat as a "string of pearls." To accomplish this, a controller must carefully adjust each inbound's speed so that the aircraft follows the one in front of it just so. Yet, since airspeed indicators and winds aloft change with altitude, an indicated 200 knots at 15,000 feet might be substantially different than the same speed near the ground. So speed adjustments must be made continuously and regularly. They are also the most imprecise of all the adjustments available to you, for while the human eye can read the

reported altitude off the radarscope directly, and can note direction of travel with some certainty, speed of target motion across the scope is particularly difficult to discern.

Sample vocabulary:

Controller: "Seneca Two Nine Two, please make your speed now one seven zero knots."
Response: "Roger, SenecaTwo Ninety-Two is coming back to One hundred Seventy."

Controller: "Tinker Twenty-three, can you keep your speed at one eighty on final?"
Response: "Roger, Tinker Twenty-three, one eighty all the way in."

PAR Commands

Once an aircraft is handed off to the PAR controller, the set of available commands both changes and decreases. Here the controller is dealing with an aircraft in a continuous descent, where precise control over altitude is not possible. Moreover, the aircraft's heading must be monitored and directed almost continuously. Therefore, a different set of control commands comes into play, commands that give both pilot and controller more close control over an aircraft in close proximity to the ground.

The first major change involves overall communication procedure: whereas virtually every other control position issues commands to the aircraft and requires a pilot to echo back a reply to verify that he heard and understood the command, the PAR regime relaxes that requirement with the instruction "Do not acknowledge further transmissions. If nothing heard for 15 seconds, execute missed approach and return to the Approach controller's frequency." This revised procedure allows the PAR controller exclusive use of the (simplex) communications channel, but it also imposes a responsibility to maintain almost constant communications with the approaching aircraft. During a PAR, the controller does not preface his instructions with the aircraft's callsign, since he is only controlling a single aircraft at a time.

When the aircraft reaches the final approach fix and intercepts the glideslope, the controller will start him down with the instruction "Begin descent now." The phrase "wheels should bedown" may be added here. With this instruction, the aircraft should assume its approach configuration -- typically wheels down, some flaps, approach speed, and a descent rate that yields about a three degree glideslope. Any turns from this point on are to be half-standard rate (or one and one-half degrees per second) instead of standard rate, and individual vertical corrections are assumed to be small.

1. ***Altitude.*** Instead of asking aircraft to "descend and maintain" a fixed altitude, during a PAR the controller simply advises an aircraft about its relationship to the optimal glideslope presented on the upper half of his radarscope. Commands take the form "(Well/slightly) Above/below glidepath (and correcting slowly/rapidly)", where the phrases in parentheses are optional. The pilot uses his own judgement to correct his descent rate according to these commands. For instance, the instruction "Well above glidepath" would imply that more correction is needed than the instruction "Slightly above glidepath," but if the aircraft were already descending at a fast clip, no additional correction might be required in either case. The "...and correcting..." modifier tends to let the pilot know how much additional correction he appears to need, if any.

2. ***Heading.*** In addition the usual "turn left/right heading ___" as used by an ASR control position,

the PAR controller may also issue positional information as commands: "(Well/slightly) left/ right of course (and correcting slowly/rapidly)". The heading-based turn command requires the pilot to fly a particular heading, while the positional instructions let the pilot determine what heading correction to apply.

A PAR approach is terminated whenever the pilot sees the runway and may proceed visually to the runway, or when the controller informs him that he has reached decision height and must execute the published missed approach procedure. The controller has an absolute responsibility to call decision height -- if he does not, a pilot should be watching his altimeter and start the miss anyway, but he could be so busy controlling the aircraft that he might fly right into the ground. The PAR controller can also "lose" an aircraft which flies off the edges of his scope. Thus, the PAR position has control responsibilities corresponding to the ASR position's separation and surveillance directives.

This, then, is your charter as a RAPCON controller:: **Keep 'em apart, but keep 'em on course and on time!**

Section 3. General Description of the Simulator

RAPCON provides a simulation of the complex real world of military air traffic control. There are many aspects to this world, some you may adjust and many you cannot.

For instance, in real life traffic ebbs and flows according to time of day, geographic sector, and a host of other variables. In RAPCON, you may choose a particular sector to control and set the number of simulated aircraft which will be generated for that sector. The program's built-in rules determine the appropriate traffic mix for each sector. At Eglin AFB, for instance, most traffic arrives and departs East and West, since the Gulf of Mexico lies to the South and rural Florida is to the North.

This Section discusses the RAPCON parameters that you may adjust, as well as presenting an overview of RAPCON's display screen and the various components you see there. In order to better comprehend it, you might activate RAPCON by typing *rapcon* at the DOS prompt. This first section points out the features of this entry screen and startup dialog box you will see before you.

3.1 Start-Up Dialog Box

The centerpiece of the screen is a large dialog box which allows you to change various RAPCON parameters. If you are a beginning user, you should probably just press **Enter** to begin the simulation and a suitable set of aircraft will be generated in the (default) Edwards AFB sector. As you progress in capability, you may want to change the initial values through this dialog box to generate more aircraft in different sectors and change pilot proficiencies and weather conditions.

You interact with this and all other RAPCON dialog boxes using keystrokes and/or mouse clicks which follow conventions typically used in microcomputer software. Each value within the box can be highlighted and changed in turn. Initially, the first value (*Name*) is highlighted. When you have finished entering a new value, press **Enter** to move the highlight to the next value in the box. **Backspace** erases characters you have typed, just as in a word processor or DOS. **Tab** moves the highlight to the next value without changing the current setting, while **Shift-Tab** moves it backward. For multiple-choice values, such as the *Weather* area, **up/down arrow** keys choose among the alternatives. When you tab out of multiple-choice value areas, a check mark indicates your final selected choice. When the dialog box finally has everything set up just the way you want it, press **Enter** to "accept" it and begin the simulation.

*Remember: Pressing **Esc** or **Alt-X** whenever a dialog box is showing will exit RAPCON back to DOS.*

If you have a Microsoft-compatible mouse, you can simply click on whatever dialog box item you want to select and then type in a new value (if necessary). Press **Enter** as usual or double-click on any value to begin the simulation when all values have been entered properly.

The Startup dialog box contains the following values which you may change using the above method(s):

Name

Enter your name (first, last, or both). If more than one person will be training, make sure that each user enters his/her name the same way each time.

Best Score

The highest score for each user will be stored and recalled after the name is entered. You cannot edit this dialog box value.

Control Sector

The filename of the sector you want to control. Sectors files included in this package are:

EDW.SEC	Edwards Air Force Base
NKX.SEC	Miramar Naval Air Station
LSV.SEC	Nellis Air Force Base
VPS.SEC	Eglin Air Force Base
NPA.SEC	Pensacola Naval Air Station

(A disk of many other military control sectors around the country should be available shortly from Wesson International.)

Simulation

For a completely new simulation, enter "NEW" (echoed as "(new)" to distinguish it from a file-name); to re-execute a previous simulation, enter the name of that simulation. The trailing ".SIM" is assumed and should not be entered. Previous simulation data includes all aircraft and random number seed data, so the aircraft behavior will be identical and you may train on any particular scenario over and over.

___ aircraft over ___ min.

Fewer aircraft and/or more minutes will simplify; more aircraft over a shorter time will make the simulation more difficult. The maximum value for each of these fields is 99.

Weather

Use **up/down arrow** keys to move the highlight bar to the weather pattern you wish. The further down the list, the harder an approach will be for all pilots and thus the more missed approaches you will encounter.

* *IFR*. The weather is keeping all the puddle-jumpers at home, but traffic is moving normally. Wind defaults to 10 knots. All approaches will terminate in a landing.

* *Minimums*. Occasionally an approach will be missed and an aircraft will popup as though taking off when you think you've finished with him (with the message "*aircraft*, Missed approach" in the Communications box). Initial miss instructions will be to continue on final approach heading, climb to FAF altitude, and contact Approach Control. Wind defaults to 20 knots.

* *Turbulent* and *Stormy*. Approaches are mighty difficult and lots of misses occur. Winds default to 30 and 40 knots, respectively.

Pilots

Select as above. *Perfect* pilots never make mistakes (hah!). *Average* pilots might ignore some commands, misinterpret others, execute a command intended for another aircraft, forget to turn at fixes, and do many other things that make life "interesting" for the controller in reality. *Lousy* pilots make it miserable. The most perfect sequencing of approaches can be totally destroyed by one turkey who misses the approach and has to come around again for resequencing, or a pilot who just doesn't understand or hear what you want him to do.

If pilot skill other than *Perfect* is selected, be prepared for the following sorts of pilot errors:

* Pilot does not reply to a command. Normally, every command you give will be at least "roger'ed" by the pilot. A short unobtrusive beep accompanies this reply, simulating the aural feedback of a normal radio transmission. If you do not receive this confirmation that the pilot heard and understood your command, then you must assume that he did not hear it and will not execute the last command unless you issue it again.

* "Please say last command again." He missed the command and needs it repeated in full. He continues his previous actions until you repeat the command. There are many variations of this action, including, "Sorry, approach. Had my head in a map. Please say again..." etc.

* Pilot misinterprets a command. For instance, when given a left turn he might turn right instead, or a turn to heading 080 might be implemented as climb to 8000 feet. Problems like this are insidious He might echo the command as he understood it, but then again he might not! It's up to you to spot his mistake and correct it for him!

* The wrong pilot might start executing a command not intended for him. Really tricky to detect, but it happens, especially when callsigns are similar (e.g., N12898 and N21989)!

* An aircraft overshoots a flightplanned turn or doesn't hold where required. For instance, assume an aircraft is tracking an airway heading 100 degrees. The airway veers right to 125 degrees, but the aircraft continues straight ahead after the turning point. Or, when climbing to 6000 feet, the aircraft continues its climb past that assigned altitude. Again, it's up to you to notice this sort of error and gently correct it without damaging the pilot's ego.

* A pilot strays from some assigned value. Told to climb and maintain 10000 feet, he gets there, levels off, then gradually over time descends down through 9000. Or, limited to 160 knots, he lets his speed creep up to 250 knots.

You should expect that pilots of the simpler aircraft will make more mistakes more often than those of the more complex, just as in real life. Military pilots flying out of their own bases have probably flown their routes hundreds of times, but a guy tooling around in his Bonanza probably doesn't get much actual IFR time and is likely to be less famiiliar with procedures in the area.

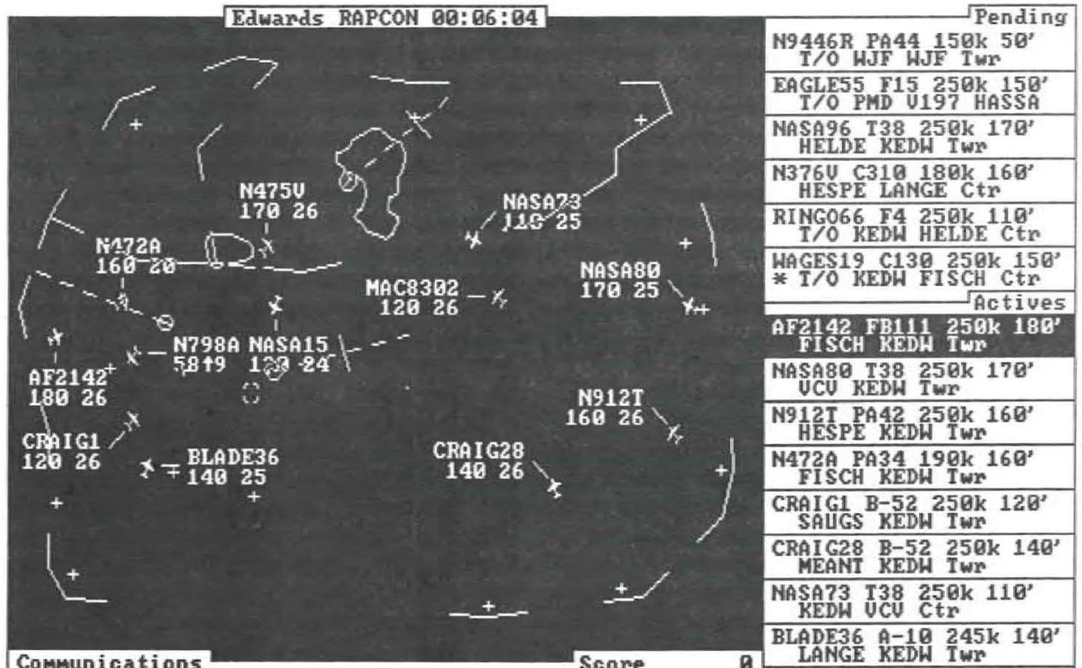
Wind

When you tab into the wind compass rose, the value in the middle indicates the wind speed in knots, while the arrow indicates the wind direction (where it's blowing from). Note that each weather pattern has a default wind speed. You set wind speed by simply typing in a number. Set the direction by pressing one of the eight keypad keys to the nearest 45 degree direction (e.g., **PgUp** = wind from the Northeast; **End** = Southwest; etc.). If you have a mouse, you can simply click on the compass rose to set the direction anywhere you want.

3.2 Screen Arrangement

In real life, a controller's work area is cluttered with computer-generated icons and hatch marks on his scope, printed strips of paper all over his console, taped-up communications frequencies and notes to himself, and of course, the radar targets of the aircraft in his sector. Your screen is considerably simpler, although your basic control task can be just as complex as his.

For all examples in this manual, we will use the Edwards AFB sector (EDW.SEC). Please refer to



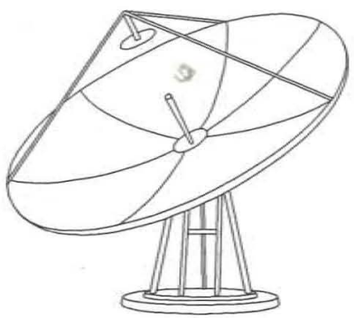
Approximate Coverage of EDW.SEC

the map on the facing page and the flying chart previously shown for the examples in this section.

The ASR screen is divided into four basic areas for this simulation -- the main *Radarscope* itself, which represents these charts electronically, the *Pending* flightstrips, which tell you what aircraft are coming at you; flightstrips of *Active* aircraft, and the *Communications* area where your interactions with the active aircraft and other control personnel are echoed.

Airport Surveillance Radar (ASR)

The largest area of your screen consists of the ASR radarscope. It is black with amber lines and icons just like in real life. Imagine it as a "God's eye" view of your sector, with airports marked as circles (their ILS instrument approaches shown as dashed lines crossed by FAF points, non-precision approaches shown as dashed lines only), intersections and radio beacons shown as plus signs. You should pay careful attention to the representation of these elements on the radarscope -- after some practice, you will begin to memorize the locations of the airports, important fixes, and even airways connecting them. (Pressing **Alt-M** during a simulation will display the entire Map complete with the name of every fix and airport, while **Alt-A** will display the Airway map complete with connecting lines between fixes. This display will revert to normal after one radar sweep.)



