SYSTEMS PHASE PLANNING GUIDE

JANUARY 1995

USAF TEST PILOT SCHOOL
EDWARDS AFB, CA

This Systems Phase Planning Guide has been reviewed and approved.

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MEMORANDUM FOR DISTRIBUTION: 22 Jan 96

FROM: USAF TEST PILOT SCHOOL/EDS

SUBJECT: Change 1 to the Systems Phase Planning Guide

1. Replace pages 3.131 - 3.138 of the Systems Phase Planning Guide with the attached change 1 pages 3.131 - 3.138.

2. Annotate the front cover of the Systems Phase Planning Guide, beneath the January 95 date, with "Change 1, 22 Jan 96".

3. Post this letter at the back of the Systems Phase Planning Guide.

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F-15 CAPTIVE COMPATIBILITY DEMO/ASYMMETRIC STORES (PILOT/FTN)

REFERENCES:

1. F-15A/B/C/D Flight Manual.
2. MIL-STD-1797A, *Flying Qualities of Piloted Aircraft.*
3. MIL-HDBK-244, *Guide to Aircraft/Stores Compatibility.*
4. MIL-STD-1763, *Aircraft/Store Certification Procedures.*
5. AFR 80-54, *Aircraft/Stores Certification Program (Seek Eagle).*
6. *Systems Test Theory and Flight Test Techniques,* Chapter 8, "Stores Certification."
7. Flight Clearance (FC) 92-052-A1: 610 Gallon Fuel Tank in an Asymmetric Configuration on AFMC F-15A/B/C/D Aircraft (Fig. 3.21).

PURPOSE:

1. To demonstrate a captive compatibility flight profile (CFP) sortie IAW MIL-STD-1763, *Aircraft/Store Certification Procedures* and MIL-HDBK-244, *Guide to Aircraft/Stores Compatibility.*
2. To demonstrate the degradation in flying qualities with an asymmetric store IAW MIL-STD-1797A, *Flying Qualities of Piloted Aircraft.*
3. To compare F-15 asymmetric flying qualities with the basic F-15 aircraft.

AIRCRAFT:

F-15B/D, with a full 610 gallon tank on station 2 or 8.

GENERAL:

A typical CFP sortie consists of 6 to 10 data points selected from throughout the aircraft's operational envelope, including the PA configuration, flown in a buildup fashion. The higher mach/airspeed points may require the aircraft to be in a dive of 30° or more to achieve desired parameters, requiring several passes through the data band to complete the test point. As a result, a tanker is usually required and typical sortie times are 3.5 to 4 hours.

MIL-STD-1763A, Test 250A, defines the following CFP tests:

1. Test 251, paragraph 251.5, handling qualities tests:
   a. Taxi and ground handling characteristics.
   b. Take-off characteristics, including crosswind.
   c. Climb, cruise, maneuvering descent characteristics, including effectiveness of speed brakes, power, and configuration changes.
   d. Subsonic, transonic, supersonic characteristics (as applicable) including trim and stability changes as follows:
      (1) Trim shot.
      (2) Steady state sideslip analysis to confirm positive Cn_{β} and Cl_{β}.
      (3) Longitudinal dynamic short period analysis to confirm positive stability.
      (4) Lateral-directional dynamic analysis to confirm positive stability.
      (5) Roll performance.

(6) Maneuvering stability up to maximum symmetric g noting stick force per g to provide an indication of dynamic longitudinal maneuvering stability.

(7) Speed stability while accelerating to the next data point (without trimming).

(8) Upon completion of the final test point, or at the highest speed authorized, evaluate trim change induced when speed brake is extended.

e. Buffet onset and intensity, vibration and stall/high AOA characteristics.

f. Low speed flying characteristics.

g. Trim changes when lowering gear and flaps, while performing turns, and while approaching stall warning.

h. Air-refueling.

i. Operationally representative maneuvers including tracking tasks.

2. Test 252, paragraph 252.5, Structural integrity tests (loads):

a. Maximum positive symmetric g.

b. Maximum positive unsymmetric (rolling) g.

c. Maximum negative symmetric g.

d. Maximum negative unsymmetric (rolling) g.

e. Engine spillage test (throttle chop).

3. Test 253, paragraph 252.5, Vibration and endurance test (speed soak):

a. 30 minutes at the lowest practical altitude (not higher than 1000 ft MSL) at 0.9 mach or the maximum allowable airspeed, whichever is less.

MIL-HDBK-244, paragraphs 6.2.1.7.6 and 6.2.1.7.7, gives further guidance on how to accomplish the required maneuvers and breaks down the testing into two sorties:

a. Part I/First sortie: Structural integrity and handling (test 251 and 252).

b. Part II/Second sortie: Vibration and endurance (test 253).

A typical CFP will include the handling qualities tests (Test 251) and the loads tests (Test 252) at each data point. The loads tests are usually accomplished at the same time as the maneuvering stability [1.d.(6) above] test point. Portions of these tests may be omitted if analogous to another previously certified or tested item on that aircraft. When fuel and time will allow, the first and second sorties are often combined into a single sortie, performing the speed soak test (Test 253) at the end of this sortie.

Additionally, when the configuration to be tested involves lateral asymmetry the requirements of MIL-STD-1797A must be qualitatively evaluated throughout the CFP. As a minimum the following paragraphs should be evaluated:

4.1.11.5 Control margin.

4.2.7.2 Pitch axis control power in maneuvering flight.

4.5.8.6 Roll axis control power for asymmetric loading.

4.6.6.3 Yaw axis control power with asymmetric loading.

4.6.7.5 Yaw axis control force limits with asymmetric loading.

This TPS syllabus sortie includes a mix of data points from a typical CFP as well as demonstration data points designed to show the differences in handling qualities between a symmetrically and an asymmetrically loaded F-15. The sortie is fuel limited, so a timely accomplishment of the test points is required to complete the entire profile.

FLYING QUALITIES FULL DATA SET:

For this TPS mission, a flying qualities full data set will include the following maneuvers:

1. Trim shot.
2. Longitudinal dynamic short period motion analysis: evaluate using a 1 g pitch doublet, pitch CAS on then off.
3. Lateral-directional dynamic analysis: evaluate using a rudder doublet, yaw and roll CAS on then off.
4. Rolls: both directions, through 120° (±60°) to avoid exceeding the 180° TPS limit. With gear down use 60° (±30°) to avoid exceeding the 90° flight manual limit. Use a 1g load, build-up approach, all CAS on then all off. The rolls are usually done away from the store first to ensure sufficient roll axis control power to stop the roll.
5. Steady Heading Sideslip: to full deflection, both left and right direction, CAS on only. Not accomplished in PA configuration.
6. Maneuvering Flight: wind-up turn to symmetrical load limit. CAS on only. The turn is usually done opposite the direction of anticipated departure, or in the direction opposite the store if you are not sure, so that the aircraft will roll towards wings level if it departs controlled flight.

LOADS FULL DATA SET:

For this TPS mission, a loads full data set will include the following maneuvers, with CAS on only:

1. Wind up turn to the maximum positive symmetric g limit. This is the same as the Maneuvering Flight test point described above. When both flying qualities and loads are accomplished at a particular data point there is no need to do this maneuver twice. If aircraft departure is a concern, perform the turn opposite the direction of anticipated departure, or in the direction opposite the store if you are not sure. Otherwise, turn into the store in preparation for the loaded roll.
2. Loaded 120° roll (to avoid exceeding the 180° flight manual limit) at the maximum positive unsymmetric g limit, maintaining maximum roll rate. Although a direction for the rolls is not specified, this roll is usually done away from the store to maximize stress on the store. If the wind up turn was accomplished into the store then after its completion simply unload to the unsymmetric g limit and accomplish the roll. Otherwise, establish a turn in the direction of the store at the unsymmetric g limit and accomplish the roll away from the store.
3. Pushover or inverted turn maneuver to the maximum negative symmetric g limit.
4. Loaded 120° roll (to avoid exceeding the 180° flight manual limit) at the maximum negative unsymmetric g limit, maintaining maximum roll rate. This roll is usually done in the direction of the store to maximize stress on the store.

A build-up approach is used during both the 1g and the loaded rolls. For this TPS sortie use 1/4 and 1/2 aileron deflection from trim to buildup to the maximum roll rate of 120° per second (see

Fig. 3.21, remark 9). Note the sideslip buildup during the rolls. Careful planning is required to avoid exceeding flight manual and flight clearance roll rate and bank angle limits.

Load levels requested at the data point are normally noted as a percentage of the test limits, and computed using a baseline of +1.0 g. 80% values are calculated using the difference between the maximum value and 1.0.

LIMITATIONS:

1. Crosswind limits for takeoff and landing will be 10 kts from the side opposite the store and 15 kts from the side with the store.
2. All points will be performed at or above 10,000 ft AGL when above 21 units AOA with the exception of the takeoff and landing evaluation.
3. Any emergency aggravated by an asymmetric load condition will require immediate feeding or jettisoning of the external fuel tank prior to landing.
4. The external tank must be entirely full prior to engine start to prevent fuel sloshing during flight. The external tank fuel reading should be 4,090 ± 250 lbs with JP-8.
5. The aircraft must have an operative AOA gauge and g-meter in the rear cockpit.
6. Non OWS aircraft g limits apply until the external tank is empty because the system is unable to determine that the wing tank has "trapped" fuel in it.
7. Flight manual and flight clearance restrictions for carriage and jettison of the store will be observed. As this is not an authorized operational configuration for the F-15, a copy of the AFSC Form 4839 is attached (Fig. 3.21) showing aircraft carriage and jettison limitations. Reference the "AEOL and Waiver" book in operations for the Flight Clearance. The TPS test limitations for this sortie are shown in Table 3-1. For instances where TPS has added no further restriction, flight clearance or flight manual limitations, whichever are most restrictive, will be used.

Table 3-1. TPS Test Limitations

PARAMETER	CRUISE (CR)	POWER APPROACH (PA)
Maximum Acceleration (g) --Symmetric --Unsymmetric	 +4/-0.5 +2.5/+0.5	 Flight Manual Flight Manual
Angle of Attack (AOA)	25 Units	25 Units
Airspeed	600 KCAS	Flight Manual
Mach	1.4M	Flight Manual
Roll Rate (p)	120°/SEC or 1/2 aileron input from trim	120°/SEC or 1/2 aileron input from trim
Roll (Ø change during rolls)	180°	±45°
Control Augmentation System	On > 500 KCAS	Not Applicable

Data band limits are ± 2,000 ft, ± 10 KCAS, ± 0.05M.

Table 3-2. Maneuver Abort Criteria and Procedures

MANEUVER	ABORT CRITERIA	ABORT PROCEDURE
Steady Heading Sideslip	- Any uncommanded increase in ß - Any decrease or reversal of aileron deflection (stick force) with increased rudder application - YAW rate tone comes on	- Smoothly return control surfaces to neutral - Reengage CAS - Apply opposite rudder (if required)
Short Period	- Oscillations increase in amplitude	- Reengage CAS - Dampen with appropriate pilot input
Dutch Roll	- Oscillations increase in amplitude - YAW rate tone comes on	- Reengage CAS - Dampen with appropriate pilot input
Rolls	- Excessive adverse/proverse yaw - Excessive slow/unpredicted roll rate - YAW rate tone comes on	- Terminate roll and decrease AOA - If airspeed is -- Slow: increase airspeed -- Fast: decrease airspeed
Man. Flight	- Unpredicted stick force or reversal	- Quickly neutralize or decrease g
Structural Integrity	- Unpredicted store vibration - Any compromise of store integrity - Excessive slow/unpredicted roll rate - Excessive pitch sensitivity	- Reestablish 1.0g - If airspeed is: -- Slow: increase airspeed -- Fast: decrease airspeed - Dampen oscillations with appropriate pilot input
Stall Investigation	- Classic indications of stall/approach to stall limit AOA or airspeed	- Decrease AOA and increase airspeed
Speed Soak	- Unusual noise or vibrations - Any compromise of store integrity	- Decrease airspeed and increase altitude

MISSION EVENTS: (Gradesheet, pg A.23)

1. Mission Preparation.

The student is responsible for the planning and flying of an efficient mission profile with special emphasis on moving efficiently from point to point and observing the appropriate limitations. The student should have developed and be thoroughly familiar with the mission data cards, including specific limitations for each event.

2. Briefing.

The IP will brief the general mission profile and specific test techniques. The student will brief jettison procedures, external tank failure to feed, mission limitations, maneuver abort criteria and procedures (Table 3-2), and F-15 asymmetric flying qualities as described in the flight manual, section 6.

3. Preflight/Ground Ops.

Check the AFTO Form 781 for proper fueling (approximately 15,940 ±500 lbs). Ensure the tank and pylon jettison cartridges are installed. Perform a flying qualities ground block and mark stick positions for in-flight reference. 3/4 stick deflection from ground neutral will be used in data point #2; however stick deflections during rolls will be 1/4 and 1/2 displacement from airborne neutral, and should not be marked on the ground. Run aileron trim full deflection left and right and note stick position and aileron deflections. Review the tank jettison procedures prior to takeoff. Note that there are no jettison controls available to the IP in the rear cockpit.

Make sure the fuel tank is loaded into the Armament Control Panel. In the event that the external wing tank must be jettisoned, the EMER JETT button is the quickest way to accomplish this. In addition, the WING TANK switch on the fuel control panel must be placed to "STOP TRANSFER" to ensure the tank will not feed. Finally, set the bingo bug to 3,500 lbs. This will provide sufficient fuel to accomplish the first touch and go and landing should the tank fail to transfer. Realize that at bingo the fuel guage "TOTAL LBS" window will show approximately 7,600 lbs; 3,500 lbs of internal fuel plus the 4,090 lbs of unused fuel in the wing tank.

4. Taxi.
Note the effects of an asymmetric load on the taxi characteristics and qualitatively evaluate controllability. Items to note include ease of tracking the centerline and acceleration/deceleration effects.

5. Takeoff.
Perform a military power takeoff in accordance with the flight manual recommended procedure, using the normal takeoff trim setting. Avoid abrupt pitch inputs and be prepared to counter wing dip at lift off. Note handling qualities effects during the takeoff roll, liftoff, and climbout.

6. Selected Data Points.
Data will be acquired at selected test points using the flight test techniques described above, as defined in MIL-HDBK-244, paragraph 6.2.1.7.6.2. These points have been selected to provide a maximum exposure to the CFP profile with the limited fuel available. Between points, note the speed stability during the acceleration to the next point. The pitch trim should not be changed during this evaluation, although the automatic trim feature of the flight control system may mask some of the effects of acceleration/decelerations and configuration changes.

a. Data Point #1 - 15,000 ft MSL, 350 KCAS. This is a typical CFP "heart-of-the-envelope" starting point. Perform a flying qualities full data set (CAS on and off) and a loads full data set to 80 % of the test limits. Complete the test point with a throttle chop.

b. Data Point #2 - 20,000 ft MSL, 200 KCAS. This is an investigation of aircraft flying qualities (MIL-STD-1797A) with an asymmetric store at high angle of attack in the CR configuration. Perform only with CAS on. While applying aileron trim to maintain wings level, slow the aircraft to the speed corresponding to full lateral trim opposite the store (cease trimming if 21 units AOA is reached prior to full lateral trim). Without further trimming, continue to slow the aircraft to increase the AOA in one unit increments until 25 units AOA or 3/4 lateral stick travel from ground neutral is reached. Use rudder to maintain the ball centered and ailerons to maintain the wings level throughout the maneuver. Note the sideslip angle, rudder required, and aileron required as the AOA is increased, and the F-15 Aileron Rudder Interconnect (ARI) effectiveness in this configuration.

c. Data Point #3 - 20,000 ft MSL, Airspeed as Required. This is an investigation of aircraft flying qualities in the PA configuration. It demonstrates the nature of the asymmetric stores landing problem and the potential effects of sideslip on approach speed and controllability.

(1) Establish the PA configuration, noting trim changes required. While applying aileron trim to maintain wings level, slow the aircraft to the speed corresponding to full lateral trim opposite the store (cease trimming if 21 units AOA is reached prior to full lateral trim). Note the airspeed for use in the touch and go evaluation, and the fuel weight.

(2) Perform a flying qualities full data set (CAS on and off), except for steady heading sideslips and maneuvering flight.

(3) Slow the aircraft to establish 25 units AOA with the CAS on. Make gentle turns (20 -30° bank). Note the cross-coupling (α trading with β) that occurs during turns.

(4) (Optional) Reestablish a 21 unit AOA simulated approach with approximately 700-800 ft/min descent rate with the CAS on. Pull the engine opposite the wing tank to idle, and perform a go-around with the heavy side engine in afterburner. Note the handling characteristics and the ARI effects during this maneuver. Ensure the aircraft is below 20,000 ft MSL to avoid Region II afterburner operation.

d. Data Point #4 - 30,000 ft, 0.9M. This is a typical build-up point for a CFP. Perform a flying qualities full data set (CAS on only, to save time and fuel) and a loads full data set to 100 percent of the test limits. Complete the test point with a throttle chop.

e. Data Point #5 - 520 KCAS and 1.3M (altitude will be approximately 30,000 ft MSL). This is a typical end point for a CFP. The objective is to hit the KCAS and Mach simultaneously. One technique to achieve this is to accelerate to the mach number a couple thousand feet above the anticipated altitude and then descend at constant mach until the KCAS increases to the desired airspeed. Open the air refueling door prior to this test point to prevent the wing tank from feeding. Perform a flying qualities full data set (due to TPS limits, perform with CAS on only) and a loads full data set to 100 percent of the test limits. At the completion of this point, accomplish a throttle chop and trim change with speed brake evaluation. Close the air refueling door prior to descending.

CAUTION

Descending faster than 10,000 fpm with the air refueling door open could collapse the wing tank.

7. Straight In Touch and Go.

Using the previously computed approach speed for 21 units AOA, perform a touch and go at Edwards AFB. The straight in will be flown at 18 units if the tank is partially full (more than 500 lbs has fed). Use rudder to keep the ball centered. Observe handling characteristics, sideslip angle, and flight control inputs required (review flight manual procedures for expected handling qualities with asymmetries during approach, landing, and rollout). These observations will be compared to landings once the tank has been fed. At the completion of this point start feeding the external tank.

CAUTION

Avoid large or abrupt pitch inputs. During the flare to landing ß increases approximately 2° for each 1° of α increase. Consequently, rapid α increases above 21 units can result in a large yaw rate developing just prior to touchdown.

8. (Optional) Speed Soak. (500 ft AGL min, lesser of 550 KCAS or 0.9M).
Duration is usually limited in this TPS sortie to the time it takes to feed the external wing tank.

9. Drag Characteristics Investigation Subsonic.
Accomplish after transferring the wing tank fuel. Repeat 6a, data point #1, 15,000 MSL, 350 KCAS. Perform a repeat of the flying qualities full data set (CAS on only, to save time and fuel) and the loads full data set to 100 percent of the test limits to compare tank empty flight characteristics with tank full flight characteristics. To save time and/or fuel, not all maneuvers need be repeated.

10. Drag Characteristics Investigation Transonic.
Perform a level acceleration at 20,000 ft. MSL from 0.9 Mach to 1.10 Mach to examine asymmetric drag effects without any fuel in the tank. Use rudder to keep the ball centered and note rudder available during the maneuver. Note the differences with the ARI inoperative (the ARI is inoperative when supersonic).

