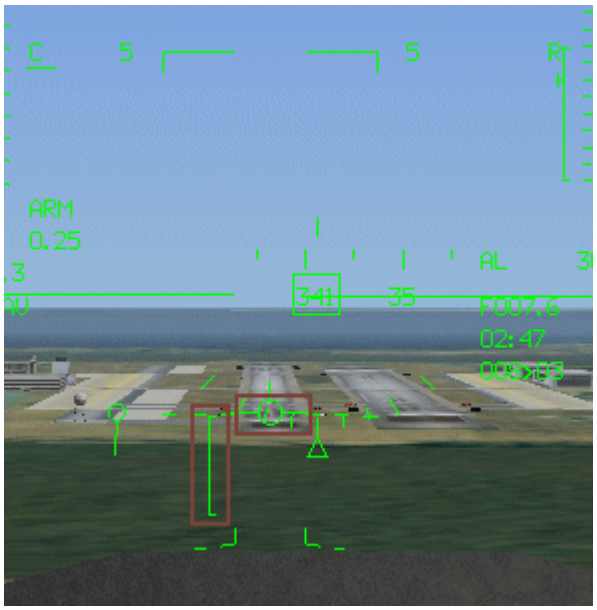
LEARNING TO LAND THE F-16 THE VIPER PILOT WAY

INTRODUCTION

Ever since Falcon 4.0 came out one of the most difficult tasks for people new to the program has been figuring out how to land properly. This tutorial was written for those people who are looking for a landing technique that they can use for their F4.0 experience. Still, don't get the idea that this is only a tutorial for beginners. Many people are able to land just fine but they may not be landing in a way that is safe or easy. I personally had a great system for landing that I used for almost a year before learning of another system that worked better. I took it upon myself to learn how to land using this new system. The system I refer to is based on the approach that real F-16 pilots use to land the real aircraft. Some of you may find that this approach is much different from the one you have used in the past. If you are interested in landing properly like a real F-16 pilot or if you are simply interested in seeing how it is done, read on!

Perhaps most people who land using Falcon 4.0 monitor their Flight Path Marker (FPM) and airspeed above all else. The approach that I outline below ignores airspeed and places emphasis on the AOA bracket. By using the FPM and AOA bracket, you can do very nice landings at any weight without having to monitor airspeed at all. In fact, you will notice that the airspeed isn't displayed at all in any of my screenshots below! Once you are on the glideslope and your speed is low enough to drop your gear, you can ignore airspeed and focus on landing using the FPM and its relation to the runway and the AOA bracket. Once you follow the proper procedure for landing, your airspeed will be exactly where it should be automatically.

The image below shows both the FPM and the AOA bracket. They are both outlined inside of a red square:



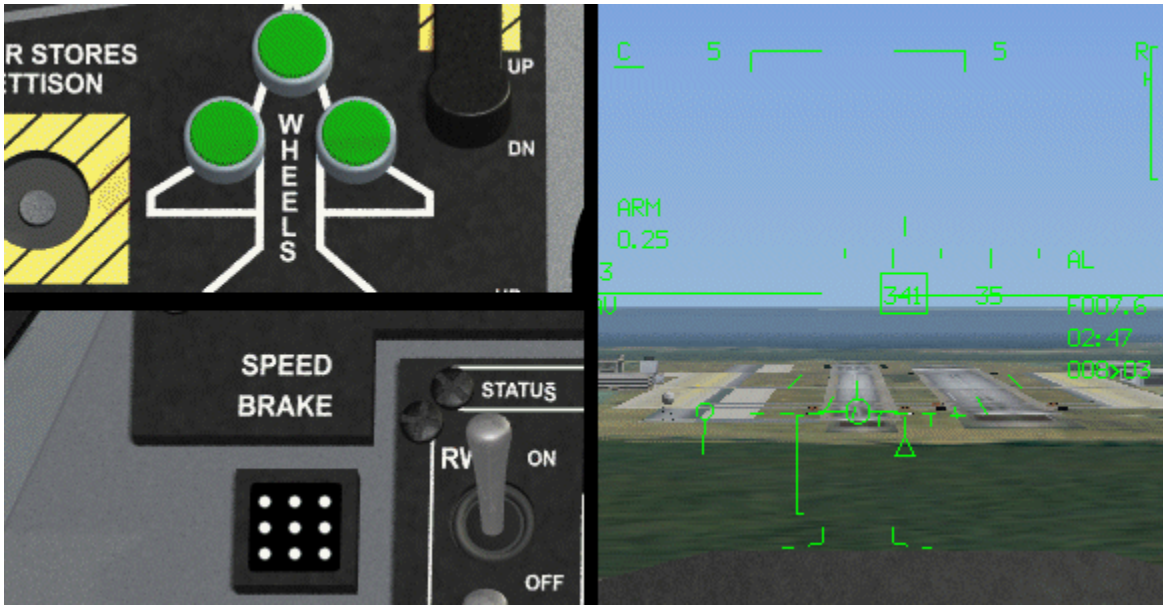
FPM AND AOA BRACKET

You will all be familiar with the FPM but you might not be familiar with the AOA bracket. The AOA bracket is a bracket shaped item on the HUD that indicates your angle of attack (the number of degrees between the direction of travel - the FPM - and the direction your nose is pointed - the gun cross) . It generally appears on the HUD after you lower your landing gear. If the FPM is above the AOA bracket then your angle of attack is lower than 11 degrees. If it is at the top of the bracket (like in the image above), then you are at 11 degrees angle of attack (AOA). If in the middle you are at 13 degrees AOA (optimum AOA for landing) and if at the bottom then you are at 15 degrees AOA (too high of an AOA for a safe landing).

This tutorial is divided into two sections. The first is called LANDING THE F-16 and the second is titled FLAMEOUT LANDINGS. You should know the basics of regular landing before tackling the flameout landing section.

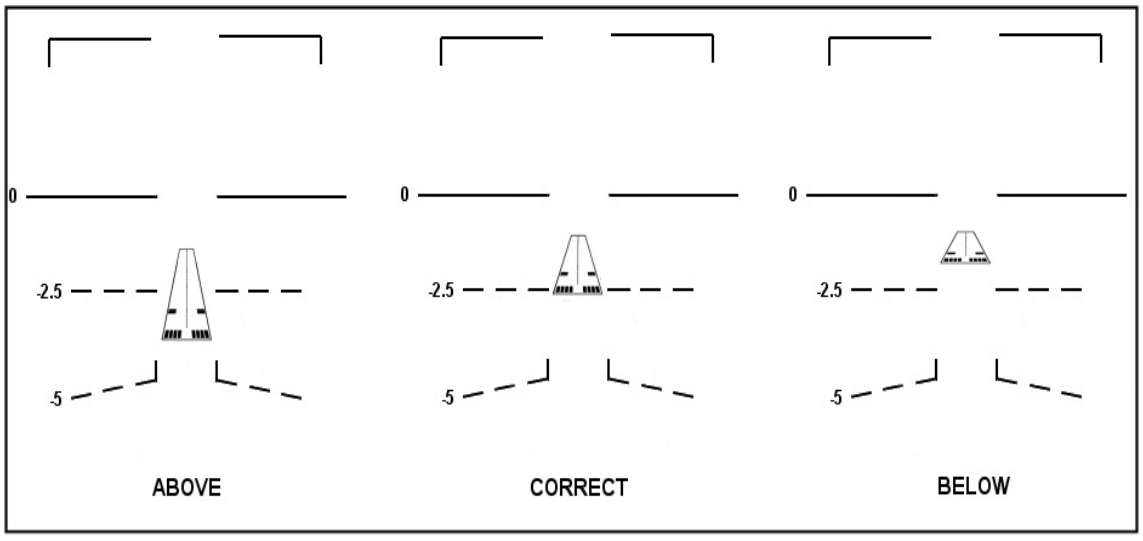
LANDING THE F-16

Now that we have gotten that all out of the way we can talk about landing. When approaching the runway and within a few miles distance, lower your brake and get your speed below 250 kts. Lower your gear when it is safe to do so.