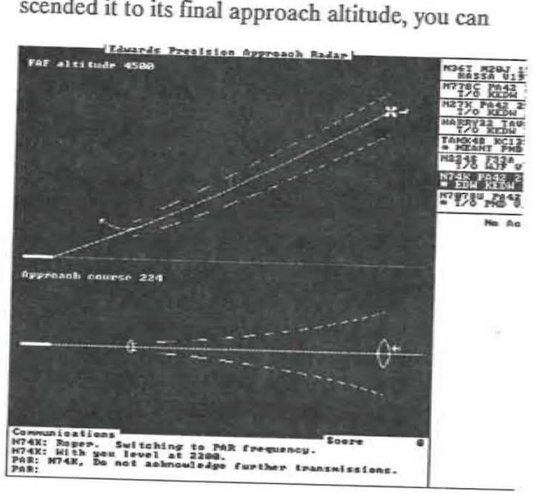
Since an instrument flight does not proceed by reference to ground landmarks, it must use some electronic method of locating its position. Radio beacons have been established for this purpose, and most planes fly from one beacon to the next. Like highways on the ground, these established routes of flight are called *airways* and have been given unique names. Low altitude ones are called Victor airways and usually are denoted by a 'V' followed by a small integer. High altitude ones are called Jet airways and are denoted using a 'J' instead of a 'V'. Scattered among these physical radio beacons are intersections of these airways, created by the intersection of specific radio beams from two beacons. Taken together, these beacons and their intersections form fixes which allow planes to determine their precise location in space while flying in clouds. During IFR flying, airplanes generally fly from one fix to another, usually along airways, so flightplan clearances typically are stated as a sequence of fixes and airways.

To approach and land at an airport after flying there in the clouds, pilots and controllers alike consult appropriate handbooks which list the published instrument approaches for the destination airport. Usually only one or two of these are in use at any one time, depending on the wind direction and traffic. On this RAPCON radarscope, the active instrument approach is shown as a dashed line, with the dashes and spaces each equal to one mile. The final approach fix (FAF) is shown as a perpendicular cross line about a mile wide. As mentioned before, the controller's job includes vectoring an aircraft so that it can be handed off to the tower at a position from which it can initiate an instrument approach to the airport.

On the scope, aircraft will appear and move around. Each aircraft is shown via a small aircraft icon oriented in the direction of travel. Information about that aircraft is shown next to it, offset by a leader line to one of the eight major compass directions (N, NE, E, SE, S, SW, W, or NW). The information shown is its ID number, current altitude (in hundreds of feet), a small up/down arrow or slash if it is climbing or descending to a newly-assigned altitude, and its ground speed in tens of knots (e.g., "25" means 250 knots). (Remember that ground speed varies according to the wind component -- an aircraft flying at 250 knots into a 50-knot headwind will actually be travelling at 200 knots, but if it turns around, its speed will increase to 300 knots.)

Precision Approach Radar (PAR)

When an aircraft approaches within a few miles of its final approach fix (FAF), and you have descended it to its final approach altitude, you can



PAR screen with sweep on.

When you are working the PAR position, the (only) aircraft under your control will not reply to your keystroke commands, but instead simply acts on them accordingly. Moreover, the keypad commands (see Section 4) change to accomodate the different type of command instructions that you will be issuing. For instance, while in ASR mode, up-arrow means "Climb and maintain...", but in PAR mode it means "Above glidepath...". In the ASR case, an aircraft will increase its altitude after you issue a command based on the up-arrow key,

PAR screen with sweep off.

choose to hand it off to either the tower controller at its destination airport, or to the PAR control position. If you choose the latter, you can then "become" the PAR controller -- the rest of your world "freezes" while you're working this position -- and your ASR scope will change to a split-screen PAR scope. The upper half of the PAR scope gives you a vertical glidepath from the final approach fix (shown as a Maltese cross) to the missed approach point (shown as an upward-swinging arrow), witih miles from the runway shown logarithmically as vertical lines. The bottom half of the screen shows you a magnified view of the horizontal approach course from the final marker to the inner marker (both shown as fan markers on the scope), with mileage from the runway marked similarly.

while in the PAR case it will tend to decrease its altitude faster in response.

Naturally, as you might expect, lousy pilots misinterpret your commands on a PAR just as they would on the ASR position. It is somewhat more difficult to notice this problem during a PAR, since their responses can only be inferred from their behavior and not heard.

Pending Flightstrips

About five minutes before an aircraft will be handed off to you from the Center or wishes to takeoff from one of the airports in your airspace, a flightstrip will be posted on the *Pending* stack (located on the top righthand side of your display, light grey on color displays). A flightstrip gives you information about the aircraft's type, current position (including location, altitude, and speed), and requested flightplan (or route).

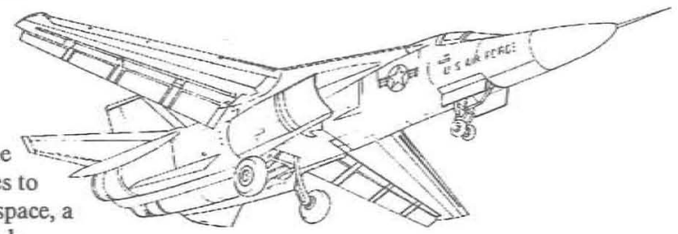
A flightstrip looks like this in RAPCON:

```
SLATE34 F111 340k 150'
SOLED V201 PMD KEDW Twr
```

This particular aircraft, callsign Slate 34, is an F111 flying at 340 knots, level at 15,000 feet. Your control sector only extends upward to around 18,000 feet -- above that, the Center handles it, so that a nonstop flight from San Diego to San Francisco level at 25,000 feet would never appear on your scope.

This fighter is coming in from SOLED intersection (one of the fixes that instrument pilots use to locate themselves using radio navigation when flying in the clouds); will travel via Victor airway number 201 to the Palmdale radio beacon, then direct to Edwards AFB airport where the tower there will assume final control for landing.

If you do nothing, the F111 will proceed blithely along this course and arrive at Edwards doing 340 knots at 15,000 feet. You job, then, is to get Slate34 down from 15,000 feet to Edwards' FAF altitude (4500 feet) without vectoring it too close to any other aircraft under your control.



Recall that you can control an aircraft by either turning (real controllers say "vectoring") it, asking it to climb or descend to a particular altitude, giving it a speed assignment, or holding it at a specified fix. Each simulated aircraft has performance parameters (that you can request popped up onscreen -- the command is **Alt-I**) which limit and circumscribe these options.

For instance, aircraft make "standard rate" turns so that their headings will always change at about three degrees per second. A jet will thus use up far more airspace than a piston single during a turn, for example. Each aircraft stalls out below a certain speed and cannot exceed other maximum cruising speeds, and each climbs and descends at various rates typical for its type (generally between 500 feet per minute and 10,000 feet per minute). Using the performance envelope for each type of aircraft, RAPCON's simulated aircraft will move through space in a manner consistent with, but not exactly equal to, the performance parameters shown for its type. In other words, an aircraftwhose normal cruise speed is 150 knots might enter your airspace actually doing 142 knots, for example.

An aircraft is posted to this stack five minutes before becoming active, giving you the opportunity to look over its intentions before having to do anything about them. You may select an aircraft in the Pending stack and display its intended flight path visually onscreen, but otherwise you cannot control these aircraft.

Active

The flightstrips of all active aircraft are shown in this (light grey-blue) area of the screen below the *Pending* stack. Each aircraft occupies two lines and you may use the screen commands to select aircraft here, scroll their flight plan lines, scroll the entire *Active* stack up and down, and otherwise view all the active aircraft. Note that the first line of each flightstrip remains constant, with the speed and altitude shown being the requested altitude of that aircraft rather than the actual values.

Communications

Since the IBM PC does not come with a voice recognizer, just below the radar scope is the (bright blue) written *Communications* area. Consisting of three to six lines, depending on your monitor, it echoes all communications between you, the active aircraft, and the adjacent controllers, as well as other commands you have entered and the simulation's responses to those commands. Pressing keys constructs a command in this area, and when you terminate the command (typically by pressing **Enter**), the command is simultaneously spoken through your PC's internal speaker and sent to the aircraft. Usually, the aircraft will respond via voice appropriately, although less than perfect pilots might not hear you from time to time.

You will soon notice that interactions between yourself and the pilots are relatively standardized. Whenever you accept a handoff from Center, the communications box echoes your "*aircraft -id*, radar contact" transmission. When you issue a descent and the target aircraft hears it, he responds with "*aircraft-id*, out of *current-altitude* for *newly-assigned-altitude*" All phraseology has been adapted from current procedures.

Transient Screen Items

Other information may appear onscreen from time to time. Some of it you will initiate; some you will not. For instance, pressing the help key **F1** or the alternate help key **Alt-F1** will popup a help box describing either the keypad keys or the **Alt**-keys. Pressing **Alt-M**, as mentioned above, will show the complete map with all fixes and airport names, while **Alt-A** will display airways. If you double-click the mouse pointer on an aircraft, a small mouse menu will popup just below the aircraft. These are the sorts of things that you can make happen onscreen.

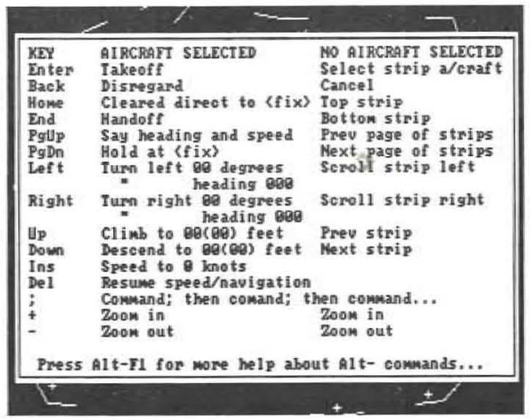
Other boxes are automatically popped up by RAPCON. You will learn to dislike these boxes, for they usually report an error condition that detracts from your score measurably. These error conditions are described more fully in Section Five.

3.3 Exit Dialog Box

Pressing **Alt-X** will popup the *Exit* dialog box which displays your final score (broken down by error types) and offers you the options of **Exit**ing the program, **Continu**ing (if there are still active aircraft to be handled), or **Restart**ing the simulation again. The **spacebar/backspace** and **right/left arrow** keys allow you to select which of these options to execute, or simply typing an option's first letter or double-clicking on it with the mouse will execute it directly.

3.4 On-Line Help

As has become standard with most microcomputer programs today, RAPCON has online help available via the **F1** function key. Pressing **F1** will give you information about the twin uses of the keypad keys -- what commands they issue to selected aircraft, and how they manipulate the flightstrips when no aicraft is selected. Pressing **Alt-F1** will popup a help window showing all the main keyboard commands accessible via the **Alt** keys.



Section 4. Operating the ASR

This Section discusses how to issue commands in the ASR screen of the RAPCON simulator. There are usually several alternative methods available to issue a command.

4.1 Command Syntax

As you have probably noticed by now, the general format of an aircraft command as stated verbally is:

> *aircraft-id* followed by
> *command* followed by an optional
> *parameter*

For example, to climb a N123DV to 6000 feet, a controller would say:

WAKE18,	*aircraft-id*
Climb and maintain	*command*
6000 feet	*parameter*

Or to clear the same aircraft directly to the Torrance airport, he would say:

WAKE18	*aircraft-id*
Cleared direct to	*command*
Eglin AFB airport.	*parameter*

Some commands have no parameter slot:

WAKE18	*aircraft-id*
Resume normal navigation	*command*

So the general syntax for an air traffic control command is:

1. The aircraft you want to maneuver;
2. What you want that aircraft to do (turn, climb, etc.); and
3. The value you want the aircraft to achieve when it finishes the command (heading to turn to, altitude to climb to, etc.)

Every command must begin when only the *App/Dep:* prompt is showing on the last line of the *Communications* section; if something else is showing after that prompt, you are midway through some other command and should cancel it before continuing by pressing the **Esc** key.

4.2 Selecting an Aircraft

The first part of each command requires that you "select an aircraft," which can be done in a multitude of ways.

1. Type in enough of the aircraft ID to uniquely identify it. This involves the end of the aircraft identifier, not the beginning -- "N3953T" would normally be called "Cherokee Five Three Tango" on the radio and abbreviated here using its trailing "53T", not the leading "39" as you might otherwise expect. Terminate with any whitespace character (**space**, **Enter**, **comma**, etc.); or

2. Use the **arrow** keys to highlight the aircraft's flightstrip and press **Enter**; or

If you have a mouse, you can position the mouse cursor over the aircraft icon or the aircraft's flightstrip and click the left mouse button to select it.

3. To reselect a just-previously-selected aircraft, simply press **Enter** again. This is especially useful for issuing a rapid-fire sequence of commands to the same aircraft.

To cancel a selected aircraft, either click the *right* mouse button, press **Enter** again, or press the universal Cancel key **Esc**. An aircraft is selected when you see its full ID echoed just after the *App/Dep:* prompt, and the next command you issue will affect that aircraft as though you had keyed your microphone and said, "Southwest Two Three Four, please ..."

If the aircraft you selected is awaiting takeoff, pressing **Enter** again will immediately clear it for takeoff and you should see it on your screen within a minute or two once it gains some altitude. Unless you intervene, it will automatically turn on course and climb to its flightplanned altitude. A second **Enter** like this will similarly accept inbound handoffs.

4.3 Keypad Control Commands

For all other aircraft maneuvers, you may then complete the command with a keypad key followed by a typed-in parameter followed by **Enter**:

Command	Keypad	Next Parameter
Turn right (heading) ...	Right arrow	000 or 00 degrees
Turn left (heading) ...	Left arrow	000 or 00 degrees
Climb and maintain ...	Up arrow	hundreds of feet
Descend and maintain ...	Down arrow	hundreds of feet
Change speed to ...	Insert	knots
Resume normal nav...	Delete	
Cleared direct to ...	Home	fix name
Handoff to Twr or Cntr	End	
Hold at	PgDn	fix name
Say heading and speed	PgUp	

If you press the wrong keypad key, the **Backspace** key will undo it and you can then repress the correct one.

Turn (to a Heading of) ___ Degrees...

For the first two vectoring commands, if the last parameter is a two-digit number, the turn is a relative turn; if a three-digit number, it is a turn to an absolute heading. For example, "53T, **right-arrow** 20" is echoed as "N3953T, turn right 20 degrees," but "53T, **right-arrow** 020" will read "N3953T, turn right heading 020 degrees" (that's a North-northeast heading).

Climb/Descend and Maintain ...