11. Straight-In Full Stop.
Fly a straight-in approach observing handling characteristics and flight control input changes from an asymmetrically loaded aircraft.

12. Debrief.
The student should be prepared to debrief the FTT's flown with respect to desired tolerances, as well as observations of the flying qualities and cross-coupling effects.

INSTRUMENTATION/DATA REDUCTION:
VTR, tape recorder, stopwatch, etc., as desired.

REPORT: (IAW "TPS Reports Requirements," Test Management Phase Planning Guide).

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SECTION I
INTRODUCTION

The Systems Test Phase Planning Guide is an aid to the student to assist in planning the systems phase test flights/evaluations at the USAF Test Pilot School (TPS). It provides the student up-to-date information regarding these missions.

This phase is an introduction to the fundamental theory, flight test techniques (FTTs), and test management considerations used to design, build and evaluate current systems. The flying and academic training are closely integrated and provide both practical and realistic learning experiences. During this phase, students will be exposed to a wide variety of aircraft and related systems, thereby broadening the test pilot/ navigator/engineer's base of experience. It will also provide an opportunity to tie together and apply flight test skills already learned in the previous phases into an overall systems evaluations of an aircraft.

The magnitude, complexity and importance of systems test can be better appreciated when we consider these tests include weapons, electronic countermeasures, communications, navigation, egress, environmental control, flight controls, fire control systems, engine, instrument and crew station analysis, plus support and test equipment for these systems. Systems testing not only includes evaluation of individual aircraft systems, but the integration of these systems into the airframe and with each other to maximize operational effectiveness. Systems testing is a major portion of all current aircraft flight test programs.

The one constant in systems testing is that new systems have improvements in technology for which there may not exist a "standard" test method or technique. The test team might be inclined to build a test approach based on how it was done on similar systems or simply test against contract specifications.

Rather than use this limited approach, the test pilot and flight test engineer/navigator (FTE/N) should approach systems testing by trying to answer the question: "What are the goals of this system and how well does the system meet these goals?" The expected performance for any system should include goals for operational suitability, reliability and maintainability and systems integration, in addition to measuring how well a given system meets its technical specification. This important phase of flight test places the greatest demands on the technical competence, ingenuity, aggressiveness and managerial skills of the test pilot and FTE/N. Remember, technical competence is directly related to how much time is devoted to researching a given system.

A test team must become an expert on the "nuts and bolts" of that system's operation as well as the operation of similar systems. The impact of any aircraft system on other aircraft systems (systems integration) must also be closely monitored.

Because the majority of all flight testing is directly related to systems test, graduates of the USAF TPS should expect to spend the majority of their flight test career in this area and should endeavor to develop the strongest foundation possible in order to contribute to this portion of the test environment.

FLYING:

The Systems Test Phase flying curriculum provides demonstration (demo) and practice of flight test techniques (FTTs) and profiles, data missions and qualitative evaluations (qual evals) of a wide variety of aircraft and their systems. The aircraft used in this phase are the F-15, F-16, NC-131H, T-38 plus guest qual aircraft selected to present various sensor and display systems unavailable in TPS aircraft. Students will be exposed to a wide variety of aircraft systems architectures, including those with modern, "glass," multi-function display cockpits and highly integrated avionics, as well as aircraft with older, partly-integrated or non-integrated avionics suites. Students will also operate a variety of airborne sensors and displays such as infrared optics, television optics, radar systems, and heads-up displays. Weapons delivery systems will be used with practice or captive ordinance when resources permit.

The flying in the Systems Test Phase will be the most enjoyable flying of the TPS curriculum! You will have an opportunity in the next 3 months to fly a greater variety of aircraft and a greater variation in mission profiles than you will ever be exposed to again. Enjoy it! Your greatest effort during this phase should be directed toward ensuring that you are prepared for each flight. If you are not fully prepared, take yourself off the flying schedule. Your learning during this phase, particularly in the flying area, will be directly related to the amount of effort you put into it.

GRADING:

Pilots will be numerically graded on the F-16 Systems Evaluation mission. FTEs will be graded on their performance as a test manager in the telemetry room during the F-16 Structures flight test technique (FTT) mission. FTN's will be graded during the FTN Systems Evaluation. Grading criteria are contained in the mission description for the applicable sortie in Section III.

REPORTS:

Systems phase missions may require informal reports such as Initial Flight Test Reports (AFSC Form 5314), letter reports or more formal Written and Oral reports. The type of report required for each mission is listed at the end of each mission description in Section III. Also, consult the *Test Management Phase Planning Guide,* "Reports Requirements" section for additional instructions for each report.

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SECTION II
OBJECTIVES AND LIMITATIONS

OBJECTIVES:

The desired learning outcomes of the Systems Test Phase flying curriculum are:

1. To ensure that the student test pilot and FTE/N has a working knowledge of techniques for test major aircraft avionics systems.

2. To increase the student test pilot/engineer's flight test capabilities by broadening his or her systems base of experience. Exposure to a wide variety of types of systems as well as a variety in sophistication of systems is desired.

3. To expose the student test pilot/engineer to the latest developments in the systems field and provide an insight into future systems and systems testing.

LIMITATIONS:

1. Systems testing may require the use of an airborne target. Follow test plan restrictions, or if using aircraft from other Major Commands or Services, the owning unit's safety regulations (whichever is the most restrictive).

2. Surface targets may also be used during systems testing. Refer to Air Force Flight Test Center (AFFTC) Regulation 55-2 for use of surface ranges at Edwards AFB. Follow local regulations at other locations.

3. Low level navigation routes may be used during systems testing. Refer to AFFTC Regulation 55-2 or local regulations as applicable.

4. Systems Qual Eval flights will be conducted under the broader Qual Eval programs described in the *Test Management Phase Planning Guide*. See that document for restrictions during Systems Qual Evals.

5. Additional limitations applicable to individual curriculum missions are addressed in the specific mission descriptions in Section III.

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SECTION III
SPECIFIC MISSION REQUIREMENTS

This section contains guidance for specific curriculum missions. Additional missions may be added as Systems Qual Eval flights.

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HUMAN FACTORS COCKPIT EVALUATION

REFERENCES:

1. MIL-STD-1472C, *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.*
2. MIL-STD-203G, *Military Standard, Cockpit Controls, Location and Actuation of, for Fixed Wing Aircraft.*
3. MIL-A-8806, *General Specification for Acoustical Noise Levels in Aircraft.*
4. MIL-STD-411E, *Military Standard, Aircrew Station Signals.*
5. AFGS 87240A, *Lighting Equipment, Airborne Interior and Exterior.*

PURPOSE:

1. To qualitatively evaluate the crew station of a specified aircraft for its primary mission.

2. To practice supporting recommendations and conclusions through the written word.

AIRCRAFT:

As assigned.

GENERAL:

1. The purpose of conducting a cockpit evaluation at TPS is to acquaint the student with the evaluation of human design requirements as related to aircraft testing. Because the cockpit is most often the focal point of the man-machine interface, it is the area which should normally receive maximum emphasis in human engineering design. Unfortunately, many individual cockpit items receive little to no emphasis concerning crewmember accommodation or compatibility. Not until all cockpit items are assembled into a mock-up or into an actual cockpit do many significant human engineering design deficiencies become identifiable. Thus, human factors flight test can be extremely important in determining the final design of the cockpit. However, correcting deficiencies this late in the development of an aircraft is extremely challenging since design changes during flight test can be prohibitively expensive, timeline constrained, or technically difficult to implement.

2. Regardless of an aircraft's performance and flying qualities potential, the aviator in the cockpit is the conduit through which its potential is processed into reality. Important variables which control this process are (1) the capabilities and limitations

of the aviator, and (2) the cockpit integration and design interface that link the crewmember and the aircraft to one another.

PREPARATION:

1. Flight manual study and discussion with pilots/engineers experienced with the aircraft are essential starting points for this exercise. Become familiar with the aircraft normal and emergency procedures, and choose an appropriate mission(s) to define the scope of your human factors evaluation. Plan to evaluate the crews' ability to perform the chosen mission. Also, establish "worse case" events such as degraded system operations and in-flight emergencies that may occur during a flight. The crewmembers ability to interface with the aircraft to adequately perform the mission or return the aircraft safely under these scenarios should not be overlooked.

2. Subjective opinion will play a dominant role during human factors evaluations. However, one pilot's opinion is not necessarily the truth. Before you take a stand, consult with others. Don't be the only one in the world that has your particular opinion (unless your absolutely right). History is full of instances where the design engineer has had to flip flop on a design change because he listened to only one pilot or to the loudest, most dominant pilot, instead of seeking a consensus.

THE EVALUATION:

1. General Guidelines.

a. Go through normal and emergency procedures in full flight gear with all team members. The entire crew station should be evaluated. Concentrate on human factors concepts such as tactile cues, functionality, utility, correct operative sense, and feedback.

b. Narrow your focus as problem areas or outstanding features are encountered. Use your crewmember expert to help explore these areas in depth.

c. Consider corrective action that could be done to correct problem areas. However, don't ignore the problem if the solution is not obvious. Let the design engineer come up with the actual solution. Your team should only recommend possible solutions.

d. Prioritize your deficiencies. Realistically all will not be corrected. Determine which items need to be corrected now, which can wait, and which can the aircrew live with.

e. Report on the most critical items. A complete report would go beyond the boundaries set for this exercise. Stay within the limits!

2. Areas to evaluate are listed in this section's attachment. Additional material that might be helpful in your evaluation is presented below.

3. Anthropometry.

a. Body sizes vary considerably. Detail aircraft specifications generally require cockpits to accommodate 5th through 95th percentile sized aviators for older airplane cockpits and crew stations (prior to 1970) and 3rd through 98th percentile in newer cockpits (since 1970). One might assumed that if their body measurements, such as height and weight are 50th percentile (average) that all his dimensions will be 50th percentile; this is not true. Uniformity in body dimensions is very rare. Only by knowing your own various percentile ranks can you make relative judgments as to the overall anthropometric accommodation of a particular cockpit.

b. If measurements are taken during the evaluation, insure your reference point is valid (reproducible). Two common reference points are the design eye point (DEP) and the seat reference point (SRP). The DEP is the most commonly referred to reference point. The DEP is the point in space where the pilot's eyes should be able to see all displays and have adequate exterior vision. To physically locate the DEP, two other reference points need to be defined.

DEFINITION: Seat Reference Point (SRP) is a centerline intersection of the seat back tangent line and the seat surface.

DEFINITION: Neutral Seat Reference Point (NSRP) is the location of the SRP when the seat is adjusted to the midpoint of vertical adjustment.

The DEP is then defined as the point in space located at the sitting eye height dimension of the 50th percentile aviator measured vertically above the NSRP and 13 inches measured horizontally forward of the seat back tangent line.

c. Adjusting the eyes to the DEP before making anthropometric evaluations is more critical now than ever with the increasing emphasis on heads-up displays and other optical devices which require strict adherence to line-of-sight criterion. Realize, however, the DEP may not be where most crewmembers are comfortable sitting for a specific mission. For instance, a fighter pilot tends to sit as high as possible to increase visual lookout. Also realize all postural measurements are subject to wide variance due to fatigue and individual differences in regard to time spent in any one position. Thus, these non-DEP sitting positions are just as important as the DEP itself. In the case where the DEP and normal sitting positions do differ, data from the DEP would be used for contractor compliance. The data from the normal sitting positions would determine mission suitability. Finally, measurements by themselves will not tell your story. They just make nice charts. Measurements should be used when comparisons are needed or when good or bad characteristics of a cockpit layout are documented .

4. Controls Design. Controls must meet various design criteria to be satisfactory. These criteria include, but are not limited to:

a. Proper Location. The criticality of control functions establishes its priority of location within a crew station. The most important controls should be the easiest to reach and manipulate. For example, an emergency stores jettison button ought to be placed where the crewmember can use it quickly and easily. Additionally, controls should never be located such that the hand or arm manipulating the control is in the line of sight required to see its effect on a display or to see its setting.

b. Natural Direction of Motion Relationships. Actuating controls like a toggle switches forward, outboard, or up should turn systems on. Turning rotary controls clockwise should increase system output. Standard direction of motion relationships should be adhered to in all control actuations. Additionally, controls should correspond to the display being adjusted. In other words, the left most knob of a control set should effect the left most display controlled by that set.

c. Shape Coding. Controls which may require manipulation without direct visual monitoring should feel different to the touch if they are near controls of dissimilar systems. Hands on Throttle and Stick systems are prime examples of shape coding.

d. Inadvertent Actuation. Controls which can be activated incorrectly should be designed to prevent such activation either by electronic circuitry or mechanical guards. Proper safeguards should be in place to prevent inadvertent actuation of controls which might be caused by clothing items or personal equipment, such as survival vests, flotation devices, or checklists. Controls that you may want guarded include: fuel shutoff, fire extinguishers, jettison buttons, sensitive emitters, etc.

e. Actuation Feedback. Controls should have proper tactile cues or visual cues relative to actuation. One should "feel" or "see" the click of a toggle switch or push button without necessarily hearing it. This was identified as a problem for the touch sensitive Multi-Function Displays during the advanced tactical fighter (ATF) development. Controls should have the proper resistance and range of displacement as specified in Reference 1.

5. Displays Design. The content and format of displays should be limited to essential information and should not require mental computation or translation to be usable.

There must be provisions within displays to alert an operator to display failure if the failure is not immediately obvious. The location and arrangement of displays shall be assigned priority relative to importance for normal and emergency operations. Other criteria, such as viewing distances and grouping should also be considered.

6. Labeling. Items of equipment which must be identified, manipulated, or located should be adequately labeled to permit efficient human performance. Blueprints which illustrate control panels often portray a straight-on-view. However, when the control panel is installed in a cockpit, it is quite frequently offset from direct line of sight of the crewmember using the panel. The three dimensional line-of-sight offset often results in labels (numbers, ON/OFF legends, or other nomenclature) being obscured by the very controls to which they are related. It is important to evaluate labeling legibility in low ambient light conditions as well as in daylight. If an items must be labeled for normal daylight use, it should be legible at night. Night Vision Goggle (NVG) capable aircraft should have the labelling evaluated for both NVG and normal night lighting modes.

7. Environment. A complete evaluation of the environment is not practical for this exercise. However, different areas to evaluate are presented for reference.

a. Heating, ventilation, and air conditioning should be evaluated if a complete human factors evaluation is to be conducted. Hand-held instruments can be used as well as fixed thermocouples to measure the temperature as well as the relative humidity. Specifications generally require an Environmental Control System (ECS) to maintain between 60 and 80 degrees F ambient temperature in a crew station and 10 degrees F maximum differential between head and foot level.

b. Interior ambient air should be sampled throughout the flight regime or mission profile of any aircraft. Carbon monoxide or other toxic fumes are potential hazards, particularly during operations such as taxiing downwind, gun or rocket firing, and during refuelling operations when directly behind a tanker.

c. Noise is the most serious and persistent problem among those working in and around aircraft. The maximum allowable noise limits relative to aircraft type are described in Reference 3. It should be recognized that high noise levels of less intensity than those specified as physically damaging to hearing can produce human fatigue and degrade an aviator's effectiveness. Also consider intermittent impulse noise problems, guns, bombs, rockets, infrequent hydraulic actuators, etc.

d. Various levels of instrumentation are available in evaluating the acoustical environment ranging from small pocket sized decibel meters to sophisticated type recording devices that record noise samples which can be analyzed in detail for various frequency bands. When conducting an interior noise survey, exercise any equipment which may increase the acoustic level, such as air conditioning or defogging systems, heater blowers and air vents.

8. Lighting.

a. Often, there is little emphasis on the evaluation of a cockpit's illumination system. Typically, during night flights, general lighting observations are made by crewmen who are busy flying or conducting other airborne tasks, thereby overlooking possible lighting deficiencies. If serious deficiencies are suspected, push the test team to formally evaluate the aircraft's lighting system. For this exercise, a complete lighting evaluation may not be possible since the aircraft will more than likely not be blacked out nor be in a dark hanger.

b. In a lighting evaluation, all lighting schemes should be evaluated. Check the lighting at all intensities and under different lighting conditions. Probably the worst case scenario for lighting is at dusk flying towards the west or at dawn flying towards the east. Listed below are some helpful hints for doing a good lighting evaluation.

(1) Do the evaluation in appropriate flight gear.

(2) Cover the canopy with an opaque cover to prevent ambient light from entering. This allows you to conduct the evaluation day or night.

(4) Accomplish the test at the DEP *and* where you normally fly.

(5) Make sure your eyes are adjusted to the dark (10-15 minutes).

(6) Evaluate all lighting modes (normal, NVG, emergency, etc.)

(7) Look for brightness imbalances, glare, and reflections that might effect a crewmember.

(8) Use a tape recorder. Writing usually requires light and this light might effect your night vision.

(9) Evaluate the legibility of labels, visibility of controls, etc. For example, blue lit labels may be difficult to focus on and to read if the lettering is too small.

(10) Test at dusk or dawn at various sun angles.

LIMITATIONS:

1. Three hours cockpit time maximum.

2. The ground evaluation will be conducted under daylight conditions using ground electrical power.

3. Ensure that all ejection seat and canopy jettison safety pins are in place prior to entering cockpit. *Leave the pins in place throughout the evaluation.*

4. *DO NOT* evaluate the emergency ground egress procedures. Do not evaluate nonstandard or special test instrumentation, missing items, or old worn out labeling. Do not evaluate how well the various systems function.

5. Use normal everyday flight gear for this evaluation.

ADMINISTRATION:

1. Preparation.

a. The student will accomplish a quick review the Dash 1(if available), concentrating on sections two and three. A minimum of two days prior, coordinate with your POC: ensure the aircraft has been scheduled for the cockpit evaluation; ensure ground power has been requested; ensure an experienced aircrew will be at the aircraft; obtain a flight manual and aircrew checklists (if needed); and develop a plan of action for your 3 hours at the aircraft. If photographic support will be available, coordinate the meeting location for the photographer and your team.

b. Anthropometry. You should have already completed anthropometric measurements earlier in your school year. Of those measurements you received, some of the more important dimensions relative to aircrew station design are: Total sitting height, sitting eye height, sitting shoulder height, bideltoid breadth (shoulder width), functional reach, fingertip reach and buttocks-to-knee length.

c. Discussions with pilots experienced in the mission being evaluated is very important part of the preparation for this exercise. You may have little or no operational experience in the design mission of your aircraft, so take this opportunity to learn the aircraft's mission requirements from these crewmembers. For this evaluation, you may use comments from experienced crewmembers to support your conclusions.

2. Ground Evaluation.

a. For this ground evaluation, concentrate on normal and emergency procedures under daylight conditions. The MIL-STDs listed as references should only be used as a guideline for good human engineering design practice and terminology. For this exercise, there is no desire to grade the cockpit against the military standards.

b. Actuate (or simulate actuating) switches, dials, etc while going through normal and emergency checklists. Use crew concept with your team mates, if applicable. Concentrate on those areas listed in this section's appendix.

c. Use a protractor and tape measure to quantify anthropometric and field of view deficiencies. Remember, do not measure for measurement sake. Measure to document deficiencies, outstanding features, or comparisons.

d. Discuss observations among the team.

3. Post Ground Evaluation.

a. Consolidate your notes, list the deficiencies you discovered with the problems they would cause, prioritize the deficiencies. Talk over your observations with someone who is familiar with the aircraft/mission to see if you are on the right track. These actions will help you when you write your conclusions and recommendations.

b. Coordinate with the photographer, the date when pictures will be ready.

