3rd TACTICAL FIGHTER SQ

NEW GUY BOOK #2

All New Digital F-4E

By
Major TIMOTHY A. KINNAN
414FWS
Nellis AFB, NV 89191

WHAT ON EARTH IS A DMAS?

Since the birth of the F-4 we've been dropping bombs and navigating with analog systems while the rest of the world has been going digital. This means (in the language of fighter pilots) that we've been computing with pulleys, ropes and levers while our friends in A-7s and F-111s have been using mirrors and flashing lights.

Well, welcome to the digital age. TISEO equipped F-4Es are being modified with the AN/ARN-101 Digital Modular Avionics System (DMAS), and the increase in aircraft capability is tremendous. With this aircraft capability, however, comes a real burden on you, the aircrews, because in order to turn this machine into a combat capability, you're going to have to do some serious dedicated training.

The purpose of this article is to introduce the ARN-101 system and to pass on some thoughts about system use. This article will be supplemented by a TAB on ARN-101 employment. Due to the complexity of the system, I'm not going to attempt to tell you "how to do it." For these details, refer to the Dash One and Dash 34 ops supplements. These books are very detailed and exhausting reading, but they'll tell you everything you'd ever want to know about the system. An excellent source for beginners is the FWIC text, which was written for the system introduction at Nellis. This text does not go into the laborious details of the supplements, and yet has enough detail to serve as the "big picture."

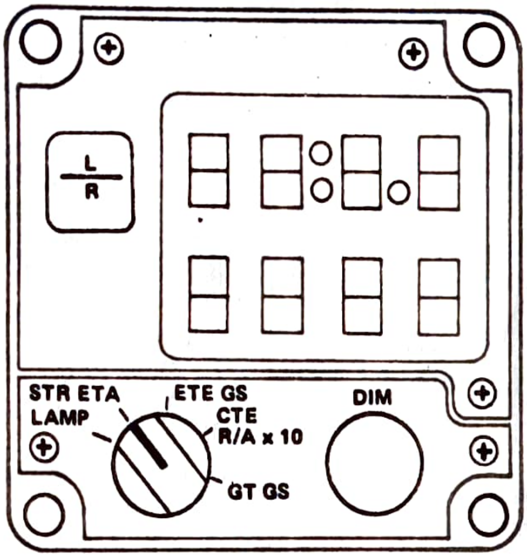
HOW LONG UNTIL WE GET DMAS?

It's here. The formal "system introduction" is complete. Beginning in the Summer of '79, four crews in the 414th FWS flew with the system, developed and tested a syllabus for instructor upgrade and conducted informal tactics development. Working with the 4444th Operations Squadron, we published a phase manual and the textbook and developed an academic program. Eight outstanding instructors from Spangdahlem and Seymour Johnson then attended our 21 hours of academics and flew the syllabus missions. They are now setting up training programs in their own units.

WHAT DOES IT DO?

The first thing you have to understand is that the ARN-101 is a whole new airplane. It cannot be flown by untrained aircrews. A simple cross-country flight requires an hour of instruction and a locally-produced checklist. The point is that some heavy-duty management is going to be required in order to integrate these airplanes into operational units.

The heart of the system is the "all-singing, all-dancing" digital computer. It stores, recalls, bombs, navigates and occasionally frustrates. Add a LORAN receiver and a new INS, and you have the DMAS. The modification takes several months per airplane and was originally supposed to include the digital LRU-1 and the airborne video tape recorder. These other modifications are not on track and will be done later. However, we are getting VOR and ILS with the ARN-101.



AUXILIARY DIGITAL DISPLAY INDICATOR (ADDI)

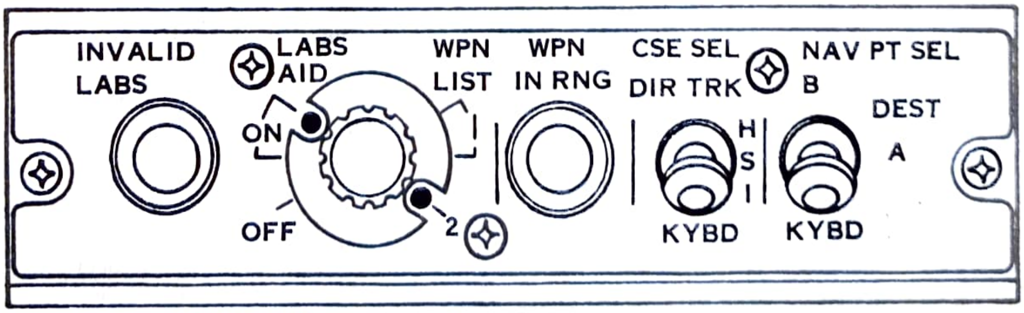
Externally we have a new low-profile LORAN antenna (no more picket fence) and some static dischargers on the wings and tail. The cockpits are changed dramatically (see included figures). In the front we have a new digital display to show us ground track, ground speed, ETE, ETA and other bits of data. There is a course select panel under the HSI which allows us to select steering modes and certain weapon delivery parameters. Other switches have been modified with new positions and functions.

The rear cockpit is a whole new world. The most obvious changes are the digital display (called a DDI) and the keyer controller. The keyer controller replaces the old nav computer and WRCS panels, while the DDI is up in the instrument panel. The WSO communicates with the computer through the DDI and keyer controller by selecting an "interactive list." The computer then steps through a series of key words on the top row of the DDI while the WSO enters data in the bottom two rows. He can enter mission data in the update, mission and destination lists. While flying he can select turn points, OAPs and monitor selected flight parameters through the flight list.

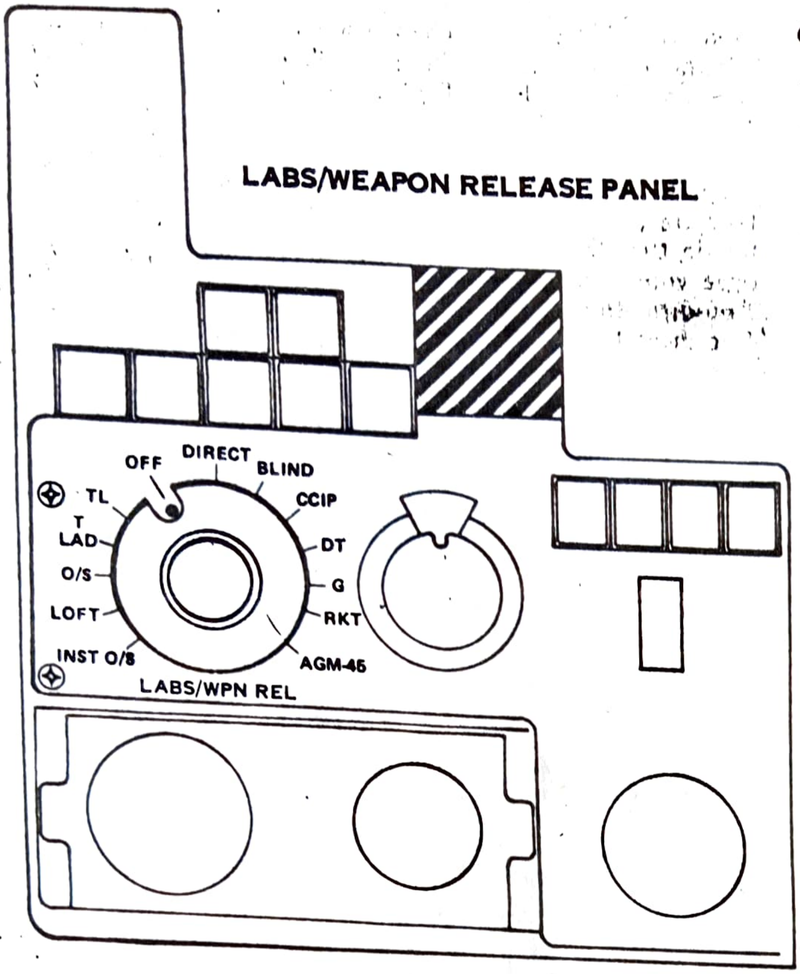
Other panels in the rear cockpit include the nav computer set control (NCSC), the sensor select panel (SSP), target insertion controller (TIC) and the Pave Tack control panel. The NCSC is for system turn on, INS alignment and nav mode selection. The SSP replaces the TISEO panel and allows the WSO to select and control various "sensors" (TISEO, radar, Pave Tack, Maverick). The TIC replaces the old "freeze" and "insert" functions. Anyone who's played piccolo will appreciate the new antenna hand control. Besides the normal trigger switch, tilt wheel and APX-80 interrogate button, we have a laser fire button, thumb tracker for controlling sensors, and two field-of-view switches. So far, most WSOs have found it difficult to get used to.

NAVIGATION

The navigation capability of the system is spectacular. The primary nav mode is called "LORAN integrated." This mode combines the short term accuracy of INS with the long term accuracy of



COURSE SELECT PANEL



LABS/WEAPON RELEASE PANEL

LORAN. Inputs from both are sampled and filtered together and the computer comes up with a "best" present position. We've enjoyed following our bearing pointers back to our parking spots!