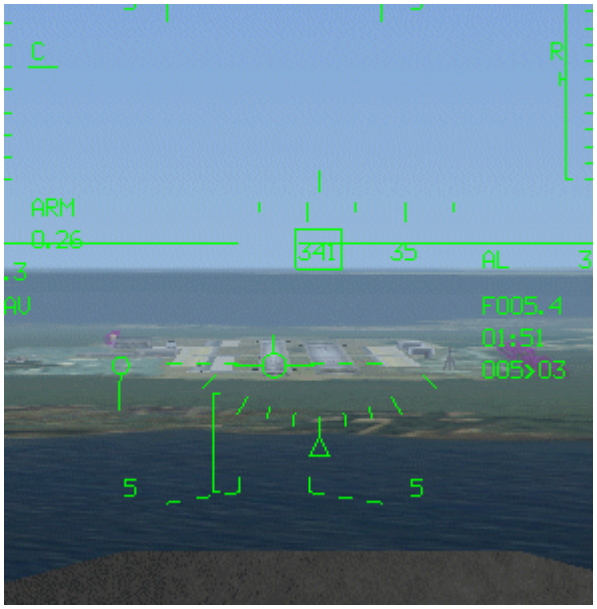


INTERCEPTING THE GLIDESLOPE - BRAKE OPEN AND GEAR DOWN

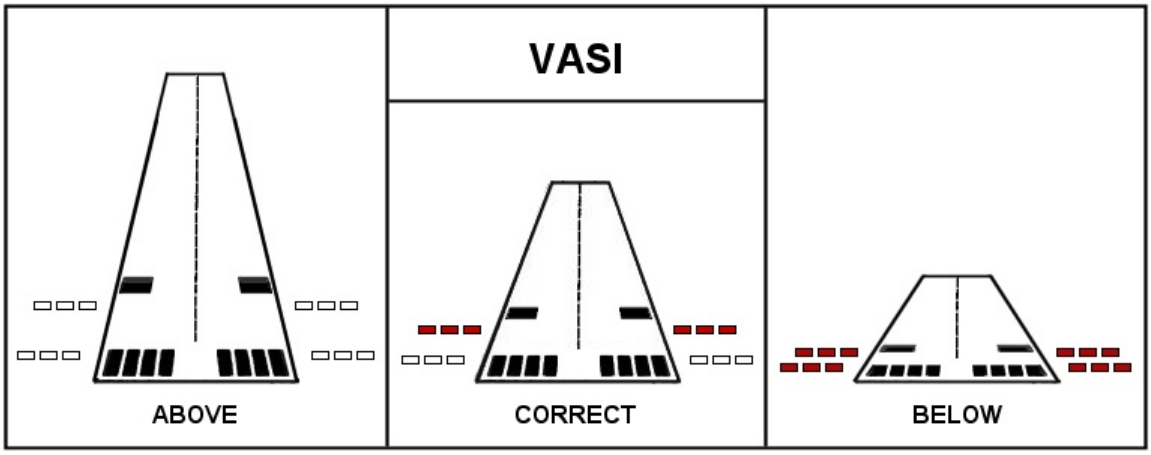
You will want your glideslope to be 2.5 to 3 degrees. If the front of the runway lies in the middle of the 0 and -5 degree pitch ladder on the HUD then you will know that your glideslope is correct. A dotted line can be seen in between the 0 and -5 pitch ladder. This 2.5 degree line can help you make sure you are on the glideslope. If you are above the glideslope then the runway threshold will be below the dotted 2.5 degree pitch line. If you are below the glideslope then the runway threshold will be above the 2.5 pitch line.



Once you are on the proper glideslope, place your FPM on the front of the runway using the control stick. This event can be seen in the image below:



There is another way to know whether you are on the glideslope or not. You can use the VASI lights which are located at the front of the runway. On each side of the runway you will see two sets of lights. One set sits in front of the other. If both sets of lights are "white" then you are too high. You need to lower your altitude and get back onto the glideslope. When you are on the glideslope the far set of lights will be red and the close set will be white. If you are low then both sets of lights will be red. You will need to gain altitude to get back onto the glideslope. Here is an image illustrating this:



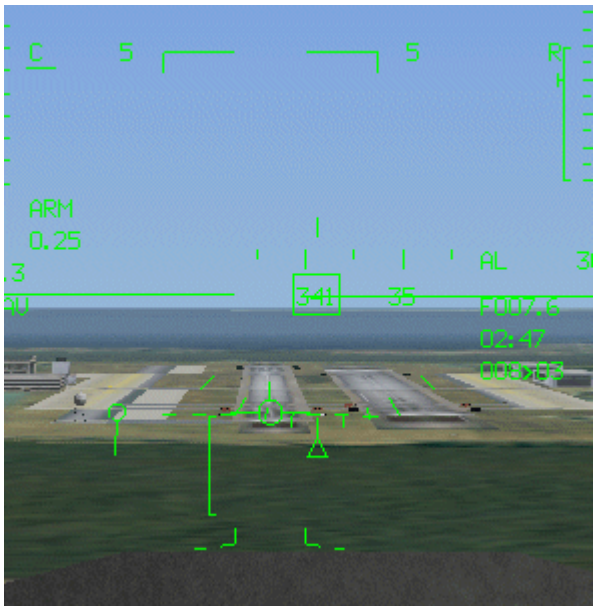
Very good, two things have now occurred:

1. We are now on the 2.5 degree glideslope (notice how the runway threshold is directly between the 0 and 5 degree pitch ladder lines).

2. The FPM is sitting on the front of the runway.

There is now a third thing we need to do. We need to get the FPM to the top of the AOA bracket. We can control our angle of attack using the throttle. If the FPM is above the AOA bracket then you will need to reduce power so that your AOA increases. I will usually drop the throttle completely to idle. Remember to keep the FPM on the front of the runway while you increase your AOA. With your throttle at idle the separation will happen quickly. In the image above the FPM would meet the top of the bracket on idle in about 10-15 seconds. Once you have gotten the FPM near to the top of the AOA bracket you will need to increase your power to keep the FPM at the top of the bracket. Usually a setting of 6000 fuel flow for light aircraft or 6500 fuel flow for heavy will keep you on the top of the bracket with no real problems.

The image below is probably the most important image in this tutorial. It shows an F-16 properly aligned for landing:



You will notice that all three conditions are now met:

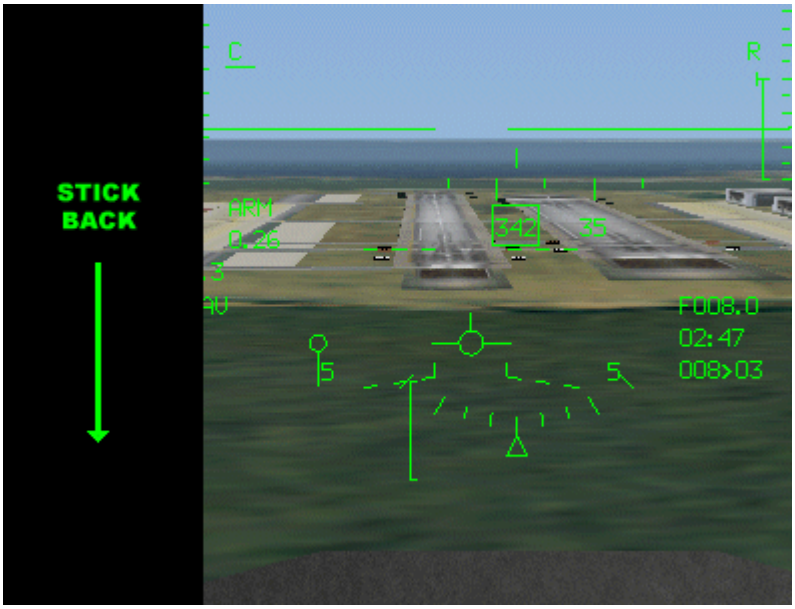
1. We are on the glideslope. The dotted 2.5 degree ladder is at the front of the runway.

2. The FPM is at the front of the runway.

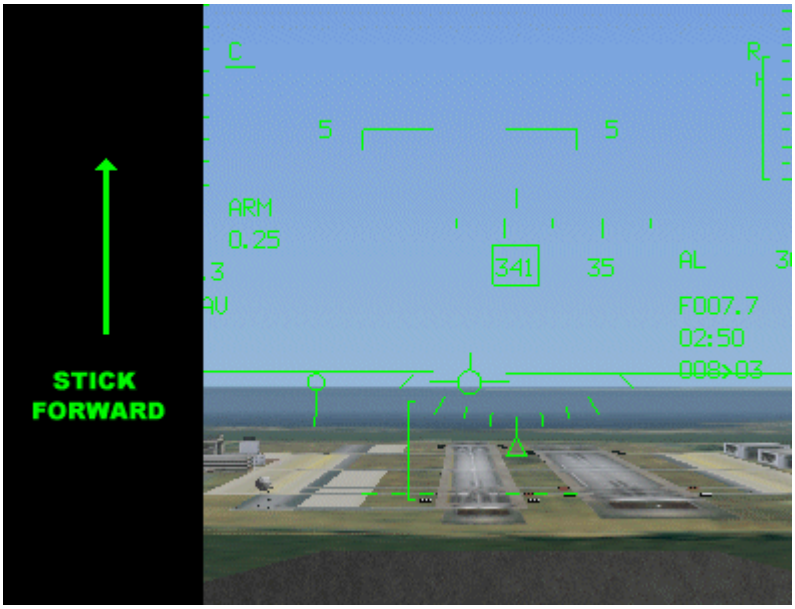
3. The FPM is lined up with the top of the AOA bracket.