INSTRUMENTATION:

1. Tape recorder (if desired).

2. Tape measure.

3. Protractor with string.

4. Data cards (note pad).

REPORT:

1. This is Pass/Fail Technical Letter Report.

2. Prepare IAW "TPS Reports Requirements," *Test Management Phase Planning Guide.*

3. Use attachment 1 as a template.

4. Do not go over your page limit

HUMAN FACTORS COCKPIT EVALUATION

OF THE

XXXX

{NAME}
CAPTAIN, USAF
PROJECT LEADER
USAF TPS CLASS XXX

DECEMBER 1994

MEMORANDUM FOR USAF TPS/EDS 19 Dec 94

FROM: USAF TPS/EDx (Names of group members)

SUBJECT: USAF TPS-TLR-XXX, Human Factors Cockpit Evaluation of the XX-XX

1. INTRODUCTION

a. Background

- Describe this report as a limited human factors cockpit evaluation of the XX-XX aircraft

- State location, dates, and scope of test:
  Location = ____________________
  Date = ________________________
  Ground Eval-Power Off = ______Hrs
  Ground Eval-Power On = _______HrsFlights (# sorties/hrs) = _______
  Test Conditions = ______________
  (Night/Night with FLIR/Day/Etc)

- Describe the aircraft mission(s) that are pertinent to your evaluation. Consider:
  -- Gnd Ops
  -- Take-Off/Landing
  -- Navigation (Deployment/Redeployment/Instrument Flight)
  -- Specialized Mission (Air to Air, Air to Gnd, Bomb, etc)

b. Test Item Description

- Along with a brief general description of the aircraft, include a description of aircraft systems. Describe briefly all avionics systems evaluated. Don't regurgitate the Dash-1! List these systems and other aircraft systems in Table 1.

c. Test Objectives

- Short and concise.

- Limited in scope so TLR will answer the objectives.

2. TEST AND EVALUATION: Evaluate and discuss the following areas if applicable for your aircraft.

a. DISPLAYS

(1) VISUAL DISPLAYS: Describe the primary displays (Table 3).
HUD
MFD
Engine Instrument
ADI
NAV display
Comm displays

- How well do the displays integrate to perform a mission (IMC, low level, bombing, airdrop, etc)?

- How do you know the status of critical safety items? (Weapon Arming, being off required parameters, emergency situations, etc)

- Display measurements: Tabulate angles and distances from design eye to center of each Critical/Primary Display. Make conclusions on positions.

- Display Illumination and Color: Type, color, and balance.
  -- Control separation between background video & symbology
  -- Rheostat Range
  -- Adequacy
  -- NVG compatible
  -- Day/Dusk/Night suitability

- Display grouping logic - mission/emergency, etc.

- Conclusion & Recommendation considerations:
  -- Do displays provide adequate information for IFE/day/night/IMC/combat conditions?
  -- Can they be better - how?
  -- Comment on effects of workload/performance/mission accomplishment & survival.
  -- What errors can you expect from deficiencies noted?

(2) AURAL ANNUNCIATORS/CONTROLS

- Voice
    -- Frequency (Hz)
    -- Synthetic voice (Male or Female)
        --- How big is the vocabulary
    -- Problems with normal noise attenuation devices?

- Number and types of Different Cues
    -- Growls, beeps,squeaks, volume changes, etc
    -- Volume control (Confusion?)

- Stereo Cueing

- Radios
    -- Number/Priority
    -- How do you know who's talking/who you are talking too? (i.e. which radio)
    -- How well do you know what frequency your on?

- Intercom system
    -- Ease of use
    -- Fidelity/separation in volume controls
    -- Failure modes
    -- TEMPEST secure?

- Conclusion and Recommendation considerations:
    -- Do displays provide adequate information for IFE/day/night/IMC/combat conditions?
    -- Can they be better? How?
    -- Comment on effects of workload/performance/mission accomplishment & survival.
    -- What errors can you expect from deficiencies noted?

(3) MISCELLANEOUS ANNUNCIATORS

- Pedal Shaker
    -- When does it initiate
    -- What if feet are not on pedals?

- Seat Kicker

- Head Knocker (A-7)

- Conclusion and Recommendation considerations:

-- Do displays provide adequate information for IFE/day/night/IMC/combat conditions?
-- Can they be better? How?
-- Comment on effects of workload/performance/mission accomplishment & survival.
-- What errors can you expect from deficiencies noted?

b. CONTROLS

- Describe the controls and actuating devices evaluated
  -- Side Stick
  -- Center Stick (Which is better? Why?
  -- Throttle
  -- HOTAS - Picture/Diagram with function from -1 or -34
  -- Flaps (Standard shape/location?)
  -- Gear (Standard shape/location?)
  -- Speed brake (Standard shape/location?)
  -- NAV/COMM Controls
  -- Up Front Controls
  -- Master Controller
  -- Master Fire Control/Navigation Panel..etc
  -- AAR Door
  -- Fuel Switches
  -- Boost Pump
  -- All Emergency Switches (EPU, Fuel Master, Gen etc)
  -- Unusual Activation
    --- Voice
    --- Head Steered
    --- Automatic Control
    --- Light
    --- RF, etc

- Is there quick access to frequently changed settings (radios, altimeters, courses, headings, etc)?

- Are menus well organized and logical from an aircrew perspective?

- Are there menu driven items that should have their own dedicated controller?

- Are there dedicated control heads that could be integrated into the menu driven integrated system?

- Control Measurements
  -- Center of Seat to each Control (Angle and Distance in cm)

- Conclusion and Recommendation considerations:
    -- Do controls provide adequate information during IFE/day/night/IMC/combat conditions?
    -- Can they be better? How?
    -- Comment on effects on workload/performance/mission accomplishment & survival.
    -- What errors can you expect from deficiencies noted?

c. ANTHROPOMETRICS/BIO-MECHANICS

- Cockpit Dimensions (CM)(Tables 3 & 4)
    -- Rail to rail
    -- Seat pan to closed canopy (seat full up and down)
    -- Design Eye Box
    -- Rudder pedals (leading edge of seat to full aft & fwd)
    -- Distance to ejection handles (seat center to handles)
    -- Distance and direction to control stick-full forward,AFT
    -- Distance and direction to throttle Cut-off to MAX
    -- Distance from seat center to major displays MFD/HUD/ADI/Eng Controls/Com/Nav, etc
    -- Distance to gear handle, hook, etc
    -- Distances & direction to all emergency switches
    -- Other as you deem appropriate (Mission essential)

- Evaluate locations versus reachability.

- Bio Mechanics
    -- Estimate by trial/gages if possible. Force required to activate following controls. (Too Hard & Too Little?)

Rudder Pedals
Stick Pressures
Gear Lever
Hook
Any other difficult switches
Any other critical controls

- Conclusion and Recommendation considerations:
    -- Does the cockpit layout provide for an adequate environment during IFE/day/night/IMC/combat conditions?
    -- Can they be better? How?
    -- Comment on workload/performance/mission accomplishment/survival effects.
    -- What errors can you expect from deficiencies noted?

d. AVIONICS INTEGRATION/AUTOMATION

- Describe which systems are integrated.

- Which systems are not integrated but could be?

- Are their integrated systems that should be stand alone?

- Diagram of who talks to whom (not detailed, just important mission effects, -34 diagram okay).

- Conclusion and Recommendation considerations:
  - Does the system integration provide adequate information during IFE/day/night/IMC/combat conditions
  - Can they be better? How?
  - Comment on effects on workload/performance/mission accomplishment/situational awareness/survival.
  - What errors can you expect from deficiencies noted?

e. LIFE SUPPORT

- Ejection Seat
  - Type of seat
  - Capabilities 0/0, 0/50, etc
  - Preflight complexity
  - Activation controls-face curtain (F-4)/T-38 handgrips/F-16 pull
  - Special Features (i.e. pop up pitot tubes - AFTI)
  - Types of pilot/seat connection-no. & type
  - Describe kit-harness

- Egress
  - How difficult is Ground Egress?

- Oxygen Regulator
  - Standard Connection to Pilot O_2 Hose?

- OBOGG's?

- G-Suit
  - Left or right connection
  - Standard connection
  - How difficult to get off - one hand, no hands
  - G-Suit Pressurization Schedule (Hi flow/low flow)

- Seat Kit
  - -- How big - standard or smaller/soft or hard cover

- Survival Equipment/Life Rafts
  - -- Location/ease of access.
  - -- Sufficiency

- Fire fighting capability
  - -- Self contained fire suppression for engine starts?
  - -- Location and type of on board fire extinguishers.
  - -- Location and effectiveness of smoke masks.

- Positive Pressure CW Protection?
  - -- How Much
  - -- Auto, etc

- Specialized Equipment - describe as appropriate
  - -- OBOGGS
  - -- SEWARS
  - -- AWARS

-Conclusion and Recommendation considerations:
  - -- Comment on whether the equipment is standardized.
  - -- Comment on workload, mission accomplishment and survival.

f. PHYSIOLOGICAL COMFORT

- General
  - -- Environmental Control - Heat/Air Conditioner/Humidity
  - -- Seat Comfort
  - -- Noise Level/Control
  - -- Excrement Provisions
  - -- Rest Quarters
  - -- Eating Resources
    Food & Water
    Microwave
  - -- Cockpit Pressurization - Positive/Negative

- Conclusion & Recommendation considerations:
  - -- Cockpit too big? too small?
  - -- Any distances inappropriate?
  - -- Any controls too difficult/too easy to actuate
  - -- Any physiological square corners
  - -- Comment on effects on workload

-- Comment on effects on performance
-- Comment on effects on mission accomplishment & survival

g. ERROR ANALYSIS

- Active Errors (Performance Errors)
  -- Normal Operations
  -- Emergencies/Contingency Operations
  -- Combat Operations
  -- Night Operations

- Misinterpretation/Judgement Errors
  -- Normal Operations
  -- IFE (Telelight Panel etc)
  -- Loose Situational Awareness
    --- Misprioritization
    --- Spacial Disorientation

3. CONCLUSIONS AND RECOMMENDATIONS

- PUT IT ALL TOGETHER! (Recap R&C, no new information)
  -- Standardization
  -- Workload
  -- Physiology
  -- Mission Accomplishment (Performance)
  -- Situational Awareness
  -- Intuitiveness
  -- Training
  -- Survival

NAME, Capt, USAF
Project Leader, Class XXX

Attachments:
1. Table 1, XX-XX Systems
2. Table 2, XX-XX Display Characteristics
3. Table 3, Anthropometric Measurements
4. Table 4, Cockpit Control Measurements

5. List of Photos
6. References

REFERENCES

- DASH 1

- MIL STANDARDS

- DASH 1 CHECKLIST

- DASH 34 (if used)

- USAF TPS Human Factors FTT Slides

- USAF TPS Cockpit Evaluation Guide

- USAF TPS Human Factor Class Slides

LIST OF PHOTOS

Table 1

XX-XX Systems

NAVIGATION	YES	NO
Attitude Indicator		
TACAN		
ILS		
VOR		
INS		
GPS		
LORAN		
MLS		
ADF		
Radar Altimeter		
Pneumatic Altimeter		
HSI		
HSD		
GCAS/GPWS		
Digital Data Base		
Moving Map		
Color Map		
StarTracker		

MISSION		
HOTAS		
Radar		
RWR		
IR		
Low Light TV		
Laser Illum		
Laser Designator		
NVG Compatible		
TISL		
Center Stick		
Side Stick		
Yoke		
Aerial Refueling		
AAM		
AGM		
Gun (type)		
Particle Beam		
Conventional Bombs		
Uncon. Bombs (type)		
CCIP		
Head Targeting		
Other (specify)		

LIFE SUPPORT	YES	NO
Ejection Seat		
G-Suit		
Combat Edge		
OBOGGS		
SEWARS		
C-W Gear		
Positive Pressure		
Seat Kit		
Quick-Don Mask		
Life Rafts		
Survival Equip (Specify)		

COMMUNICATIONS		
UHF		
VHF		
FM		
HF		
DMDG		
IDM		
ATM		
ATHS		
Secure (specify)		
Have Quick 1		
Have Quick 2		
SatCom		
Other (specify)		

DISPLAYS		
Color		
Analog		
Digital		
HUD		
MFD		
HMD		

AUTOMATION	YES	NO
Auto Take Off		
Autopilot		
Pitch		
Roll		
Yaw		
Auto Throttle		
Auto Land		
Waypoint Sequence		
Turn Short		
Fly over		
Inflight Route Planning		
Data Transfer Module		
Auto ECM		
Auto Chaff/Flare		
Positon Updates		
Integration (specify)		

OTHER SYSTEMS		

Table 2

XX-XX Front Cockpit Visual Display Characteristics.

FRONT COCKPIT	TYPE	DIST	ANGLE	DIM	COLOR	ADJUST
HUD						
MFD 1						
MFD 2						
MFD 3						
ENGINE INST.						
ADI						
COMM (UFC)						
MASTER CAUTION						
TELELIGHT PANEL						
WEAPONS STATUS						
GUN STATUS						
TERRAIN FOLLOW-ING STATUS						
AUXILIARY INSTRU-MENTS						

Note: The upper number represents the angular distance from the design eye, with the L or R indicating left or right. The lower number indicates the angular depression of the display.

Table 3

Tester Anthropometric Measurements

DIMENSION	MEASUREMENT	PERCENTILE
Weight		
Stature		
Hip Breadth		
Crotch Height		
Eye Height		
Sitting Height		
Shoulder-Elbow Length		
Elbow Wrist Length		
Thumb Tip Reach		
Gender- Male/Female		
Note: Weight is in pounds, and lengths are in centimeters		

Table 4

XX-XX Cockpit Control Measurements

	Front Cockpit/ Left Seat		Rear Cockpit/ Right Seat	
Control	Distance[1] (inches)	Angle[2,3] (degrees)	Distance[1] (inches)	Angle[2,3] (degrees)
Stick				
Throttle (IDLE)				
Gear Handle				
Hook Switch				
Flaps				
Rudder Ped Adj				
JFS Handle				
Canopy Handle				
Oxygen Reg				
Engine Start				
Side Sticks				
Alt Gear Handle				
Canopy Jettison				
Stores Jettison Normal Emergency				

[1] Distance measured from the seat reference point (SRP) defined as the intersection of the seat back and seat pan at the centerline of the seat with the seat in the full down position.
[2] Angle measured from a vertical plane running through the centerline of the seat to the control, with the vertex at the SRP.
[3] Negative angles indicate items to the left of centerline as seated in the aircraft.

INTEGRATED SYSTEMS EVALUATIONS
(PILOT, FTE/N)

REFERENCES:
1. Aircraft Flight Manual.
2. *Systems Phase Textbook,* "Navigation Systems," Chapter 2.
3. *Systems Phase Textbook,* "Human Factors," Chapter 3.
4. *Systems Phase Textbook,* "Radar," Chapter 4.
5. *Systems Phase Textbook,* "Electro-Optics", Chapter 5.
6. *Systems Phase Textbook,* "Avionics Integration", Chapter 7.
7. USAFTPS OI 51-9, *Qualitative Evaluation Program.*
8. "ASTTA Demo/Data Sortie Descriptions," this manual.

PURPOSE:
During certain qual evals flown during the Systems Phase, students will be required to evaluate the avionics systems onboard rather than the aircraft's performance and flying qualities. The flight profile outlined in this guide provides a framework for doing such a systems qualitative evaluation. This is also the framework for the FTN Systems Evaluation checkride.

AIRCRAFT:
Systems qualitative evaluation aircraft (varied).

OBJECTIVE:
The primary objective of this flight is to evaluate as many of the avionics systems onboard the aircraft as possible in one flight. Depending upon the aircraft being flown, it may be impossible to thoroughly evaluate all the systems. In this case, the student should pick one or two items to concentrate on but still qualitatively evaluate basic operations of the others.

LIMITATIONS:
1. All flight manual limits/restrictions (as modified by USAFTPS Test Management Phase Planning Guide) will be strictly adhered.

2. Ground training in the aircraft will be completed IAW USAFTPS OI 51-9.

3. All navigation legs will normally be flown at or above 1,000 ft AGL. Descent down to 500 ft AGL is authorized for short periods to check navigation system position

accuracy, update navigation systems, or if it highlights system operation or limitations.

4. Maximum dive angle for simulated weapon deliveries is 45°. Minimum recovery altitude for simulated dive attacks are (may be adjusted higher by owning command or instructor pilot):

PLANNED DIVE ANGLE	MIN ALT (AGL)
0 - 14°	500 ft
15 - 24°	1,000 ft
25 - 45°	1,500 ft

5. Air-to-air radar tests will be limited to a minimum altitude of 1,000 ft AGL for the test aircraft and 500 ft AGL for the target. Formation flying will be conducted in accordance with TPS directives. Aircraft will maintain at least 1,000 ft vertical separation during intercepts within 10 NM until visual contact. There will be no head-on (>135 heading crossing angle) co-altitude setups.

6. Applicable portions of the air-to-air and air-to-ground rules of engagement, as specified in AFMCR 55-7, will be briefed prior to each mission.

MISSION EVENTS:

1. Mission Preparation.

a. In order to prepare a profile for the flight, the student must be familiar with what systems are on the aircraft. Review the available avionics systems by reading the Flight Manual, talking to anyone who has previous experience with the aircraft and/or getting a briefing by the aircrew. The instructors in the Systems Branch will be able to provide basic guidance.

b. Once you are generally familiar with what systems are available on the aircraft you will be flying, you should decide which systems you plan to concentrate on during the evaluation. Develop a sequence of tests to do functional evaluations of as many systems as possible, but plan to concentrate on the major weapon system during flight. To aid you in structuring the flight, a set of generic mission cards are provided at the end of this FTT. These mission cards provide suggested evaluations that are appropriate for each phase of the flight.

c. In order to make this type of evaluation as meaningful as possible, ground training is essential. A ground training session with someone familiar with operating the specific equipment on the aircraft will be arranged IAW USAFTPS OI 51-9. This will normally be one of the aircrew members that brings the aircraft to Edwards for the evaluation, and a one or two hour training session will be scheduled.

2. Cockpit Fam/Eval.
Prior to flying, a cockpit familiarization/evaluation should be conducted with someone familiar with the aircraft systems IAW USAFTPS OI 51-9. In addition to providing a chance to get familiar with switchology, time spent in the cockpit on the ground should be used for evaluation of the avionics systems as well, if electrical power and cooling air are available. The following list of items provides suggested areas to investigate.

a. Human factors:

(1) Is the general cockpit layout logical?

(2) Are there switches/circuit breakers that are difficult to reach? How often are they needed?

(3) Can all labels be read easily? How about at night?

(4) Are switches easily distinguishable? Are any switches guarded? Is the guard effective? Can anything on the consoles be turned off inadvertently by route books/approach plates/a misplaced hand?

(5) Is there enough room to store in-flight pubs/charts/helmet bags/the maintenance forms?

(6) Are there hand holds for maneuvering? How about when the canopy is closed?

(7) If there are keyboards for data entry, can you feel when a key has been depressed? Is there a way to orient your fingers so you can use it by feel (bumps, raised keys, etc)?

b. Systems Operations:

(1) HUD

(a) Can the symbology be seen easily in the sunlight?

(b) Does the designed eye position allow adequate head motion? Is this a comfortable sitting height for seeing over the canopy rails and the aircraft nose?