There's good news and bad news about LORAN. The good news is that it's a fully automatic no-brainer. It doesn't break lock during hard maneuvers or at low altitude in deep valleys.

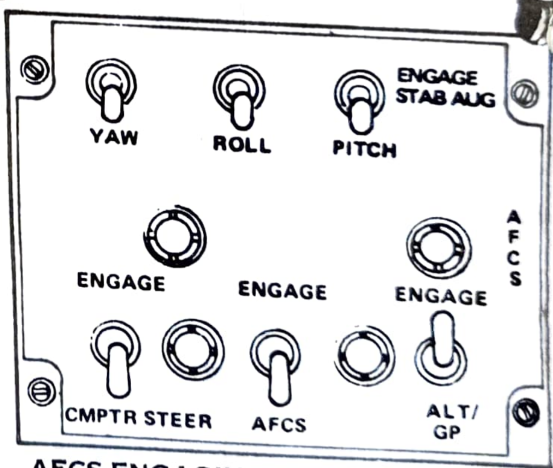
The bad news is a thing called "propagation errors." LORAN waves travel at different speeds when passing over and through different kinds of terrain. While the computer is converting LORAN signals to latitude and longitude, these errors appear. The errors are corrected by entering a complex set of numbers called propagation constants. Despite intense efforts, we were unable to get these constants developed for the Nellis ranges for the system introduction, so we had continuous position errors. We have succeeded in tricking the system with false coordinates for selected targets, but offset targeting gets confusing with two sets of coordinates for each point.

Other navigation modes include a pure INS mode (better than 1nm hour); an "air data" mode and three other LORAN modes which are aided in varying degrees by other systems.

A large number of turnpoints can be entered in the destination list prior to flight. They can be called up during flight as turnpoints, targets or offset aim points (OAPs). An automatic mode will allow your steering to sequence to the next turnpoint as you overfly the previous one. You can either steer directly to a point (as with the present system), or you can follow a bank steering bar to intercept a course to the point (little, if any, tactical use).

The autopilot can be engaged in a "computer steer" mode and it will fly the aircraft to center the bank steering bar, using 45 degrees of bank – again, not much tactical value, but great for cross countries.

Finally, you have a computer approach mode. You enter coordinates for the touchdown point, runway heading, glidepath angle and go around height. You then get ILS-style steering for an approach.



AFCS ENGAGING CONTROLLER

WHAT ARE WE REALLY HERE FOR?

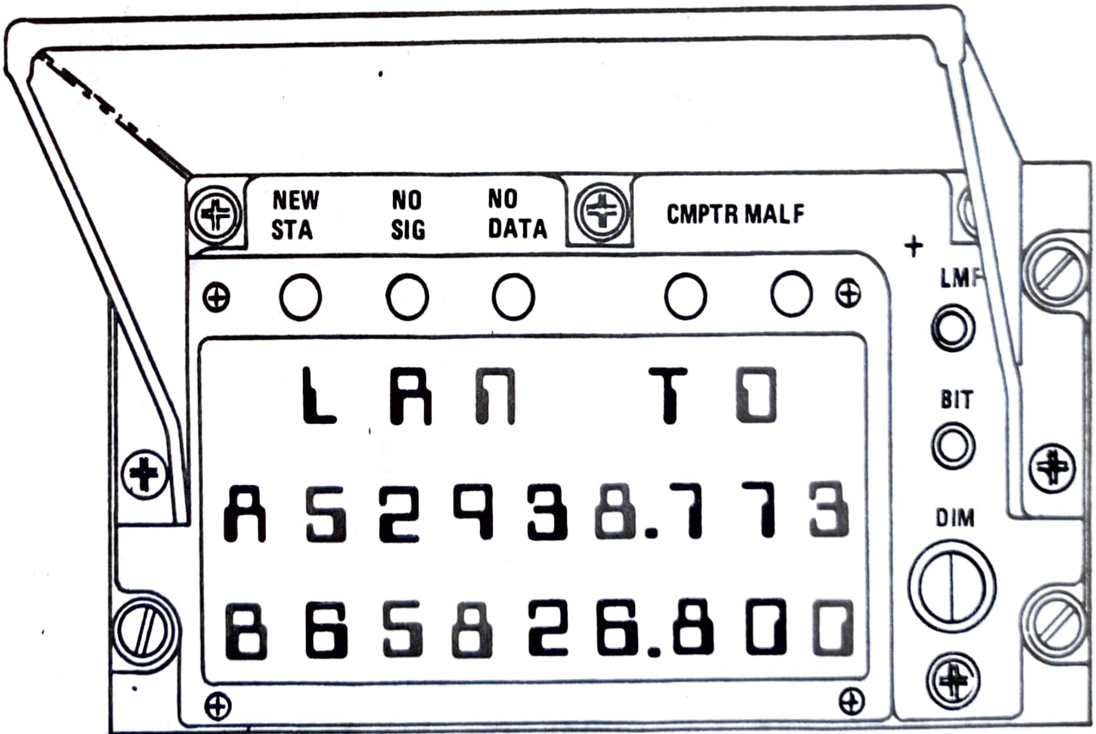
Bomb dropping with the DMAS comes in two categories: visual and blind. Both modes take advantage of the digital computer's ability to store a full ballistic curve for the weapon you're dropping. You tell the computer what type of bombs you have, and your quantity, release advance and spacing. It will then accurately solve the release point problem through a wide range of airspeeds, slant ranges, dive angles and altitudes.

The "blind" mode drops on a memorized point. This can be a set of coordinates for a true blind bomb (using LORAN), or you can employ offset targeting or sensor aiding. The bombs can be released in level, dive, loft or toss deliveries without changing any switches.

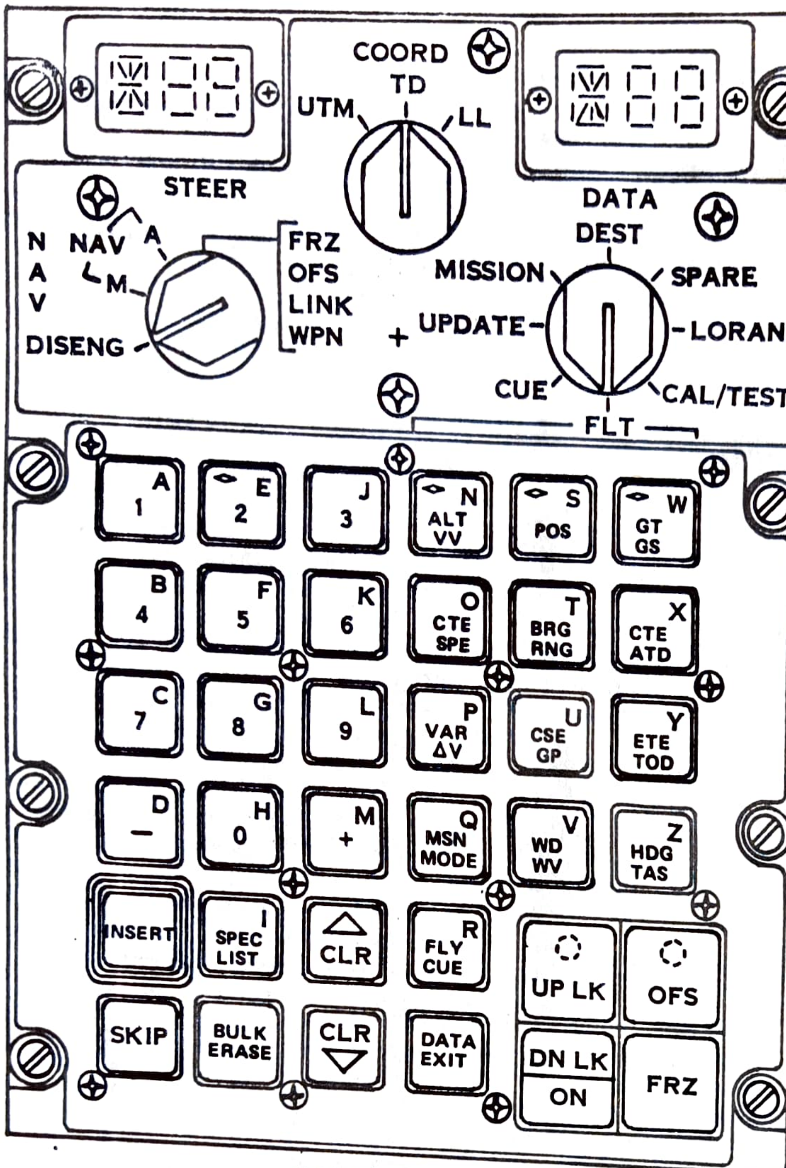
The offset targeting problem can be solved with an OAP using radar cursors, overflight, Pave Tack pod or visual designation with the LCOSS. Target or OAP location can be updated by the use of any sensor (radar, LCOSS, Pave Tack, TISEO or AGM-65).