In other words, the front of the runway, the 2.5 pitch ladder, the FPM, and the top of the AOA bracket are all lined up with each other. Now all you need to do is hold it there! Below are four images showing glideslope alignment problems and their solutions. They are basic and pretty understandable.

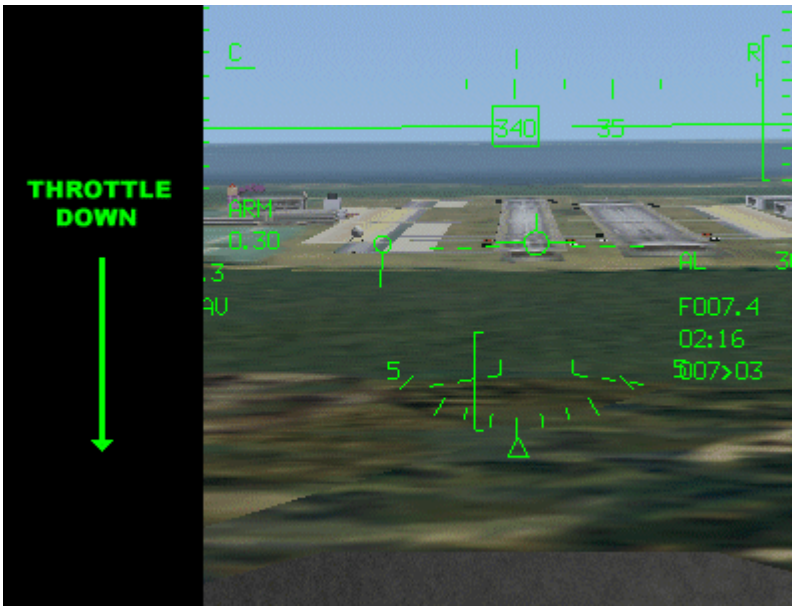
In this first image the FPM is below the runway threshold. All you simply need to do is pull back on the stick to get yourself back on the runway. Make sure you are still on the glideslope.



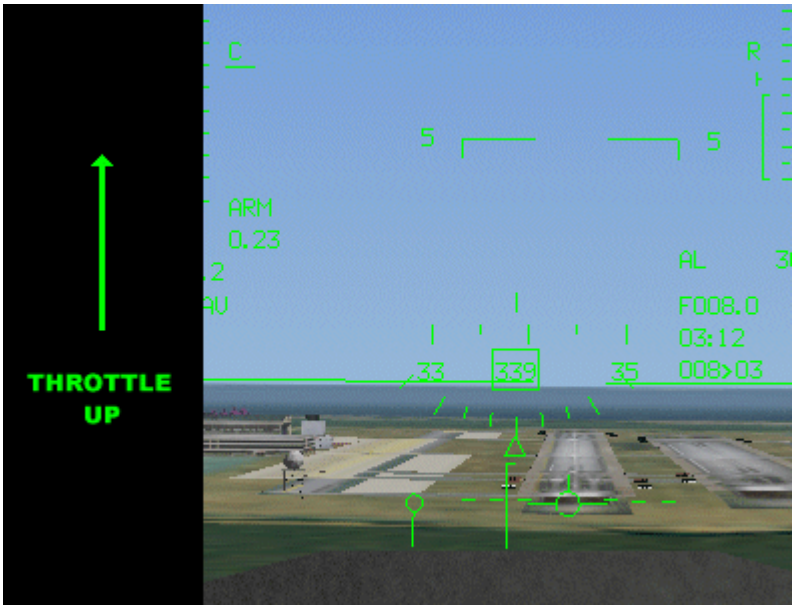
This next image shows the FPM too high in relation to the runway. Answer? You guessed it: Stick forward.



This next image shows the AOA too low (the FPM is above the bracket). Decrease power slightly to get your AOA up.

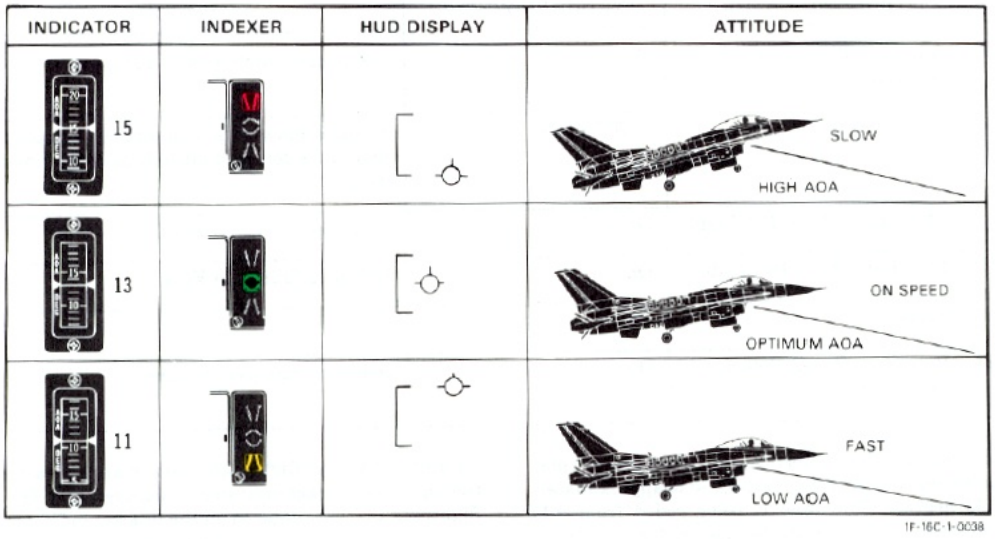


This last image shows the FPM deep in the AOA bracket. In this image the FPM isn't in a really bad position but you might want to think about adding a touch of power if it drops any more.



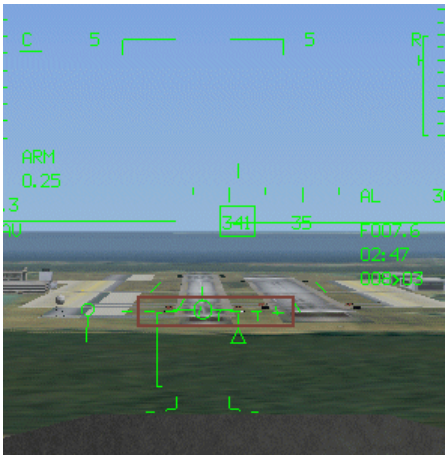
Keeping the FPM at the top of the AOA bracket is not difficult. It does require a bit of finesse though. Only small amounts of throttle change will be required to keep the FPM where it should be. I tend to land by doing quick taps of the keyboard throttle keys (+ and -). It works ok with a regular HOTAS setup also.

Here is a final image for reference purposes. It comes from the F-16C/D FLIGHT MANUAL (T.O.1F-16C-1). This particular image shows the 11 degree AOA as being fast but that is ok for the approach.

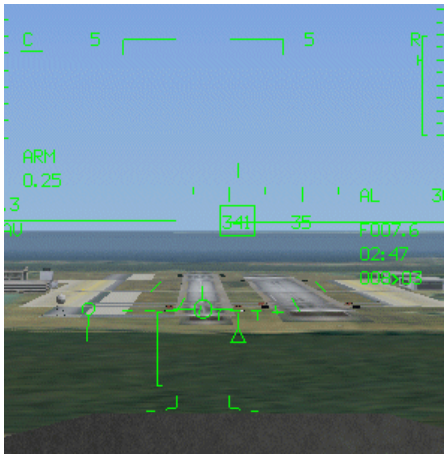


OK, so that is basically it. You will want to control the location of the FPM with the stick and the AOA with the throttle. Once you get used to this then landing becomes easy. Once all three conditions are met and you are on a proper approach your speed will be exactly where it should be (about 160 kts for a light aircraft and 170-180 kts for a heavy one). This approach of monitoring the FPM marker and the AOA bracket is helpful in that you don't have to worry about proper speeds for proper weight. Many F4.0 pilots find themselves falling out of the sky because they attempt landings using speed and get their speed wrong (too slow). A high airspeed results in lower AOA landings that could have dire consequences in the form of bouncing or crashing. Staying on the glideslope with a proper AOA keeps you from having to worry about airspeed at all.