(c) Are the controls easy to use?

(2) Displays

(a) Are any electronic displays (radar scopes, multi-purpose displays, up-front controls) readable? What type display are they; CRT, LCD, etc.?

(b) Are they protected from glare with a hood, glare shield, anti-reflective coating?

(c) How do the brightness/contrast controls work?

(d) Are multi-function displays programmable? How easy is it?

(3) Communications equipment

(a) Is it easy to turn on/off?

(b) If there are preset channels, are they easy to program? Can you tell what frequency is in each channel? How do you know whether you've selected preset or manual frequencies?

(c) Where is the transmit switch?

(4) Navigation equipment (TACAN, GPS, INS, OMEGA, etc.)

(a) Is it easy to turn on/off?

(b) Do an INS alignment.

(c) If it can be used for position updating, how easy is it to program?

(d) How easy is it to tell the machine its present position?

(e) How long does it take?

(f) Can you monitor the alignment status?

(g) Can you interrupt the alignment for taxi?

(h) How do you program steerpoints for a navigation route? Can you identify points as targets? How do you set up offset points? Do these points integrate with other displays such as moving maps, the radar, or the HUD via special symbology, pre-placement of cursors, etc? Are these symbols readily distinguishable from the other symbology on the displays?

(5) Sensors (Radar, IR, AAI, ECM, RWR, etc.)

(a) Are the controls easy to reach?

(b) Are switches easily identifiable by feel/position?

(c) Are switches marked so that you can tell which marking goes with which switch?

(d) Is the main ON/OFF switch protected so it can't be turned off unintentionally?

(e) How operator intensive are the bit checks?

3. <u>Briefing</u>.

The general mission briefing, to include formation responsibilities if applicable, will be done by the instructor pilot/aircraft commander. The student will brief the specific test items for the mission. If a dedicated target aircraft is used, the briefing should include specific conditions for the target. Using air-to-air TACAN and Mode 1 IFF codes will aid with target radar identification.

4. Preflight.

If any systems could not be evaluated during the cockpit fam/eval session, try to complete this task during engine start/taxi. If the aircraft has a quick reaction (scramble) mission, you may want to exercise this mode of system turn-on/BIT check if not previously done. Remember that doing a quick INS alignment will normally give degraded operation which will not only show up in navigation capability but may also affect any doppler aided radar modes as well. Regardless of what scenario is used for system turn-on (normal or quick reaction) attention should be given to what slows down the start-to-takeoff sequence the most; getting the airframe ready for flight or the systems.

5. Dedicated Air-to-Air Evaluation.

a. Takeoff and climbout. If a dedicated target aircraft is available for an air-to-air systems evaluation, do a radar trail type of departure (15 to 20 second spacing). Note how the radar performs in the low altitude, low closing velocity (V_c) region while doing a radar trail departure. Evaluate this capability both while locked-on and in the search modes. Once established in the climb, lock-on to the target and look at the cues in the radar display and the HUD. Use this time to get familiar with the symbology before moving into more dynamic situations. This is also a good time to do a weapons checks; i.e., look at missile boresights (AIM-9, AGM-65, etc.), intercept steering cues, gunsight symbology, and missile launch switchology. This is also a good time to practice doing automatic acquisition lock-ons to get familiar with switchology.

b. Plan to work along Cords Road for all radar tests. If this isn't available, offset 5-8 NM to the north. A line between the north edge of Cal City to the Three Sisters works well. Use this part of the flight to evaluate the search mode capabilities of the radar (blip scans), maximum lock-on range and tracking maneuvering targets. Set up the tests to see both good and bad points in the system; look-up versus look-down, high altitude versus low, opening and closing velocity, maneuvering and non-maneuvering test aircraft, etc. Use the instructor's experience with the system to develop operationally representative set-ups. Other air-to-air systems, if available, should be integrated into the evaluation, such as IFF interrogators and optical identification systems. Depending upon the endurance capability of the test aircraft, a time or fuel limit will be needed for the air-to-air eval if air-to-ground systems will also be evaluated on the same flight. This will normally mean that the target aircraft will be released before it reaches BINGO fuel.

6. Navigation/Air-to-Ground Systems Evaluation.

a. Plan to do this evaluation along the Blue Low Level Route. This route is approximately 27 minutes long at 420 knots ground speed and has points that can be used for checking INS accuracy, doing simulated visual bombing attacks, and simulated radar/E-O system attacks. The terrain varies from flat to mountainous. If the flight will only involve air-to-ground systems, a longer low level can be flown by using the Blue Route with the Black Extension. This will add another 10 minutes to the flight. The low level route should be scheduled through TPS scheduling, or Current Ops on the day of the flight. Coordinate with SPORT before you step to be sure they received the request. If multiple bombing attacks are planned, book the low level for 20-30 minutes longer than it would take to fly it without any delays. Normally, this eval will be done single ship, but two-ship tactical operations are authorized if they either enhance the evaluation or serve to better familiarize the student with the operational mission of the weapon system.

b. This section outlines suggested items to evaluate along each leg of the low level route. Sample flight cards are also included. These cards are stored in a computer file in the TPS word processing software, and can be modified for the aircraft flown to show specific system terminology/switchology. Instructions on how to access this file will be given during the FTT briefing for this flight, and any questions should be directed to the Systems Branch. Keep in mind the following ideas and the accompanying flight cards are only suggestions. The wording has been kept as generic as possible, and switchology and nomenclature will change for each aircraft evaluated.

(1) Enroute to Point 1. Call SPORT prior to entering the low level route and give them your entry and exit times. Be prepared to give them an estimated time of arrival (ETA) to the hill at the north end of the Panamint Valley (North Lake Hill; Point 5) and/or the mine complex on the west shore at Owens Lake (Bartlett Mine; Point 10). (Note that the turnpoints are numbered for all points along the Blue Route with the Black Extension, even if the Black Extension isn't used). This info may be needed for SPORT to deconflict traffic along different low level routes. Use NAV system steering (INS, GPS, LORAN,etc) to locate the turnpoint and get familiar with the available steering cues; HUD, HSI, ADI, Radar display, etc. Once the point is spotted visually, overfly the point (500 AGL minimum) and note the NAV system present position and the time of day. This can be done throughout the flight (including the dedicated air-to-air portion) to record NAV system errors versus time.

(2) Enroute to Point 2. After passing the first turnpoint, sequence the navigation steering to the next turnpoint, unless this happens automatically. If this is a manual function, it will need to be done at each turnpoint. Use this leg to further evaluate the steering cues, to include ground speed readouts, and to use the radar for ground mapping. Look for human factors types of things while using the radar: antenna elevation control, radar tuning to include ease of reaching/identifying the controls, and steering and altitude cues on the radar display. There are some power lines that run approximately perpendicular to the ground track about halfway down this leg. See if these paint on the radar. Note the NAV system present position once again when overflying turnpoint two.

(3) Enroute to Point 3. Sequence the NAV steering if needed. Continue to get familiar with the radar ground mapping capability. About halfway down this leg climb as needed to get line-of-sight with Searles Lake, the town of Trona and the Trona Airport. If the system is capable, use the south end of the Trona Airport's runway (there's only one and it runs approximately north/south) as an offset point for getting steering information to the turnpoint, which is a group of buildings in the middle of a triangular shaped series of roads. Follow the steering to see how close it takes you to the turnpoint. If possible, configure the system to do a simulated visual update to the NAV system as you overfly the turnpoint. If you are tracking NAV system errors do not actually update the system. Rather, go through as much of the switchology as possible to see how easy it is to do. This is not a particularly good point for getting a NAV system accuracy check, however.

(4) Enroute to Point 4. This next point is a good place to do simulated visual weapons deliveries, so get the system configured for this. If the evaluation is being done from a seat that has neither visual bombing capability nor a way to monitor the delivery (such as HUD repeater), consider not looking at this type of operation. This would however, still provide a chance to see visual bombing tactics if the evaluator is unfamiliar with them. Evaluate the ease of configuring the system: selecting the desired delivery mode, selecting the weapon(s) and arming. If multiple delivery modes are available, plan to do multiple attacks. Also, if the system is capable of storing a target's position as it is overflown and giving steering cues to "reattack," try doing this as a Close Air Support (CAS)/"Road Recce" type of operation. Note: This radar site is sometimes used by other aircraft for practice, so be vigilant for possible traffic conflicts.

(5) Enroute to Point 5. This area (the Panamint Valley) is often used by various types of aircraft from Edwards AFB and China Lake. As such it can provide

targets of opportunity for exercising any air-to-air systems. Search at altitudes from approximately 5,000 ft MSL to 30,000 ft MSL for possible targets. Evaluate air-to-air systems during this phase of flight from the point of view of how they fit into the low altitude navigation task: are NAV system steering cues available in the radar display, does the radar automatically configure for low altitude operation (selects an appropriate PRF, rejects the side lobe returns, etc.), can radar returns or IFF interrogations be displayed on other navigation aids such as moving maps or the HSI to help correlate where they are relative to the desired route of flight? This is also an opportunity to look at the Radar Warning Receiver (RWR) if any targets are also using radar. Again note the present position at this turn point. This is a good time to evaluate the updating mode again if it couldn't be done previously, or to look at another updating method instead of the visual overflight method (E-O, HUD).

(6) Enroute to Point 10. The next turnpoint is a large building that makes an excellent radar/electro-optical target. This building can be used either as a simulated target or as a radar offset for another point that doesn't show on radar. As with the visual attacks, configure the system for weapon delivery (select the delivery mode, select and arm the weapon(s)). If the aircraft is nuclear capable, try arming/unlocking a simulated nuke if conventional weapon switchology was done previously. Acquire the target with the radar and note the steering cues provided for weapon release. Repeat the attack using a different delivery mode and/or with an electro-optical system, if available.

(7) Enroute to Point 11. Configure the radar for air-to-air search at approximately 80 NM. Airline traffic should be present in the San Joaquin Valley between about 15,000 ft and 30,000 ft. Continue the evaluation of air-to-air search capability using multiple aircraft tracking modes, if available. Do another present position check at the turnpoint.

(8) Enroute to Points 12, 13, and 14. Continue using the air-to-air capability if required. Once satisfied with this part of the evaluation, switch to terrain following/terrain avoidance (TF/TA) if capable. Evaluate ease of interpretation of the radar display, ease of following the manual TF/TA cues and ease of doing the navigation task while using the TF/TA cues, (is NAV steering available on the TF/TA display?). Couple the TF/TA system to the autopilot for automatic terrain avoidance, if able, and see how this affects doing other tasks (is there now time to do more tasks?). If TF/TA is not available, then climb to 10,000 ft MSL (1,500 AGL minimum) and evaluate the basic autopilot modes (altitude hold, heading/ground track hold, automatic navigation). Note how the pilot interfaces with the autopilot to change

parameters (heading/altitude), to override the system, and to disconnect it. Do a present position check over both point 12 and 13. At point 14, call SPORT and report departing the low level route.

7. Approach and Landing.

Setup for an instrument approach. Evaluate the approach guidance cues available in both the head-up and head-down displays. Use the radar for course guidance as an alternative/additional task. Note the NAV system present position and the actual position prior to shutdown.

8. Debrief.

Debrief with the IP/aircraft commander to discuss your impressions of the avionics systems and to clarify anything that may still be confusing. Give special attention to how system operation in-flight compared to expectations gained during preflight study.

INSTRUMENTATION:

Tape recorder or on-board video/audio recorder (if available).

REPORT: IAW ("TPS Reports Requirements," *Test Management Phase Planning Guide*). See Test Management "Single Look Qual" for details.

An Individual Daily Written report should be turned into the qual program monitor within two days of the flight.

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BLUE LOW LEVEL WAYPOINTS

	Align coords	N	W	ft
	ASAT Triangle	N 34-55.114	W 117-51.909	2280 ft
1.	Water Tank	N 35-09.92	W 117-51.29	2573 ft
2.	RR Junction	N 35-29.25	W 117-38.29	3225 ft
3.	Searles Building	N 35-44.61	W 117-19.50	1618 ft
	OAP-Trona RWY	N 35-48.2	W 117-19.6	1716 ft
		Brng 360.0	Rng 22900 ft	
4.	Ballarat Radar	N36-02.04	W 117-16.14	1210 ft
5.	N. Lake Hill	N 36-23.07	W 117-24.22	2030 ft
10.	Bartlett Plant	N 36-28.59	W 118-01.86	3650 ft
	OAP	N	W	
		Brng	Rng	
11.	Templeton Pk	N 36-18.83	W 118-12.39	9930 ft
12.	Needles	N 36-06.58	W 118-29.06	8245 ft
13.	Microwave Twr	N 35-42.34	W 118-32.52	6980 ft
14.	Emerald Mnt	N 35.15.00	W 118-15.00	6698 ft
	Shutdown Coords	N	W	ft
		GS		

After Engine Start

1) INS - Align
   - Load parking spot coordinates
   - Lat______________________
   - Long_____________________
   - Time to Align:______________
   - Ground Speed:______________

2) Load Steerpoints

At Last Chance

1) Normal Checklist - Complete
2) Select INS Steering to 1st Turnpoint
   Bearing/Dist --
3) Set-up Radar for A/A or A/G (as appropriate)
   --Az Scan --El Scan
   --Range --Mode
4) Note Present Position (P/P) when over ASAT Triangle
   N 34-55.114 N 34-____________
   W 117-51.909 W 117-___________
   TIME:___________ HEADING:___________
5) Check Weapons Switches

TAKE-OFF

TIME:_______________

1) Radar Trail (if wingman avail)
   --Manual lock-on
   --Auto lock-on
2) Weapon System Check
   --HUD Symbology: Missiles/Gun
   --Missile Seeker-head alignment

DEDICATED A/A EVAL

1) Search Modes
   --Normal, Expanded volume (Track-While-Scan, etc)
   --Eval look-up/dwn, PRF's, max range capability, etc.
2) Auto Acq Modes
   --Cycle thru all modes
   --Eval ease of switchology, HUD/radar displays when tracking
   --Use during maneuvering flight

LOW LEVEL ROUTE

Enroute to Pnt 1 (Cal City water tank)

1) Call SPORT with entry/exit times
2) Use INS Steering to find the point: HUD, HSI, radar moving map, etc.
3) Note P/P over the tank (500 AGL)
   N 35-09.92 N 35-____________
   W 117-51.29 W 117-____________
   FUEL:__________ TIME:____________
   TURN: 015°/420 grnd spd

Enroute to Pnt 2 (R/R Y)

1) Sequence INS steering to Pnt 2
2) Eval steering cues
   --Note INS Ground Speed readout
3) Practice with A/G radar use
4) Note P/P over Pnt B (500 AGL)
   N 35-29.25 N 35-____________
   W 117-38.29 W 117-____________
   FUEL:________ TIME:____________
   TURN: 030°/420 grnd spd

<u>Enroute to Pnt 3</u> (Seales Lake)

1) Sequence INS steering
2) Set-up radar for ground map
3) Eval steering cues from radar
4) Observe Searles Lake on radar
5) Observe Trona Airport as OAP
   N 35-48.2 } South End of
   W 117-19.6 } Trona Runway
   1716 ft elevation
   From turnpoint: 360 deg True/22,900 ft
6) Climb to 3,200 MSL (1,500 AGL) to avoid airport
7) Perform simulated overfly update at turnpoint
   FUEL:_______________
   TURN: 352°/420 grnd spd

<u>Enroute to Pnt 4</u> (Ballarat Radar)

1) Sequence INS steering
2) Set-up Weapons Release Switches for Simulated Visual Delivery On Radar Site
3) Perform Simulated Vis Delivery (Use HUD Repeater if Avail)
   Option 1)
   Option 2)
   Option 3)
4) Mark Location for Reattack (Simulate unplanned, CAS target)
5) Egress North for Reattack
6) Do Visual Reattack from a random direction
   FUEL: _______________
   TURN: 327°/420 grnd spd

Enroute to Pnt 5 (North Lake Hill)

1) Sequence INS steering
2) Use A/A Rdr and AAI to look for airborne targets
   --Eval Search modes, Track-While-Scan,
   Single Target Track, etc.
3) Note any RWR signals
4) Note P/P over Pnt 5 (500 AGL)
   N 36-23.1 N 36-______________
   W 117-24.2 W 117-______________
   FUEL:_______ TIME:___________
   TURN: 262°/420 grnd spd

Enroute to Pnt 10 (Barlett Mine)

1) Sequence INS steering
2) Set-up radar for simulated Radar Attack
3) Set-up Weapons Release Switches for simulated release
   Option 1)
   Option 2)
4) Acquire Tgt/OAP with radar
   --Direct the attack using steering cues from the radar
   --Simulate a level release, 500 AGL, 420 grnd spd
5) Repeat attack with IR sensor if avail
   FUEL:________________
   TURN: 199°/420 grnd spd

Enroute to Pnt 11 (Templeton Mnt)

1) Sequence INS steering
2) Use radar for A/A Search
   --Lock-on tgts of opportunity
   --Use AAI if avail
3) Note P/P over Pnt 11
   N 36-18.8 N 36-___________
   W 118-12.4 W 118-___________
   FUEL:_____________ TIME:___________
   TURN: 214°/420 grnd spd

Enroute to Rest of Route

1) Sequence INS to each point
2) Climb to 10,000 MSL/1,500 AGL (whichever is higher)
3) Engage Auto Pilot
   --Use appropriate modes to navigate to INS steer-points
   --Evaluate ease of crosschecking autopilot performance
4) Continue A/A Radar eval
5) Note P/P over Pnt's 12 & 13

Pnt 12 (Easternmost Needle)

N 36-06.6 N 34-___________
W 118-29.0 W 118-___________
FUEL:___________ TIME:___________
TURN: 171°/420 grnd spd

Pnt 13 (Microwave Twr)

N 35-42.3 N 34-___________
W 118-33.2 W 118-___________
FUEL:___________ TIME:___________
TURN: 135°/420 grnd spd

After Landing

1) Landing Time:_______________
2) Terminal INS Data:

Actual Location	INS Position
N 34-___________	N_______________
W 117-__________	W_______________
Ground Speed:______	Heading:__________

Shutdown Time:___________

F-16 ELECTRO-OPTICS DEMO (P/FTE/N)

REFERENCES:
1. T.O. F-16A-34-1-1
2. F-16A/B Avionics System Manual for Block Z1A+ or Z1B (as appropriate)
3. Hughes Maverick Operations Supplement, MAV-M-100-2A-TV Maverick
4. Hughes Maverick Operations Supplement, MAV-M-1060-3-IR Maverick
5. Hughes Maverick Video Tape
6. T.O. 1F-16A-1-3
7. T.O. 1F-16A-1-4

PURPOSE:
1. Demonstrate the effect of various targets when viewed at optical and infrared (8-12 microns) wavelengths. The imaging of these targets will be viewed at various distances, elevation depression angles, and aspect angles from the energy source (heat or illumination).

2. Evaluate the human factors involved in the mechanization of the Maverick on the F-16A/B without the ACRIU improvements.

AIRCRAFT:
F-16B with LAU-117's on station 3/7, TGM-65B and TGM-65D or G on stations 3 and 7, respectively; centerline or 2 external wing tanks.