The visual modes are Dive Toss and Continuously Computed Impact Point (CCIP). Their advertised accuracy is 7 mils and again the computer solves the problem regardless of release parameters. We also have CCIP modes for strafe and rockets.

As I mentioned, there is no need to meet precise parameters in any bombing mode, as far as the system is concerned. However, we must get in the habit of meeting specific parameters every time we drop. If we don't, (1) impact angle and impact velocity will suffer to the detriment of weapons effects, CBU patterns, etc; (2) fuze arm and safe escape will be jeopardized; (3) LGB guidance time and envelope may be adversely affected; (4) aircrews lacking BFM skills may fly into the ground and (5) improper delivery airspeeds may degrade aircraft maneuverability. I think my personal rules of thumb are fairly realistic and I offer them for your consideration. First of all, plan your delivery for a specific set of parameters, considering frag envelope, weapons effects, etc. While delivering ordnance, never accept (1) release below preplanned release altitude, (2) release airspeed 20 knots slow or below corner velocity, (3) airspeed 30 knots fast (due to turn rate and radius) or (4) dive angle more than 5 degrees steep or shallow.



DIGITAL DISPLAY INDICATOR (DDI)



KEYER CONTROLLER

If you consistently release above your planned release altitude without violating these five "rules," consider lowering your apex (or roll-in) altitude. You may be planning for too much tracking time. The 335TFS at Seymour Johnson always drop their first bomb in "Direct." This is an excellent training technique because it emphasizes release parameters while maintaining necessary skills in manual deliveries.

TRAINING TOWARD COMBAT CAPABILITY

If we can't turn the ARN-101 abilities into a combat capability, we might as well be bolting these things into jeeps. This combat capability is going to be the result of aircrew training — aircrew training which will be conducted in operational units by operational instructors while simultaneously meeting all other commitments. The point is, the squadron jocks are not going to learn this system by strolling into academics with a "teach me" attitude. Every single guy is going to have to get into the books and study on his own. The academic program will tie up the loose ends for him.

I'll outline a sample training program. This is a logical sequence of missions using the "building block" training concept.

Academics are very important. Twenty-one hours is adequate, but only if the upgraders get into the books on their own in addition to the classroom instruction. Use caution not to get bogged down in sensor cueing and offset targeting. This system will do "circus tricks" (such as cueing different sensors to different OAPs). These things have little (or at best obscure) tactical application. Your "engineers" can dig these out later if they wish but don't discuss them in initial upgrade.

As you enter training, don't let your people go for more than a week without flying an ARN-101 mission.

Profile 1: System Introduction

This is a "dollar ride," but a very important part of the training. All upgraders are in the pit. At a leisurely pace they do everything the system can do. As a minimum, the upgrader needs to see navigation modes, system updates, basic sensor cueing and offset targeting (stressing use of the thumb tracker), all bombing modes and a computer approach. Be sure to step to the airplane early enough to allow for slow data entry. This mission will answer a lot of questions and clarify the academics.

Profile 2: Conventional Weapons

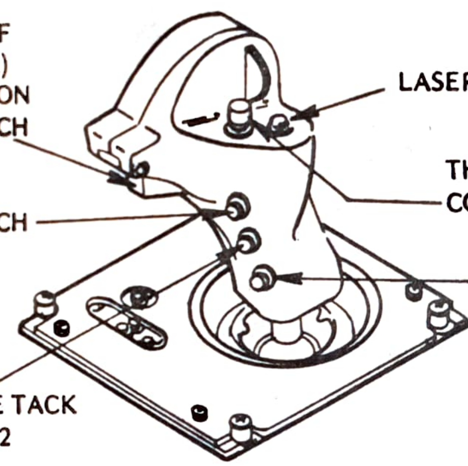
All upgraders are in their assigned cockpits with an instructor in each airplane. We start with a navigation route to the range. During this route, look at NAV modes and data displays in both cockpits. On the range, drop high altitude bombs as well as low angle and high angle events from a box pattern. Finish with a computer approach.

Profile 3: Nuclear Weapons

Start with a low level and meet a hard TOT. The ETE and ETA functions are useful, but you'll be surprised to learn that all of these computations are made to a max range loft release point. This in no way resembles LADD or laydown impact times. Good luck, math majors!

Profile 4: Introduction to Tactics

The low level is flown in two-ship tactical formation to a tactics range (if available). Entering the range, split up for a single-ship exercise. Each aircraft makes three IP-to-target runs looking at different ways to get from an IP to a pop-loft point in a tactical environment. These will normally be: (1) LORAN direct — backed up by D.R., (2) overfly OAP — backed up by D.R., and (3) sensor-designated OAP — backed up by D.R. At this point, the aircraft join up for as many two-ship attacks as fuel permits. Always have a D.R. backup plan! Additional tactics considerations will appear in the ARN-101 TAB.



INTEGRATED HAND CONTROL

On the range, do all possible deliveries, using combinations of show/no show targets with visual/radar OAPs. If you can figure out the wind corrections in the DMAS-aided LADD, you're ready to graduate.

BUT DOES IT REALLY WORK?

Like any new system the ARN-101 is experiencing growing pains. During the system introduction, we had support problems from the point of view of spares, maintenance training and tech data. The system software is in a state of flux, with hundreds of outstanding deficiency reports. Follow-on testing and evaluation will probably identify additional requirements or problems. The bombing accuracy has been good, but not as good as advertised. The ARN-101 will eventually be everything it's meant to be. But it isn't yet. And that puts a tremendous burden on you, the operational aircrews, to overcome the growing pains, and to train professionally in spite of the frustrations you may feel with the state of the program.

"SOMETHING TELLS ME WE AREN'T IN KANSAS ANYMORE, TOTO!"

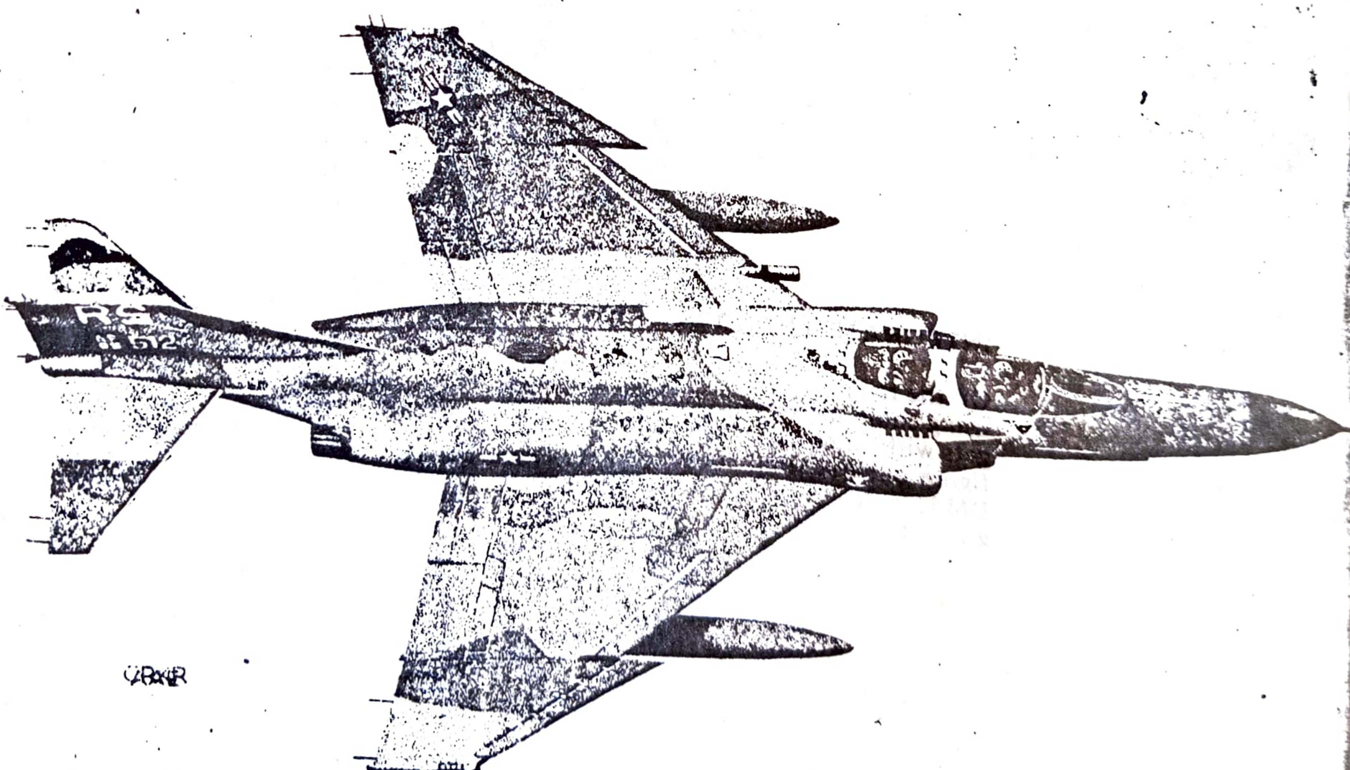
Let's sum this all up with a word about situational awareness. How well will you be able to handle the ARN-101? Will you function well when surrounded by 28 indicators, 22 switches with 83 different positions and 56 pushbuttons? How about during low level ingress in the world of MiGs, SAMs and guns? The ARN-101 is capable, but it's not sophisticated. Take all of that capability and mechanize it with two or three switches and one indicator; now that would be sophisticated! In order to turn this system into a combat capability, you are going to have to go a step beyond system knowledge, and supply the missing sophistication. You will do that by accepting some limitations and developing simple plans. Your plans must require a minimum of in-flight workload with just enough backups to cover the most likely contingencies. As the mission proceeds, do the things you know how to do well.