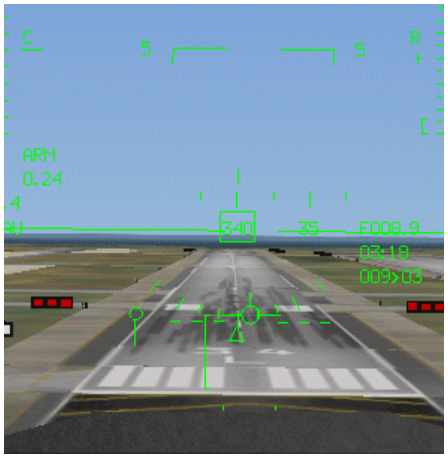
Here is that important image again showing an optimal glideslope approach with all three conditions met. It is different in that I have placed a red box around that area of the screen showing what you will want to look at clear up until the point where you flare. You can basically ignore looking at airspeed, altitude, fuel flow, the AOA light, etc. Still, there is certainly no problem with looking around the cockpit occasionally. I personally have a habit of taking glances at the fuel flow but that is just me. The great thing about using the FPM and AOA bracket almost exclusively for landing is that airspeed magically takes care of itself and you can keep your eyes on a small area of the HUD at almost all times. This helps decrease the workload while keeping SA high.



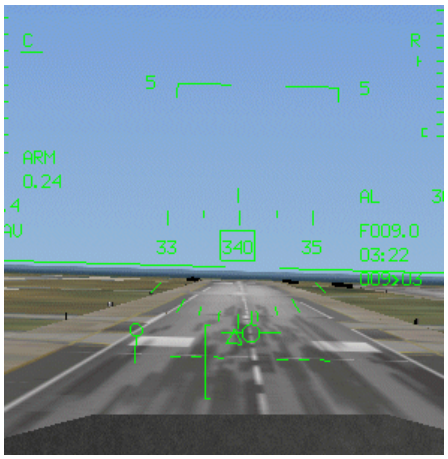
This next image shows the situation just short of the runway threshold. All three conditions are still met. My FPM is located short of the optimal touchdown point:



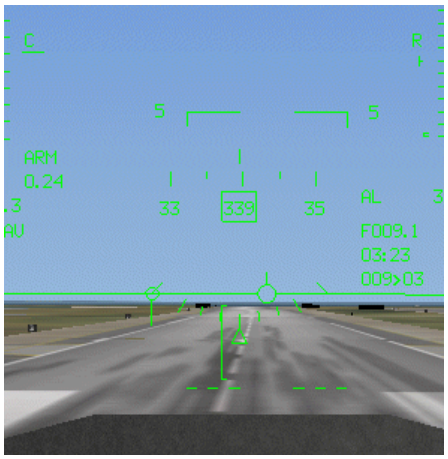
This next image shows a different landing using a heavier aircraft. Notice that the RPM is at 87% instead of 83% like in the image above. Other than that, there is no difference:



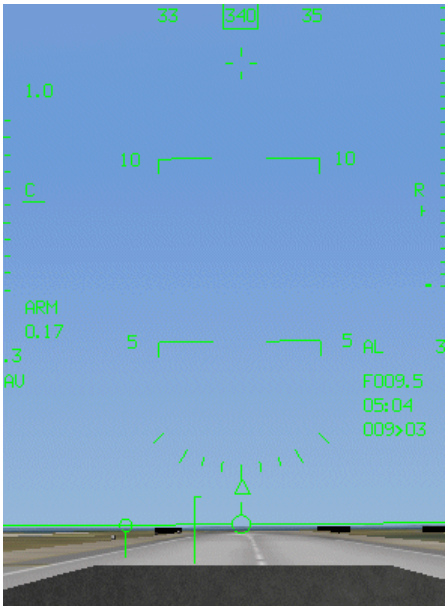
Now I am over the threshold and getting ready to flare:



I'm now within seconds of landing and I gently flare a little by pulling back on the stick. This causes the FPM to move down the length of the runway. The flare for the F-16 is very small. You do not need much of a flare at all since you will only be transitioning from 11 degrees to the optimal AOA of 13 degrees. I also decrease my power as I pull back and let the aircraft settle those last few feet to the runway.



Touchdown! This next image shows me at about 12-13 degrees AOA. At this AOA you will not have to worry about bouncing back into the air. Your aircraft will "stick" to the ground:



Be careful with the flare. Sometimes it is easy to flare too much and find yourself floating above the runway without settling. Cutting the power helps a lot. Try a few different flare techniques and see what works for you. Be careful with these landings though. It is very easy to flare too much and find yourself at touchdown at 15 degrees AOA. Once you get good at landing this way you will be able to drop your tires to the pavement at the correct AOA, speed, and location on the runway.

To summarize landing:

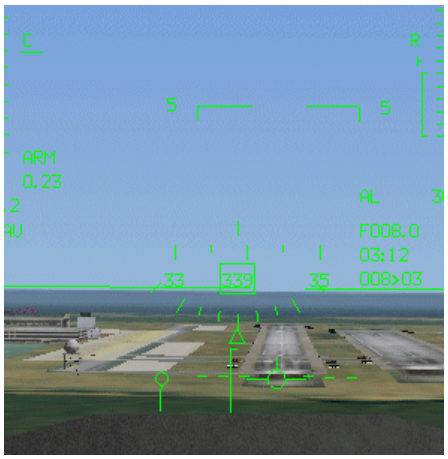
1. Get your airspeed down and your airbrake open and gear down.

2. Get yourself onto the glideslope (2.5-3 degrees).

3. Keep the FPM on the front of the runway (stick) and the FPM at the top of the AOA bracket (11 degrees AOA) (throttle).

4. When just a few seconds from landing do a small flare and cut power to idle. You may want your flare to be even smaller if you decide to cut your power at the moment your wheels make contact with the ground. Aerobrake on the ground by holding the gun cross above 10+ degrees.

Here is one final image for you. This image shows a 13 degree approach at opposed to an 11 degree approach. This type of approach is generally used by F-16 pilots for short field landings. Generally you will not want to flare at all. Just drop the aircraft right onto the runway!



I hope this helps you. Even if it doesn't it gives you a feel for an alternative approach to landing that is very similar to the type of landing done by F-16 pilots. Remember not to get discouraged if you have problems trying to land this way. Like all things it takes practice.

FINAL NOTE ON FLARING: The approach I have mentioned above is the one outlined by Pete Bonanni in the F4.0 manual. So long as you hold the 11 AOA approach to the threshold and then run the FPM down the runway you will do well. Just remember to pull back on the throttle during those final seconds and let the aircraft settle to the runway.

Here is another approach you can use as well: As you get to the threshold you can goose the power with the throttle a tiny bit and allow the additional power to move your FPM down the runway. It requires only a very small amount of power to do. You will then need to cut power to idle before touchdown. I personally do not use this approach since it is very easy to balloon the aircraft or find yourself climbing away from the runway. Still, some people successfully land this way and you might want to experiment with throttle goosing to see if it will work for you.

The approach to landing that I have outlined is not the only type at your disposal. Some pilots do the approach at 13 degrees AOA instead of 11 and they control their airspeed/AOA with the stick and sink rate with the throttle. This traditional approach to landing is very different from the one I have outlined. Both techniques work. Here is some valuable information from the F-16C/D FLIGHT MANUAL (T.O.1F-16C-1) related to this subject:

Two distinct techniques may be used when landing. One technique is to trim for approximately 11 degrees AOA and to fly that airspeed throughout the final approach. Attitude/glidepath is controlled by the stick, and airspeed/AOA is controlled by the throttle. This technique allows better pitch control, better over-the-nose visibility, and a more stable HUD presentation. In gusty wind conditions, the aircraft wallows less, and during the flare, the sink rate is easier to control. The aircraft will float approximately 800-1200 feet from flare initiation to touchdown. Another technique is to trim for 13 degrees AOA and to fly that airspeed throughout the final approach. The throttle is used primarily to control glidepath, and the stick controls airspeed through control of AOA and direction through bank angle. This type of approach primarily allows better control of touchdown point and more efficient energy dissipation; however, since the aircraft is already at 13 degrees AOA, the flare is more difficult, and care must be exercised to avoid scraping the speedbrakes or landing firm. The aircraft will float approximately 500-700 feet from flare initiation to touchdown.

You might have noticed that I never talked about the AOA light to the side of the HUD. F-16 pilots rarely look at it. Don't worry about the fact that the AOA light shows you fast (low AOA) while on approach. That is normal. All that is important is that you are in the "green" at the point where your tires touch the ground. The transition to "green" usually occurs during the flare. As far as airspeed is concerned, it is generally only referenced during landing if there is a HUD failure or under certain AOA malfunctions.