Altitude changes are accomplished with the **up-** and **down-arrow** keypad keys. Pressing **up-arrow** after an aircraft has been selected will issue a "Climb and maintain..." command, while pressing **down-arrow** issues its inverse: "Descend and maintain...". Since controllers almost never assign altitudes in other than hundred foot intervals, the altitude parameter is entered in hundreds of feet. Typing in "19" will assign an altitude of nineteen hundred feet, while typing in "100" will assign ten thousand feet. A pilot will complain if you type in

something like "6000" for the altitude assignment, since you are really asking him to climb to six hundred thousand feet (which would be in low earth orbit!).

Reduce/Increase Speed to ...

The **Ins** key is the speed assignment key. Use this to slow down or speed up an aircraft. Your assignment must be within the performance capabilities of the target aircraft or its pilot will complain. For instance, asking a jet fighter to slow down to 80 knots will just not work, since that class of aircraft typically stalls at around 120 knots. And asking a Cherokee to speed up to 250 knots is similarly futile.

Resume Normal Navigation

Speed restrictions are tremendously useful, but you should remove them as soon as possible, since pilots hate them and your score will therefore suffer. The **Del** key accomplishes this and simultaneously gives the aircraft authority to proceed directly to the next fix in its flightplan and from there along its previously-planned route of flight. It basically means "Cancel any restrictions I have placed on you and continue normally along your flightplan." The assigned altitude remains unchanged, however.

Cleared Direct to ...

The **Home** key clears an aircraft directly to a fix. After pressing it, you must type in a fix (intersection or radio beacon) name or just the **Enter** key. If you just press **Enter**, the aircraft will proceed directly to the next fix in its flightplan. If you actually type in a fix name, the aircraft will then proceed direct from its present position to the fix you typed.

An alternative way to indicate the destination fix for a "Cleared direct to..." command is to click on it using the left mouse button. That way you do not even have to remember its name!

Cleared for ILS Approach

The **End** key is used to handoff an aircraft to the appropriate tower controller specified as the last item in the aircraft's route on the flightstrip. When you clear an aircraft for an approach, it will turn and intercept the approach course for its destination airport. You still have control of the aircraft until it reaches the FAF, whereupon it will switch over to the tower frequency and you will be unable to contact the aircraft unless it misses the approach and the tower hands it back to you for another try.

If the aircraft reaches the FAF without being at the required final approach altitude for the airport or is more than 30 degrees off the final approach heading, the aircraft will automatically execute a missed approach and fly outbound on the approach heading at its last assigned altitude. You must then bring the aircraft around again for another try, losing points in the process for inefficient fuel use and loss of time.

Handoff to Center

Pressing the **End** key for an overflight or departure will handoff that aircraft to Center, just as pressing it for an arrival will hand it off to Tower.

If you attempt to handoff an aircraft to the center before it is within seven miles of the handoff fix, the center controller will tell you that because it cannot yet see the aircraft on its radarscope it is unable to accept the handoff. If the aircraft is not at its requested altitude when it reaches the handoff fix,

an error will still occur but the handoff will be accepted and the center controller will try to sort out the mess you created for him.

Handoff to PAR Controller

After having lined up an arrival outside the final approach fix like you would for initiating an ILS (see above), if you press the **End** key twice in quick succession, you will initiate a PAR approach for that aircraft instead of merely hand it over to the tower. This will freeze all the other aircraft on the ASR scope and will display the PAR scope with the selected aircraft shown in level flight near the FAF. See Section Five for PAR control instructions.

Hold at ...

Pressing the **PgDn** key will command an aircraft to proceed directly to a fix and hold there until you release it. Aircraft cannot really just stop in space like helicopters can. Holding an aircraft requires that aircraft to fly in a circular pattern based upon the fix location until you tell it to "resume normal navigation" or clear it directly to another fix. This maneuver is aviation's equivalent of "just a moment" but deducts points since the aircraft is burning fuel while waiting in place. Pilots hate holding more than almost anything you can do to them!

Say Heading and Airspeed

The **PgUp** key asks the selected aircraft to say its current heading and airspeed. Its real life counterpart is frequently used when a controller needs more precise information than he can deduce from his display to space aircraft properly for landing or intercept the glide slope.

Remember that airspeed and ground speed may be quite different, depending on the wind speed and the aircraft's direction of flight relative to it.

4.4 Ending Keypad Control Commands

When you have finished entering the complete aircraft command, pressing **Enter** will automatically issue that command to the selected aircraft. If the pilot heard it and makes no mistakes, the aircraft will execute the command as issued and you are free to issue the next one. Of course, average and especially lousy pilots make mistakes, and so you will sometimes have to repeat commands or correct a pilot's interpretation of the command you issued to him.

If you end a command with a **Semicolon** instead of the **Enter** key, the command becomes part of a multiple-part, stacked command that can guide the aircraft's movement in complex ways. Pressing ';' echoes "; ... then ..." and you are expected to begin another command for the same aircraft as though you kept your microphone button depressed and just continued speaking.

For instance, a nice SOP (standard operating procedure) for taking inbounds from the Southeast into KEDW is:

aircraft-id,	Cleared direct to EDW TACAN;
then...	Turn left heading 220;
then...	Speed 180 knots.

An aircraft executing this stacked command will turn immediately and head straight for EDW TACAN. Upon reaching EDW, it will <u>then</u> turn left heading 220 degrees (which will intercept the final approach course for KEDW nicely). When the turn is completed, it will then begin slowing down to 180 knots.

Stacked commands are executed in sequence, with each subcommand beginning immediately <u>after</u> the previous subcommand completely finishes. This means that an aircraft must reach a cleared-to fix or the newly-assigned altitude, speed, or heading before the next subcommand will be executed. (To have multiple changes going on at once, you can use the traditional commands terminated by **Enter** -- the aircraft will execute all such commands immediately upon receipt.) Also, please note: you may NOT include a handoff instruction (**End** key) in a stacked command. Handoffs, which necessarily involve coordination with adjacent sector controllers and frequency switching by the pilot, must occur in real time.

If, during execution of a stacked command, you issue a real time command to the same aircraft, the type of the commands determine the resulting actions. Speed, altitude, and heading commands are regarded as separate types. A newly-issued command of one type will erase all stacked subcommands of the same type, but not those of different types. Thus, using the above example, if the flight is heading for EDW and you issue the real time command,

"*aircraft-id*, Turn right heading 340"

then the stacked commands to head for EDW and then turn left to 220 will be ignored. The speed command in the list will continue in effect, however, and will become the active command from the stacked command list, so *aircraft-id* will begin slowing to 180 knots immediately. If an aircraft is executing a stacked command to proceed directly to a fix then descend to a new altitude, and you clear it to another altitude before it reaches that fix, then the stacked conditional descent will be ignored.

Pressing the **Del** key will cancel all stacked commands for an aircraft, of course, and force it to resume normal speed and navigation.

Note that communication stops during your construction of stacked commands, just as it does when your microphone button is depressed in real life. If you take too long in constructing such a command, you might end it and have several take-off requests and other backed-up communications quickly scroll by.

The best way to understand stacked commands is to practice using them in "don't-care" simulations.

4.5 Mouse Control Commands

As previously mentioned, you may select an aircraft using the mouse by clicking on its icon or its flightstrip. This simulates your pressing the microphone button and stating the aircraft's call sign. A command would normally be issued next from the keyboard.

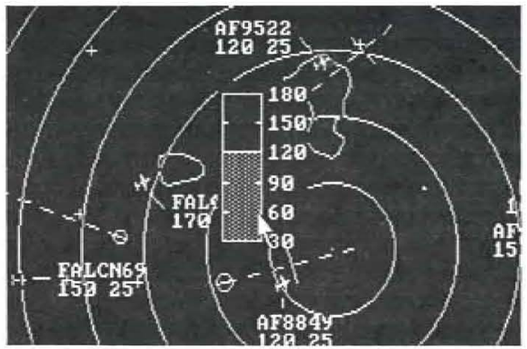
If you <u>double-click</u> on an aircraft's icon, however, a command box pops up near the aircraft and you will be able to complete the command with at most two more clicks. The following options are available on the popup mouse command menu:

<u>Mouse menu</u>	<u>Command</u>
Left ..	Turn left to a heading of ..
Right ..	Turn right to a heading of ..
Alt ..	Climb or descend to .. feet
Speed ..	Make your speed .. knots
Resume	Resume normal navigation/speed
Direct ..	Cleared direct to ..
Hold ..	Hold at ..
Handoff	Handoff to center or tower

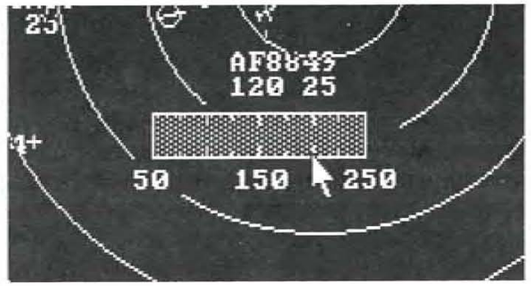
As you move the mouse pointer down the list of options, each one will highlight as the mouse passes over it, and you may select it with a simple click. The options which are followed by two dots require one more click to complete the command:

Command	To Complete
Left .. or Right ..	A compass rose replaces the mouse menu. Click anywhere on the circle to complete a heading command to the nearest 5 degree increment.

Alt ..	An altitude "thermometer" replaces the mouse menu. The filled-in part of the thermometer shows the current altitude, while the assigned altitude (if different from the current) is shown as a white bar. Click on the thermometer at the new altitude assignment.



Speed ..	Like altitude, but a horizontal tape appears. It runs from 50-250 knots with 25-knot increments, or from 100-500 knots with 50 knot increments for high performance aircraft. Click on the new speed assignment.



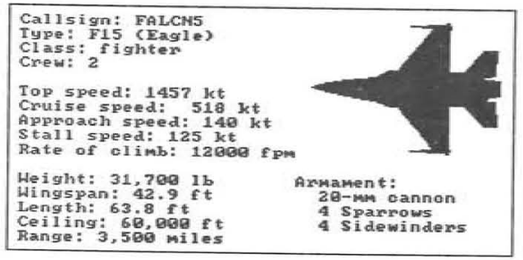
Direct ..	The mouse menu disappears. Click on a fix and the aircraft will be cleared directly to that fix, whose name will echo in the communications area.
Hold ..	Similar to the "Direct .." mouse command, but the aircraft will proceed to the indicated fix and hold there.
Handoff	The aircraft is handed off to either a tower or Center controller in the same fashion as if the **End** key were pressed.

Mouse-issued commands are echoed in the communications area the same as keypad-issued commands, and at any time during a mouse-issued command, you may complete it using its keyboard equivalent. To cancel a partially-constructed mouse command, simply click outside the popup mouse box. All mouse commands may be issued by at most four button presses -- a double-click to popup the command box, a click on the command, and (possibly) a click on a parameter box or fix to complete the command.

4.6 Information Requests

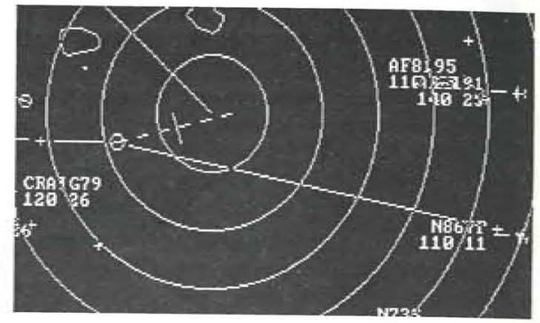
Other commands are available to get more information about an aircraft and its intentions. The main keyboard can be used when an aircraft is selected as follows:

Alt-I Display Information about performance parameters for this aircraft, including its full name and type, climb, cruise, and approach speeds, climb rate in feet per minute, etc. The information will be displayed in a small popup white box and will disappear with the next radar update. Included will be the silhouette of the aircraft type, the number of crew (and passengers if appropriate) it is currently carrying, and any armament on board.



This command works to get information about an airport, too -- just preface it with the airport's three or four letter ID. Especially useful when you forget the FAF altitude for an airport!

Alt-F Show Flight path for the selected aircraft on the radar scope. It will disappear with the next radar update. This command is incredibly useful to see just where an aircraft will go once it becomes active, or where the rest of its nominal flightplan would take it. Expert RAPCON controllers use it frequently.



/ (slash) Set aircraft's leader line and information block to quadrant specified followed by the next keypad key pressed. **Home** = NW; **Up-arrow** = N; **PgUp** = NE; ... **Left-arrow** = W. Eight positions are available.

Mouse users note: You can move an aircraft's leader line to any quadrant by pressing and holding the left button down on the aircraft, dragging from the center of the aircraft icon in the direction you want the leader line to point, and then releasing. It takes far longer to say than to do it.

4.7 Flightstrip Commands

Another set of commands do not require an aircraft to be selected -- they generally manipulate flightstrips and the display in general. If a keypad key is not preceeded by an aircraft ID, then it adjusts something in the righthand flightstrip area instead of the aircraft on radar:

Keypad	Meaning
Down arrow	Highlight the next flightstrip, scrolling down as necessary
Up arrow	Highlight the previous flightstrip, scrolling up as necessary
Right arrow	Scroll the highlighted flightstrip's route right one column
Left arrow	Scroll the highlighted flightstrip's route left one column
PgDn	Next page of currently-selected flightstrips (either Pendings or Actives)
PgUp	Previous page of currently-selected flightstrips
Home	To first flightstrip in current area (either Pendings or Actives)
End	To last flightstrip in current area

Remember: If an aircraft is selected (and showing on the *App/Dep:* command line), then the keypad issues the middle phrase of a three-part aircraft control command. If no aircraft is selected, the keypad controls the flightstrip display.

4.8 Simulation Commands

Finally, various other commands can be entered as **Alt**-key combinations from the keyboard. Remember that you issue them by holding down the Alt key and depressing the regular key simultaneously.