The pilot navigates, stressing t... WSO accomplishes disciplined ra... or visual search for threats. Now in-tegrate the ARN-101 into these ba... functions as an aid. This is your sop... cation: the ability to consistently exe-cute the basics while making optimum use of (but not becoming a slave of) your aircraft systems. Systems may occasionally fail, but the basics don't!

THE BOTTOM LINE

The F-4 is going to be around for a long time. The ARN-101 is a giant step toward making our airplane a viable tactical system for years to come. With a logical training program and a great deal of individual effort by you, the aircrews, the "digital F-4E" is going to be a giant leap in combat capability. Like the man said, "...anything else is rubbish." Happy hunting!

Major Timothy A. Kinn...
Nellis AFB, NV 891...



Listen When Arnie Speaks

Major Bob French
422nd T E S
Nellis AFB, NV 89191

Life used to be so easy in the F-4. This was when you could do all the air-to-air and air-to-ground BIT checks after engine start and still have time for a cup of coffee and reading the morning paper. That was before Lear Siegler got hold of old double ugly and had him revived as ARN-101 – "Arnie" to his friends. Just when I thought I had made all the mistakes you could make in the F-4, the number of possible errors increased by a factor of ten. Rejoice, all is not lost. The boys from the 4th TFW at Seymour Johnson came to the rescue. In preparation for "Gunsmoke '81" (where they were the top F-4 and third overall), the 4th TFW flew a concentrated schedule during which they conducted their own test and evaluation of the ARN-101 system. The results are a better understanding of the ARN-101 system and a more effective way to employ it.

Compensating for errors has always been the way fighter pilots were separated from those who just fly fighters, and Arnie is no exception. Before we see what we can do to recognize and compensate for Arnie's errors, let's look at how he solves the bombing problem.

First, there are the inputs, mostly from the Central Air Data Computer (CADC). These inputs are converted by the Signal Data Converter (SDC) to digital information that Arnie's computer can understand. Arnie's computer then processes the information and directs the gun sight to a point on the combining glass representing bomb impact point. We tend to blame the computer when bomb scores are bad. While the computer can make errors, it is far more likely that one or more of the inputs has caused the bad bomb. The most likely culprit supplying erroneous inputs is the CADC, and the input most frequently in error is altitude. Recognizing the importance of altitude information in bombing, let's look at how Arnie uses altitude information in the bombing solution.

The CADC constantly supplies altitude information, but Arnie doesn't always pay attention to it. As long as a climb or a dive of 80 fps (4,800 fpm) is not exceeded, the CADC altitude will be the only altitude information used in the bombing problem. However, Arnie knows about things like altimeter lag, so he says that anytime the Vertical Velocity Indicator (VVI) exceeds 4,800 fpm, he will take the last CADC supplied altitude and have his Instrument Measuring Unit (IMU) calculate altitude change from that point on. This means that the magnitude of error present when Arnie accepts the last CADC input will remain essentially constant until the bomb is released. The only thing that will override this CADC input is slant range information from RADAR lock-on or laser slant range from PAVE TACK. So, the bottom line is that we need to know how good our CADC and RADAR are before we drop a bomb using the ARN-101. The following methods were developed by trial and error as well as from discussions with Lear Siegler personnel.

In addition to the usual items involved in preflight planning, a mission to the range to drop conventional bombs in ARN-

101 aircraft should include a plan to best determine what the aircraft is going to do before a bomb is dropped. This is best accomplished by planning some dry maneuvering prior to range entry. Pick a location near the range where you can do some dry passes under controlled conditions. Try to choose an area reasonably flat that contains a clearly definable point target. From a map of the area you will need to extract coordinates of the point and an accurate target elevation. Obtain a 1:50,000 or smaller scale map. Surveyed point elevations would be even better, but usually these are not available. Once you have your data, you are ready to plan a profile that will allow you to gain an insight into your system before you drop that first bomb. I suggest you plan a box pattern with the same attack heading as you will have on the range. Try to make at least two dry passes using the same parameters as you intend to use on the range. The extra fuel you use accomplishing this will pay for itself when the bomb scores are all in.

PRETAKEOFF CHECKS

After Arnie is awake and has finished his morning exercises (INS in NAV), you are ready for your first glance at how your jet will drop its bombs. First, there is the BARO ALTITUDE check. This is very important as it tells you how close your CADC is to actual conditions. Dial in 29.92 in your pressure altimeter and note the elevation. This should be pretty close to the pressure altitude listed on the weather sheet or on ATIS. Now go to special list #35 and see what it says the altitude is. A good CADC will only differ about 20 feet or less. One hundred feet or less is probably an acceptable deviation; however, anything over 50 feet should be suspect. What if it's off more than the prescribed amount? Write it up. Remember, however, that it is going to take time before maintenance is up to speed on what you're talking about, so be very specific in your writeup.

The next thing to check is RADAR slant ranging. How do you check RADAR slant range? Not with the analog bar on the gunsight. It's about as accurate as war stories in the bar! You must use Arnie in order to be accurate. It would be nice if there were an item in the myriad of interactive lists in the ARN-101 that you could call up and read slant range directly. The good news is that such a display is available. The bad news is that the display is in octal – that is, numbers to the base eight for you noncomputer types. Is it easy to convert octal to decimal? Fortunately it is, but some effort is required. Here's how to do it:

RADAR SLANT RANGE CHECK

1. Select TEST on radar STBY/TEST/OPERATE switch.
2. Select A/G mode.
3. Select 10-mile range.
4. Select BIT 5.
5. Lock onto the first BIT target.
6. Select CAL/TEST on Keyer Control DATA switch.
7. Enter 7 under ITEM.
8. INSERT until DMO appears on first row.
9. Enter 132075 in 2nd row.
10. Record reading in 3rd row.
11. SKIP and observe 132076 in 2nd row.
12. Record reading in 3rd row.

If the value you record in Step 10 is other than 000001, either you locked onto the wrong BIT target or your system error is tremendous. Further calculations are not required.

EXAMPLE

Assume Steps 10 and 12 gave you the following: 000001 and 073400. The 000001 converts directly to 4096. Now we must convert the second value. Each digit is multiplies by its respective constant. The results are tabulated below:

CODE x CONSTANT = SUBTOTAL

Code	0	7	3	4	0	0	
Constant	2048	256	32	4	.5	.063	
Subtotal	0 +	1792 +	96 +	16 +	0 +	0	= 1904

Constant 4096
Subtotal + 1904

Slant Range = 6000

Of course, you won't always get a perfect 6000 feet. In fact, you will probably never get perfection if for no other reason than the RADAR synchronizer's breathing. You see this breathing by noting that the last two or three digits in address 132076 that you looked at in Step 10 almost constantly changes. It is worthwhile, therefore, to compute your slant range for the greatest number among the many you see and to also calculate range for the smallest number. Comparing the two, you see the total distance that your synchronizer breathes. Additionally, if you average the largest and smallest results, you will have the average slant range your RADAR is going to provide you. Compare this value to 6,000 feet and you see how much in error the slant range is. Two hundred feet is the old tech order limit. Unfortunately, that is unsatisfactory for good bombs. How good is acceptable? You could get into a lot of trig and higher math arguing this. Personally, I expect less than 50 feet of error and generally will not use the RADAR if its error exceeds this amount. Be your own judge considering the circumstances and the required accuracy for your mission.

AFTER TAKEOFF CHECKS

During the departure when things are convenient and speeds have stabilized, you need to compare the front seat true airspeed meter to what Arnie says it is on the DDI. Up to about 10 knots is acceptable. When Arnie is bad, he is usually very bad and gets worse. Normally when you discover a large difference between true airspeeds, a simple reset of the SPC will remedy the problem. If that does not solve the problem, do not use the system to drop bombs. They will be terrible! Go direct and hope for the best. Also during this time you should check baro altitude again. Remember, that's 29.92 altitude and is found in special list 35. As on the ground, it should be pretty close. If it isn't, don't use Arnie.

If you are at an altitude close to those you will encounter in the gunnery pattern, then you should compare system altitudes again, preferably with other aircraft in the flight in close formation. Big differences mean trouble; however, you should expect some error. Until we get digital CADCs, we are going to have errors.