It is highly recommended that you do not let your AOA while on approach increase beyond 11-12 degrees (unless you are doing short field approaches). During the flare, the F4.0 program has a habit of allowing the pilot to increase beyond 13 degrees AOA much quicker than in the real aircraft. For this reason, it is better to err on the safe side and keep the AOA at 11 units. You should figure out an approach to flaring that will get you to 13 degrees AOA at the moment of touchdown. Be careful with the flare though. Since you are only transitioning from 11 to 13 degrees, it can hardly be called a flare. Don't overdo it.

Q1 landings should occur between 300 feet of the runway threshold and 1000 feet down. If you land beyond 1000 feet of the threshold you should not pat yourself on the back. Keep practicing until you can land consistently in the Q1 area. Once you get good at landing it will be possible to set down on the runway touchdown markers quite often.

Straight-in approaches are generally only flown in the real aircraft when weather is bad, when approaches are being practiced, under certain emergencies, or while heavily weighed. Try doing overhead approaches. Try turning off of base and onto final while only a mile or two from the runway threshold. This obviously requires more skill that a straight-in approach but it duplicates real F-16 landings to a higher degree. These approaches can be difficult due to view restrictions imposed by your computer but they are certainly doable.

CONCERNING ILS APPROACHES: While an F-16 visual approach should have you landing 300-1000 feet down the runway, an ILS approach will have you landing farther down. This is normal though. Accept the longer touchdown. Most pilots, if they break out of bad weather early, will intercept the 2.5 degree glideslope and land visually. They will generally switch off the ILS to remove clutter from the HUD.

The following is taken from the military FLYING OPERATIONS: PILOT OPERATIONAL PROCEDURES - F-16. While this specific information does not have much practical value for helping you land the F-16, it does allow you to understand a little bit about real F-16 landing procedure:

Approaches and Landings.

The desired touchdown point for a VFR approach is 500 feet from the threshold, or the glidepath interception point for a precision approach. When local procedures or unique runway surface conditions require landing beyond a given point on the runway, the desired touchdown point will be adjusted accordingly.

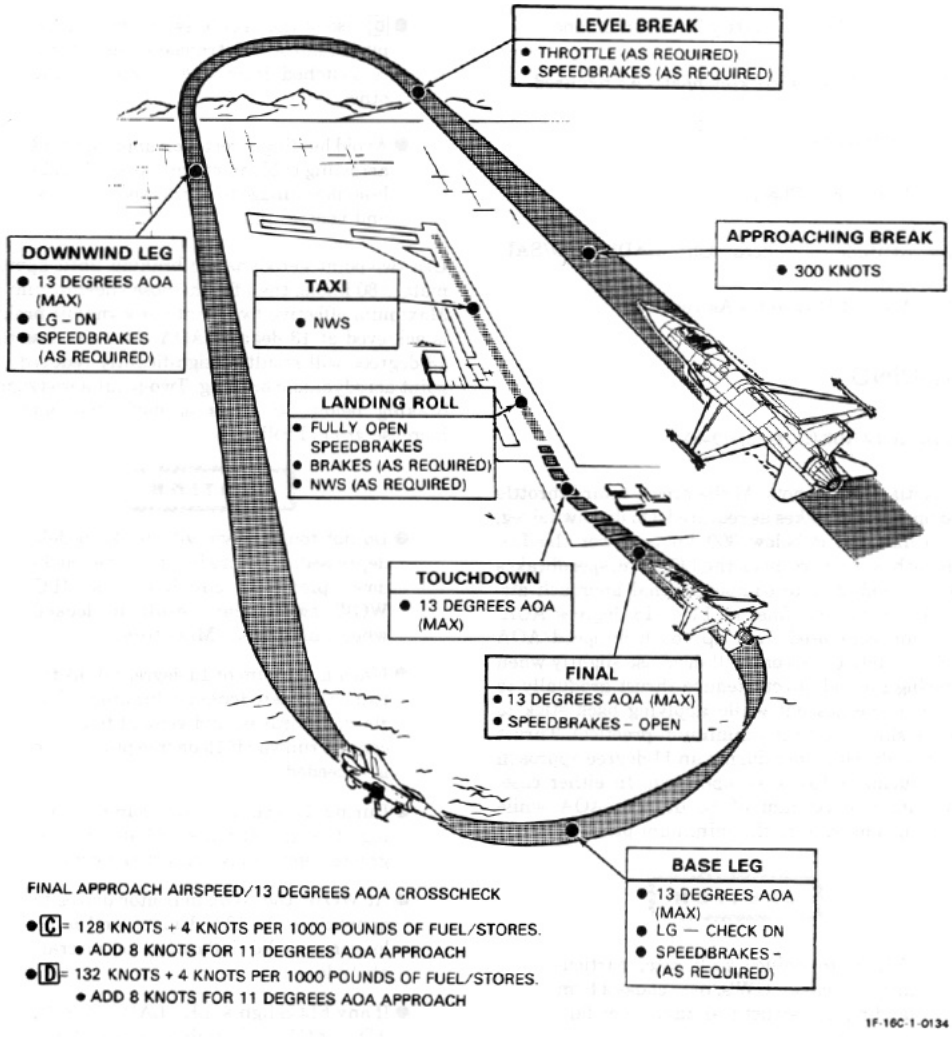
Final approach will normally be flown at 11 degrees AOA. Touchdown spacing behind an aircraft while flying a 13 degree approach will be a minimum of 6,000 feet due to susceptibility of the aircraft to wake turbulence and speedbrake/tail scrapes. Minimum pattern and touchdown spacing between landing aircraft is 3,000 feet for similar aircraft (e.g. F-16 versus F-16), 6,000 feet for dissimilar aircraft (e.g. F-16 versus F-15) or as directed by MAJCOM or the landing base, whichever is higher. When wake turbulence is expected due to calm winds or when landing with a light tail wind, spacing should be increased.

To avoid possible speedbrake or nozzle damage, touch down either past a raised approach-end cable, or 500 feet prior to the cable. With centerline stores, touchdown will normally be past an approach-end cable. Circumstances that may dictate landing prior to the cable include runway length, wind, runway condition (wet or icy), gross weight, or an aircraft malfunction where full normal braking may not be available. Single-ship or formation landings with centerline stores may be made across BAK-12 arrestment cables which have been modified with an 8-point tiedown system.

Now that you know how to land you can have fun fun attempting normal landing patterns. The following image shows a typical F-16 pattern (F-16C/D FLIGHT MANUAL (T.O.1F-16C-1)):

T.O. 1F-16C-1

Normal Landing Pattern (Typical)



Detailed information related to flying these patterns can be found at mirv's site: http://members.cox.net/mirv/InsRec/

Information related to flying TACAN/ILS approaches can be found at: http://members.cox.net/mirv/ILS/ILS.htm

FLAMEOUT LANDINGS

Flameout landings really aren't that difficult. In fact I have found them to be quite easy. This section of the tutorial will try to teach you some basics in learning how to do them successfully.

The first thing you should do when a flameout occurs is to jettison your stores. Jettison all of it as soon as you can.

One thing that makes this type of landing different from the normal type of landing is that you will want your glideslope angle to be 11-12 degrees as opposed to 2.5-3 and your AOA to be 6 degrees instead of 11. The high glideslope and low AOA are necessary to get you to the runway without losing all your energy and crashing short of the field. This first image shows me intercepting the glideslope. I have placed the FPM on the front of the runway. Do not lower your gear or open your speedbrake yet! I should mention that you could really use any angle between 11 and 17 degrees but it is much better intercepting the glideslope at 11-12 degrees.

Two important conditions have now been met in the above image:

1. We are now on the 11 degree glideslope (the FPM is just below the 10 degree pitch ladder line).

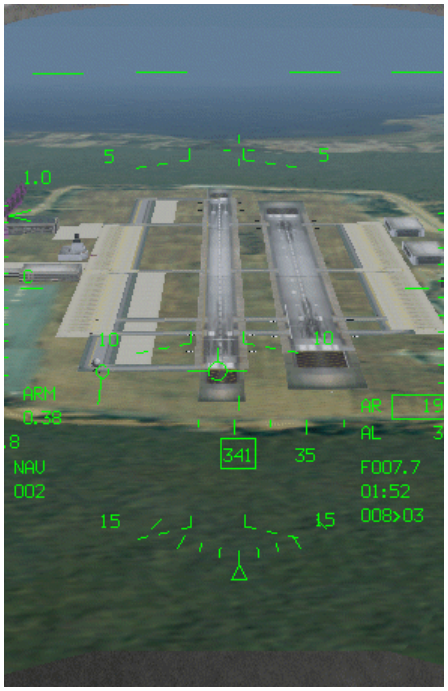
2. The FPM has been placed on the front of the runway.