Keypad	Meaning
Alt-A	Three-way toggle displays Airways as connecting lines between fixes, Airways plus names, or turns them off. Airways plus names automatically reverts to normal screen after one radar sweep.
Alt-B	You may display the Boundary of your sector with the **Alt-B** toggle command. Pressing it once will turn the boundary on, while pressing it again will turn it off. Fixes along the boundary determine where aircraft will enter and exit your control, so displaying this boundary will give you a good visual indication of entry/exit points.
Alt-C	Changes the screen Colors. (Hint: Pause with **Alt-P** before using this command.) This command should not be used on monochrome systems. The Left-arrow and Right-arrow keys selects the display object to change:

0	Overall background
1	Radar background
2	Screen borders
3	Aircraft icons
4	Inbound aircraft
5	Airway names on **Alt-M** map display
6	Caution box
7	Error box
8	Flightpath display (**Alt-F**)
9	Help box
10	Fix names on **Alt-M** map display
11	Pending flightstrips background
12	Radar sweep and concentric circles
13	Active flightstrips background
14	Communications text
15	Communications background

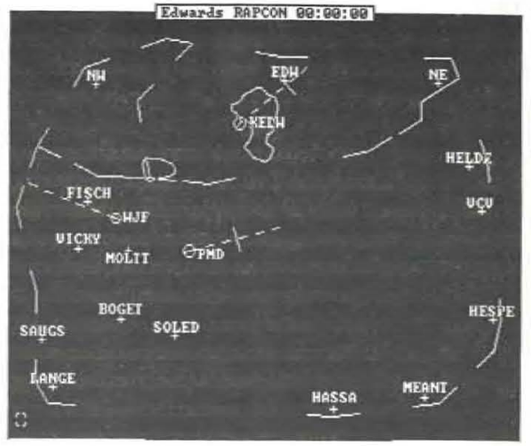
The **Up-arrow** and **Down-arrow** keys change the EGA or VGA color of the selected object. Color values can vary from 0 (black) all the way to 63 (white). A good procedure is to experiment with color settings using this command, then exit and edit the RAPCON.INI file to make your selected changes permanent. See Section Six for more information about RAPCON.INI.

Alt-E Three-way toggle to set your Equipment reliability. RAPCON comes delivered so that your radar data processing (RDP) equipment is somewhat unreliable in associating a datatag with the radar return of each aircraft. Your equipment will "fail" from time to time, just as in real life. When this occurs, the datatags on your radarscope will disappear and the little aircraft icons will be replaced with primary target "blobs" for an indeterminate period of time varying from a few seconds to several minutes. Pressing **Alt-E** once will disable RDP permanently so that you can experience the non-RDP equipment that many of the smaller RAPCON facilities must use. Pressing **Alt-E** again will set your equipment to full-up, perfect RDP status, and pressing Alt-E once more will return it to its preset "unreliable" status.

Alt-G Toggles Ground/coastline display on/off. It is delivered initially on.

Alt-H Toggles on/off a Heading overlay on-screen. Press it, and your sector will be surrounded with a red compass rose similar to the physical one bordering the real RAPCON scope pictured on the front of the manual. Press **Alt-H** again and it will disappear.

Alt-M Displays a Map of fix names. The map will disappear after one complete radar update. To change the map colors press **Alt-P** then **Alt-M** then **Alt-C**. Compare the display below with the flight chart of the Edwards area shown in the Appendix, and you can see how the electronic chart relates to a paper one.



Alt-N Toggles Noise off/on. You have noticed by now that RAPCON beeps, rings, and whines depending on who is "communicating." This parameter defaults to on, but can be changed by editing the RAPCON.INI file.

Alt-P Pauses the simulator. Press **Alt-P** again to resume action. You should never use this command, because it is really cheating, but it does allow you to stop the simulation for a moment to collect your wits. Pausing the simulator immediately deducts 10,000 points from your score so you will not be tempted to use it during a scenario that "counts."

Alt-S Saves all the aircraft flightplans for this simulation to a file of your choice. To execute the same simulation more than once type in `rapcon` *filename* and the program will either load the specified simulation (`*.SIM`) file if it exists or create it if it doesn't and save the next simulation to it. For consistency with RAPCON's naming conventions, the filename you enter should have a SIM extension.

Alt-T Three-way toggle for Talking. RAPCON comes delivered with both pilots and controllers talking. Press **Alt-T** once and only pilots will talk. Press it again and talking will be turned off completely (useful for late-night sessions!). Press it a third time and all talking will resume.

About the only side-effect of talking is that mouse input is ignored during speech output, so you can only use it during periods of quiet. (The keyboard works properly, however, so you can type in commands during voice output, up to the limit of the keyboard buffer -- typically 11 keys or so.) This happens because of the extraordinary programming we had to do to get voice out of the PC -- we turn off interrupts, reprogram its timer chip to rev up the clock, and just generally give its insides a big kick in the pants. During stressful periods, when you're frustrated at not being able to issue commands nearly as fast with voice on as with it off, just remember that real controllers have to deal with similar restrictions due to frequency congestion and slow-speaking pilots.

Alt-X Quits the simulator and eXits back to the DOS prompt.

*** (asterisk)** The keypad's '*' key (also **PrtSc** when shifted) toggles a display of concentric circles onscreen, each 5 miles apart and begins a radar sweep. Press once to display the sweep and circles and again to erase them. The circles are useful to get an idea of distances, and the sweep improves fidelity with real ATC radarscopes. However, on monochrome screens, both may interfere with your primary control responsibility, so you may turn them off using this key.

F10 Jumps the simulator's clock forward one cycle. Held down and repeated, it forces the computer to zip the aircraft across the screen as fast as its processor can go. Since a real controller's life is hours of boredom punctuated by moments of sheer terror, do not use this command if you want to experience what a controller really does, but it does save time when simply finishing out a scenario and also allows you to skip over boring periods when nothing interesting is happening.

+ (plus) Pressing the plus key (on the keypad or the main keyboard) will zoom the radarscope on the selected or last-selected aircraft. Each press will increase the zoom by a factor of two, so that after you press it once, the scope is shown at 2x magnification, and after the next press it is shown at 4x. You can thus look more closely at a congested area, but be careful -- events might be happening offscreen that also demand your attention.

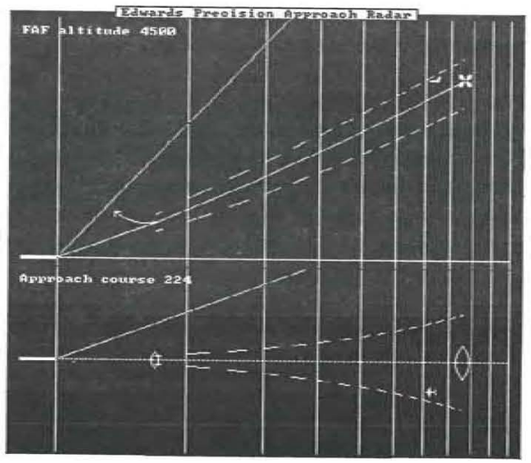
- (minus) The minus key (on the keypad or main keyboard) performs the inverse function -- it zooms back out after you have zoomed in using the plus key. If you are displaying the radarscope at 4x, the first press of minus will zoom out to 2x, while the next press will zoom out to 1x.

Section 5. Operating the PAR

This Section documents the control commands available to you during a PAR.

5.1 Initiating a PAR

You may initiate a PAR approach for an aircraft by simply double-pressing the **End** key. The selected aircraft will first be handed off to the PAR control position via a voice call. Then, your screen will display a PAR control position and the keypad will assume a slightly altered meaning. The aircraft will display twice on the scope -- once on the vertical glideslope display and once on the final approach display -- and check in with you. The command "do not acknowledge further transmissions" will be automatically generated for you, and the aircraft will proceed inbound.



Note that you are not required to send an aircraft to a PAR -- all approaches could be terminated via an ILS and a routine handoff to the tower. However, choosing to work a PAR for an aircraft will generate "bonus points" for that aircraft, a phenomenon discussed more fully in the next section.

As usual, pressing **F1** during a PAR will pop up a help page for the PAR scope.

5.2 Keypad Control Commands

As with the ASR scope, pressing keypad keys generates instructions that are communicated to the aircraft and affect its flightpath. Pressing **backspace** will backup one "phrase" of a command under construction, again as in the ASR scope. Recall that the aircraft on a PAR will not reply to your commands, except to alter its flight parameters according to how it interprets what you're telling it.

Use the following keys to issue commands during the PAR approach. Remember that you must maintain continuous communication with the pilot -- if he goes fifteen seconds without hearing anything from you, he will break off the approach, execute a miss, and lower your score accordingly.

Command	Key	Next
Begin descent now.	Ins	
On course, on glidepath	Enter	
Turn right heading	right-arrow	000
Turn left heading	left-arrow	000
Right of course	right-arrow	Enter, +, -
Left of course	left-arrow	Enter, +, -
Above glidepath	up-arrow	Enter, +, -
Below glidepath	down-arrow	Enter, +, -
Well ...	plus *as a prefix to an arrow key*	
Slightly ...	minus *as a prefix to an arrow key*	
... and correcting rapidly	plus *as a suffix to an arrow key*	
... and correcting slowly	minus *as a suffix to an arrow key*	
Terminate approach	End	

Begin Descent Now

Normally, you will begin a PAR with your target(s) outside the final approach fix (shown as a Maltese Cross on the vertical display and a large fan marker on the horizontal display) flying straight and level, heading more-or-less for the runway. Pressing **Ins** will initiate the approach by asking the pilot to configure her aircraft for the approach and begin a descent appropriate to the glideslope angle for this runway. You must wait a few moments to see whether or not the pilot-chosen descent rate will require corrections from you.

On Course, On Glidepath

Pressing **Enter** by itself during the PAR will tell the aircraft that the approach is proceeding normally. This instruction reassures the pilot that he is on course, descent rate looks good, and not to change anything about his flight configuration. Of course, winds and the aircraft's natural instability often conspire to change this idyllic condition. However, when things are shaping up nicely, use this command regularly to maintain communications and keep the pilot informed of his status.

Turn Right/Left heading ___

Pressing the right or left arrow key followed by three digits will tell the pilot to fly a particular heading. This class of command forms the primary horizontal guidance that you have available. Generally, corrections should be less than ten degrees at one time, since the pilot is flying the aircraft low and slow and is changing heading at one-half the standard rate.

The final approach heading will usually have to be worked out by trial and error, since wind speed and direction, aircraft speed, and nominal approach course will all interact to yield the actual course over the ground. For instance, if the nominal approach course is 224 degrees and the wind is blowing from the Southeast at 30 knots, the actual aircraft heading might need to be 215 degrees for a slow Cherokee but 221 degrees for a fast fighter. You will normally converge on the correct course gradually, but should have it well established by the time the aircraft is about half-way down the approach.

Right/Left of Course

If you follow a **right-** or **left-arrow** key with either the **Enter**, plus, or minus key, its meaning changes from a turn directive to a relative position report. Pressing **left-arrow** and then **Enter** will simply say "Left of course", for instance. Notice that the effect is exactly opposite of an arrow key used as a turn command -- turning an aircraft left should be used when the aircraft is to the right of course, and vice-versa. So if you issue the above "Left of course" command, the aircraft will tend to turn right to intercept the approach course.

When you use this command, the amount the aircraft turns and its actual heading are unknown to you and varies according to the pilot's proficiency (lousy pilots do not control their ships very well, after all) and its current heading. Issuing many of these commands repetitively, for example, may generate such a substantial final correction that the aircraft will zing across the final approach course almost out of control before you have a chance to recognize what is going on via the display. For this reason, most professional PAR controllers use the more precise heading-based control variation for horizontal control.

Above/Below Glidepath

Unfortunately, there is no precise altitude control available, either to you or the pilot. Unlike directional gyros, which are relatively accurate and responsive, an aircraft's vertical speed indicator is imprecise and lags actual control input sufficiently that it cannot be "flown" similarly. Therefore, you are left with this imprecise vertical position command, issued whenever you press the **up-** or **down-arrow** key. As mentioned above, note that pressing an arrow key will tend to cause the aircraft to go in the opposite direction -- e.g., telling him that he is "below glidepath" will cause a pilot to pull up and attempt to decrease his rate of descent.

Well/Slightly

The **plus** and **minus** keys (either on the keypad or regular keyboard) may be used to prefix a positional command. Pressing the **plus** key before an **arrow** key will begin the command with the word "Well", while pressing the **minus** key will begin it with the word "slightly". Thus, pressing **Plus** followed by **up-arrow** followed by **Enter** will issue the command "Well above glidepath."

These modifiers tend to affect the aircraft's response to your positional information. An aircraft "well left of course" will tend to crank in more heading correction to the right than one only "slightly left of course."

... and Correcting Rapidly/Slowly

Pressing the **plus** key after an arrow position command will add the suffix "... and correcting rapidly" to the command; suffixing using the **minus** key will add "... and correcting slowly". As with prefixes, these suffixes will tend to change a pilot's response to the position command. If he is correcting rapidly, for instance, he may not change anything in response to your report, or he may, in fact, change a bit in the opposite direction.

The **plus** and **minus** keys may be mixed and used as both prefixes and suffixes on a single command: Pressing **plus right-arrow minus**, for instance, will generate the command "Well right of course and correcting slowly."

5.3 Terminating the PAR Approach

Each PAR approach will be terminated by your pressing the **End** key, but the actual circumstances of the approach termination will vary.

Often, especially when you have selected IFR weather, the pilot will break out of the clouds early, report the runway in sight, and tell you that he is proceeding visually. He will continue his approach to the runway until you press any key, which will exit the PAR screen after telling you how many bonus points you received for working this PAR approach successfully.

Other times, however, you must report that the aircraft has reached decision height and must

immediately decide whether or not to proceed visually. This you do with the **End** key. If the pilot can see the runway at that point, he will continue the approach and land. If he cannot, he will execute a missed approach; you will receive some bonus points (but not as many as if he was able to land); and the PAR screen will revert to the ASR screen.

However, if you allow an aircraft to proceed below decision height or the missed approach point (shown visually as the upward-sweeping arrow and fan marker closest to the runway), then the pilot will execute a missed approach on his own initiative and the maximum bonus points that you could have received will be subtracted from your score.

At any time during the approach, you may press the **End** key, which will issue the instruction "If runway in sight proceed visually; otherwise, execute missed approach procedure." Usually, if the pilot has not reported the runway in sight, he is still in the clouds, so this action generally causes a missed approach, but it is a handy way to terminate a PAR approach gone awry without suffering the lost points of losing the aircraft off radar or descending it below decision height. You will receive no points either way if this happens.

5.4 Practice PARs

Because PARs are difficult at best, you may want to practice a little before tackling a complete simulation. To do this, select an aircraft destined for a PAR or ILS-equipped airfield and press **F2**. This will magically position the aircarft about two miles outside the final approach fix at FAF altitude, ready for your practice runs. Use this capability for practice only, as it is considered cheating.

Section 6. Make a Plan and Make It Work!

The title of this Section is an old saw in ATC circles. It means that you have to think ahead and commit yourself to a plan of action and then follow through decisively. Bad control emerges from making tentative calls and then constantly revising them. In this Section, we will discuss how to make that plan, how to make it work, and what to do when it falls apart!

6.1 Elements of Good Control

A good air traffic controller handles traffic at several mental levels at once. The basic DOD manual of Air Traffic Control requires that a controller "Give first priority to the separation of aircraft ... and to the issuance of safety advisories." What this means operationally is that your first priority is to insure that aircraft never be permitted to come within a prescribed distance of each other. In RAPCON, as is generally true throughout the system nationwide, this means three miles or a thousand feet.