PRETARGET ACTIVITIES

Having arrived near the target with some intelligent information regarding how we expect Arnie to perform, it is time to refine the info into usable numbers. There are two basic techniques. The first method concerns altitude updates.

How do we perform altitude updates? The Dash 34-1-1-2 checklist contains the procedure. It is simple to do, but very difficult to get repeatable results. This is why you should perform many altitude updates, but rarely accept them by depressing insert on the keyer control. With the RADAR in air-to-ground, we cue to our selected point by depressing IP INSERT. Remember, this is a point we selected in our preflight planning and contains accurate elevation data. After cueing, we lock onto the ground. When we depress the APX-80 button, the DDI will display ALT ERROR. You could accept this update by depressing insert. I suggest you reject it by skipping and data exiting. Why reject it? As I said before, the results are rarely repeatable. And if they were, you would only be correcting Arnie for one given set of conditions. It would not be magic for all altitudes. The lack of repeatable results probably comes from the fact that it is extremely hard to duplicate conditions. Consider that the maximum lookdown angle of the RADAR in level flight is 20 degrees. It can be less, and if it is, you will have graze angle errors like we always had on the vanilla F-4s. When doing updates like these, you must consider how high above the ground you are and calculate a range from your cue destination that you intend to lock onto the ground. If it is anywhere beyond a pure 20-degree lookdown angle, then some error will be present. As a rule of thumb, I use about 2.5 miles for 30-degree altitudes, two miles for 28-degree and 1.5 miles for 10-degree. If the terrain around your cue point is very flat, then tend to shade these distances closer to the target.

Now let's turn to dry deliveries. These can tell you how to correct Arnie for each delivery you plan on the range. The catch is that if your RADAR slant range check failed specs on the ground, then dry deliveries will not do much for you.

Just as in altitude updates, parameters in dry deliveries are very important. You must strive for repeatability. Concentrate on parameters just as you would if you were dropping in Direct. Use altitudes that will be as near to those on the range as the terrain will allow. You should plan to do at least two dry passes in each event planned. Cost too much gas, you say? OK, if you are a gambler and don't really care if you get 30-meter bombs instead of 15-meter or better, then press on. Obviously, one pass is better than none.

Set the front seat switches so that BOMBS and CCIP are selected. Make sure the MASTER ARM is safe! Roll in on your simulated target as you normally do. When wings level on final, the WSO should lock on. At pickle, a Weapons Point will be generated.

Before the WSO hits Data Exit, he should skip through the "W" point data, noting two values in particular. The first is ELEV. This is the elevation Arnie calcualted after receiving RADAR slant range information at lockon. If it is the same number as you inserted in the mission list, then there is a 99.9% probability that Arnie did not recognize the RADAR lockon and, therefore, used only mission list inputs in the bombing solution. The second value of importance in the "W" point is PITROL. The neumonic stands for pitch and roll. It's the pitch we are interested in because for all practical purposes, it can be considered our dive angle. Now go back and do another dry pass. Are the target elevations close to one another? If they are, you're in business. Simply note the difference between the W point elevation and the surveyed (or map) elevation and apply this difference to your real target elevation.

For example, let's say your "dry" target elevation is 3,000 feet. Let's further assume that your two dry passes generate W point elevations of 3,100 feet. Your difference is 100 feet higher than surveyed. What about the "real" target you want to bomb? If its surveyed elevation is 4,000 feet, you should insert 4,100 in the mission list, i.e. 100 feet high. You should now get good bombs provided you repeat the parameters your numbers were derived from, e.g. 30-degree dive, 8,000-foot MSL base altitude, etc.

If the W point elevations are significantly different, look at the PITROL – that's dive angle, remember. If the dive angle differs between two passes more than a couple of degrees, you should expect to find different ELEVs in the "W" points. If the dive angles are reasonably close, make a final true airspeed check between cockpits. If the airspeed has run away with itself, abnormal results will occur in the bombing pattern. Reset the SPC and check it again. Always be prepared to drop in Direct.

After doing all your dry deliveries and recording the ELEVs from the weapons points, you are ready to enter the range for your first deliveries. You are now loaded with a wealth of information. Unfortunately, it may not all be good news, but information it is jsut the same.

TARGET AREA

Entering the target area, it is time for some last minute checks before the first weapon is released. Go to the mission list and insure you have entered the target elevation you derived from your dry deliveries. Remember, this value will probably change for each different dive angle. Check your release advance value. It should be zero until you have a reason to change it. Then, of course, arm up. We don't want to waste all that effort with a dry pass due to a switch error.

When the first bomb is on the ground, it is time for refinement. A shack, you say? Okay, you can press on, but for most of us it will not be a shack, and we must evaluate our data. First of all we must make a realistic assessment of where our pipper was at pickle. Don't be naive enough to think it is always going to be on the pylon. It simply does not happen. Let's assume for the time being that the pipper was on the pylon. Now where did the bomb hit? Normally the error will be a 6-12 error. A 3-9 error must be corrected with a little pipper offset. Let's look at the weapons point and see if we can get a clue why the bomb was not a shack. If the score is a gross error, it usually points to TAS runaway or the incorrect weapons ballistics (WL2 V. WL 1). TAS runaway is identified in the weapons point by noting delivery true airspeed and calculated winds. You should know approximately what TAS you released the bomb. If the weapons point says 540 knots when you are about 480 knots, you have found the problem. Try an SPC reset. If the TAS between cockpits is back in order, you found it. If not, go Direct. Do not waste any more bombs on the ARN-101. Make an intellgent writeup when you get on the ground. A knowledgeable weapons officer will throw the bomb out despite what comes from your alibi sheet. These types of malfunctions are not easy to duplicate, but weapons point data will show anyone familiar with the system what the problem was.

If you were lucky enough to get a decent bomb, you should now make a change that will bring the bomb closer to the pylon. Check the weapons point for dive angle. Is it about the same as you had when you developed your estimate of target elevation? In general, Arnie will tend to drop short if you are shallow just as happens if you are shallow in a direct delivery. The important point is that you developed a target elevation based on meeting a parameter. If you did not meet that parameter, then you cannot say your number is bad if you can't repeat the conditions you derived it from. In other words, if it says you were at 20 degrees, then you just dropped a 20-degree bomb, not a 30-degree bomb. Never forget this very important point.

We'll assume that you met your parameters. There are several techniques to correct your next bomb. The one you use doesn't really matter, so let's look at the different methods.

First, you can make target elevation changes. If your bomb is short, you must decrease your target elevation. Conversely, if your bomb is long, an increase in target elevation is required. Think of LASS as a memory aid – long, add; short, subtract. The obvious question is how much. That is a difficult question with no cut and dried answer. Let's talk in generalities first. Remember that elevation, i.e., altitude error is more critical at the shallower dive angles. Therefore, if we want to make changes in 30-degree dive angle passes, our target elevation changes need to be larger than they are in 10-degree deliveries. As an oversimplified rule of thumb, try approximately 100 feet of altitude change for every 20 meters your bomb score is off in 30-degree deliveries. Use progressively less as your dive angle decreases. The key point is that elevations must be subtracted to move your next bomb forward and vice versa.

Another method is to use release advance. With entries in feet, the release advance method may be the most comfortable for you at first. Theoretically, if your bomb is 20 meters short, you should simply have to put a NEGATIVE release advance in of approximately 60 feet (20 meters approximately equals 60 feet). In practice this does not work so simply. Generally, a lesser amount is required. As a starter, we generally use 2/3 or 3/4 of the value.

The third method is what we will call Combat Offset CCIP. This technique requires the least amount of thought and serves very well until you begin to set bombs inside 15 meters. With scores like this you would like to have a distinct point to pickle on rather than some obscure estimated distance short of or beyond the pylon. To apply this technique, you drop your first bomb and consider where the pipper was and where the bomb hit. You then fly the pipper to a point that will cancel the error you just found represented by your bomb score. For this method to be more than moderately successful, a great deal of skill and some luck is required. Still, it does not require any manipulation of numbers in the computer.

The final method and by far the simplest is to use a RADAR lockon. We generally avoid this particular method because the RADAR just has not proven consistent enough. However, if despite all your efforts, you have been unable to satisfactorily determine a target elevation that will work for your deliveries, then RADAR lock may be the only way to go. Don't forget, however, that all previous checks of the RADAR slant ranging must have been within reasonable limits. Otherwise, you should go Direct. An example of when you might go with a RADAR lockon is when time does not permit you to go through all the dry deliveries, but all RADAR checks are nearly perfect. Under these circumstances a RADAR lockon delivery would be preferred to Direct. Remember, if you use RADAR lockon, release advance or combat offset are the only methods of corrections for bad bombs.

POST FLIGHT ANALYSIS

As you may have noticed as you waded through this article, we have assumed we knew nothing about the jet we were flying. Wouldn't it be nice if we already had some information on the aircraft before we launched? Of course it would. The way to get that information is through accurate system tracking. Simply plotting bomb scores by an aircraft does not tell the story.