Now we need to do a third thing. We need to get our AOA to 6 degrees. For our regular landings we were able to get to our 11 degree AOA by using the AOA bracket. For our flameout landing we will not have an AOA bracket to work with since we have not lowered our gear. We do not need the bracket though. We can visually tell what AOA we are at by looking at the difference between the FPM and the gun cross. The image above shows us at about 4 degrees AOA. You will notice that the distance between the FPM and the gun cross is only 4/5 the distance from the 5 and 10 degree pitch ladder lines.

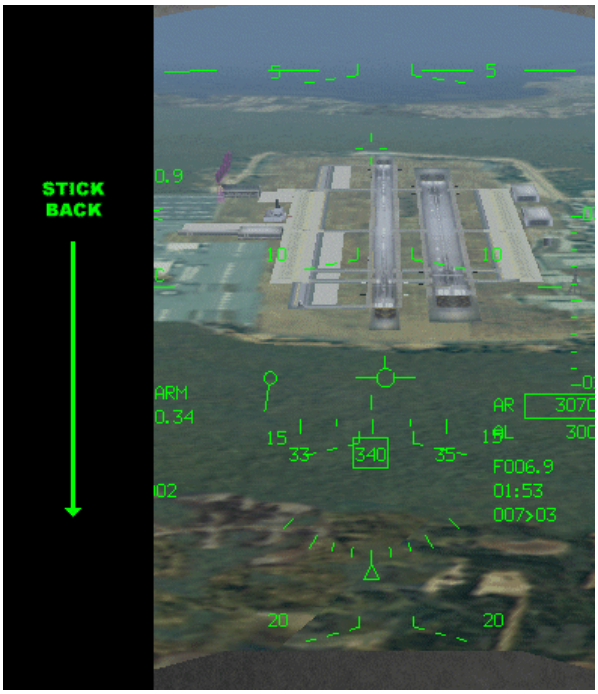
So if our AOA is low, how do we increase it? We need to decrease or speed. We can do this by opening up the speedbrake. We simply need to open it until we reach 6 degrees. At that point we can close them again. If the AOA is too high then we will need to make sure the speedbrakes are closed so that the AOA can decrease.

You will notice that I have not talked about airspeed. As long as your stores have been jettisoned, you are on a glideslope of 11 degrees, and your AOA is at 6 degrees, you will be at 210 kts airspeed which is exactly where you want to be. I do occasionally take a glance at the airspeed but you generally will not need to. Like in the first section of the tutorial there is no airspeed showing in any of my screenshots. It isn't necessary to place too much of an emphasis on it.

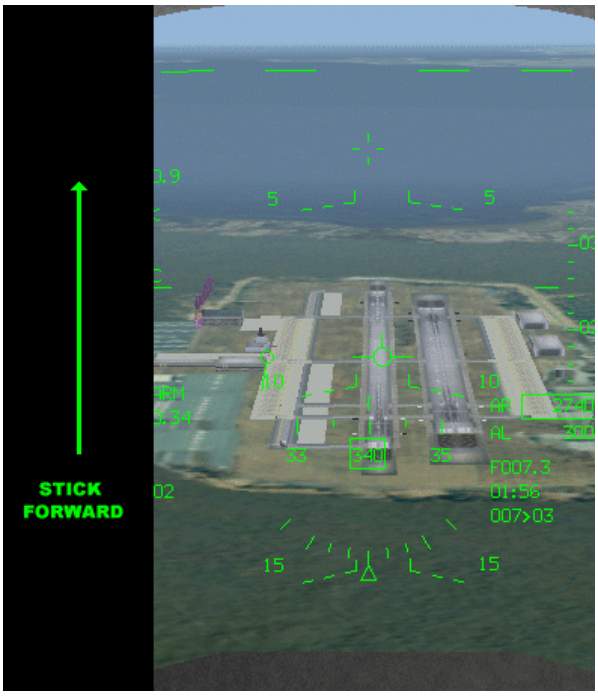
This next image is the most important image in the flameout tutorial. It shows exactly what you should see for an approach that is at a proper 11 degree glideslope and an AOA of 6 degrees:



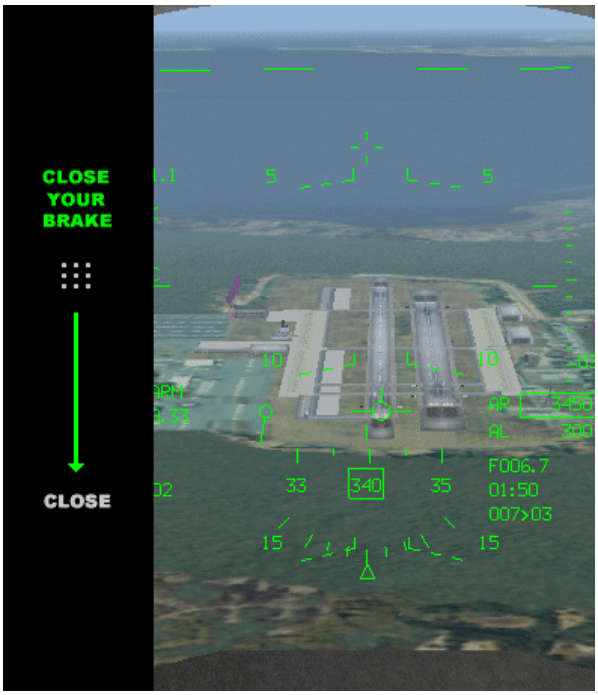
The next four images show solutions to various approach problems. This first image shows the FPM below the front of the runway. The solution is very simple. Pull back on the stick to get that FPM to the runway threshold.



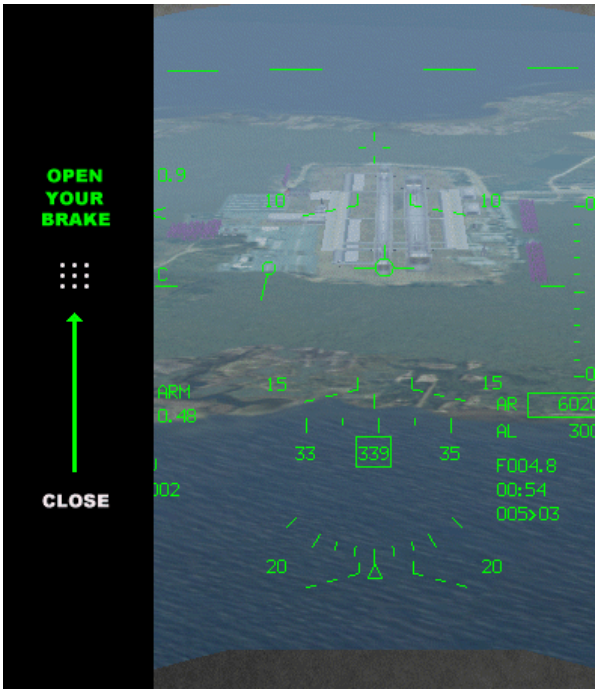
This second image shows the FPM too high. Push forward on the stick.



This next image shows the AOA too high. We are going too slow. If our brake is open we will need to close it to get our speed back up and our AOA lowered. This image shows our AOA at about 7 degrees. Remember that we want 6 degrees.

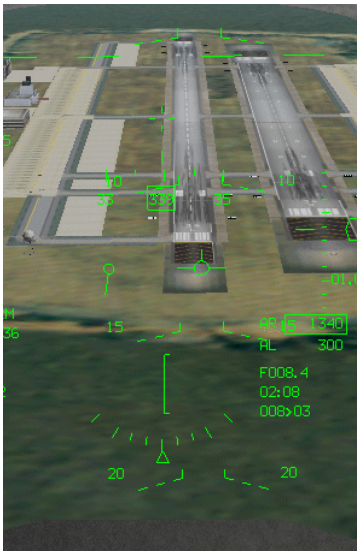


This final image shows the reverse situation. Our AOA is too low because our speed is too high. Open your speed brake. This will create drag slowing you down and raising the AOA.

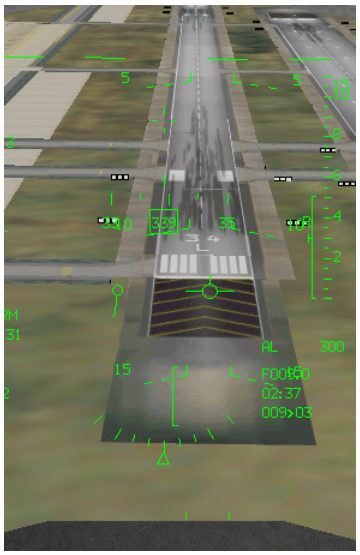


You will notice that the big difference between a flameout landing and a regular landing is that we use the throttle to control our AOA in a regular landing and the brake to control our AOA in a flameout landing.