If they do, you have caused what is called a "separation conflict". In today's safety-oriented ATC environment, even one such separation conflict is cause for disciplinary action. You should never tolerate a separation conflict, even in this simulation. A real air traffic controller's life is spent in a zero-tolerance environment where no mistakes are allowed. Your goal should be the same: separation restrictions must always take precedence over your other activities.

Once you have separation achieved, there are other requirements you face:

Arrivals

Arrivals must be set up for their approach via a series of vector and descent commands. Typically, Center will have descended an arrival from its cruising altitude to somewhere near the top of your control sector, ten to twelve thousand feet or so. When you first see the aircraft on your radarscope, its blinking will indicate that Center has offered you the handoff. After selecting the aircraft and pressing Enter, you have accepted it and can now issue control commands. Usually, you must continue its descent down to the FAF altitude for its destination airport. This altitude is listed in the airport information at the back of this manual and is available online using the **Alt-I** information key (simply type in the three- or four-letter airport designator at the *App/Dep:* prompt and then press **Alt-I**).

Then, while the aircraft is descending, you must vector it into alignment with the approach course. If you have multiple aircraft inbound for the same airport, you may also want to use speed adjustments to set up all the aircraft on extended final approaches with minimal separation. Although vectors are usually given in absolute magnetic headings (e.g., "...turn left heading 170 degrees"), a handy shortcut is to turn aircraft relative to their current heading (e.g., "...turn left 20 degrees"). This latter command syntax allows you to make small adjustments to an aircraft's course without having to remember its current heading.

Once you get an aircraft within the vicinity of the approach course, you can use the **End** key to clear it for the approach into the airport. The aircraft will immediately turn to a heading that will intercept the final approach course, fly that heading until it is lined up for the approach, then continue inbound to the final approach fix where its pilot will switch to tower frequency and begin a descent to the field. Unless the aircraft misses this approach, it becomes the tower's responsibility at that point and you are finished with it. For extra points, of course, you may double-press **End** and work the PAR position for this aircraft.

Departures

Although an airport's control tower "owns" the runway and clears all departures for take-off, they must have your permission to release an IFR departure. You therefore can determine when to take an aircraft off after the tower informs you that the aircraft is ready. Bear in mind that the aircraft is sitting at the end of the runway with its engines running, so you should try to release a departure as soon as possible after you receive that request.

Once you release a departure, the tower clears it for take-off and the pilot begins to rev-up his engine. After a few moments, he starts his roll down the runway and before long is airborne. Since your radar cannot pick up targets until they reach a few hundred feet in the air, you will typically not see a departure on your radarscope until a minute or so after you release it.

Once airborne, a departure will begin turning to its on-course heading and climb to its flightplanned altitude unless you direct him otherwise. It will climb out at a normal rate of climb for that aircraft until it reaches its flightplanned cruising altitude, then level off and continue flying on course. You may, at any time, alter these initial instructions with vector, altitude, or speed commands of your own, but the aircraft must be at its requested altitude, speed, and outbound fix when it reaches the edge of your sector for handoff. If you do not issue any instructions to the aircraft before it reaches that outbound fix, and the aircraft has not climbed enough to reach its requested cruising altitude, you may still hand it off to Center normally there. If you have countermanded its normal procedures with instructions of your own, however, you must hand it off at the flightplanned altitude and speed.

Overflights

Many aircraft will merely transit your sector, flying from an entry fix to an exit fix straight-and-level. These are typically the easiest aircraft to handle, since all you really have to do is accept the entry handoff and then hand them off to Center when they reach the exit fix.

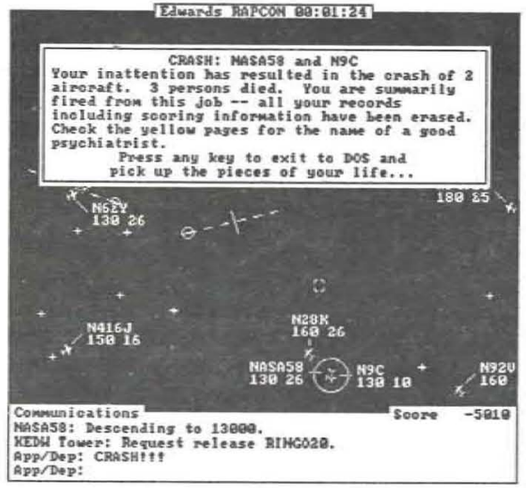
They do tend to complicate your control problem, however, since they tend to remain on your scope for long periods of time. Remember also that airline overflights tend to cruise at flight level altitudes (e.g., above 18,000 feet) so the overflights you get will usually be general aviation aircraft with relatively slow cruise speeds. A Piper Cub cruising at 50 knots will remain on your scope for a long time, cluttering it and making coordination with the faster traffic more complicated.

6.2 Keep 'Em Apart!

RAPCON, like its real-life counterpart, has many constraints placed on your ability to accomplish the above procedures. Violating the primary constraint, so that aircraft do indeed come too close together, can cause three different types of errors.

The most critical of these is not to *Crash* two (or more!) aircraft together. A Crash is defined as a separation of less than 1/2 mile horizontally and

500 feet vertically. If that occurs, the simulation ends immediately: you lose your job, all your employment records (i.e., previous high scores) will be erased, and you will be unceremoniously dumped back to the DOS prompt after an unpleasant message about the number of people you have killed (computed based upon the number of passengers in the aircraft involved) and about your probable future. The program may recommend that you enter psychological counseling for killing those poor unsuspecting passengers, for instance. Causing an airplane crash is not something to be taken lightly, even in RAPCON!



A less serious error is a *Near Miss*, defined as separation of less than one mile and 1000 feet vertically. This and all other errors subtract from your point score, depending on their severity. This one subtracts a lot -- it is the worst thing you can do and not be immediately dismissed. It is accompanied by a high-pitched lengthy wail that should awaken you to your error and keep you from ever wanting to do that again.

The least serious separation error -- a simple *Separation Conflict* -- will occur when you break the 3 mile/1000 foot rule mentioned before. While not as severe as a near miss, you still receive a reprimand and a long series of beeps. As in real life, the computer continuously monitors for these separation errors and automatically notes them in your performance review.

The above errors are substantial. The latter two are cumulative, in that every sweep of the radar will announce the error anew and deduct points from your score. Thus, the longer you have a separation conflict in progress, the more it counts against you.

6.3 Handoff Errors

Interfacing with adjacent controllers, you must accept and handoff aircraft properly, too. When an aircraft first appears on your radarscope, it will blink and announce itself in the Communications section. You will first see the aircraft at the edges of your scope and it will be traveling directly to the inbound fix shown on its flightstrip. If you do not accept the handoff by selecting the aircraft and pressing **Enter** (or by double-clicking on the aircraft with a mouse), it will reach the end of its Center clearance and go into a holding pattern at the inbound fix and stay there until you accept the aircraft. This, of course, will ultimately deduct from your score, since it stops the aircraft's forward motion through your sector and hence increases its delay.

Landing aircraft must be cleared for the approach before reaching the FAF for their destination airports. If you have successfully vectored them so that they arrive at that FAF within 200 feet of the required altitude for the approach and heading within 30 degrees of the final approach course, then the Tower for that airport will accept the aircraft and they will disappear off your scope normally as they descend on the instrument approach. If an aircraft is not within this envelope when you attempt a Tower handoff, it must declare a missed approach and continue on the approach heading at

its last assigned altitude until you bring it around again for another try. These restrictions also apply to the PAR handoff.

Handoffs to Center for aircraft leaving your airspace must be handled properly, too. If you have vectored (or allowed its own internal navigation to get it there) an aircraft to within five miles of its flightplanned outbound fix at its requested altitude, then the Center will usually accept your handoff. Of course, during bad weather, the Center controller may have his hands full with the aircraft already in his airspace, so you will occasionally "hear" him reply to your handoff request that he is too busy to accept an aircraft just then. You will simply have to hold the aircraft or vector it around for a couple of minutes and try again later. Eventually, Center should accept your handoff.

Coordinating with Center is sometimes touchy. If you attempt to hand an aircraft off to Center when the aircraft is more than five miles from its outbound fix, the Center controller will report that he cannot yet see the aircraft on his scope and to call again later. Also, if you do not have the aircraft at its flightplanned altitude and speed at the handoff point, a yellow Caution message box will popup and points will be deducted from your score. This is not a severe error, but it does increase the workload for the Center controller and cause him to question your abilities.

If you forget to make the handoff altogether and allow the aircraft to reach its outbound fix without a handoff, a yellow box will popup reminding you that you let the aircraft fly out of your sector without coordinating with the adjacent controller. Losing an aircraft like that from your scope is a red error, not only serious but really bad form.

Occasionally, as these sorts of errors occur or other information needs to be shown, a small box will temporarily popup on the main radar screen. The color of this box will mirror its contents:

Red Bad error. Near Misses, Separation Conflicts, and losing an aircraft off your scope produce this color box.

Yellow Not-so-severe error. Missed approaches or letting an aircraft reach its outbound fix without a handoff will generate a yellow box error.

Blue This sort of box displays routine information such as aircraft performance or airport parameters (only when you request it).

6.4 Scoring

As you successfully handle an aircraft, your score will rise according to how well you did with it. You get points each time you make a successful handoff (to either Tower or Center), but those points are adjusted downward by the distance you required the aircraft to travel beyond its requested flight path. Points are also subtracted according to how long you held the aircraft on the ground or at its inbound fix before accepting it. Points are deducted for every control command you gave to the aircraft. Remember -- your job is to be unobtrusive. The more you "interfere" with an aircraft's planned route of flight, the worse you are doing (at least from his individual perspective). Finally, bonus points are awarded for working the PAR position -- more points the longer the aircraft remained in the clouds, less points if he breaks out early or misses because of low ceilings, and negative points if you lose him or let him descend below decision height without the runway in sight.
Since different types of aircraft use fuel differently, the actual number of points awarded after handling an aircraft depend on its type. Military jets gulp fuel at an astounding rate and generally merit the most such fuel-related point adjustments. In descending order of importance, fighters, trainers, twins, and then piston singles also get you points when they are finished.

These adjustments are relatively minor compared to the sorts of negative deductions that occur with errors. Points (far more, generally) are deducted whenever you make any mistake mentioned before during the simulation. In sum, then, the more aircraft you successfully handle per unit of time, the higher your performance review at the end.

See Section Seven for more information on point values for the various aircraft operations.

Section 7. Varying the Simulation

This Section describes all the ways you can vary the simulation. You have probably noticed that you can enter your name on the startup dialog box, as well as change the number of aircraft generated and the time span over which they enter your sector. You can also change the sector itself, as well as weather and pilot capabilities.

These are temporary settings, valid only for the current session. In this Section you will learn how to permanently change the defaults presented to you in that startup box. You can even permanently change scoring parameters, screen colors, and error probabilities. All this can be done by editing the RAPCON.INI initialization file.

RAPCON comes to you configured for an "average" beginning user. Ten aircraft are generated over a twenty-minute period in the Edwards sector (the example sector used throughout this manual), resulting in about four aircraft onscreen at once and a total scenario run time of about forty minutes to an hour. This results in scenarios which, although still difficult to handle without any practice, are nonetheless not too slow and boring.

You should be able to reasonably handle these beginner scenarios without too much trouble before attempting to change anything about the simulation. The only exception to this rule might be if RAPCON is not interpreting your graphics card properly in its automatic mode, forcing you to edit the first line of RAPCON.INI to fix that problem. See the Video section below for more information.

7.1 RAPCON Files and What They Do

The distribution diskette should contain at least th following files. A READ.ME file (if present) will document any discrepencies from this list.

`RAPCON.EXE` The main program. You cannot change anything in this file.

`RAPCON.INI` Initialization file. See the special section below for information on this file's internal structure and how to customize it to meet your particular needs. This is the only RAPCON file that you should try to edit or customize.

`RAPCON.SMS` A font file for CGA systems. Not necessary on non-CGA systems -- if you have a Hercules Monographics, MCGA, EGA, VGA, or PS/2 system, you can safely delete this small file from your working disk.

`*.SEC` Sector data files. Each control sector has one of these files. In the standard distribution version, the following files should be present:

`EDW.SEC`	Edwards Air Force Base
`NKX.SEC`	Miramar Naval Air Station
`LSV.SEC`	Nellis Air Force Base
`VPS.SEC`	Eglin Air Force Base
`NPA.SEC`	Pensacola Naval Air Station

`DEMO.SIM` Continuously-running demonstration scenario.

`DEMO.DMO` Annotations and commands to be issued for the `DEMO.SIM` scenario.

`LOGO.SCR` Stores the entry screen's logo in different formats for the various graphics cards supported.

`*.VOI` RAPCON's voice comes from highly compressed digitized speech stored in these files.

`AIRCRAFT.INF` Information file used when **Alt-I** key is pressed.

`AIRCRAFT.TYP` Aircraft parameters - cruise speed, stall speed, rate of climb, etc.

7.2 Other Sectors

If you tire of handling traffic around Edwards AFB, or if you live in another part of the country and would rather train on a sector closer to home, you should choose a different sector in the opening dialog box. Type in one of the above three-letter sector filenames in place of EDW.SEC. You should not type in the .SEC extension -- RAPCON will supply that automatically.

Then, instead of the EDW sector, you will see a completely different geographic area displayed on your radar scope. You should probably use the **Alt-M** and/or **Alt-A** commands once or twice to get a sense of its airway structure and the names of its fixes and airports. Remember that the **Alt-I** command is always available to get more information about any airport in any sector.

You can make any sector the default for the startup dialog box by editing the "Sector" entry in RAPCON.INI. See below for more information.

7.3 Traffic Loads

After a few hours of sampling RAPCON, you will notice that minutes go by without your issuing any comand in the delivered configuration. To make life more interesting, and to continue learning control techniques, shortcuts, and develop standard operating procedures through experience, you should always try to handle the most aircraft per unit time as possible.

You can vary the number of aircraft handled and the time period over which they enter the sector in the startup dialog box. Once you progress well beyond the 10 aircraft over 20 minutes delivered default, you should probably edit the appropriate items in RAPCON.INI to automatically default to more appropriate values for your skill level. Notice that the time period for aircraft entry into the sector is always shorter than that taken to complete a scenario, since the last-generated aircraft will take some time to transit your sector.

Just what those values should be depends on your personality. If you like going for high scores, then you should keep the time period relatively long and substantially increase the number of aircraft generated. The score for any particular scenario is increased mainly by the number of aircraft handled and decreased by the number of mistakes and inefficiencies you introduce. For a maximum score, you should therefore handle many aircraft, and that means long scenarios. The maximum number of aircraft you may enter for a single simulation is 99, while the maximum time over which they enter is 99 minutes. Such a scenario will typically require over two hours to complete.