Let's look at what information we have in hand after our mission. First there is gun camera film. This is a must. Furthermore, because Arnie causes the sight to jump 25 mils at pickle and the camera just isn't fast enough to pick this up, it is imperative that you turn the camera on before pickle. With our film in front of us, we finally see EXACTLY where we pickled. You must look at the film a frame at a time because looking at it at 24 or 48 frames per second can trick you into thinking that you pickled exactly on the pylon. In addition to gun camera film, we have our bomb scores. Look at the pipper/pylon relationship and the bomb score. Is it where you expected it to be? Does the score make more sense now? Finally, you have your weapons point data. That is, you have it if you were smart enough to take a Data Transfer Module with you and unload it after the mission. Compare your pipper, score and weapons point data. The three together can give you a wealth of information. For example, you may have found you pickled right on the pylon with a number that should have worked in your target elevation. The weapons point showed you were considerably shallower than you thought. In fact, if you look real close, for example, you may find that if you had used 20-degree target elevation data instead of 30-degree data, your bomb may have been a shack. Of course, there is no way to know this in advance, so once again, we see the importance of parameters.

After analyzing the information, we can very accurately determine where the aircraft tends to drop its bombs. It then becomes an exercise to determine the best way to log this and have the information available to the next crew to fly the aircraft.

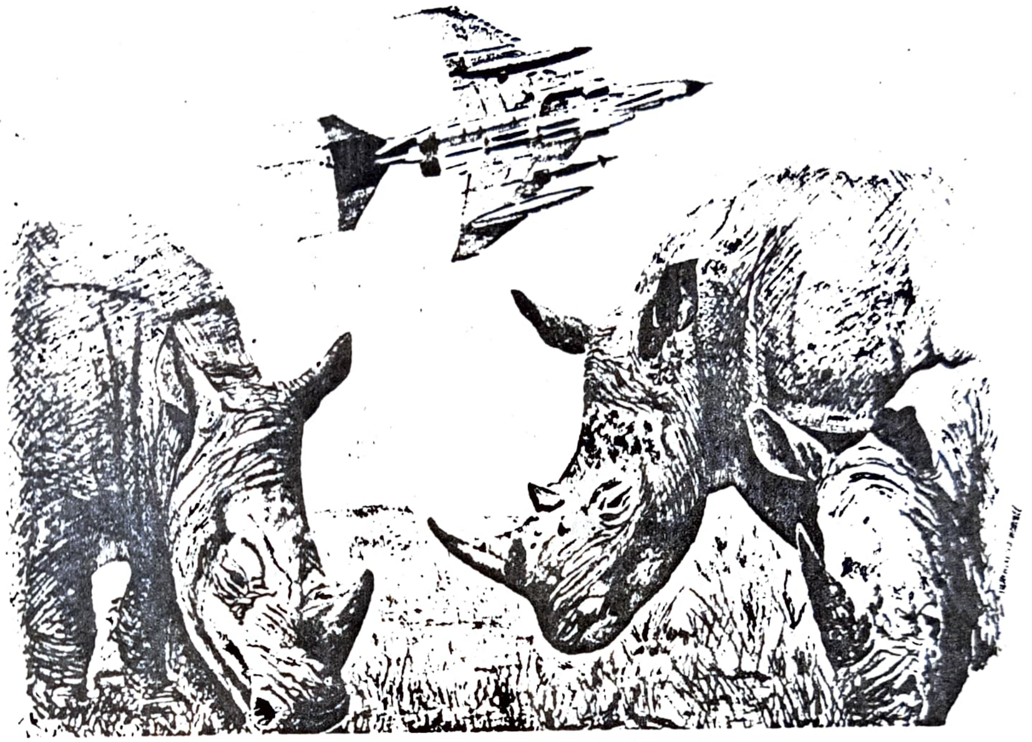
SUMMARY

The ARN-101 is a very accurate bombing ssytem that has proven itself against the best in the Air Force. It does require, however, skill on the part of the aircrew to analyze the information available in order to utilize the system to its design limits. The methods described in this article represent a small beginning in the collection of a wealth of information that will continue to develop as we learn more and more about the DMAS F-4E.

Major Bob French
Nellis AFB, NV 89191

Rhino Brain Transplant

By
Captain TOM GRAVES
422 TES
Nellis AFB, NV 89191



The F-4 isn't getting older; it's getting better........ With the advent of ARN-101 and PAVE TACK, the F-4 has been extended well past 1990. These new systems replace much of the analog avionics of the 60's with the state-of-the-art digital capability of the 80's, resulting in more accuracy, less exposure, and increased crew tasking. To continue the digital avionics update, the F-4 is now being modified with a new air-to-air capability: the Digital Target Intercept Computer (LRU-1).

This change involves a new solid state, 16,000-word memory computer, an off boresight Computer Auto-Acquisition (CAA) capability and heads-up shoot lights in both cockpits. Additionally, it provides realistic missile launch solutions for the AIM-7E/F and AIM-9P/N.

The analog system we have all become familiar with has always provided us with target azimuth, range and closing velocity. With the addition of the digital computer, new data is available such as target aspect angle, altitude velocity, direction and turn rate. (I know; you are asking yourself right now, "Why isn't that information being displayed to me in the cockpit?" Well, keep the faith; the solution is being worked. Or, to put it another way, "The check's in the mail.") This new information allows for the computation of more accurate long range intercept geometry and missile envelope computations, as well as air combat maneuvering missile envelopes.

If a target is more than five miles away, or at an altitude above 32,000 feet, the computer selects the Long Range Intercept (LRI) mode, and a new long range intercept geometry is established based on the missile selected. The computer programs a varying lead collision course beyond R_{max}. This lead pursuit course generates the correct lead from which the missile can fly a collision course to the target without any corrections after launch.

The target to dot relationship in this program is no longer two-to-one like it was in the analog computer. Instead, the target to dot relationship varies depending on fighter/target altitude difference, and range to the target. So, all the formulas we once used to determine target aspect angle, heading, etc., that were dependent on that two-to-one target to dot relationship are out the window.

The ASE circle represents the maximum angular deviation from desired course allowed, just like it always did. However, the computer now has much more accurate information than it did in the past, so it can make a detailed determination of missile performance. Because of this, the maximum allowable deviation from desired course has been increased from 15 to 25 degrees. The absolute maximum, however, is still dependent on lead angle required for the intercept.

computer now figures R_{max} for the missile instead of as it did in the past. To do this, the computer makes some assumptions. It assumes that a missile launched at max range will intercept the target with a velocity equal to launch velocity. It compares that to the missile seeker limit for a two-square meter target, and uses the lesser of the two as R_{max}. In determining R_{max} the computer always assumes a one "G" target in the LRI mode.

The Air Combat Maneuvering (ACM) mode is automatically selected by the computer when the target is inside five miles and the fighter is below 32,000 feet. When these conditions are met, the computer compares actual fighter and target flight conditions to stored missile envelopes and determines whether the fighter is, at that instant, within missile capability. One warning here though; the computer does not make a prediction for the time it takes from trigger squeeze to missile away. So, if the target goes inside min range or outside max range after you squeeze the trigger but before the missile comes off the aircraft, it will probably be a bad shot. So, use caution on those edges of the envelope shots.

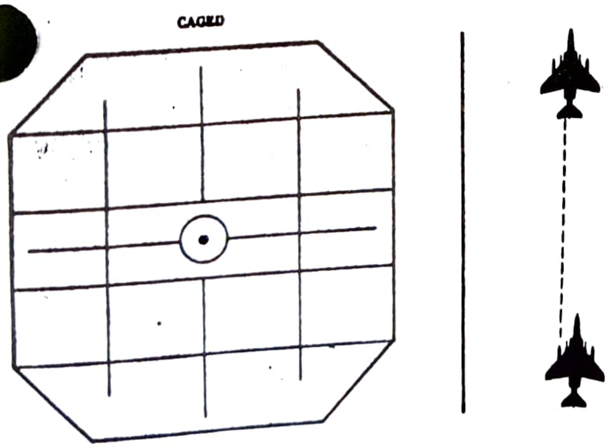
The computer assumes a visual fight once the target is inside five miles, so in the ACM mode it will always program R_{max} at five miles or less. In radar, the ASE circle is a fixed .56-inch circle. With heat selected, the circle is a fixed .2-inch circle with the missile head caged, and a fixed .56-inch circle with the missile head uncaged. With either heat or radar missile selected, the ASE circle represents the angular limits of the missile launch envelope, with the center of the circle representing the fighter velocity vector.

With radar selected, the aim dot represents the center of an instantaneously available missile envelope. Thus, with the dot centered, the fighter velocity vector is pointing directly at the center of the missile envelope. In heat, with the missile head caged, the dot represents a boresight pursuit course. So, with the dot centered, the fighter velocity vector is pointing directly at the center of the missile envelope. In heat, with the missile head uncaged, the dot represents the missile pointing vector. If this has you confused, take a look at Figure 1 and maybe it will be a little clearer.