GENERAL:
1. This mission is designed to introduce the student to the differences between visible and IR sensors in the flight environment. Operationally there are situations where each has the advantage over the other and thus are employed differently. Because flight test must test these sensors/weapons to meet operational requirements, it is important for the tester to understand what targets, run-in angles, and weather conditions the sensors should be tested in so as to evaluate them properly. Additionally, the tester should evaluate the mechanization of the sensor/weapon for workload, common errors that a design may induce, and other human factors areas as appropriate.

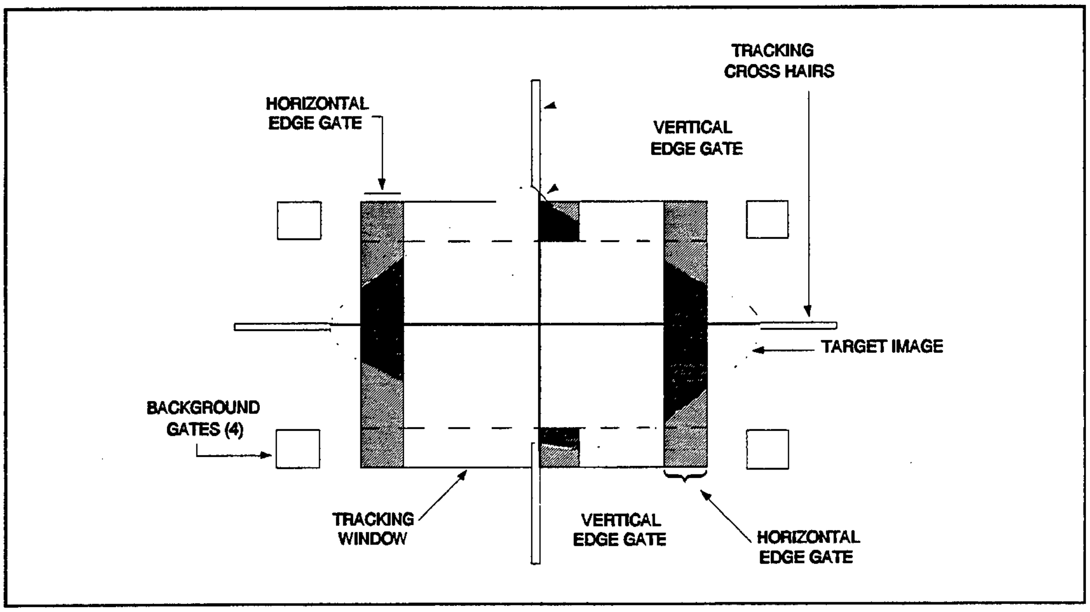

FIGURE 3.1 GATED VIDEO TRACKER

2. The mission will be flown by pilots, engineers, and nav/WSO's. The student should thoroughly understand the required switchology to accomplish the mission. Since different weather conditions and time of day may have significant impact on the use of the visual TV sensor and the IR sensor, the student should be prepared to evaluate the system taking the existing conditions into account.

LIMITATIONS:

1. Flight manual restrictions will apply to all phases of the flight. The mission will be conducted within the normal flight envelope.

2. All maneuvering will be conducted above 1500 feet AGL. For momentary periods as the target is approached, the aircraft may be descended to 1000 feet AGL if it is required to stay within guidance unit gimbal limits.

3. No simulated weapons will be loaded on the aircraft for this mission to prevent accidentally dropping the LAU-177 and missile.
Exception: Simulated AIM-9 may be loaded on stations 1/9.

4. Maximum airspeed in visible moisture is 350 KIAS or 0.53 Mach (See Ref 6 and 7).

5. Maximum missile ground power-on time is 15 minutes. Maximum time in the

Ready Mode (power-on time) for the mission is 60 minutes with 30 minutes in the Activate Mode (video present). Time limit for missile Ready Mode and Activate Mode is limited to 35 minutes and 5 minutes respectively if the sustained mach number exceeds 0.90 Mach. Therefore, stay below 0.90 Mach except for momentary excursions. The TGM-65B is limited to 3 minutes maximum of video per activation. After this, a good rule-of-thumb is to leave the TGM-65B video off about three minutes before video power is reapplied (See Ref 3 and 4).

6. DO NOT attempt to uncage the missile seeker head prior to 3 minutes after power on as damage may occur to the TGM-65B.

BACKGROUND:

1. Optical TV Sensor

The combined effects of dive angle, sun angle, target contrast, and background level should be considered when selecting the contrast polarity (B/W, W/B, AUTO). Once track has been established, the contrast selection remains what it was at track initiation until the track is broken. AUTO allows the seeker to use the contrast information in the background gates and tracking window to select either B/W or W/B. This requires additional time for the track to be completed and this function should be evaluated by comparing it to operator selection of contrast. Good definition between target and background must exist on all sides since the TV seeker head uses contrast edges of the target to define the tracking window (see Figure 3.1). This effect will be encountered on some of the targets. For some targets a lock-on may not be possible from some angles. The background gates must be in an area slightly lighter than the target for B/W or slightly darker for tracking.

Optimum targets for the TV seeker head are those which contrast well with the background, present an approximately square or round profile to the seeker head, and are large enough to be visible and identifiable at a reasonable range. A dark target usually provides the best contrast for a sandy or desert background, while a light target is best for a background of forest or vegetation. For water targets, the optimum target contrast is determined by heading and sun angle. Since the TV seeker head does not see color, targets which appear to the eye as having good contrast (red tgt on green background) may often appear as nearly the same shade of gray to the TV camera. Optimum results can only be obtained if the attack heading, sun angle, and target contrast are considered. Even though many TV seeker heads have sun shutters to protect them from sun damage, the shutters are often disabled in track modes so care must be taken to prevent seeker head damage. At the completion of each pass exit the A-G mode to remove seeker power.

2. IR Sensor

For the IR seeker head many factors must be considered to ensure target acquisition, not the least of which is that we humans do not routinely "see" in the IR spectrum and thus do not always interpret images correctly. Target factors that play an essential part are all related to the IR energy emitted by the target or other objects in the area (temperature and emissivities) and the propagation of that energy through the atmosphere. Not only is the current target area weather important, but the previous day's weather has a marked effect on the absorbed IR energy from solar radiation. An example is a target area three hours after sunset following a day of direct sunlight. Dark metal objects which absorbed solar energy are most likely going to be warmer than foliage. Following a cool overcast day, the dark metal objects may very well be cooler than the foliage. Since metal objects in general radiate heat faster than soil and foliage, at some point the metal object will appear cooler than the soil and foliage. As the sun rises in the morning the opposite effect takes place. "IR crossover" occurs at the point of temperature equalization and at different rates for different types of target materials/emissivities. Cloud cover decreases the rate of cooling at night and the rate of heating during the day. Surface winds may also effect the rate of heating/cooling. The type of target has a major affect on the IR signature. If a target is internally heated, it has a characteristic IR signature which changes with aspect often due to the location of the motor or exhaust of the target. Target thermal mass must also be considered as the more mass in the target the slower the target will change its temperature. Surface composition also affects a target's IR signature. Targets with higher emissivities appear brighter than lower emissivity objects at the same temperature. During daylight hours objects that appear visually lighter than their background will probably appear darker than their background in the IR display if in "white hot". With the seeker head used in this mission "white hot" is the only polarity available. Tracking polarity can be changed to hot-on-cold or cold-on-hot, but hotter is always lighter.

MISSION EVENTS: (Gradesheet, pg A.3)

1. Mission Preparation

Thorough study of necessary switchology for the aircraft and preparation of data cards facilitating in-flight data note taking is required prior to the brief. Arrange the test runs in a logical order to make efficient use of time and gas. You're encouraged to ask a staff IP or classmate to review your plan. Review of the Dash 34 checklist for proper preflight and in-flight procedures will be accomplished.

2. Briefing

The IP will brief the general and specific briefing guide to include the preflight of the missile and suspension equipment, test techniques, and switchology appropriate to the mission. The student will brief applicable limitations and procedures for jettison, carriage, and return to base. Call SPORT (before the briefing, if possible) and brief them on the airspace to be used and any other requirements.

3. Pre-flight

The IP will demonstrate the correct preflight of the TGM and LAU-117's. Ensure the forward and aft orifices are 4 and 3 respectively (See Ref 1).

4. Pre-Takeoff Checks

After completing all normal checks, including loading the SMS, you will need to check out the Mavericks on the ground prior to flight. Normally this is accomplished at EOR, however it may be accomplished in the chocks. The following procedure should be followed IAW the -34, Ref 1:

1. Ground Jett Enable - On
2. RCP Mode Knob - Out of Off
3. Armament Switch - Sim
4. A-G Button - Depress
5. AGM Wpn - Select
6. SCP Power OSB - Depress (ON)
7. Uncage Seeker Head - Man Rng Knob Z-axis
8. Polarity as required - SCP OSB or Cursor slew Z-axis
9. FOV change - Man Rng Knob Z-axis
10. Slew seeker head - DSG and cursor slew to tgt
11. Release DSG to command track
12. To change target return to step 9
13. To break track uncage seeker head

After completing the ground check, power off the TGM-65's and de-select Grnd Jett Enable. Remember 15 minutes maximum power on time on the ground. It should not take more than 1-2 minutes after timeout to complete the TGM ground check. The same procedures should be used for in-flight except that the Grnd Jett enable switch should be off. Load the required INS points (either manually or via DTC) into the FCNP for the targets that will be used later in the flight. Figure 3.2 depicts the SCP and the symbology found that is Maverick specific. Figure 3.3 depicts generic EO symbology on the REO and what it means. Figures 3.4 and 3.5 are TV and IR seeker head symbology. Figure 3.6 depicts the HUD symbology in EO A-G mode.

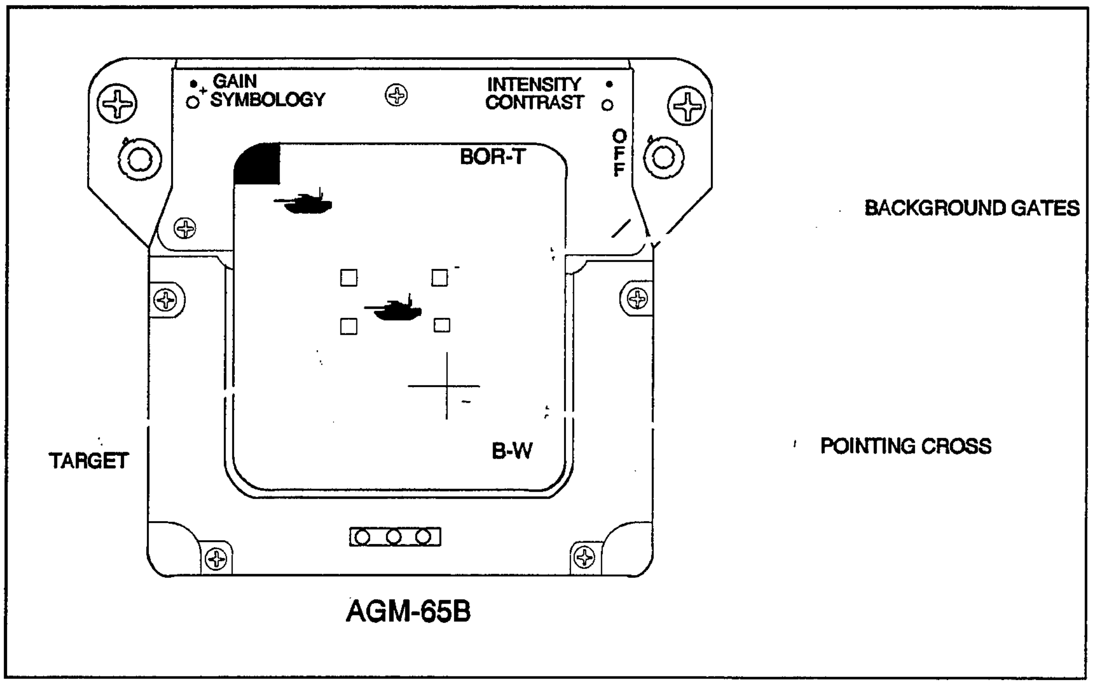

FIGURE 3.4 TGM-65B SYMBOLOGY

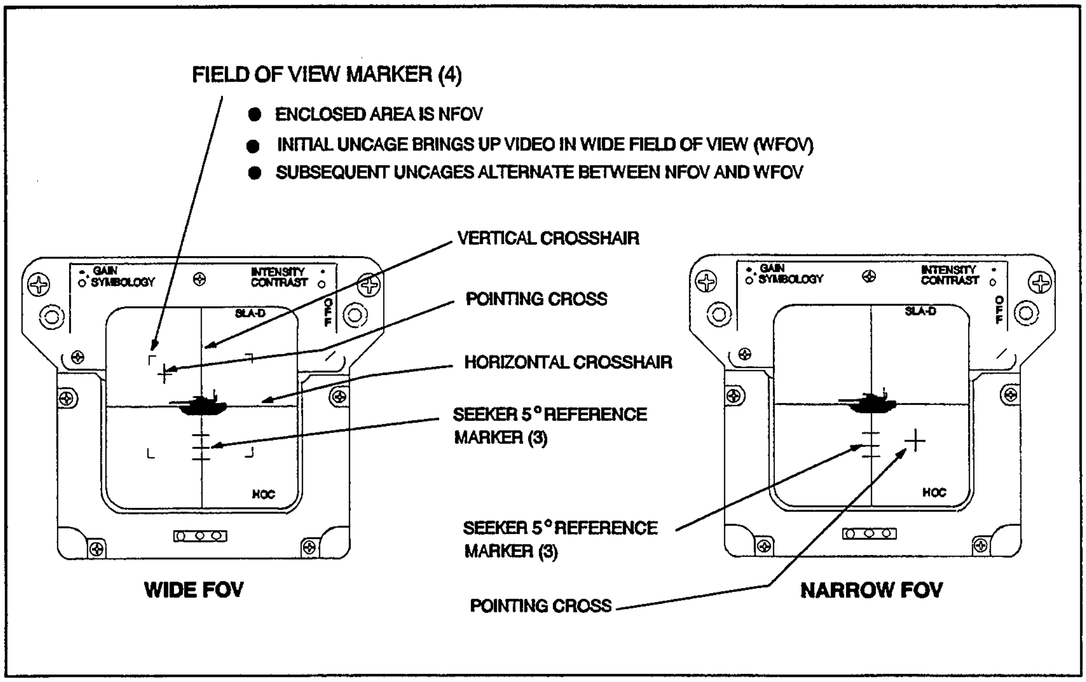

FIGURE 3.5 TGM-65D SYMBOLOGY

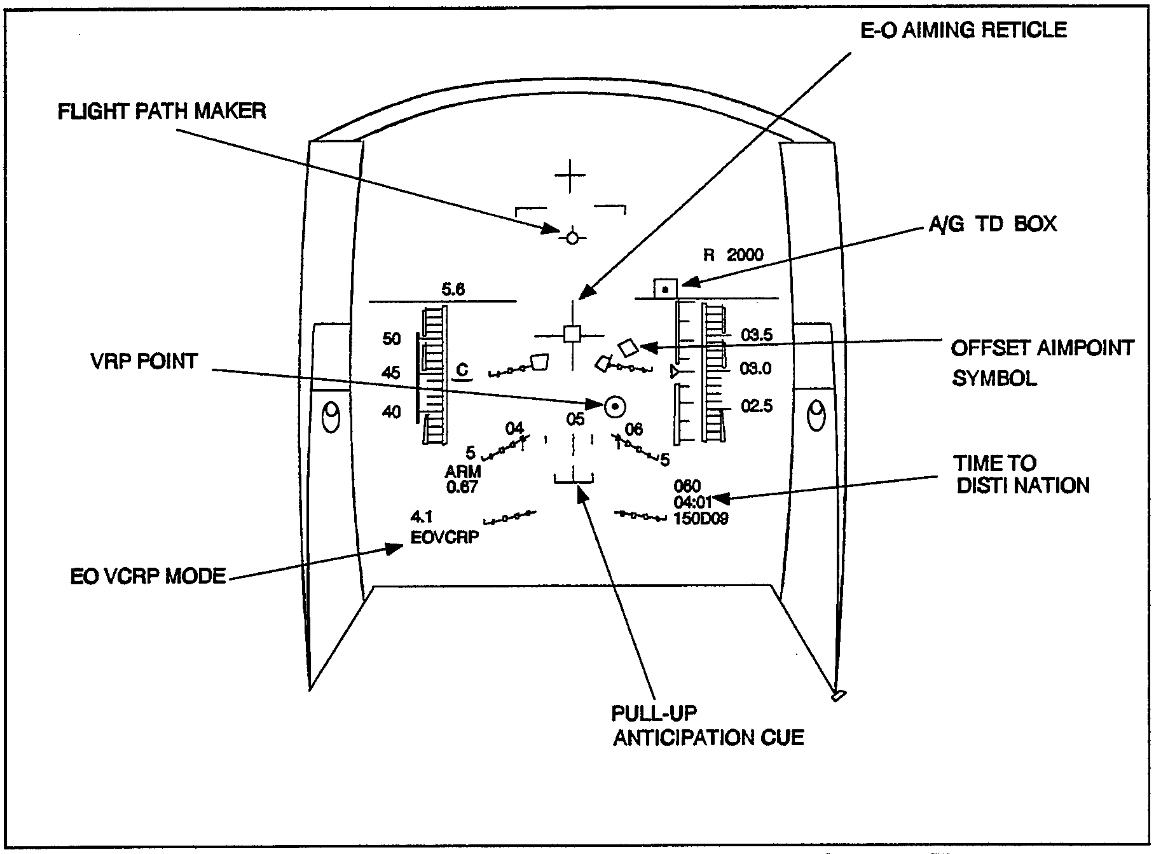

FIGURE 3.6 HUD ELECTRO-OPTICS SYMBOLOGY

4. Takeoff

Perform a normal takeoff. Maximum power should be used if GW is in excess of 28,000 pounds. Depart to R-2515 and climb to 5,000 - 10,000 feet MSL.

5. Sensor Comparisons

Since some of this mission is flown at relatively low altitudes, ensure that throughout the flight airspeed is maintained sufficiently high for an airstart capability. For the majority of the flight 300 to 420 KIAS, as a function of altitude, is adequate.

Enroute to the first target, power up the TGM's the same way as on the ground except for the Grnd Jett Enable switch. The mission runs may commence after the three

minute timeout has passed (i.e. "NTO" is removed from top left of the SCP).
The targets to be used are:

	Coordinates	Elevation
A. Boron Radar	N 3504.87 W 11734.94	3070
B. Cal City Tank	N 3509.92 W 11751.35	2600
C. Railroad Tunnel south end	N 3527.83 W 11737.33	3214
D. Water Tank at RR "Y" north of tunnel	N 3529.68 W 11738.37	3179
E. Solar Farms	N 3500.27 W 11733.97	2450
F. Mojave Apt (2500' AGL/5 sm)	N 3503.30 W 11809.80	2787

The elevation/depression angle of the seeker plays a large part in the background contrast in both TV and IR imaging. Very often shadows will affect the TV image background, and background heat clutter will affect the IR image background by creating a larger effective background at low elevation/depression angles. With open sky background, there is often insufficient detail for the tracking gates to use even though the target itself may be very clear and distinct. Because of this, lookup scenarios with these sensors may have limited success. On each run, the IR and TV sensors should be compared against each other to show the effectiveness of each spectrum at various depression angles, ranges, and run-in angles. The following matrix gives a synopsis of recommended runs.