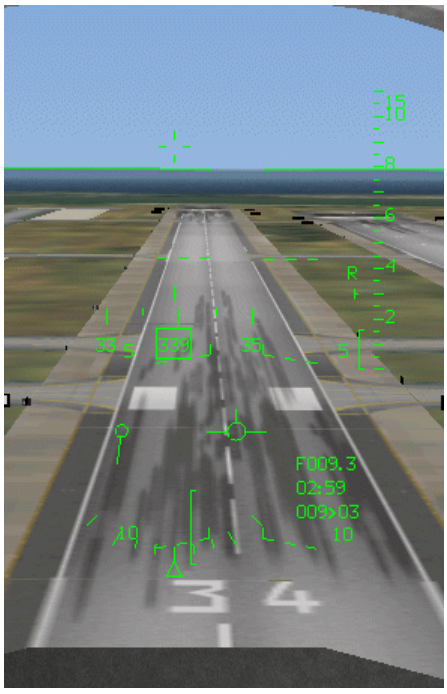
Anyway, on with the tutorial: Usually, once I get to 2000 feet from the ground (ok I admit it, I do look at my altitude sometimes) I will make sure my brake is closed and then lower my gear. This next image shows me just before I lower the gear. At this point I am still doing everything right for a proper landing (11-12 degree glideslope and 5-6 degree AOA).

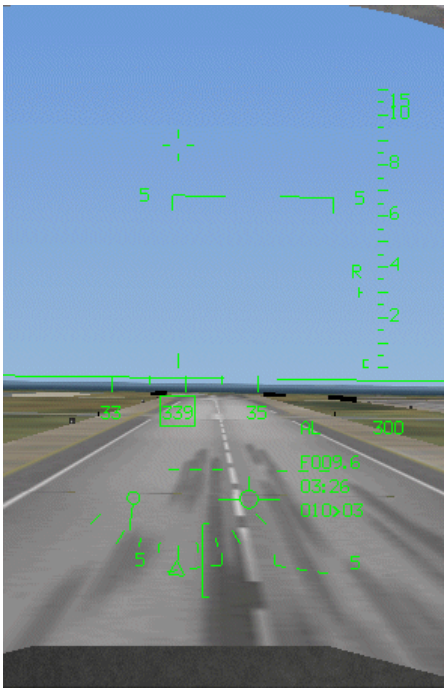


My gear has been lowered and you will notice that my AOA is only about 4-5 degrees. This is of course normal since the lowered gear will decrease the AOA slightly due to flaperon extension. I don't worry about the speed brakes anymore once I lower my gear. Its job ends once the gear is down. Do not worry about the low 3-4 degree AOA that ultimately results when you drop the gear.

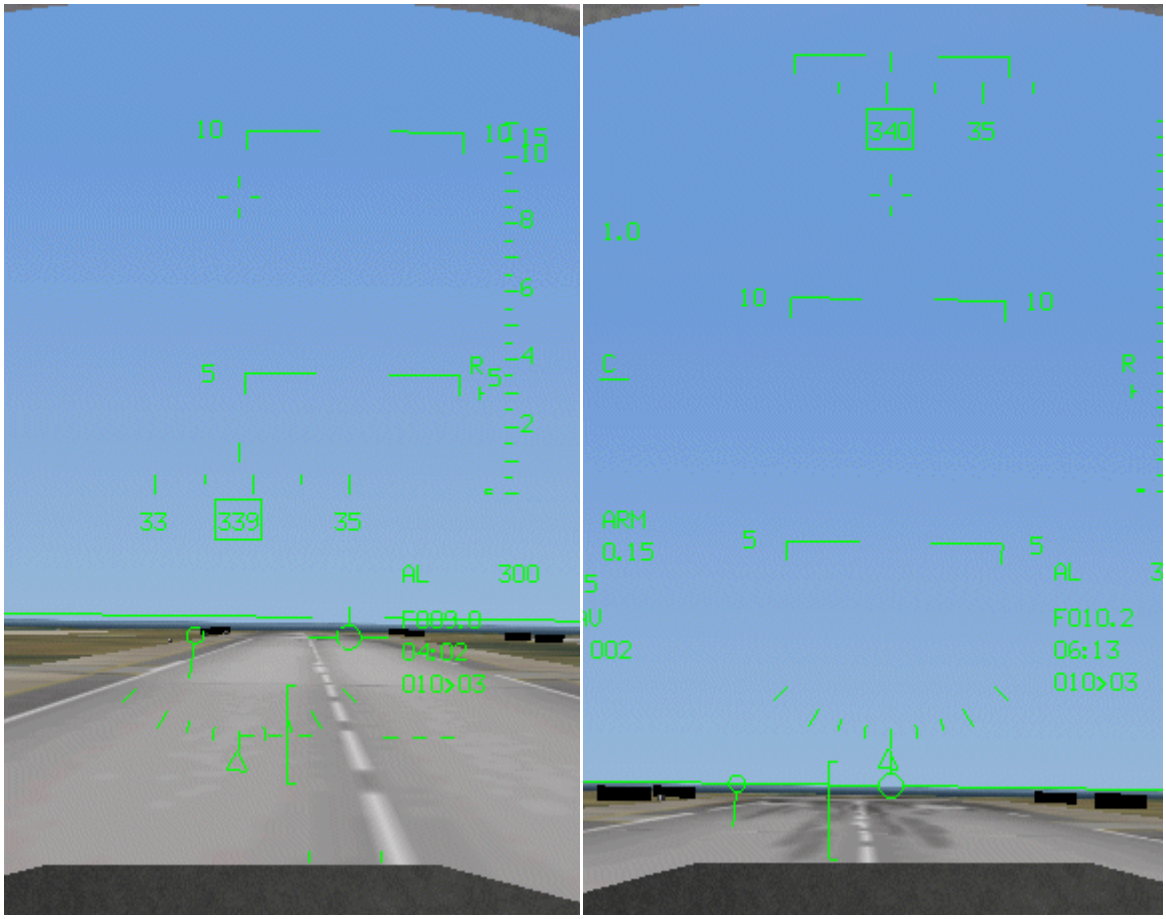


At about 500-300 feet (the altitude in the image above) we will start flaring. Now you may be wondering why we are starting to flare 500 feet above the ground. With our normal landing we flared about 100 feet above the ground. Trust me, you will want to start flaring at the 500 foot level. The flare will be very gradual as you slowly move the FPM down the length of the runway. The image above was taken 15 seconds from touchdown and I spent all 15 seconds transitioning through the flare. Here are two more images showing my flare and my relation to the ground:





Here are my final two images. The first shows me only seconds before touchdown. My FPM will usually float near the end of the runway for about 3-5 seconds before touchdown. Sometimes, if my AOA seems low (about 6 degrees) I will place the FPM on the horizon and float a few feet above the ground for a few seconds allowing my AOA to increase. The final image actually shows my touchdown. My AOA is near 10 degrees. Do not worry too much if your AOA is a little lower. You will also notice that you will land further down the runway than usual. This is normal for a flameout landing. Don't go too far though if you can help it.



Upon touchdown you will want to extend the speed brake to help slow you down. Increase your AOA above 10 degrees to help aerobrake you.

That's it. Here is a recap of flameout landing procedure:
1. Jettison your stores!
2. Intercept the 11-17 degree glideslope.
3. Keep the FPM on the front of the runway (stick) and your AOA at 6 degrees (brake).
4. At 2000 feet close your brake (if open) and lower your gear. Ignore the brake from now on and fly the FPM.
5. Start flaring between 500-300 feet AGL. The flare will be gradual and needs to be timed so that the FPM is at the end of the runway when just short of touchdown.
6. Upon touchdown aerobrake by holding your nose at 10+ degrees and open your speedbrake.

Here are some suggestions from the F4.0 manual concering flameout landings should you flame out below or above the glideslope:
1. If the runway is rising in your HUD and your airspeed is bleeding off, you will not make it to the runway.
2. It will take you about 7000 feet of altitude to execute a 360 degree turn. If you are high and have an extra 70000 feet then do a descending 360 turn.
3. If you are high (above the 11-17 degree glide path) but not high enough to do a 360 degree turn, use the speed brakes and a series of S-turns back and forth to get down to the proper glide path.
I mentioned that I thought flameout landings were easy. They are. If you have difficulties, practice, practice, practice.