The Computer Auto-Acquisition mode provides the F-4 with a limited off boresight auto-acq capability. The system has a dynamic range of five miles, and a scan rate of 120 degrees per second. It scans in elevation from +57 to -21 degrees. Because of filters in the system, the lockon limits are +45 to -9 degrees, and 5 degrees either side of centerline. To help reduce the problem of the radar locking onto the ground return, the lockon range is decreased with increased look-down. See Figure 2 for the exact range limits.

However, there are some tactical considerations for using the CAA. As the LRU-1 FOT&E Final Report will indicate, the computer loves the ground return. Also, anytime the lookup gets much above 15 degrees high, the A.C. has a hard time putting the target in that ±5-degree beam. So, if the target background is dirt, or if the lookup is over 15, you should go for a stab-out lockon instead of using the CAA.

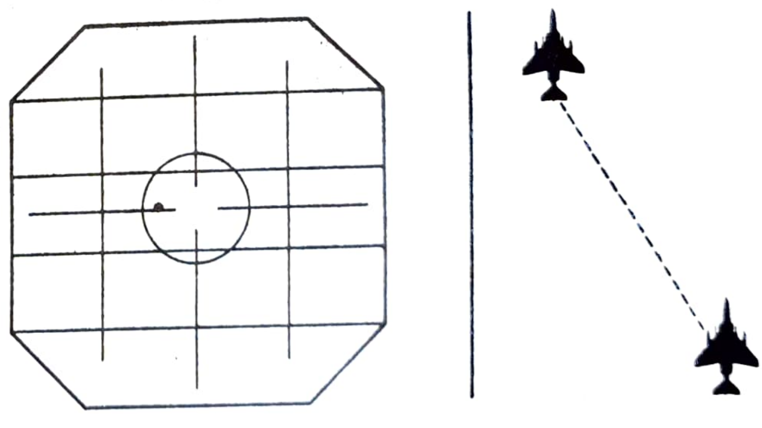
CAGED



RADAR DISPLAY-MISSILE HEAD CAGED

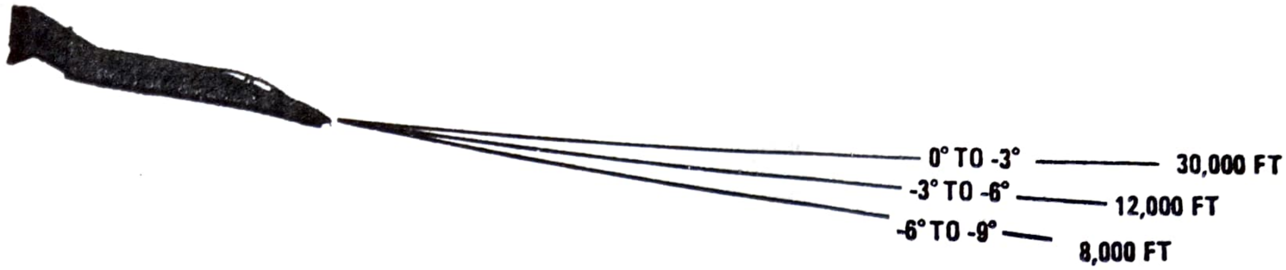
FIGURE 1a

UNCAGED



RADAR DISPLAY-MISSILE HEAD UNCAGED

FIGURE 1b



CAA DYNAMIC RANGE
(LOOK DOWN)

FIGURE 2

How could any discussion of a radar be complete without a long, involved discussion of radar BIT checks? Well, this is not going to be long and involved, but there are some significant BIT check changes that deserve a mention. In the pre-BIT switch setup, you now need to be in high "G" instead of low, and you must be in one bar scan. Do BIT 0 the same way you always did. BIT 6 has a number of important changes. R_{max} will now be 15 $\pm$ 1.5 miles instead of 10.1 $\pm$ 1 miles. R_{min} is now at 5 $\pm$ 1.25 miles instead of 2 $\pm$ .85 miles. The aim dot is going to remain stationary instead of moving to the right as you move the range strobe outside 15 miles. It will go out and the shoot lights will come on when the range strobe is between R_{max} and R_{min}. They will go out and you will get a Break X when the range strobe is inside R_{min}. The ASE circle remains fixed instead of expanding and contracting. Also, if the V_c is reading 900 knots, the computer is computing for an AIM-7F. If the V_c is 000 knots, then it is computing for an AIM-7E. BIT 1 is done the same way we always did it, except that in Step 14, the aim dot will remain in the calibration box, and the V_c is 900 + 200 knots. The check is over after Step 14. BIT 2 now checks Range Track Acceleration and Antenna Position, but is done in the same way. We also do BIT 3 the same way, but now it only checks Angle Track. BIT 4 now checks HOJ, Angle Track Memory, AOJ, Pseudo and Simulated doppler, and Corridor Scan. The only difference in this check is an additional step to check the Corridor Scan. BIT 5 now checks Range Rate Noise, PLMS and CAA. The check is done the same way with a couple of exceptions. The first time you hit the auto-acq button, the radar will lock onto the first target past the last target in the computer memory, instead of the first BIT target. Then it will cycle through the targets like it always did, but it will never lock onto the 5th BIT target. There now, that wasn't so painful, was it?

The LRU-1 modification gives us a valuable training aid that we have never had in the past: the Tactical Information Retrieval System (TIRS). This system gives us the ability to recover fighter, target, and missile firing parameters. The system has the capability to record fifteen snap shots (trigger squeezes). It records all shot parameters when the trigger is squeezed as long as the radar is in some track mode. The shots are cumulative (even if the radar has been turned off), and the memory is not cleared until the snap shots have been dumped into the TIRS memory unit. Recovering the information is a little harder than replaying a video tape, but the data is very accurate and invaluable to missile shot assessment. The procedure for dumping the TIRS information from the aircraft is not in the checklist yet, so I will give it to you now. Your CRS people must hook the TIRS memory unit up to the umbilical behind door 172 on the left side of the nose, and you need power on the jet. Place the radar power switch in TEST, the mode switch in RDR and the DSCG mode switch in RDR. Place the test switch in DOT BAL and release. A light will come on in the memory unit in about two seconds to indicate that the information has dumped into the memory unit. Remember, if you plan to use the TIRS information for debrief, you have to dump it prior to takeoff to insure the computer memory is empty.

Well, this has been quick and dirty on the Rhino radar's new brain. If you have any questions about the system after reading this article, get in the Dash 34 or get your hands on a copy of the LRU-1 Test Final Report that will be forwarded to your weapons shop shortly, or give us a call at the 422nd TES. Good Hunting!

Captain Tom Graves
Nellis AFB, NV 89191

Rhino's New Bullet: the AIM-7F

By
Captain JOHN BARRY
422 TES
Nellis AFB, NV 89191

Contrary to popular belief the F-4E is now packing the AIM-7F. With the recent Digital LRU-1 modification the F-4E radar is now compatible with this missile and, with changes to the software, the future AIM-7M. Unfortunately, there are unique aspects of this new matchup that are not available in the Dash 34 or FWS text that, if not known, will affect mission readiness. This article will focus on "need to know" information for the aircrews; i.e., what can be used in the cockpit: AIM-7F basics, BIT check clues, turning procedures, rules of thumb changes, firing considerations. In addition, the 422nd Test and Evaluation Squadron at Nellis AFB recently completed their FOT&E on the LRU-1. This report gives more detailed information on the F-4E/AIM-7F interface.

BASICS ON THE AIM-7F

The AIM-7F has some significant improvements over the AIM-7E-2/3:

- Reduced minimum range
- Increased maximum range
- Increased missile reliability
- Improved ECCM capability
- Improved P_k
- Greater missile maneuverability at intercept
- Minimum engagement time for each target

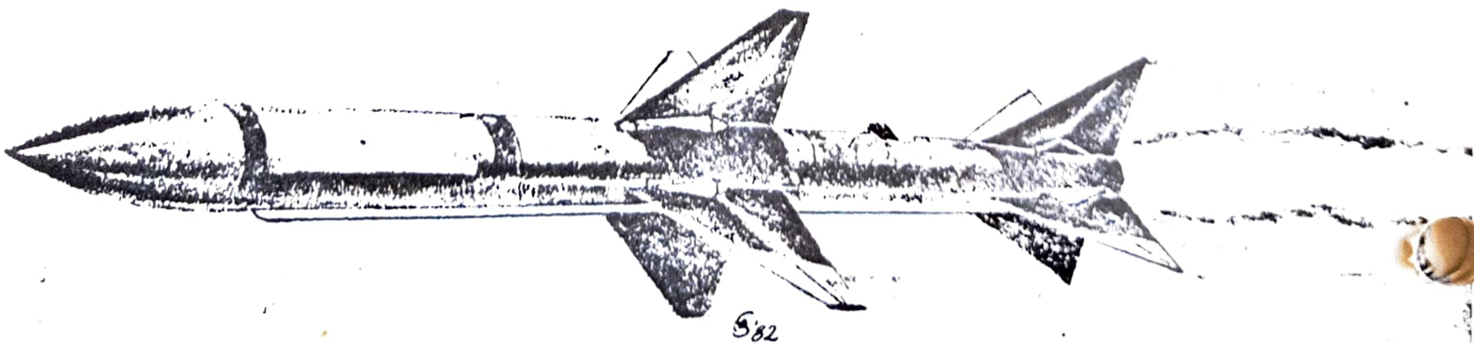
One interesting fact about the 7F, which will aid in understanding some of the changes discussed later on, is that the missile tunes and then goes dormant (goes to sleep for you Phys Ed majors). This dormant state "saves the missile" till the shot and gives added evidence of its reliability. After it tunes, the missile couldn't care less if the CW switch is moved back and forth from CW STBY to ON, or if the Master Arm is on or not. It will only wake up at trigger squeeze or if the radar power or CW switch are cycled to off and back on. This differs from the AIM-7E which is always "talking" to the radar. Keep this in mind.