TGTS	ALT (AGL)	A/S (min)	HEADING TO TGT (+/-20 degrees)
A	1500	420	285 degrees and 105 degrees
A	10,000	300	285 degrees and 105 degrees
B	1500	420	280 degrees and 135 degrees
B	10,000	300	280 degrees and 135 degrees
C	10,000	300	350 degrees and 320 degrees
D	10,000	300	030 degrees
E	1500	420	255 degrees and 165 degrees
E	10,000	300	255 degrees and 165 degrees
F	1500	420	260 degrees
F	10,000	300	260 degrees

Fuel and time will permit approximately 14 total runs. Since you will not be able to complete runs at every altitude and heading, arrange the mission to look at each target from the most interesting headings and altitudes based on your knowledge of E-O Sensor Performance.

Runs should be accomplished with a 12-15 mile run-in. This distance may be altered if required but both spectrums should be viewed at approximately the same distance, aspect and depression angles.

During each run uncage and view the target with the IR sensor first (tracking the target will be the easiest method of keeping it inside the FOV). Observe the target in both wide field-of-view (WFOV) and narrow field-of-view (NFOV). Next uncage the TV sensor and view the target as was done with the IR. Evaluate the differences between the ease of detection and tracking with both spectrum sensors at the different look-down angles, aspect approaches, and ranges. Evaluate the change of the target

NOTE: Ensure that the Mavericks are powered off at the one hour Ready Time point in the flight.

as compared to the background as the angles change (often observe polarity reversals of target and background) and what impact this effect might have on the testing of sensors and the approaches you might use.

6. Recovery and Landing

Recover for either a straight-in or overhead. Do not fly an SFO unless GW limits are complied with.

7. Debrief

Debrief and discuss with the IP the overall assessment of the two different spectrum sensors. Highlight specific items that were noticed in flight that each had unique capability to discern. Comment upon the human factors aspects of the employment of the TGM's on the F-16A/B model.

INSTRUMENTATION:

None.

REPORT:

Individual Daily Written Flight Test Report to IP within 3 days.

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AVIONICS SYSTEMS TEST TRAINING AIRCRAFT (NC-131H) DEMO/DATA (PILOTS, FTE/N)

REFERENCES:

1. *ASTTA Operational Training Manual,* Calspan Corp., Buffalo NY.
2. NC-131H Flight Manual.
3. ASTTA Test Plan, USAF TPS, Edwards AFB CA. (Current)
4. *Criteria for Evaluating Airborne Thermal Imaging Systems,* Shimer, S.E. September 1984.
5. ASTTA Run Cards (Appendix B).
6. MIL-STD-1787, *Aircraft Display Symbology.*
7. MIL-STD-203F, *Aircrew Station Controls and Displays.*

PURPOSE:

The student will apply knowledge of avionics system theory and FTTs to gather radar, infrared detecting set (IRDS), E-O system and INS performance data. A human factors integration evaluation will be conducted in conjunction with avionics testing using human factors theory and guidelines.

The general objectives of training in the Avionics Systems Test Training Aircraft (ASTTA) are to:

1. Demonstrate and practice FTTs used to investigate the capabilities of:
   a. Air-to-Air Radar
   b. Air-to-Ground Radar
   c. Infrared Detectors
   d. INS
   e. Global Positioning System (GPS)

2. Demonstrate and practice operating multiple avionics systems in a dynamic, real time environment.

3. Investigate the systems integration aspects for mission suitability.

4. Practice the evaluation of crew station human factors.

AIRCRAFT:

The test aircraft is an adaptation of the USAF/Calspan NC-131H aircraft. The major components of the avionics suite include the APG-66 radar, AN/AAS-36 IRDS, LTN-72R INS, US Customs Service/Westinghouse Systems Integration Package (SIP) and Interface Control Unit (ICU), Kiowa/Calspan TV video platform (interchangeable with IRDS), Total Inflight

Simulation (TIFS) mode, with fly-by-wire variable stability system stick and throttle, avionics crew station and Westinghouse Mini-Console for data capture.

SUPPORT:

1. Target Aircraft (T-38 or other aircraft as available). Air-to-air TACAN is required in all participating aircraft.

2. Cords Road or other appropriate airspace for radar intercept work.

3. Alpha corridor for the TPS radar reflector array in Rosamond Lake and PIRA/large infrared (IR) board.

4. GPS P-code loaded for INS tests

LIMITATIONS:

1. Aircraft will maintain at least 1000 ft vertical separation during intercepts within 10 NM before visual contact. Aircraft will maintain 1000 ft separation (1000 ft bubble) with visual contact.

2. Minimum altitude for all testing is 500 ft AGL (2000 ft AGL night, except when on run-in to the IR Board, under SPORT control and in the PIRA/Alpha Corridor). Maximum altitude for the ASTTA is 10,000 MSL.

GENERAL:

1. All flights are conducted within the scope of the ASTTA Test Plan. There are three curriculum flights for each student. Each sortie is approximately 2 hours. Students will be scheduled as teams of two.

a. ASTTA GROUND TIME. Each student will be scheduled for 1 hour of cockpit time to become familiar with the procedures and techniques used during the airborne tests. In order to maximize the cockpit time allowed, the attached checklist of events should be accomplished by the student with an instructor on hand to demonstrate the techniques as required. Preparation time greatly improves learning.

b. ASTTA 0. This sortie serves as the student's introductory flight. Students flying ASTTA 0 will observe and assist other students who are flying their ASTTA1 flight. Students are expected to participate in mission planning, attend the mission briefing, observe and assist in flight and operate the data system as necessary. This sortie may be waived by the Director, Student Training for qualified students.

c. ASTTA 1. This 2-hour flight will consist of a variety of basic FTTs used in testing radar (air and ground modes), IRDS and INS. Each student will occupy the right (systems) seat for approximately half the flight. Each flight profile should cover a variety of air-to-air FTTs, but must include test points from each of the following areas:

(1) Blip Scans
(2) Max Lock On Range
(3) Track-Through-The-Notch Eval
(4) Air Combat Mode (ACM) Eval
(5) Radar/IRDS Integration Eval

The flight will also include a navigation route flown using the radar, IRDS and INS. The route will last about 30 mins, enabling each member of the test team to fly a portion of the route from each seat. Pilots may fly the aircraft in TIFS mode while operating the systems to evaluate workload. FTE/Ns may fly under supervision of an IP depending on proficiency.

d. ASTTA 2 (Night). Emphasis during the 2-hour flight will be on IRDS, air-to-ground radar, INS and systems integration testing. Each student will spend a portion of the mission operating each system. Two sets of teams will normally fly on each night mission.

MISSION EVENTS: (Gradesheet, pg A.4 A.5 & A.6)

1. Mission Preparation.

ASTTA test missions must be carefully planned to provide optimum use of fuel.

a. Pilots and FTE/Ns will coordinate the selection of data points and the completion of data cards for the mission. Partially completed sample data cards are in Appendix B. Provide a copy of the data cards to the instructor, the TPS Ops desk and to the NC-131H flight crew.

b. Cords Road is the recommended work area for air-to-air tests. If Cords Road is active with other aircraft, request to fly a parallel ground track approximately 5 miles north of Cords Road between the north side of California City and the Three Sisters dry lakes.

c. Ground radar tests can be flown against the RADFAG or the Rosamond Lake radar reflector range in conjunction with IRDS tests. After completing each point, turn to keep away from the Edwards main runway traffic and return to the initial point for the next run. Use caution to avoid exiting the Complex to the south.

d. For IRDS tests, the IR board ground crew (call sign: Downfall) will reconfigure the target between runs. Radio comm with Downfall is essential to assure the target is configured properly. A thorough pre-mission briefing with Downfall, as well as the usual one with SPORT, is required (5-5603).

2. Mission Briefing.

a. The Test Team will conduct the preflight briefing with instructors and target aircraft crew in attendance. The Test Team will brief the data requirements and the support requirements/status. Crew coordination is essential, and such items as radio and intercom discipline must be briefed with the NC-131H flight crew. Intercept Rules of Engagement (ROE) will be briefed in detail for air-to-air radar test points.

b. The Test Team will insure that range/support personnel are briefed on mission requirements and procedures and that safety considerations for working the PIRA/Alpha corridor are extensively briefed.

c. Procedures to protect mission sensitive data will be briefed on missions requiring such data.

3. Ground Ops.

The test team members that occupy the evaluation station for the first half of the flight will warm up the avionics and perform preflight ground checklist procedures in accordance with the ASTTA Operational Training Manual.

4. Air-to-Air Radar.

a. Search Mode Tests. Perform search mode tests as follows:

(1) Maximum Detection Range (Blip Scans). Maximum detection range depends on target radar cross section, aspect and velocity, as well as radar capability.

(a) FTT. Conduct the test with a head-on target. Set up a 1-bar scan pattern, with a $\pm$ 30-degree azimuth scan, and TGT HST = 1. Place the acquisition symbol at the known range of the target. Adjust the antenna elevation so that the center of the scan is at the known altitude of the target. After first detection, continue to manually follow the target the acquisition symbol as it approaches closer in range, observing blind zones. Use caution to keep the antenna elevation at the target's altitude (usually, by keeping the sum of the lower and upper altitudes equal to twice the target's altitude will keep the beam centered on the target). Select $\pm$ 10-degree azimuth scan after the first detect to maximize the number of radar sweeps.

Do not attempt lock on for this test. This test can also be conducted with an opening target. Call out air-to-air TACAN range at 1 NM intervals.

(b) Hit Rate. Compute the number of "hits" per antenna sweep by careful post flight review of radar videotape. Count the number of antenna sweeps on which the target is displayed over a given range interval, and divide by the total number sweeps over that range interval. This value is the hit rate. Use a bar chart to show the percentage of hits for each selected range interval. Range is determined by the most accurate means available, usually air-to-air TACAN. Maximum detection range is determined from the plot of hit rate vs range by applying a pre-defined detection criterion based on percentage of hits. Compare the results to a theoretical prediction from known radar characteristics.

(c) Blind Zones. Radar blind zones are determined from the plot of hit rate vs range, based on a pre-defined hit rate criterion.

(d) Detection Range Accuracy. Determine detection range accuracy by recording and comparing the range of the target as displayed by the radar with actual range determined by the most accurate means available. Most often, air-to-air TACAN will suffice. If two tracking radars are available, SPORT data may be used for more accurate results.

(e) Azimuth Correlation. Evaluate scan-to-scan azimuth correlation by noting whether the position of the target remains fixed in azimuth or whether it appears to jump in azimuth from one scan to the next.

(f) Cursor Movement. Evaluate the adequacy of cursor movement by qualitatively assessing its rate and sensitivity. Operate the cursor controls on several different range scales.

b. Acquisition Mode Tests.

(1) Maximum Lock-on Range. Maximum lock on range depends on target radar cross section, aspect and velocity, as well as intercept geometry and radar parameters.

(a) This test is set up in the same way as the maximum detection test. Pre-defined criteria are necessary to define lock on. Upon initial detection, attempt to initiate track. Reattempt until successful.

(b) The size of the acquisition window in search mode should be qualitatively assessed. Qualitative measurements can be made on any effects that the FOV or scan pattern have on the acquisition of a target. If targets of opportunity exist, qual eval of multiple targets and maneuvering targets can be performed.

(2) Time To Stable Track Eval. The purpose of this test is to determine the

time required to achieve lock on in a typical operational scenario. Accomplish this test with the radar in an operationally representative search mode, and the target at a given position with respect to the radar aircraft. Do this evaluation at the same time the Maximum Lock-on Range test is done. Monitor the following radar parameters on strip charts if possible: Designate Switch Enabled, lock on indicator, Kalman/Doppler difference, Pulse Repetition Frequency (PRF), antenna azimuth position, range and range rate. Measure the time required from actuation of the trigger switch until the lock on criteria are met by post flight review of strip chart data.

(3) Air Combat Mode Evaluation(ACM). The purpose of this test is to measure the time required for the system to acquire and track in the various ACM modes. This test is accomplished with a head-on target, setting up beyond the range of the ACM mode. Position the antenna so as to paint the target continuously as it approaches. Monitor the same radar parameters as in (2) above. Note the distance at which track is achieved. This distance can be used, with the known closure rate, to determine the time required to achieve track.

c. Track Mode Tests.

(1) Track-Through-The-Notch Eval. This test measures the capability of the radar to track a target when the total closure is approximately equal to the speed of the radar. Begin this test with a head-on target track. At a pre-specified range, have the target initiate a 360° level turn at a specified G loading. As the target enters "the beam", its closing velocity will fall within the doppler velocity notch designed into the radar. Monitor the following radar parameters on strip charts: lock on indicator, coast flag, PRF, antenna azimuth position, range and range rate. This maneuver can be flown with the target offset laterally from the flight path of the radar aircraft to observe the effect of changes in the doppler spectrum of the main lobe clutter.

(2) Radar Range Accuracy. The accuracy of the radar's range measurement can be found by comparing the displayed value of range with the range determined by the most accurate means available.

(3) Azimuth Accuracy. The radar angle can similarly can be compared with the known geometry of the two aircraft (taking into account drift).

(4) Range Rate Accuracy. Range rate accuracy can be measured by comparing the radar's measurement with the aircraft velocities at a given instant of time.

5. <u>Ground Map Radar Test.</u>

a. Range Resolution. Line up on the TPS radar resolution array (Buckhorn

RADFAG, North RADFAG, or Rosamond Lake as alternates) from a distance of about 25 miles, with the radar in the GM mode. Measure range resolution by noting the minimum reflector spacing that can be seen on the scope.

b. Azimuth Resolution. As the aircraft approaches the resolution array, note the minimum azimuth spacing that can be seen on the display. This spacing corresponds to the azimuth resolution and varies with range. By knowing the spacing of the reflectors, the angle between the reflectors can be calculated. This angle is the azimuth resolution of the radar.

c. Ranging Accuracy. Compare the aircraft's actual position with the displayed range from the radar resolution array.

d. Display Accuracy. The pointing accuracy and scan-to-scan accuracy can be measured by noting where the targets appear when the radar is supposedly pointing directly at the targets, and noting any "azimuth jumping" that may take place from scan-to-scan.

e. Maximum and Minimum Detection Ranges. The minimum and maximum detection ranges are measured by noting the ranges at which the aircraft can first and last see the reflectors. In most aircraft, the minimum detection range is limited more by look angle than by radar parameters.

f. Radar Display Controls. Qualitatively assess the following radar display control functions:

(1) Gain

(2) Mode and scale selection

(3) EXP, DBS, and Freeze modes

Note effects of factors such as terrain, land/water contrast and changes in altitude or bank angle. Assess the gain adequacy by qualitatively noting the degree to which the target on the radar scope responds to changes in the gain control. Qualitatively assess the adequacy and ease of switching modes, ranges and other features of the radar by operating each control.

6. IRDS.

IRDS testing will be done in conjunction with radar testing to the maximum extent possible.

NOTE: Do not correct IR resolution data for atmospheric effects unless specifically tasked to do so. If LOWTRAN or other IR data analysis methods are used, the corrected data are classified CONFIDENTIAL.

a. Tuning. Tune the IRDS on the ground in accordance with the ASTTA Operational Training Manual. Adjust the IRDS for optimum airborne display as required for the viewed scene and testing requirements.

b. Prior to Takeoff. Perform the following tests as time, instrumentation and test objectives dictate:

(1) FOV. Obtain data using a tape measure or other convenient measuring tool to calculate FOV in both Wide (WFOV) and Narrow (NFOV)(IRDS) or with the lens zoomed in and zoomed out (optical system).

(2) Boresight Accuracy. Measure the boresight by comparing the IRDS orientation to the aircraft heading while taxiing or conveniently aligned in the chocks.

(3) Field of Regard. Determine elevation and azimuth limits without aircraft/IRDS obstruction of FOV.

(4) Slew Rate Limits. Use a stopwatch to measure the elevation and azimuth slew rates of the IRDS.

c. Airborne Data Points.

(1) MRTD or Contrast. Configure the target board for the first run with 2% initial heat. Set up for the first run outside the expected maximum detection range with NFOV selected and proceed toward the target on the specified track and altitude. Detection range is defined as the range at which the IR target board is first seen on the monitor. Identification range is defined as the range at which the scope observer can accurately count the number of bars on the target board. Record ranges from the on board INS or from GPS. After NFOV target board identification determine identification range for WFOV. The test should be done in both the White Hot and Black Hot polarity settings. While the aircraft is setting up for another run, the range ground crew will reconfigure the target board by increasing the temperature of the heated panels. For IRDS tests, the IR board ground crew should reconfigure the target between runs. Radio comm with Downfall is essential to assure the target is configured properly. (Note: be sure that the data collected during an IR run is adequate before having Downfall raise the temperature on the board. The board will not cool back down in the time allotted for the mission). Repeat the above procedure to measure the identification range with the new target configuration. Additional runs should be made if possible. A curve can then be drawn through the data to determine the MRTD or MRC. Plot percent heat vs spatial frequency and determine minimum resolvable percent heat (MR%H).

(2) Spatial Cutoff Frequency. From a plot of spatial frequency vs % Heat, determine the system spatial cutoff frequency. Calculate instantaneous field of view

(IFOV) and sensor angular resolution (ΘR).

(3) Dynamic Resolution. Perform dynamic resolution tests by manually slewing the sensor across the IR target board while inbound. The sensor should be slewed at a rate such that the IR target board crosses the FOV in approximately 10 secs. Compare results to static resolution results and determine line of site (LOS) stability difference in spatial cutoff frequencies.

(4) Airspeed Effects. Perform runs at different airspeeds against the same target configuration and ΔT (or contrast) to determine airspeed effects (LOS jitter due to vibration).

(5) Tuning Effects and Sample Size. Perform IRDS resolution tests by:

(a) Not varying the IRDS level and gain settings for the entire series of runs.

(b) Tuning the IRDS level and gain settings to optimize the picture on each pass. Compare the spatial frequency vs. ΔT or contrast plots.

Since perceived ranges for identification (and therefore resolution) will vary from person to person, average the resolution results of a large sample (three persons minimum).

(6) IRDS Viewing Distance. Determining the effective IRDS viewing distance is a method used to evaluate the effects of atmospheric transmission (e.g., humidity) on system performance. As atmospheric transmission decreases (mostly corresponding to higher humidity levels) the contrast between objects at long ranges (the upper portion of the display) will decrease. Thus the upper portion of the screen will appear washed out (no scene detail) while the lower portion provides usable video. The effective IRDS viewing distance is defined as the range at which scene detail is lost. Using a flat earth assumption (see Figure 3.7) the IRDS viewing distance (D_v) is :

$$D_v = [(h \text{ Tan } (\Theta + \phi + AOA))^2 + h^2]^{1/2}$$

where:

h = Aircraft altitude above ground

Θ = Angle between aircraft downward normal and bottom

ϕ = Viewing distance angle referenced to the bottom of the IRDS FOV

AOA = Aircraft AOA

The IRDS viewing distance is plotted as a function of atmospheric transmission and/or humidity level.