On the other hand, if you like intense but short periods to tune up your skills, you should keep the time period short and continuously increase the number of aircraft generated in that fixed time period. Increasing your scores this way demonstrates more capability than simply lengthening the scenario time to handle more aircraft. You will get better quicker.

A quick note about "average" values for these parameters: After a few hours of concentrated practice, you will probably be able to handle about 20 aircraft over a period of 15 minutes. Decreasing that period to ten minutes and getting through without a conflict of any type is the mark of an intermediate RAPCON user. Once you have generated and handled 20 aircraft that entered your sector within a period of 5 minutes, you will truly know what ATC stress is all about and can consider yourself an expert, at least within the context of this simulator!

A shortcut method exists for setting these two parameters when you start RAPCON from DOS. You can append the number of aircraft to be handled as a first optional integer, and the length of the simulation in minutes as the second to the DOS command to execute RAPCON. For instance, the command:

```
rapcon 20 40
```

means to create a simulation with 20 aircraft being generated over 40 minutes, while

```
rapcon 7
```

means to generate only 7 aircraft during the RAPCON.INI-determined number of minutes.

The mixture of aircraft categories, routes of flights, and destinations which is randomly generated for a simulation is controlled by the data in *.SEC, which also stores the sector geographical information such as fix and airport locations. You should not try to change these parameters.

7.4 Repeating Scenarios

In Section Four we mentioned that you can use the command **Alt-S** anytime during a scenario to "snapshot" its aircraft data to a file for use later on. If you do not use this command, the last scenario generated is always saved to a file called `LAST.SIM` as well. This feature is intended to allow you to rerun selected scenarios, ones that you had particular difficulty on or would just like to keep around for later use.

To rerun a particular scenario, you should enter its name (as usual, without the .SIM extension) after the `Simulation:` prompt in the Startup dialog box. Whenever you *Restart* a scenario from the Exit dialog box, the current simulation, which has been saved as `LAST.SIM`, becomes the default scenario in that position. Thus, by restarting a scenario, you can handle the same aircraft again, possibly to investigate alternate control procedures or simply try again without making that hideous mistake you just made!

You can also rerun a particular scenario by typing a SIM file's name after *rapcon* at the DOS prompt. For instance, you can always rerun the last scenario generated by typing:

```
rapcon last
```

to DOS. If you have saved a scenario to disk under the name `FABULOUS.SIM` by using **Alt-S** anytime during its execution, you can rerun that one by typing tracon fabulous to DOS instead.

7.5 RAPCON.INI

As mentioned before, you can edit the RAPCON.INI initialization file with any DOS-file-compatible text editor such as EDLIN.COM that comes with DOS or even your word processor. You

should make a backup of the distributed version of the file for insurance against errors on your part, and should set up your word processor in "non-document", "program editing", or "DOS" mode. The file has various sections, each of which is composed of individual lines which usually have a key word followed by one or more parameters. The amount of white space is not significant, so you may put as many spaces or tabs between the key word and its parameter(s) as you wish, but the basic format and sequence of the lines in RAPCON.INI is important and should not be changed.

In this section, we list each line in RAPCON.INI followed by a short discussion of its meaning and the possible values you can use for its parameter(s).

`Monitor Auto`

The first line in RAPCON.INI determines the monitor used. If that line shows "Auto" (the delivered default), then RAPCON auto-detects the monitor you are using and adjusts accordingly. Other monitors can be forced by editing the line so that the desired monitor is specified from the following list of supported monitors:

Monitor	Description
Auto	Automatically query the hardware and adjust to the highest-resolution graphics output achievable (Auto does not work for modes above VGA)
CGA	Color graphics -- 640 x 200 black-and-white
MCGA	PS/2 model 25 and 30 -- 640 x 480 black-and-white
Hercules	720 x 348 black-and-white
EGA	More than 64K EGA -- 640 x 350 16 colors
EGA64	Older EGA with 64K on board -- 640 x 350 4 colors
EGAROM	EGA systems such as on the Zenith Z-248 which do not contain the normal EGA font -- this option substitutes the regular IBM ROM font instead.
VGA	PS/2 models 50+ or VGA -- 640 x 480 16 colors
V800	SuperVGA mode for Video Seven FastWrite and VRAM cards -- 800x600 16 colors
V1024	1024x768 mode for Video Seven FastWrite and VRAM cards (requires high-frequency monitor and 512K memory on video card)
P800	Paradise Professional VGA card in 800x600 mode 16 colors
8514	IBM 8514 Graphics card -- 1024x768 mode 16 colors

We have observed that some clone EGA/VGA cards may give erroneous responses when our software queries them, perhaps indicating limited 64K EGA capabilities when they can actually emulate the full 256K 16-color IBM EGA or even VGA standard. Or perhaps you have an EGA card driving an RGB (CGA resolution) monitor.

You can try out RAPCON's various monitor options using a command-line switch first and then edit this line in RAPCON.INI once you discover the appropriate setting for your system. The syntax of the command-line switch is:

`rapcon /m` *monitor*

where *monitor* is one of the above monitor designatiors. Many Z-248 systems, for instance, will usually work just fine when activated with the command line

`rapcon /m EGAROM`

Some trial and error might be necessary before you ascertain just what your graphics card really does

support. Almost all graphics cards will support CGA, however, so you should make that your fall-back position if all else fails. Once you discover what setting is best for your system, you should edit this first line in RAPCON.INI to make it permanent.
Please remember that the original IBM monochrome adapter card does not support graphics at all -- if your computer uses that card, you cannot run RAPCON.

`Sector EDW.SEC`

This is the sector file that will be initially presented in the Startup dialog box. It comes delivered as Edwards AFB, but you may enter any of the following sector filenames instead:

`NKX.SEC`	Miramar Naval Air Station
`LSV.SEC`	Nellis Air Force Base
`VPS.SEC`	Eglin Air Force Base
`NPA.SEC`	Pensacola Naval Air Station

`Aircraft 10`

The "aircraft" line sets up the number of aircraft generated in the scenario. You might increase this number as your performance improves to save the bother of typing in this parameter in the startup dialog box. It can also be set through the command line, and must be between 1 and 99 aircraft.

`Minutes 20`

This parameter determines the number of minutes over which the above number of aircraft enter your sector. Increasing this number for a fixed number of aircraft tends to make a scenario easier, while decreasing it will make it harder. This parameter can also be set in the Startup dialog box or through the command line. It may have any value from 1-99 minutes.

`Weather IFR`

The startup box weather setting occurs next. Allowable values mirror those in the startup dialog box -- `IFR`, for the easiest weather; `Minimums`, for difficult but likely-to-be-completed approaches; `Turbulence`, for more missed approaches; and `Stormy`, for the worst weather possible.

`Pilots Perfect`

This parameter sets up the "Pilot" value in the Startup dialog box. There are three possible values: `Perfect`, where everyone does what you tell them immediately; `Average`, where they generally execute your commands but might not hear some of them; and `Lousy`, where they frequently miss commands and some pilots actually execute commands intended for other pilots altogether!

`WindFrom 180`

Initial wind direction. Note that wind direction means the direction the wind is blowing from, not to, so that planes will tend to be swept towards a direction of 180 degrees from the wind direction when you vector them.

`Noise ON`

You have probably heard the various bleeps, burps, ringing, and warbles that RAPCON makes as pilots and other controllers call you or you make mistakes. Setting this parameter to OFF will cause RAPCON to run silently.

```
Sweep           ON
```

Initially, the radar sweep and range rings are ON, simulating the full-impact radarscope in a true RAPCON. Many users -- especially those on monochrome systems -- may find that these display items detract from their primary control task, and so to save the need for pressing '*' to toggle them off when you start, you can simply edit this parameter to OFF and no range rings or sweep will show. You can always turn them on again using the asterisk key at any time during the simulation.

```
Talk            ON
```

This parameter determines how RAPCON starts talking. "On" or "Both" will cause both pilots and controllers to talk through your PC's speaker. "Pilots" will cause pilots to talk to you, but your commands will not be repeated verbally. And "Off" will turn off talking altogether.

```
Equipment    Unreliable
```

This Parameter determines whether or not your radar data processing (RDP) equipment fails during use. In real life, the backroom computers which associate datatags with raw radar returns fail from time to time, resulting in a controller seeing only primary radar targets with no tags on the scope for periods varying from a few seconds to several minutes. You may choose to set this parameter from "Perfect," where the equipment never fails, to "Unreliable," in which your equipment might fail perhaps once or twice during a scenario, or to "Off," which never shows datatags at all thereby allowing you to experience the control regime of smaller RAPCONs and in-the-field installations which have no RDP capability at all.

```
Shoreline    ON
```

Using **Alt-G**, this parameter determines whether or not lake or ocean shorelines of your sector are displayed on the screen.

```
Boundary     ON
```

Similar to Shoreline, boundaries in your sector may be displayed or hidden using **Alt-B**.

```
Airways              OFF
```

This parameter, defaulted to the OFF mode, displays the airways in your sector and is turned ON using **Alt-A**.

The next section of RAPCON.INI determines screen colors. Recall from Section Four that you can set the colors of individual screen items using the **Alt-C** command if you are using an EGA or VGA graphics system. Those color settings are in effect for only that particular execution of RAPCON; to make them permanent, their corresponding color line in RAPCON.INI must be edited. Color numbers can vary from 0-63.

```
EGA/VGA 16Colors
0background      0
1radarback      20
2borders        63
3aircraft       38
4inboundac      38
5weather         7
6cautionbox     54
7errorbox       44
8flightpath     36
9helpbox        27
10fixnames       39
11pendingback    7
12radarsweep    56
13activeback     3
14commandtext    0
15commandback    43
```

The first color section in RAPCON.INI sets colors for EGA and VGA sytems. You should only change the color number parameters, not the order or naming of the color items themselves.

```
EGA 4Colors
0background      0
1aircraft       38
4radarback      20
7other          55
```

The second color section in RAPCON.INI sets colors for EGA 64K sytems. Older, less expensive EGA cards might have only 64K instead of the more typical 256K that virtually all modern ones do. You will know whether or not your EGA system is a 64K one by observing that only four colors are shown onscreen in the high resolution mode we use, and one of those is black! We have chosen other colors that will permit your system to function yet differentiate between the data and radar background items.

```
CGA Color
0Foreground  2
```

CGA Color sets the foreground color in CGA mode. Color 2 is green (default). The value can be changed from 0-15.

```
Scoring Parameters
add_enroute          500
add_depart           500
add_arrive           800
add_actype           100
sub_command           10
sub_delay             20
sub_pause          10000
sub_enrwrongspeed    100
sub_enrwrongalt      250
sub_enrhandoff       500
sub_missedapp        250
sub_offradar        1500
sub_3mile           1000
sub_1mile           5000
sub_crash              0
```

The above section sets up scoring parameters for RAPCON. You may change them, but if you do, your scores cannot then be compared to others training with you using another copy of RAPCON with its original RAPCON.INI file.

Each scoring item begins with the word "add" or "sub", which indicates whether that item is added or subtracted from the accruing score. After the underscore comes the description of the item and then the number of points associated with it.

The first few items determine the basic point value of an aircraft which you handle. Each time you successfully handoff an aircraft to either an airport Tower or to Center, points will be awarded. Overflights start with 500 points, departures 600, and arrivals 800 points. To that is added 100 points for each increasing aircraft type: 0 points for a single; 100 points for a twin; 200 points for a turboprop; and so forth until an additional 500 points is added for handling a military flight. (We did this because the more sophiticated aircraft tend to burn more fuel faster and carry more passengers.) From this basic aircraft score, then, is subtracted 10 points for each command that you issue to it, and 20 points for every minute you delay it from its optimal time of passage through your sector.

For example, suppose you handle N66DZ, a Learjet taking off from Gen. William J. Fox airport

near Edwards AFB. Suppose you hold him on the ground for two minutes after he requests takeoff clearance, and because of a sequencing requirement you issue four commands which result in another three minutes being lost in vectors for traffic. You would get 760 points for handling this aircraft: 600 to start with, plus 300 because he is a corporate jet, minus 40 points for the commands you issued, minus 100 points for the delay you imposed on his flight.

The other points to be subtracted are associated with the various types of errors that RAPCON detects: handoff errors to the en route Center, approach altitude errors, missed handoff errors, vectored-off-radar errors, and the various classes of separation conflict errors. There are no points associated with a crash -- the simulation merely terminates and erases you from its records forever.

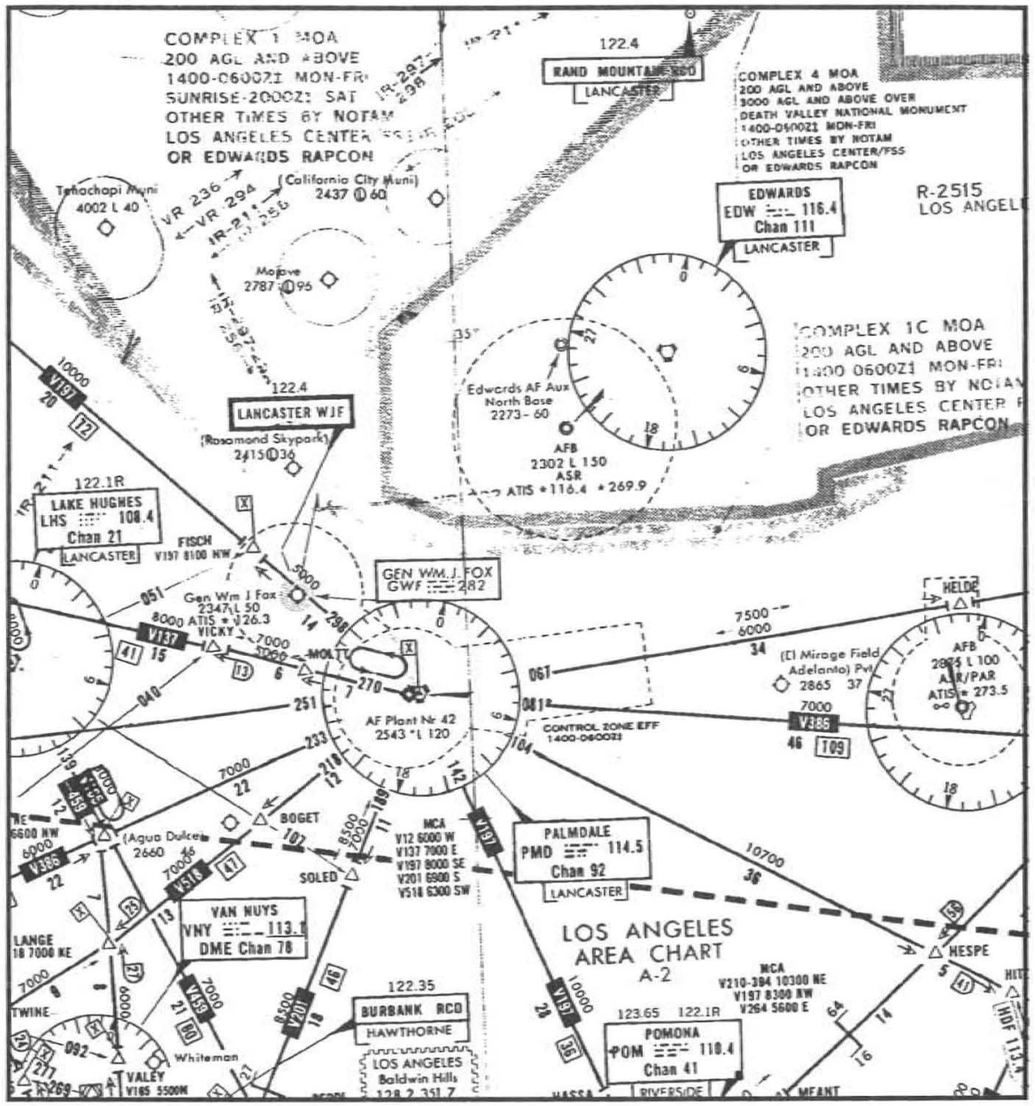
```
Pilot Proficiency
Type          Perfect    Average    Lousy
Single        100        70         55
Twin          100        80         65
Turboprop     100        85         70
CorpJet       100        90         80
Airliner      100        90         85
Heavy         100        85         65
Turbine       100        85         65
Trainer       100        85         65
Transport     100        85         65
Bomber        100        85         65
Fighter       100        85         65
Experimental  100        85         65
Helicopter    100        85         65
```