Here is information related to flameout landings taken from

FLYING OPERATIONS: F-16 COMBAT AIRCRAFT FUNDAMENTALS:

Flame-Out Approach (FO) Techniques and Procedures

A flamed-out approach may be anything from a 360 overhead to a straight-in approach. It is entirely a function of available potential energy versus distance, with certain modifiers such as the nature of the emergency, weather, airfield conditions, etc. The overriding consideration, of course, is the safe recovery of "the world's hottest fighter pilot," with "the world's most capable and awe-inspiring fighter" a distant second. It is, therefore, extremely important to recognize when recovery of the airplane is no longer feasible so that safe recovery of the pilot can be employed as early as possible to increase the odds for survival. Do not commit yourself to a dubious or unsafe approach under any circumstances. When in doubt, jump out. The good news is that it is relatively easy to determine whether you're within valid flame-out parameters as long as certain basic criteria are met .

A flamed-out F-16 has the capacity to cover a finite distance over the ground based on altitude, aircraft configuration (weight and drag), winds, and field elevation. Assuming that the best glide speed for the aircraft configuration is maintained, the only significant variable to be accommodated is the wind. A flamed-out F-16 with the EPU running maintains a full-up computer navigation system with flight path marker and pitch lines. Since the flight path marker takes winds into account and the best glide speed for the configuration generates an optimum glide slope, it is then only necessary to determine where the recovery field is relative to the flight path marker to determine if the approach will be successful. If the field lies beyond the flight path marker, the approach will be short and ejection should be considered. If the field lies short of the flight path marker, excess energy is indicated which may accommodate a variety of successful approaches and landings. The overhead approach affords the most opportunities to properly manage available energy while providing the best visual clues for pattern corrections. With reference to the HUD, however, the straight-in approach can also be a viable alternative.

Straight-In Flame-Out Pattern And Approach

In the Dash 1 discussion of a straight-in SFO, we're told to maintain an optimum speed gear-up glide until the initial aimpoint on the runway is 11 - 17 below the horizon, then lower the gear and continue the glide at optimum gear-down speed. Engine-out tests at Edwards AFB resulted in a gear-down best range glide between 10 and 11 flight path angle which could be steepened to 17 flight path angle with the speed brakes; thus the 11 - 17 window for lowering the gear. The Dash 1 doesn't include HUD techniques for the FO, nor does it discuss the effect that a headwind or tailwind will have on the 11 - 17 flight path angle window. Experience has shown that energy can be managed most effectively with reference to the HUD flight path marker and pitch lines WHILE MAINTAINING OPTIMUM AIRSPEED.

The flight path marker accounts for wind. For every 20 knots of headwind component, the flight path marker will show about a 1 increase in flight path angle (aircraft pitch/AOA to maintain optimum airspeed does not change). Establish and maintain optimum airspeed for the configuration. The HUD will then accurately depict where your optimum flight path will take you, all variables accounted for. Regardless of actual flight path angles involved, lowering the gear will increase the flight path angle 3.5 -4. When the engine quits, jettison stores and turn toward the nearest suitable runway. Establish best range speed of 210 KCAS (plus fuel/stores). Trade excess airspeed for altitude. The EPU should be on and, if the engine is windmilling with aircraft fuel available, the JFS should be turned on below 20,000' MSL to extend EPU operating time (10 minutes with normal demands; up to 15 minutes with the JFS running). The JFS will also provide B system hydraulic pressure for normal gear extension, normal brakes and nosewheel steering. With an optimum glide established, if the flight path marker is on the runway or beyond and optimum speed is maintained, the threshold will slowly move downward in the HUD field of view indicating excess energy (in terms of altitude) for the approach. This is good because sooner or later the initial aimpoint (1/3 of the way down the runway) will lie within the gear-down window. The gear may be extended when the aimpoint is between 11 and 17 and landing is assured .

If EPU fuel depletion is a factor because of range to the runway, consider a 10 gear-up glide when the best range glide has given you a 1:1 ratio between altitude in thousands of feet and range to the runway (i.e., 20,000' AGL at 20 NM). Airspeed can be increased to 300 - 330 knots, cutting time required to reach the runway and reducing EPU fuel used (see paragraph on "IMC Penetration" in Dash 1 FO procedures). When the gear is lowered (alternate extension required unless the JFS is motoring the engine), continue the glide at best range (gear down) speed. Use speed brakes as required to maintain the desired glide path and airspeed parameters, and achieve a steady-state optimum gear-down glide prior to the flare point with the flight path marker on the aimpoint. In a nutshell, if you flame out, regardless of altitude or distance out (within EPU fuel constraints), and the recovery field is below the 7 pitch line, you immediately know you can get there. Winds can affect this equation.

Unless you confirm an energy surplus, it is extremely important to maintain optimum speeds throughout the approach. Excessive airspeed will increase the glide path angle and consequently decrease range. Low airspeed will do the same thing, in addition to providing progressively less energy to flare the aircraft or zoom to safe ejection parameters. Below the gear down minimum speed, the flight path marker shifts dramatically towards you (short), and energy may be insufficient to flare and touch down without damaging the aircraft, or worse. There is no way to "stretch" the glide. If the aimpoint shifts upward in the HUD field of view beyond the flight path marker, this indicates that you will not be able to make the runway. Ejection should not be delayed in a futile attempt to salvage a questionable approach .

If you've managed your energy to achieve an optimum gear-down glide with the flight path marker on the initial aimpoint, the only chore remaining is to flare and land the aircraft so that you touchdown between 10 and 13 AOA with enough runway remaining to get the jet stopped before running out of runway or cables. Once landing is assured, the recommended procedure is to shift the aimpoint from 1/3 down the runway to a position short of the intended touchdown point. Techniques presented here will consistently produce touchdowns at 2500' to 3000'. If a shorter touchdown is required, simply adjust the optimum glide aimpoint an appropriate distance short of the threshold. The trick is to transition from a "steep final" to a touchdown flight path angle of less than 2. If the flare is too abrupt or begun too early, you will run out of airspeed prior to touchdown. The result will be an excessive sink rate and probable damage to the jet. The opposite is also true. You can't hit the runway in a 10 dive and expect good results .

With practice, a simulated flameout flare will become second nature. Meanwhile, there's an easily remembered set of parameters which will approximate what you're looking for and help you avoid the extremes mentioned above. At about 300' AGL, start a smooth flare. This will give you a picture similar to a normal final and get you into ground effect with enough energy to complete the flare (hold it off if necessary) and grease it on at 10 to 13 AOA. The speed brakes should normally be closed at this point. Use them if you need them but realize they will dramatically increase energy decay if extended during normal roundout and flare.

If your energy state (glide slope/altitude with respect to the runway) is too great to be managed with speed brakes alone, dive off altitude or modify the ground track. Use caution when employing either of these methods. It is very easy to overdo the correction since either method may involve removing the runway environment from the HUD field of view during the correction. The overhead approach may be entered at any position provided the proper altitude for that point in the pattern can be obtained. The main concern is to reach high key, low key, or base key at or above prescribed minimum altitudes.

Commentary on the above text:

1. If in doubt, eject. The pilot matters not the plane.

2. Fly between 11 and 17 degrees for the glideslope. 10-11 degrees has been shown to be the best flight path angle. Greater angles are possible but require more use of the speedbrake. I personally can't imagine coming in at 17 degrees. That is a very high angle.

3. For every twenty knots of headwind the glide angle should be increased by 1 degree. In F4.0 you will seldom if ever see a headwind that high but if you do you might want to think about using a 12 degree approach instead of an 11 degree approach.

4. When your engine first quits dump your stores and fly at 210 kts. CAS airspeed. Once on the 11 degree glideslope at 6 degrees AOA your speed will actually be 210 kts. Great huh?

5. Control airspeed with the brake. Now that's easy enough to understand. Brake open increases AOA and decreases speed and brake closed decreases AOA and increases speed.

6. As Pete Bonanni mentions in the F4.0 manual if the runway is rising in your HUD and your airspeed is dropping, you will not make it to the runway. Eject as soon as possible.

7. At 300 feet AGL start a smooth flare. This is different than the F4.0 manual. Bonanni suggests 500 feet AGL. Both altitudes work. Don't go below 300 though.

8. As the text mentions above, if your energy state is too high for speedbrakes to handle alone bleed off that energy by diving and/or modifying ground track. What does that mean? Assume we are above the glideslope, our speed is high, and our brake is open. If the brake isn't doing the job we can dive below the glideslope and then follow that track to help bleed off the excess energy. You need to be very careful with this approach though. If things go wrong, remember, when in doubt, eject.

CONCLUSION

That is it for the tutorials. I hope they were of help to you. I should mention that this tutorial is only valuable as a starting point for determining your own type of approach. Develop a style that works for you. I like landing in the way I have outlined because it seems to work very well and it almost completely reproduces the landing techniques used by real F-16 pilots. There is power in knowing that you do it correctly