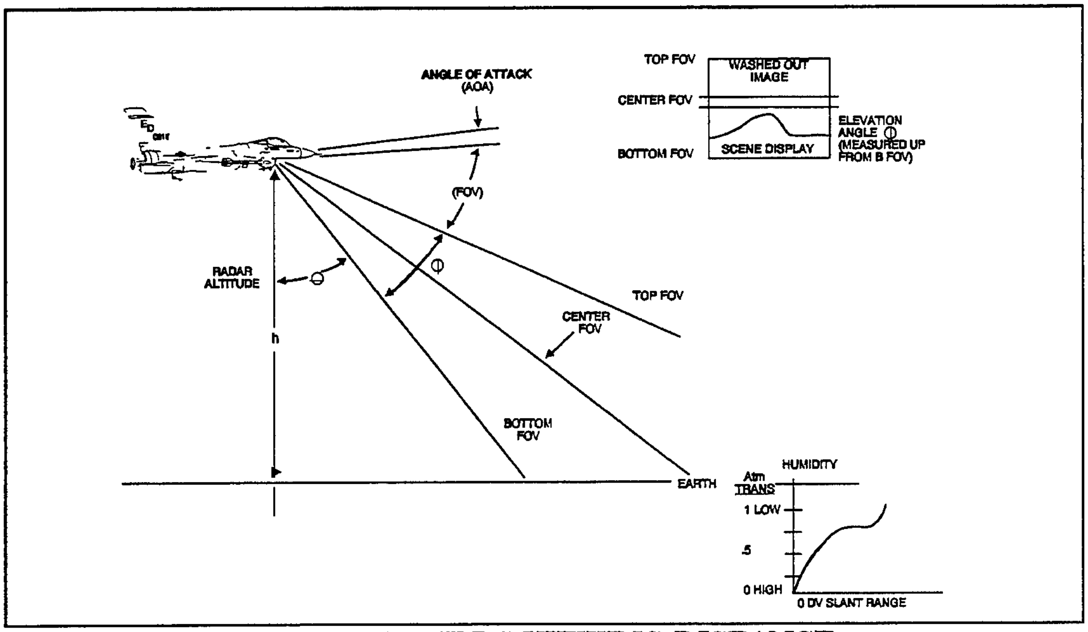

FIGURE 3.7 IRDS VIEWING DISTANCE

(7) Average Gain and Level Setting. Under nominal conditions, the gain and level setting required to obtain a good picture should be in the mid value range. By recording the gain and level setting values used by the operators under nominal conditions during the eval, it can be determined if the settings are typically in the mid value range. If the gain or level settings are found to be at one end of the range, readjustment in the video levels may be required.

(8) IRDS Navigation. Perform low level nav at 1000 ft AGL using IRDS video using the navigation route provided in class.

(9) Ambient Heating Effects (Daytime Versus Night). Qualitatively compare results of flights at different times of day (early morning, midday, late afternoon, dusk and night) for scene detail, target discrimination and system resolution.

(10) Slew Rate Limits. Quantitatively measure sensor azimuth and elevation slew rate limits. Qualitatively eval the position and rate control modes of the trackball for slew rates, utility and stability of manual tracking. Evaluate at varying LOS rates (nose, quarter, beam).

(11) Ground Track and Memory Ground Track Modes. Qualitatively evaluate the ground and memory ground track modes for tracking stability, jitter, etc., at varying LOS rates (nose, quarter, beam).

7. <u>Radar/IRDS Integration.</u>

a. Air-to-Air Radar/IRDS Integration. This test is conducted by slaving the IRDS to the radar after a target has been locked on. Evaluate IRDS WFOV and NFOV pointing accuracy as the range and bearing to the target change. If the target position should exceed the radar antenna gimbal limits, attempt to manually track the target with IRDS. Determine IRDS WFOV and NFOV detection and identification ranges for known and unknown airborne targets.

b. Air-to-Ground Radar/IRDS Integration. Slave IRDS to the radar with an air-to-ground mode selected and qualitatively evaluate IRDS to cursor position pointing error for both FOVs. Qualitatively evaluate detection and identification ranges of known and unknown targets.

8. <u>INS.</u>

INS data will be collected concurrently with radar and IRDS tests on the ASTTA 2 sortie. This mission requires GPS programmed with the current P-code for precision position measurement. INS position and GPS position will be time correlated. Final data will be obtained immediately prior to engine shutdown.

NOTE: INS data recorded during flight is correlated with GPS "truth data" by comparing time of day parameters. An accurate time hack from the GPS receiver is required.

a. Ground Ops. Have SI set the aircraft time code generator prior to flight. Align the INS in the chocks and carefully document the alignment method. Note the times when the status annunciator changes and when the Ready Nav light comes on, then place the system into NAV at the next even min. Hack a stopwatch and note the time of day when switching to NAV. Turn on GPS and wait for position data to resolve to maximum accuracy (figure of merit "1") Take data at exactly 5-min intervals until post flight shutdown. (Note: identical intervals will allow the student to better correlate multiple missions in the TPS INS data reduction program; "INSERR").

b. Takeoff.

Record INS and GPS present position and time just prior to takeoff roll.

c. Enroute.

(1) Evaluate the INS and its integration in the ASTTA as an aid to enroute navigation. Determine how well the INS, as part of an integrated system, aids in acquiring targets with the IRDS and radar, and aids in obtaining flight test data.

(2) At 5-minute intervals throughout the flight, manually record time, INS position, and GPS position. Press the HOLD button on the INS control panel and the MARK button on the GPS simultaneously at the hack. This will freeze the present

position indication, allowing immediate recording of the time and the recording of the present position when practical. To display the frozen GPS position, press line select key #4 ("DISPLAY FREEZE"). After the data are recorded, press the HOLD switch again on the INS and the CLR key on the GPS to reactivate the present position indications.

d. Landing. After clearing the runway, record the time, GPS present position, and INS present position. Record time, GPS present position, and INS present position again before shutting down the engines.

9. <u>Human Factors Eval.</u>

Evaluate each of the following areas during flights in the ASTTA. Human factors evals should consider anthropometric measurements of the evaluator and should attempt to relate all findings towards mission suitability. Make specific conclusions and recommendations to improve the ASTTA eval cockpit configuration for both the simulated mission and ASTTA student training mission.

a. Control Eval
- (1) Location and arrangement
- (2) Consistency of control display movement
- (3) Adequacy of coding
- (4) Adequacy of labeling for multimode control
- (5) Sensitivity, range and speed of activation
- (6) Accidental activation

b. Display Eval
- (1) Size, color, location and arrangement
- (2) Readability
- (3) Visibility
- (4) Illumination
- (5) Interpretability
- (6) Useful accuracy
- (7) Fail safe provisions/failure warnings
- (8) Reliability
- (9) Consistency in each mode of operation
- (10) Environmental factors
- (11) Caution and warning indicators
- (12) Perception and masking of auditory signals

c. Control-Display Compatibility

(1) Functional grouping

(2) Visibility and reachability

(3) Similar arrangement as other aircraft

(4) Overloading of tasks or sensing

(5) Optimum location (importance principle)

(6) Frequency of use

(7) Sequence of use

(8) Workload

(9) Mission requirements versus control-display design

d. Illumination

(1) Brightness

(2) Uniformity

(3) Contrast between task and background

(4) Glare

(5) Quality and color of illuminates and surfaces

(6) Flexibility and individual control

(7) Operational and maintenance requirements.

(8) Direction of lighting

e. Atmospheric Conditions

(1) Air purity

(2) Cooling

(3) Pressurization and heating

f. Noise

(1) External sources

(2) Internal sources

(3) Hot/cold mic

g. Procedural Sequence

(1) Adequate and effective checklist procedures

(2) Proper sequence

h. Crew Station Accommodations

(1) Accommodate 5th-95th percentile male and female crewmembers with applicable flight clothing

(2) Adequate clearance

(3) Comfort

(4) Sufficient seat adjustment (5th-95th%)

i. Crew station Ingress/Egress Procedures

(1) Easy ingress/egress

(2) Accessible personnel services connections

(3) Personnel restraint strap routing

(4) Emergency ground egress/in-flight egress

10. Debrief.

The student pilot should debrief the quality of the set-ups and run ins. The FTE/N should debrief the quality of the data.

INSTRUMENTATION:

1. Westinghouse Mini Console

2. Target aircraft DAS

3. Video Cassette Recorders (VHS)
   a. IRDS
   b. Radar
   c. Over-the-shoulder
   d. Out-the-front

REPORT: (IAW "TPS Reports Requirements," Test Management Phase Planning Guide.)

Results will be reported as a graded homework exercise.

ASTTA GROUND TRAINING CHECKLIST

1. Checklist
   a. Discuss and accomplish all checklist items

2. APG-66 Radar
   a. Discuss radar antenna
   b. Discuss radar control panel
   c. Discuss radar display
      (1) gain
      (2) symbology
      (3) contrast
      (4) intensity
   d. Discuss air-to-air modes
      (1) search
      (2) ACM
      (3) Track (STT vs SAM)
   e. Discuss air-to-ground modes
      (1) ground map
      (2) air-to-ground submodes
   f. Discuss control/annunciator panel
   g. Discuss sensor control unit

3. AN/AAS-36 IRDS
   a. Discuss system components
      (1) IRDS controls
      (2) video indicator
   b. Discuss IRDS modes
      (1) IRDS search
      (2) IRDS ground track
      (3) IRDS slave-to-radar
   c. Discuss IRDS displays
   d. Discuss IRDS control panels
   e. Discuss IRDS control tuning

4. LTN-72R INS

a. Discuss data entry procedures
b. Discuss waypoint coordinate entry procedures
c. Discuss automatic/manual/remote route selection
d. Discuss data display selections
e. Discuss IRDS control tuning

5. TV Sensor
   a. Discuss E-O panel functions
   b. Discuss modes of operation

6. Mission Profiles
   a. Discuss ASTTA 0
   b. Discuss ASTTA 1
   c. Discuss ASTTA 2

F-16 WEAPONS DELIVERY FAMILIARIZATION (PILOTS/FTN)

REFERENCES:

1. T.O. 1F-16A-34-1-1, *F-16 Aircrew Weapons Delivery Manual (Nonnuclear).*
2. T.O. 1F-16A-1, *F-16 Flight Manuals.*
3. T.O. 1-1M-34, *Flight Manual, Aircrew Weapons Delivery Manual.*
4. T.O. 1F-16A-34-1-2, *Ballistics Tables (F-16).*
5. AFFTCR 55-2, Vol I, Chap 12 and Vol II, Chap 8.

PURPOSE:

1. To familiarize pilots and FTNs with no or limited air-to-ground weapons delivery background with the basic piloting techniques and workload required during manual and computed bombing on a conventional range.

2. To evaluate the F-16B in the manual and computed weapons delivery role.

3. To provide an introduction to the requirements and techniques of ground controlled weapons delivery.

AIRCRAFT/SUPPORT:

F-16B loaded with 2 SUU-bomb dispensers and 12 BDU-33 bombs, centerline or 2-370 gallon tanks. Conventional Air-to-Ground Range and a mission frequency are required. Bomb scoring capability is highly desired. A C-Band beacon if required on the aircraft for SPORT tracking.

GENERAL:

1. This flight is an introduction to basic manual and computed, dive, loft, and radar bomb deliveries of conventional ordnance. The BDU-33 is used to simulate a MK-82 low drag bomb. Four events will be briefed and practiced: 30° dive bomb (DB), in both Continuously Computed Impact Point (CCIP) and manual bomb mode; 15° low angle low drag (LALD) in both CCIP and Dive Toss (DTOS) mode; Radar Lay Down (RLD), with and/or without use of an offset aim point; and 30° loft deliveries.

2. On the controlled weapons delivery phase of the mission the dive angle, ground track, and release point are going to be controlled from the ground and the aircraft needs to be precisely controlled maintaining accurate parameters within tolerances. In effect these maneuvers are high speed GCAs often at steep dive angles. These

procedures are used when it is important to place the test aircraft/test article at a precise point in space. There are many reasons why this might be necessary. Examples are establishing test parameters for a sensor lock on to a target, ensuring placement of the aircraft for Cinetheodolite tracking and photo coverage, and establishing required delivery parameters when the test aircraft does not have an adequate or applicable weapons delivery system (sight/HUD, computer, sensors, etc.). In ballistics testing, the ballistics of the new store are unknown so there is insufficient information to compute sight settings or to program weapons delivery computers so the ground controller is used to place the test aircraft at a known point in space. The ground controller is responsible for establishing ground track, dive angle and release point/altitude. The pilot is responsible for attaining the required airspeed and aircraft attitude (normally zero bank angle) as well as cross checking dive angle and altitude (need to confirm bomb range, time of fall). Controllers have been known to set up their plot boards with the wrong release altitudes.

3. Preflight mission planning is critical to accurate weapons delivery. The mil settings for each event must be computed according to the weapons delivery manual or computer program. Winds in the target area must be evaluated to determine their effects on aim points. The range layout should be studied to obtain accurate ground references to aid flying the bombing pattern and rolling into accurate dive angles. Range procedures and foul altitudes for each event must be reviewed. Preflight procedures for bomb inspection and in-flight procedures for bomb release must be understood. Corrections for off parameter deliveries must be determined to aid bombing accuracy.

4. Target elevations are as follow: Superior Valley conventional/nuclear bombing circle - 3156 ft, PIRA PB-1 - 2145 ft, PIRA PB-10 - 2485 ft, PIRA PB-12 - 2827 ft. Use Edwards tower altimeter setting for the East and West ranges and the altimeter setting given by the Range Control Officer (RCO) for Superior Valley.

COMPUTED SURFACE ATTACK (CHECKS):

1. AFTER START COMPUTED CHECKS

a. Stores Management System (SMS) Verification: Verify the aircraft stores loading and review/set the air-to-ground attack profiles.

(1) SMS Load Verification: The SMS must be programmed to reflect the actual aircraft loading. If the SMS is loaded incorrectly: 1) the Fire Control Computer

(FCC) may use improper weapons ballistics/coefficients, 2) improper release options/sequences may occur, and 3) energy management will be in error. You may verify stores loading on the Stores Control Panel (SCP) by depressing INV and depressing STEP to rotary through each type of ordnance. Confirm SMS ordnance loading (type, number, and station) matches actual aircraft load. In addition, insure you have an AIM-9P (quantity 0) loaded so you can use the ACM mode.

(2) Review/Set Profiles: Review air-to-ground attack profiles and modify where necessary. Confirm correct symbology on HUD and Radar/Electro-optics (REO) display for each mode by selecting each mode on the SCP with the Master Arm switch in SIM. Then, select the weapon, profile, and delivery mode for the first attack.

b. Accelerometer Check: Errors in the INS horizontal and vertical accelerometers will result in navigation and bombing errors.

(1) Groundspeed Check: Ground speed on the Fire Control Navigation Panel (FCNP) (POS - V/T) should read zero after alignment and be approaching zero during alignment. Any ground speed reading other than zero when you are still in the chocks indicates errors in the horizontal accelerometer(s). These errors will result in navigation and bombing errors on the range. If ground speed reads greater than zero immediately after alignment, do another alignment.

(2) VVI Check: Note the position of the vertical velocity indicator in the HUD. Any reading other than zero indicates a bad vertical accelerometer which will result in 6 or 12 o'clock errors during computed deliveries. You may consider using a manual release.

c. Computer Mission Data:

(1) Enter enroute and target L/L, elevations, and TOTs (if desired).

(2) Enter B/R and elevations for all OAP, VIP and VRPs.

d. DO NOT taxi with the INS in NORM. If you do, turn the INS function knob to off. Continue to taxi to the arming area and initiate another alignment by typing in the arming area coordinates once you have come to a complete stop.

e. Canopy Coefficients: The FCC uses a series of correction factors to account for the optical distortion of the canopy. These coefficients are checked/entered through the FCNP, data knob - MISC, data opt - C12, C34, C56, C7. These numbers are unique to each canopy and are usually found on a stamp on the canopy rail in the 11 o'clock position. If the numbers on the canopy do not match the numbers in the FCNP, then you can expect bombing errors. You can check/change them with a standard keyboard operation. The coefficients can not be read when the canopy is fully closed. You must check them prior to strap-in or as the canopy is partially lowered.

NOTE: The canopy coefficients are applied to the CCIP pipper and TD box, but not to the other symbology, such as FPM and Bomb Fall Line (BFL). This sometimes results in what appears to be a misalignment of the symbology under certain conditions. For example, the CCIP pipper may not appear exactly on the end of the BFL, or the TD box in DTOS may not be exactly superimposed over the FPM prior to designating. This is not highly unusual. Use the CCIP pipper for aiming even if it is slightly misaligned with the BFL.

2. ARMING AREA COMPUTED CHECKS

a. As soon as you stop in the arming area, check your ground speed and HUD VVI.

(1) If ground speed is zero or 1 knot, the INS platform is good. Press on.

(2) If ground speed is 2 or more, the platform alignment is bad. If possible, accomplish another alignment.

b. Accomplish an automatic altitude calibration after the EPU check by checking/entering the current field elevation in the LMD with the data knob in POS, E/A in the alpha display, and then MODE SEL. This procedure sets system altitude to the number in the LMD and automatically updates the D-value.

3. AIRBORNE COMPUTED CHECKS

a. HUD VVI: When in level flight, indicated by pitot static VVI and altitude, check for zero HUD VVI. If it is not zero, INS vertical velocities are in error. Expect degraded 6-12 accuracy in all computed deliveries, particularly DTOS. You will probably get better results in CCIP.

b. Altitude Calibration. Anytime you suspect errors in system altitude, an altitude calibration using radar AGR (air-to-ground ranging) should be performed before bombing where system altitude is used for ranging. One indication of bad system altitude is TD box movement to 6 or 12 o'clock as range to destination decreases.

(1) Check the following:

(a) SCP reading PWR ON and/or Master Arm in SIM or OFF.

(b) FCNP Dest thumbwheel--SET.

(c) RCP Mode--above STBY.

(2) FCNP:

(a) Data Knob--ALT CAL

(b) Data OPT button--Depressed (if RDR not displayed)

NOTE: For blind ACAL, radar cursors should be slewed over destination or OAP return prior to mode selection.

(3) RDR CURSOR/ENABLE--Slew the TD box or OAP diamond over the appropriate point.

(4) Mode SEL button--Depressed. Check for the ACAL mnemonic in the HUD.

(5) Check slant range decreasing smoothly on HUD readout and check height above thumbwheel destination on RMD.

(6) Designate button--DESIG. ACAL accuracy is increased at larger antenna look-down angles. Avoid look-down angles of 10° or less.

(7) DATA OPT BUTTON--Depress (DVL displayed).

(8) Check LMD for D-value and compare with forecast D-value.

(9) If you suspect you have a bad system altitude and your AGR is bad, you can still update the D-Value/system altitude. Fly level with a fellow flight member who has a good system altitude, and enter the D-Value in the LMD with DVL displayed.

COMPUTED BOMBING:

The mechanics of computed bombing are relatively simple. However, your ability to manage the system can greatly improve your scores from merely qualifying to outstanding. General procedures and philosophy apply to any dive-angle delivery.

1. CONTINUOUSLY COMPUTED IMPACT POINT (CCIP)

a. Normal Release

(1) Initiate the CCIP delivery mode on downwind by selecting air-to-ground (AG), the appropriate attack profile, and CCIP on the SCP. If you're in another delivery mode, you can select CCIP by depressing the NWS button. Verify the correct single/pair option (usually single). Also verify the number of weapons remaining. Place the Master Arm switch to ARM and check for RDY on SCP, and CCIP and ARM in the HUD.