This section determines the probablity that the different pilots of the different types of aircraft will make mistakes. One hundred percent means that no mistakes will be made, while 50% indicates that half the time, a pilot will mistake your command, ignore it, execute a command for another aircraft, etc. Notice that pilots of singles and twins are assumed to be generally less proficient than pilots of military jets and airliners. If you fly a single, you might want to change this situation, and you can.

```
Weather Factors
Type          IFR    Min.   Turb.  Stormy
Landing       100    80     60     50
CenterAccept  100    90     80     70
```

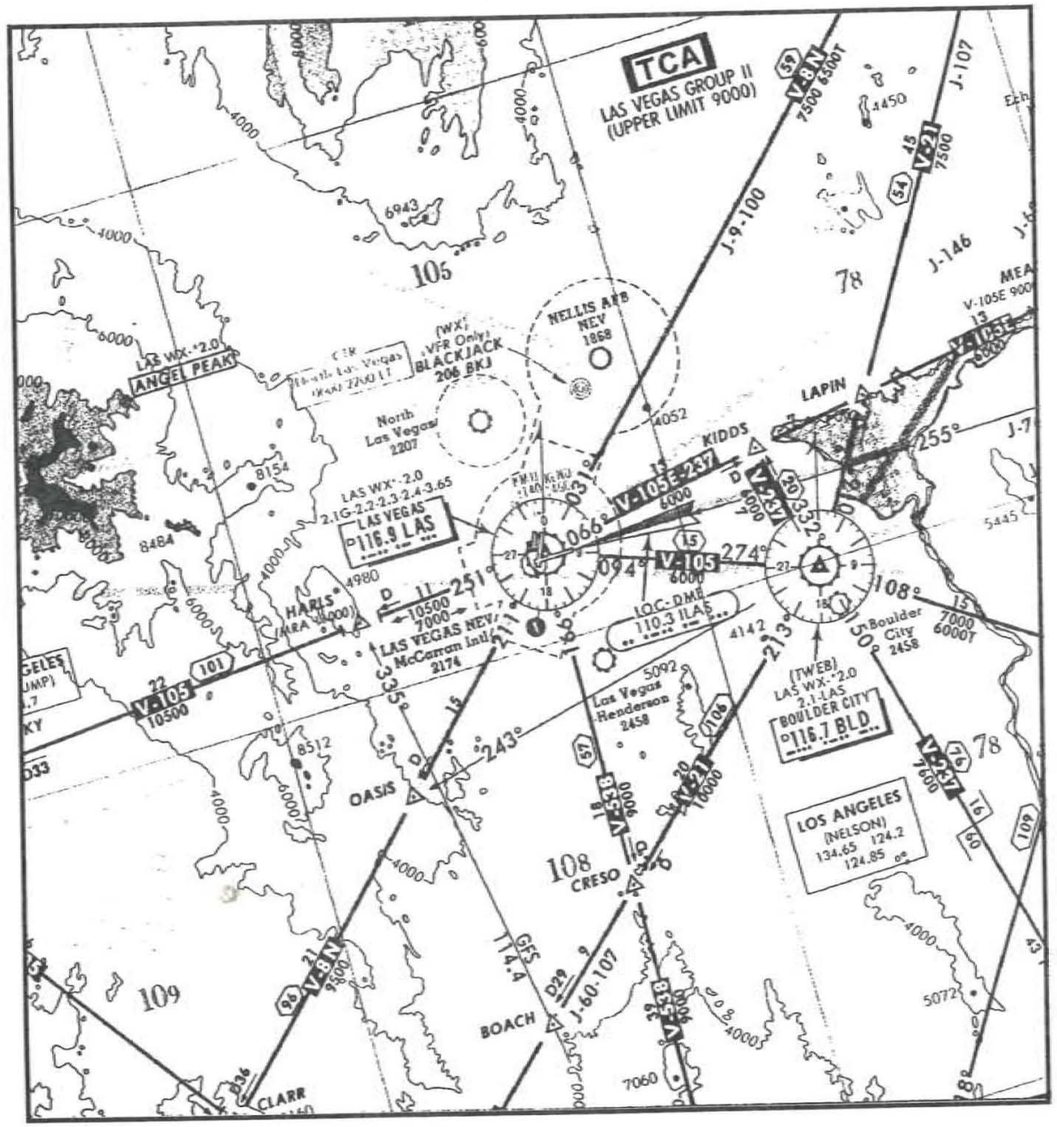
Like the above pilot "goodness" probabilities, these weather-related numbers set up the probability of missing an approach in the various types of weather RAPCON simulates. They also set the probability that Center is too busy to accept your handoffs for each weather type. Stormy weather, for example, means missed approaches 60% of the time, Center controllers with their own headaches who reject your handoffs 30% of the time.

Edwards (EDW.SEC)



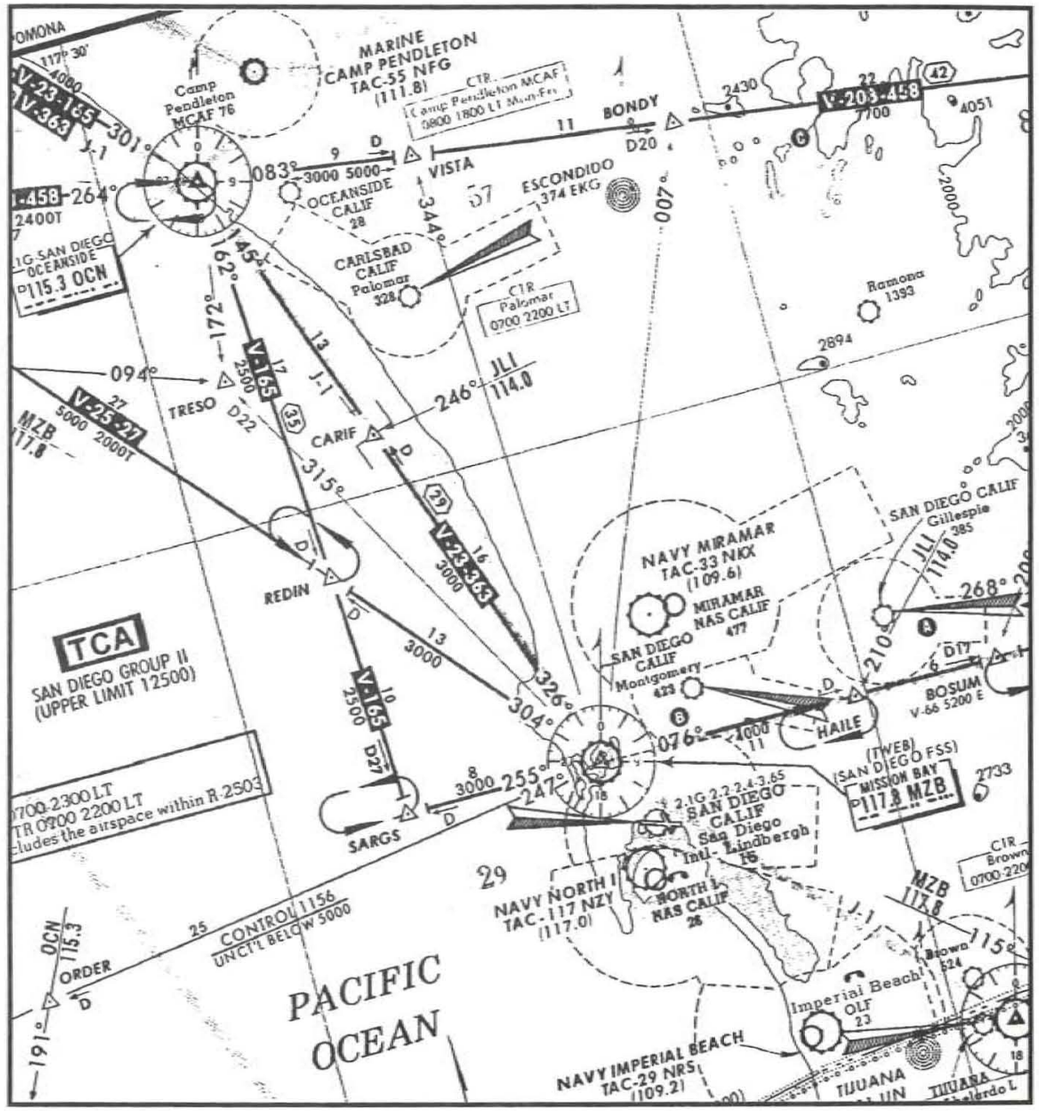
Not for Navigation – For Use with RAPCON Only!

Nellis (NSV.SEC)



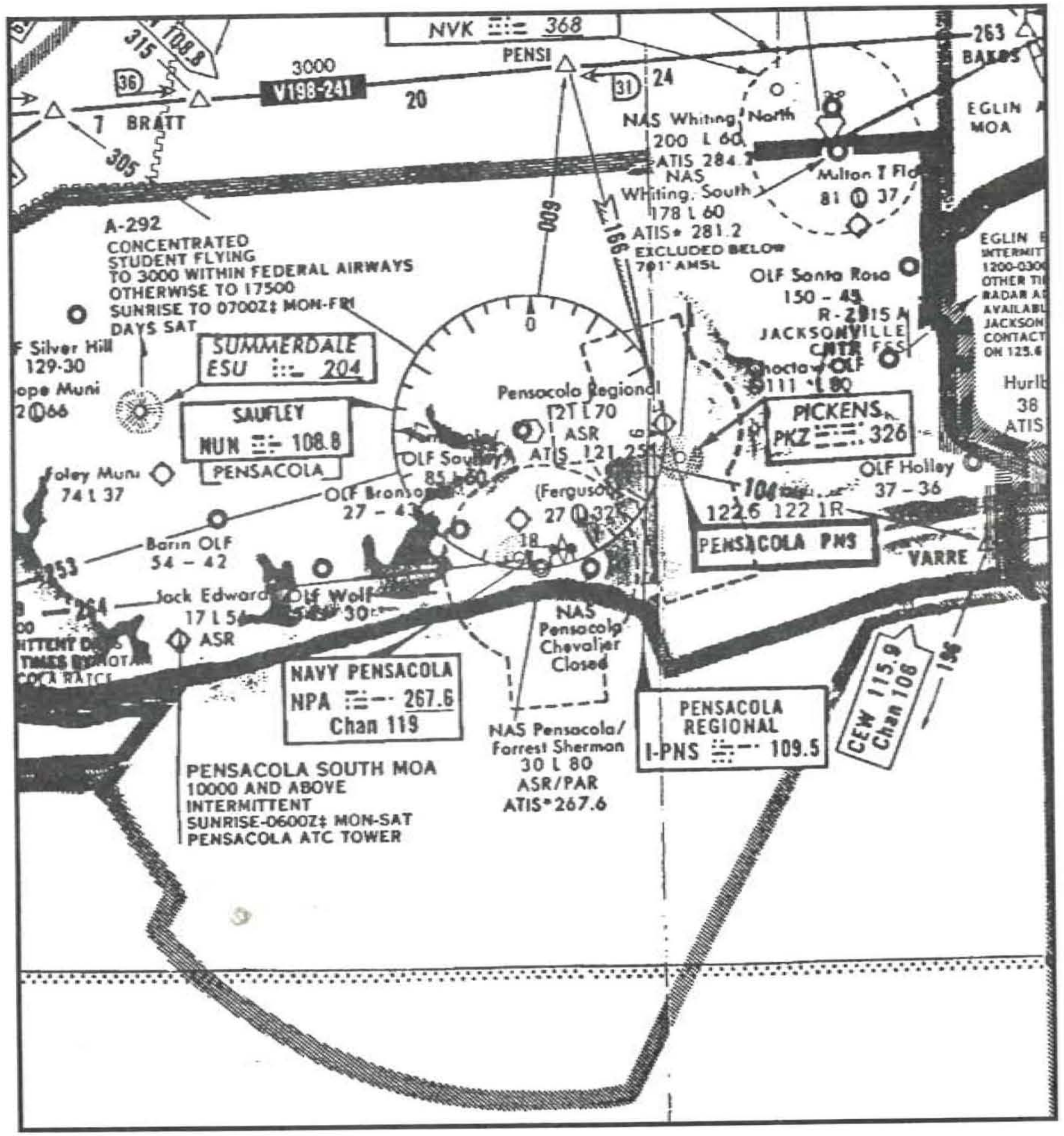
Not for Navigation – For Use with RAPCON Only!