BIT CHECK CLUES

Differences in the Digital LRU-1 BIT checks are listed in the Dash 34. One point worth reemphasizing is that BIT 6 now tells the aircrew whether a 7E or 7F is loaded. If the V_c reads 0, this indicates you have a 7E missile or a 7E SIM PLUG loaded. A loaded 7F missile or 7F SIM PLUG would be indicated by a 900 V_c reading. (SIM PLUGs for the 7F are being made, so have your WCS shop get one: PN 666FT401). Don't mistake a 0 V_c for a bad radar. By checking BIT 6 you'll always know what is loaded and whether or not your radar is computing a 7E and 7F missile launch envelope. However, if you have a mixed load of 7E and 7F missiles (discussed later) or SIM PLUGs, 900 V_c will always show up in BIT 6. Preflights are still required.

AIM-7F TUNING

There are a number of differences between tuning the 7E versus the 7F. To begin with, the AC should get a 7F RADAR tuned light within three minutes (max) of going CW ON. If the missile does not tune by three minutes, attempt to retune by going CW OFF for 10 seconds and then back on. The reason for going CW OFF and then back on is the missile will go to sleep even if it does not tune and you must reawaken it. This differs from the 7E which is always trying to tune while CW is on.



Additionally, there is no requirement to have the radar tuned lights on for one minute (per 7E instruction) because the missile tunes and goes to sleep after 2 seconds; nor do you have to have the tuned lights on 4 minutes in the air, for the same reason. Once you get a light, wait 2 seconds and then you can go CW STDY without causing any problems.

Going CW STBY after a good tune leads into the next major difference: cockpit light indications. The Dash 34 presently states that, after a successful tune, the RDR tuned lights will go off when CW STBY is selected. This is true for the 7E but not for the 7F. Not only will the RDR tuned lights stay on when CW STBY is selected (7F), but the Heads Up RADAR light and ARM light will stay on (assumes Master ARM-ARM). With the CW STBY the AC will see "RADAR" "ARM" on his Heads Up Lights and have RDR tuned lights, but be unable to fire a missile. This could result in a missed shot opportunity (CW must be on for a missile to leave the F-4). There is a proposed change at Ogden ALC to make the lights the same for the 7F as the 7E. However, for the time being watch the switches and the lights.

An additional change in light indications concern blinking RDR tuned lights and the Heads Up RADAR light. For the AIM-7E the Dash 34 states these lights will blink while the speedgate unlocks from pseudo doppler and locks onto simulated doppler. For the 7E this occurs when the master arm switch is positioned from SAFE to ARM or immediately after radar lockon. Since the 7F goes to sleep after it tunes, don't look for any blinking lights.

Now for some bad news. When the 7F is tuned with the CW ON and Master Arm switch – SAFE, the missile tunes on pseudo doppler and goes to sleep. However, when the missile is fired, it wakes up and looks for SIM doppler, not pseudo. Tuning with the master arm switch – SAFE does not check SIM doppler, nor will BIT 4 guarantee the SIM doppler is getting to the missile. The recourse, unfortunately, is to tune with the master arm – ARMED to insure SIM doppler will work with the 7F missile. The Dash 34 states this is a dangerous procedure and should only be accomplished when required for combat operations or with captive ordnance. Insure all Aero 7A launcher safety pins are installed if attempted on the ground. Once airborne and in an area which allows the master arm switch to be placed in the ARMED position, tune the SIM doppler using the following procedures:

- Radar missile power switch – CW OFF for 10 seconds
- Master arm switch – ARMED
- Radar missile power switch – CW ON
- Wait for tuned light.

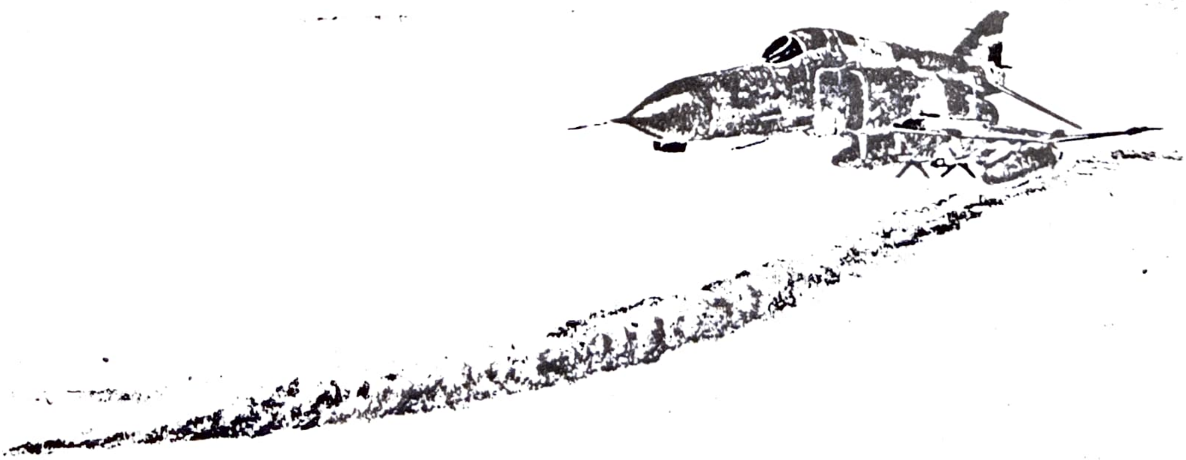
This will guarantee the SIM doppler will tune the missile so when the missile is fired and wakes up, you are sure the missile will guide. There is a proposal to do away with pseudo doppler in F-4Es and only tune on SIM doppler, regardless of the position of the master arm switch. Be heads up for changes.

RULES OF THUMB

Remember the old 2-second/4-second ROT for the 7E – forget it for the 7F. Since the missile is asleep until trigger squeeze, there is no requirement for the 2-second missile speedgate settling. Here's the new word:

- If locked onto a target and then you select master arm switch to ARM, fire immediately – no delay.
- If locked on after selecting the master arm switch to ARM, wait 2 seconds for radar settling.

Another ROT that has changed is the 2 - 5 minute tuneup period if the missile cold soaks. If Harvey Knucklefutz goes CW OFF in the air, the missile should retune within 3 minutes. On one captive carry the average retune was less than 1 minute after cold soaking the missile for 10 minutes. ACs should still go CW STBY on descents with live missiles.



FIRING CONSIDERATIONS

The recent Digital LRU-1 FOT&E indicates the missile launch envelopes generated by the computer are valid ones. What this means is, if you have shoot lights, fire. It also suggests that Interlocks-In may be a player because you won't get shoot lights unless the dot is in the circle and the target is between R_{max} and R_{min}; i.e., in the missile envelope. Interlocks-In may prevent Harvey from firing a missile out of parameters.

One other consideration that needs to be restated is: Don't fire an AIM-7E or AIM-7F while the radar is in memory. Either missile will launch in wide sweep if you have a blinking V_c with a corresponding H in the upper right corner of the scope. The difference between the 7E and the 7F is that if the 7E launches in wide, locks onto a target for 2 seconds (you lucked out if it didn't bite on the main beam clutter) and then breaks lock, the missile will sweep in narrow. If the 7F is fired, it will always sweep wide.

The next discussion has to do with mixed loads. Right now the Dash 34 says mixed loads of 7Es and 7Fs are not recommended. This is being amended. Although a mixed load causes complications, it is possible under the following conditions:

- Load 7Fs in the front two stations and 7Es in the AFT stations.
- Never load a 7E or 7F across from each other.
- After the 7Fs are fired, the AC must cycle to heat and back to radar on his pinky switch to reset the LRU-1 computer for 7E missile envelope computations.

SUMMARY

The big news is: study the AIM-7F. Get in touch with WSEP/ Combat Sage and get in the books. Remember, going CW STBY after a successful tune leaves the RDR tuned light on and will affect your Heads Up Display. Know the tuning differences between the 7E and 7F and the new ROT. Consider Interlocks-In and the possibility of mixed loads. The F-4 has a computer in its WCS so be heads up for changes when new tapes come out. Right now we can change the software in the LRU-1 as easily as the F-15 and F-16 change their computer tapes. Good hunting!

Captain John Barry
Nellis AFB, NV 89191