Miramar (NKX.SEC)



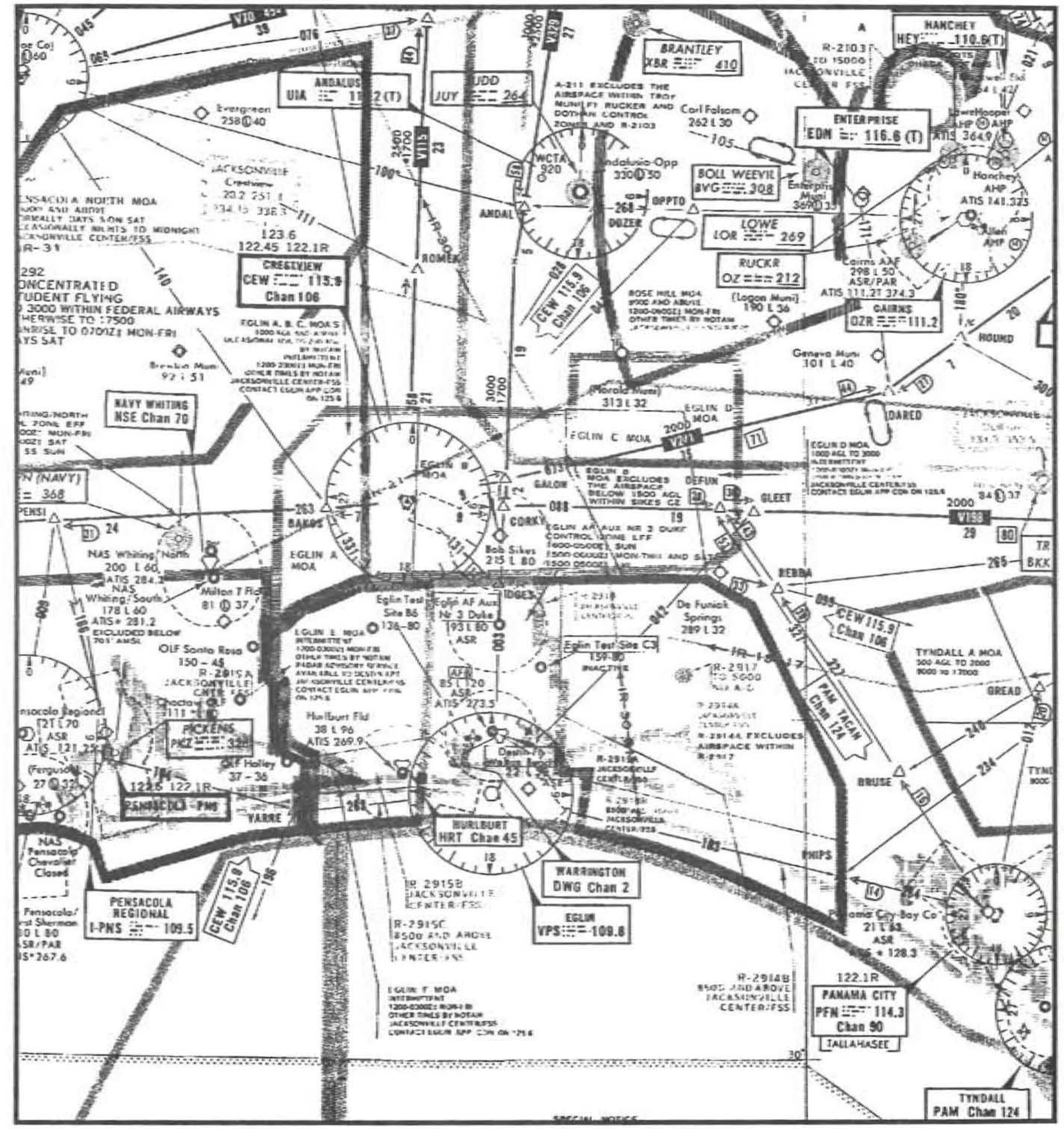
Not for Navigation – For Use with RAPCON Only!

Pensacola (NPA.SEC)



Not for Navigation -- For Use with RAPCON Only!

Eglin (VPS.SEC)



Not for Navigation -- For Use with RAPCON Only!

Air Base/Airport List

This appendix lists the important characteristics of the various military air bases and civilian airports under your control in the different control sectors. Each sector's table lists the airfield three-letter designator, its name, the distance in miles from the airport to its final approach point (FAF), the FAF altitude (arrivals must be at this altitude when they reach the FAF to begin an approach), the airfield elevation in feet, and the inbound heading to the airfield from the FAF.

ID	Name	Dist	Alt	Elev	Head	PAR
Edwards (EDW.SEC)						
KEDW	Edwards	7.6	4500	2302	224	Yes
PMD	Palmdale	5.7	4500	2543	251	Yes
WJF	Will J. Fox	2.7	4400	2347	116	No
Nellis (LSV.SEC)						
LSV	Nellis	6.9	4200	1869	207	Yes
LAS	Las Vegas	5.1	3800	2174	250	Yes
Miramar (NKX.SEC)						
NKX	Miramar	4.5	2200	478	244	Yes
SAN	Lindbergh	4.7	2000	15	90	Yes
CRQ	Carlsbad	6.3	2200	17	130	Yes
Pensacola (NPA.SEC)						
NPA	PensacolaNAS	6.0	2000	30	190	Yes
PNS	Pensacola	4.4	1700	121	160	Yes
AL15	Jack Edwards	4.0	2000	17	130	No
5R4	Foley	4.2	1700	74	161	No

Eglin (VPS.SEC)

KVPS	Eglin AFB	5.0	1500	85	190	Yes
EGI	Eglin Duke	5.0	2300	193	180	Yes
81J	Destin	3.4	1200	22	84	No
KCEW	Bob Sikes	3.8	1500	215	170	No
HRT	Hurlburt	5.0	1500	38	180	No

Glossary of ATC Terminology

Air Route Traffic Control Center (ARTCC) -- A centralized location where numerous enroute controllers have jurisdiction over a large airspace subdivided into sectors. It is frequently referred to by pilots as the "Center."

Air Traffic Control (ATC) -- Ground-based coordination of aircraft utilizing radar and pilot/controller radio telephony intended to prevent midair collisions and expedite the safe and orderly flow of air traffic.

Airway -- A path consisting of line segments joining geographic points specified by radio beacons or intersections formed by two or more such beacons.

Approach -- (see Instrument Approach)

Approach Control -- The ATC facility responsible for radar separation and coordination of aircraft in the vicinity of an airport. Approach Control's jurisdiciton extends about 20-40 miles from the airport horizontally and 10-12 thousand feet vertically.

Approach Speed -- The recommended speed contained in aircraft manuals used by pilots when making an approach to landing. This speed will vary for different segments of an approach as well as for aircraft weight and configuration.

Airport Surveillance Radar (ASR) -- Gives controllers a "God's-eye" view of the sector airspace, typically out to a range of 60 nautical miles or so.

ARTCC -- (See Air Route Traffic Control Center)

ATC Clearance -- (See Clearance)

Automated Radar Terminal Systems (ARTS) -- The generic term for computer-mediated radar data processing facilities located in most TRACONs. ARTS II systems are used at low to medium density

facilities, while ARTS III systems are available for high density situations.

Automatic Altitude Reporting -- That function of a transponder which responds to Mode C interrogations by transmitting the aircraft's altitude in 100-foot increments.

Autopilot -- A mechanical device which steers the aircraft automatically. The more sophisticated -- often called flight directors -- allow the pilot to preprogram complex functions and give him almost "button-pushing" command of the aircraft.

Beacon -- (see Fix)

Below Minimums -- Weather conditions below the minimums prescribed by regulation for the particular action involved; e.g., landing minimums, takeoff minimums.

Ceiling -- The heights above the earth's surface of the lowest layer of clouds or obscuring phenomena.

Center -- TheATC facility, also called Enroute Control, responsible for aircraft separation and coordination while in cruising flight between departure and destination airports.

Chart -- Aviation term for map.

Clearance -- A set of flightpath parameters, generated by an ATC facility and similar to if not identical to a pilot's requested flightplan, which specifies how the IFR aircraft will proceed to its destination. It consists of assigned altitudes, airways, radio frequencies, and the like, and must be obeyed until superceded by a newer clearance.

Cleared as filed -- Means the aircraft is cleared to proceed in accordance with the route of flight filed in the flightplan.

Cleared for (type of) Approach -- ATC authorization for an aircraft to execute a specific instrument procedure to an airport.

Cleared for Takeoff -- ATC authorization for an aircraft to depart.

Codes/Transponder codes -- The number assigned to a aircraft's transponder.

Collision Avoidance System (CAS) -- A method of automatically warning pilots of impending midair collisions. Some are ground-based, relying on radar returns and controller-relayed commands; others are based on airborne transponders which use cockpit displays to directly warn pilots of the proximity of other aircraft.

Conflict -- A situation in which one or more aircraft, through controller inaction, has been allowed to violate a governmental directive such as radar separation minima. A controller is charged with the prevention of conflicts as his primary job task.

Conflict Alert -- A function of certain air traffic control automated systems designed to alert radar controllers to existing or pending situations that require his immediate attention/action.

Contact (facility) -- Establish communication with a certain ATC facility.

Control Tower -- The ATC facility responsible for the visual separation and coordination of aircraft in the immediate vicinity of an airport. The Tower's airspace extends about five miles from the airport.

Controller -- Person who mans the radar scopes and performs the functions of air traffic control.

Cruise/Cruising Altitude -- Aircraft is straight-and-level flight proceeding towards its destination.

Departure Control -- The ATC facility which complements Approach control, coordinating departing aircraft via radar near a major air terminal. It is colocated with Approach control in the TRACON.

Direct Clearance -- A set of instructions which clear an aircraft directly from its present position to a specified point such as a radio beacon.

Enroute -- see Center.

Final Approach Fix (FAF) -- The geographical point at which a pilot, referring solely to a published approach procedure and his instruments, begins a final descent to an airport. This point is generally specified by a fix location and an altitude from which the approach must begin.

Fix -- A specified geographical location used in air navigation. Usually, fixes are easy-to-locate points formed by radio beacons.

Flight Service Station (FSS) -- The governmental service interface with all pilots, both VFR and IFR. The FSS provides preflight and enroute weather briefings, receives and processes flightplans, and issues initial clearances.

Flightplan -- A description of an aircraft's proposed flight, including departure time, route, altitude, etc. An IFR flightplan is a request for ATC service, subject to controllers' commands; a VFR flightplan merely records a proposed flight and aids in searching for overdue aircraft.

Flightstrip -- As an aircraft transits the various sectors and receives clearances, the current flightplan parameters are continually printed out by the computer on strips of paper. These strips are then used by each controller responsible for that aircraft as a memory aid.

Fly Heading (degrees) -- Informs the pilot of the magnetic heading (0-360 degrees) that he should fly.

General Aviation -- That portion of civil aviation which encompasses all facets of aviation except the airlines.

Glideslope/Glidepath -- Radio beacon which provides vertical guidance for aircraft during approach and landing.

Go Around -- Instructions for a pilot to abandon his approach to landing. Additional instructions follow.

Ground Control -- The ATC facility responsible for coordinating movement across and airport's surface, exclusive of the active runway(s).

Ground Controlled Approach (GCA) -- A radar approach system operated from the ground by air traffic control personnel transmitting instructions to the pilot by radio.

Handoff -- To release control of an aircraft and give it to another ATC facility as the flight proceeds past the airspac elimits of the control jurisdiction.

Hold -- A command which directs the aircraft to fly in a tight oval pattern (called a holding pattern) thereby effectively stopping its forward progress for a specified period of time.

Instrument Approach -- A procedure, standardized and published by the Federal Aviation Administration (FAA), whereby an aircraft can descend to an airport solely by reference to its flight instruments and navigational aids.

Instrument Flight Rules (IFR) -- A set of guidelines and regulations created by the FAA which define standardized requirements and procedures for flight without visual reference to the ground.

Leader line -- Connects an aircraft's identification and altitude information with the target on a controller's radar scope.

Maintain (altitude) -- To remain at the altitude specified. The phrase "climb and .." or "descend and .." normally preceeds "maintain" and the altitude assignment.

Missed Approach -- When conditions prevent a pilot from completing an instrument approach to a landing, a missed approach is declared and the pilot may elect to try again or proceed to an alternate destination airport.

Nautical mile -- About 1.15 times the statute mile. One knot = one nautical mile per hour.

Negative -- "No," or "permission not granted," or "that is not correct."

On Course -- Indicates that an aircraft is established on the route centerline.

Outer Marker -- The radio fix from which a particular kind of instrument approach -- called a precision approach -- is begun. Only the larger airports have precision approaches.

Precision Approach Radar (PAR) -- Special equipment at some airports that give controllers both horizontal and vertical course guidance.

Pilot Request -- A request to the controller, initiated by the pilot, for some change in the current clearance, such as another altitude or route of flight. The controller has the option of granting or denying the request, depending on the traffic situation at the time.

Profile Descent -- An uninterrupted descent from cruising altitude to interception of a glide slope.

Radar -- Acronym for Radio Detection and Ranging. A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

Resolution -- A command sequence given to the aircraft involved in a conflict which prevents or destroys the conflicting situation.

"Resume Normal Navigation" -- A command which directs an aircraft to fly back to the track and speed from which it had been vectored and proceed as specified in its clearance.

Runway -- A defined rectangular area on an airport prepared for the landing and takeoff run of aircraft.

Say Again -- Repeat.

Say Altitude/Heading -- Used by ATC to request an aircraft altitude or heading.

Sector -- A subset of an ARTCC's or TRACON's airspace over which a single controller team has jurisdication.

Separation Conflict -- The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures have been violated. In a TRACON, this is generally three miles horizontally and one thousand feet vertically.

Shrimp Boat -- A slip of paper containing an aircraft's identification, altitude, etc. manually placed next to its radar return on a controller's horizontal scope. These have been phased out with the advent of radar data processing facilities.

Squawk -- Controller instruction to activate specific modes/codes/ functions on the aircraft's transponder; e.g., "Squawk code zero two five six." (See Transponder)

TACAN -- Tactical Navigation radar beacon. Similar to civilian VORTAC, but transmits in the VHF frequency band.

Taxi -- The movement of an aircraft under its own power on the surface of an airport.

Terminal Area -- A general term used to describe airspace in which approach control service is provided.

Tower -- A terminal facility that uses air/ground communications, visual signaling, and other devices to provide ATC services to aircraft operating in the vicinity of an airport.

Track -- The airway segment along which an aircraft would ideally fly. Pilot inattention and controller vectors both cause the aircraft to become "off-track."

TRACON -- Acronym for "Terminal Radar Approach Control".

Transponder -- An airborne receiver/transmitter combination which replies to the ground-based radar interrogation pulse with a coded signal uniquely identifying the aircraft.

Vector -- To issue a specific heading change command to an aircraft, usually as a collision-avoidance technique. The aircraft is said to be "on a vector" until another command, such as "resume normal navigation," cancels it.

Visual Flight Rules (VFR) -- A set of governmental regulations and guidelines for aircraft not under continual control of an ATC facility and flying by visual reference to the ground.

VORTAC -- Also called VOR or omni, a VORTAC is a navigational radio beacon broadcasting in the VHF frequency band.

Waypoint -- A radio fix along the route of flight. An aircraft flies from waypoint to waypoint until it reaches its destination.

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