(2) Execute the final turn using a smooth roll-in and rollout, compensating for the wind and turn radius. Disregard the bomb fall line (BFL) and CCIP pipper during roll-in. Concentrate on rolling out with the FPM at 12 o'clock to the target on your planned Aim Off Distance (AOD). The target should be approximately half way between the FPM and the CCIP pipper at roll-out, depending on the event (See Figure

3.8). The target should be approximately two-thirds down from the FPM for LALD, equating to an AOD of 2,200 feet. Use one-half way for DB, equating to an AOD of 1,600 feet. Placing the FPM on the exact aim off point works well on controlled ranges where you might have specific aim off markers. However, on a tactical target (strange environment) your best method to set the AOD is by the target-to-BFL relationship. At roll out, place the target the proper distance from the FPM. Now freeze the FPM on that spot and allow the CCIP pipper to approach the target as you steer out any azimuth errors. Don't pull the FPM up in an effort to rush the pass. You will release higher than planned. Remember, 3 to 5 seconds on final is fast enough, don't rush it any more than that by "pulling" the pipper up to the target.

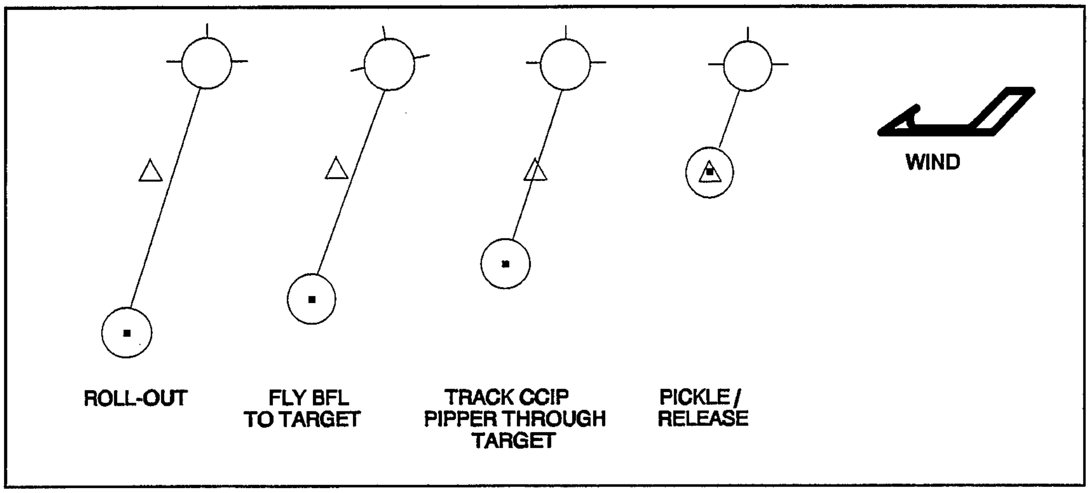

FIGURE 3.8 CCIP SYMBOLOGY

(3) Once established with the FPM at 12 o'clock to the target the Bomb Fall Line (BFL) will be near the target. Fly the aircraft to put the target under the BFL.

(4) Bank as necessary to keep the BFL through the target and walk the CCIP pipper smoothly up to the target. Avoid the common error of allowing the FLCS to raise the nose and thus creep the FPM beyond the desired AOD. This may be avoided by trimming nose down a little on base.

(5) Pickle when the CCIP pipper reaches the target. Designation in CCIP is with the pickle button (hold it down) and release is normally immediate for low drag weapons.

(6) Recover after bomb release and/or in time to adhere to recovery minimums.

b. Wind Corrections. Since the CCIP mode is a computed bombing mode, the effects of winds are automatically compensated for so the position of the CCIP pipper shows where the bomb will impact if you depress the pickle button. However, your job as the pilot is to get the pipper over the target and to do that, you need to consider the winds. The headwind/tailwind component is corrected for in the computer by the CCIP pipper being moved up or down along the BFL. Most of the crosswind correction is made by the drift stabilization of the FPM and associated symbology. As long as the drift cutout switch on the HUD is in the NORM position, the technique of placing the FPM close to 12 o'clock and the BFL through target will cause the nose of the aircraft to be crabbed into the wind. This crabbing causes the aircraft to fly over the target, thus compensating for most of the crosswind. However, with strong winds and/or high drag weapons, there is additional correction required to account for bomb trail. Once again, the pipper will always represent the actual impact point, but the BFL may appear sloped to the downwind side. Under these conditions you may wish to place the BFL slightly upwind of the target on the initial rollout.

NOTE: Do not use DRIFT C/O on HUD while in the CCIP mode. If drift cutout is selected the FPM and BFL will not be displaced downwind; however, the pipper will still show the impact point. Thus, the line between the FPM and pipper will be angled excessively and you'll find yourself in a near-constant bank keeping the target under the BFL.

c. Delayed Release. If the impact point is beyond the HUD FOV (aircraft in a bank), an "X" will appear in the CCIP pipper. For release conditions where the bomb impact point is under the nose of the aircraft, the CCIP pipper cannot be positioned low enough in the HUD at the instantaneous impact point. In this situation, the CCIP pipper is positioned approximately 14 degrees below the boresight cross and time delay is computed, based on the difference between the pipper position and the actual impact point. The presence of the time delay cue indicates this situation exists (See Figure 3.9).

(1) This delivery is exactly the same as the normal release up to the point of pickle.

(2) If the time delay cue is present, hold the pickle button depressed. Steering symbology, will appear.

(3) Fly the FPM to the steering line to null any steering error (just as in a DTOS delivery) while holding the pickle button down.

(4) Release will occur when the solution cue reaches the FPM. In most

situations the delay will be very short, i.e., less than one second, and you may even miss the post designate symbology prior to release. Your indication that release has occurred is a flashing FPM. Release the pickle button after the FPM flashes. It is a good habit to hold the pickle button down until well after the FPM flashes. This insures you will get all bombs off when you begin rippling a string of bombs rather than dropping just one.

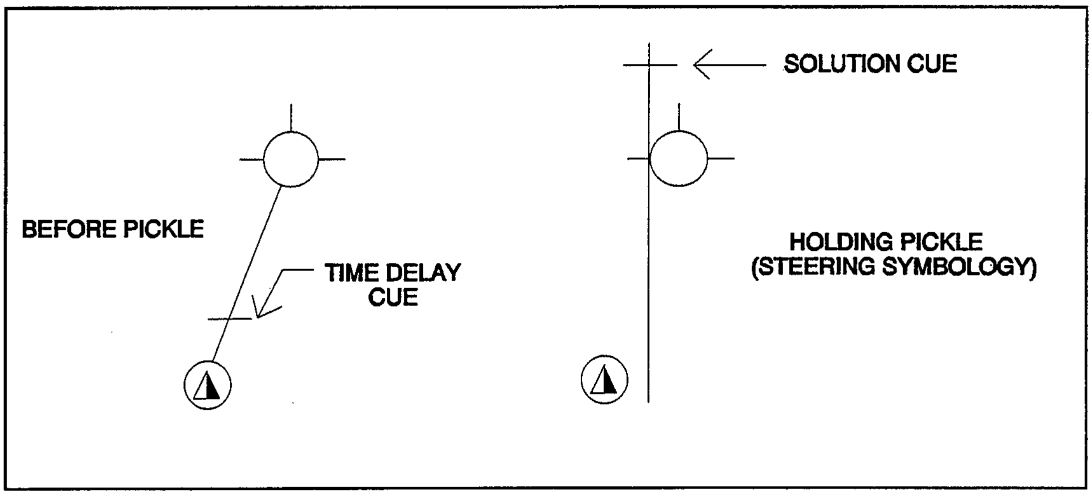

FIGURE 3.9 CCIP Delay Cue Symbology

2. DIVE TOSS (DTOS)

a. The DTOS pattern.

(1) Initiate DTOS on downwind by selecting air-to-ground (AG), the appropriate attack profile for the weapon, and DTOS on the SCP. Verify the desired single/pair option and number of weapons remaining. Check for caged symbology in the HUD. Recheck Master Arm switch ARM, RDY on SCP, and DTOS and ARM in HUD.

(2) You probably want radar AGR, so check the RCP mode knob in any position except OFF or STBY and the radar will automatically select AGR in the DTOS submode. Turn base slightly wider than the point used for manual events since you

do not need the AOD used in manual deliveries.

(3) Also check the steerpoint you've selected. If the radar works properly, the steerpoint won't be important. But, if the radar breaks lock for 3 seconds, the FCC will use the elevation of the steerpoint as the target elevation when computing a BARO solution. This is commonly referred to as BARO bombing.

(4) Execute the final turn using a smooth roll-out, compensating for wind and turn radius. Roll out on final with the aircraft flight path directly in line with the target and the FPM the desired distance short of the target. This position is described below under the individual aiming methods.

NOTE: It is possible to "press" or delay designation/final aim until past the point of desired computed release. This will result in no release, a gross error bomb, and/or a dangerous pullout.

(5) Fly out the azimuth error and insure you hold the pickle button down when the solution cue approaches the flight path marker.

(6) Execute a standard recovery when the bomb release occurs and/or in time to adhere to recovery minimums.

(7) Continue in the pattern as briefed using the score and other observations to improve the accuracy of the next pass.

b. Point-Blank Aiming. Point-blank aiming is the simplest method from a mechanical pilot skill standpoint (See Figure 3.10).

(1) Roll out on final approach with the FPM and caged TD box short of the target. Since the TD box is initially HUD stabilized you may "pre-slew" the TD box slightly below the FPM. Some find this helps them get the TD box on the target but beware of pendulum effect since the TD box is not yet ground stabilized.

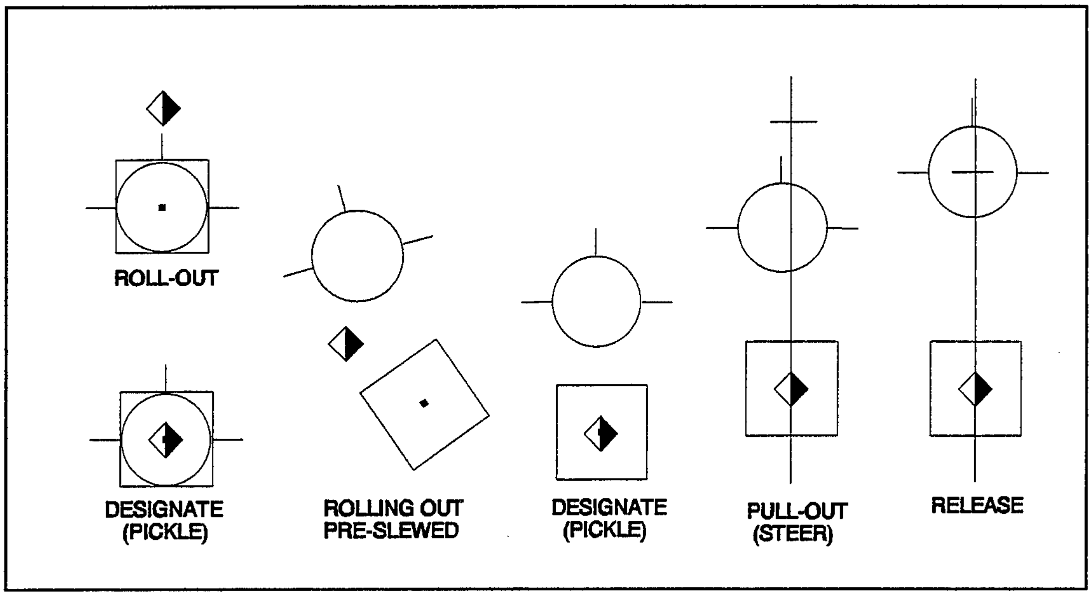

FIGURE 3.10 DTOS-Point Blank Aiming

(2) With your eyes focused on the target, bring the TD box pipper smoothly up towards the target, reducing the rate of movement as it comes to bear on the chosen aim point. Track for a split second and designate with the pickle button or designate button. When you designate, the TD box becomes ground stabilized. Designating with the pickle button and holding it until release is the easiest method. If you do designate with the designate button, you'll have to depress the pickle button prior to the solution cue reaching the FPM. Hold the pickle button depressed until the solution cue intersects the FPM and the FPM begins to flash to indicate release. The FPM will continue to flash until you release the pickle button.

(3) Initiate a smooth, recovery-type pull keeping the FPM centered on the steering line. You can continue to pull into the true recovery which results in a "dive toss" delivery or you may relax the pull when the FPM is roughly 1,500 - 2,500 ft at 12 o'clock (See Figure 3.11). This will result in a "straight dive-glide" release. Theoretically, "dive toss" is as accurate as the "dive-glide" release. However, due to the possibility of an erroneous vertical accelerometer, the "dive-glide" technique may prove to be more reliably accurate.

CAUTION: Do not press a dive-glide release to the point that you cannot recover above the minimum safe altitude (foul altitude). When making a dive-glide release you should designate slightly earlier than for a dive-toss release and stop or slow the rate of FPM movement in the vicinity of the aim off distance for the delivery you're doing.

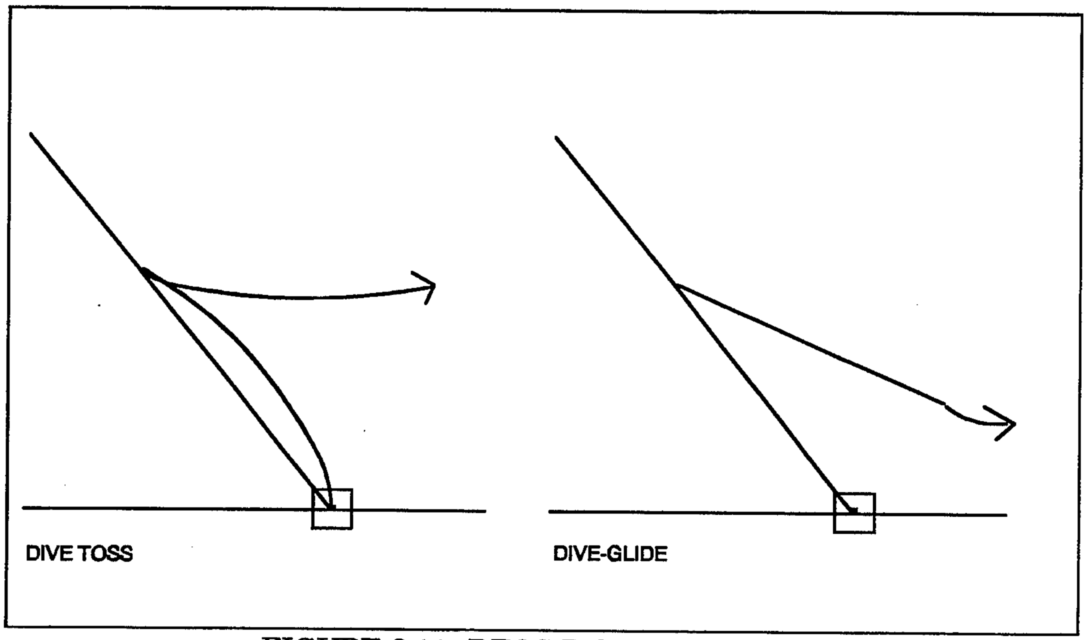

FIGURE 3.11 DTOS-Release Techniques

(4) After designation in point-blank aiming, watch the TD box for drift as you approach release. You can refine aiming using the radar cursor/enable button to place the TD box back on the target.

(5) You can get accurate bombs even if the TD box drift is toward 3 or 9 o'clock by disregarding steering and visually flying the aircraft directly over the target. You can also use this technique if the TD is off to the side when you designate.

(6) For most practice when making multiple dive toss attacks, recage the TD box to the FPM after each release by designating. If you don't, the TD box will stay on, or near, the target from pass to pass.

c. Slew Aiming. This method of aiming provides maximum flexibility in tactical situations, but mastery is most difficult. It is possible to slew aim regardless of aircraft attitude as long as the aim point is within the HUD field of view. Remember that directional control of the TD box is always referenced to aircraft attitude.

Develop slew aiming skill as follows: (See Figure 3.12)

(1) Roll out on final with the FPM/TD box near the target.

(2) Adjust power, if necessary, before you start to slew.

(3) Slew the TD box directly toward the target aim point. Move the cursor/enable button as if you were slewing the radar cursors.

(4) When the TD box is on the aim point, designate. At designation the TD box stabilizes and the steering line will appear and command steering corrections.

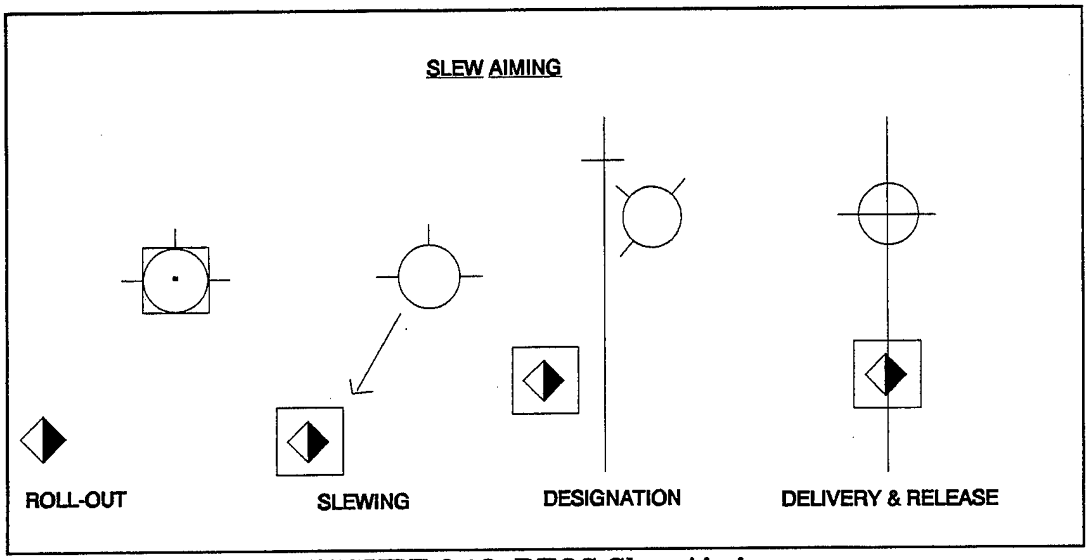

FIGURE 3.12 DTOS-Slew Aiming

(5) "Fly" the FPM toward the steering line and roll out when they coincide.

(6) Observe the solution cue progress, keep the FPM on the steering line, and complete the delivery as described in Point-Blank Aiming. If you have neglected to fly out the azimuth error while slew aiming and the solution cue is approaching the center of the FPM, you have three options:

(a) Abort the release (thumb off pickle button).

(b) Accept the error.

(c) Fly out as much error as you can and accept the result. This is preferable to accepting the error in all cases and usually better than aborting the pass. The closer the FPM is to the steering line, the better, but do not release with greater than 5° bank angle. Be careful not to violate current Dash-1 release limitations for the type bomb you are dropping.

(7) You can continue to slew after designation. In this case the TD box is ground stabilized so you are moving it over the ground rather than in relation to the FPM. In addition, each time you slew, the FCC takes a new radar range sample.

3. CONTINUALLY COMPUTED RELEASE POINT (CCRP)

a. Introduction. You normally use CCRP for making level attacks but you can use it for toss attacks as well. You'll get HUD and REO steering to the selected steerpoint (See Figure 3.13). If you've typed in offset data, you can also use the offsets to help find the steerpoint. In addition to HUD steering and time-to-release you'll see a 100 mil circle two seconds prior to the maximum range toss cue when you get close enough to the steerpoint that a 5g pull-up to 45° of pitch will get the ordnance on target.

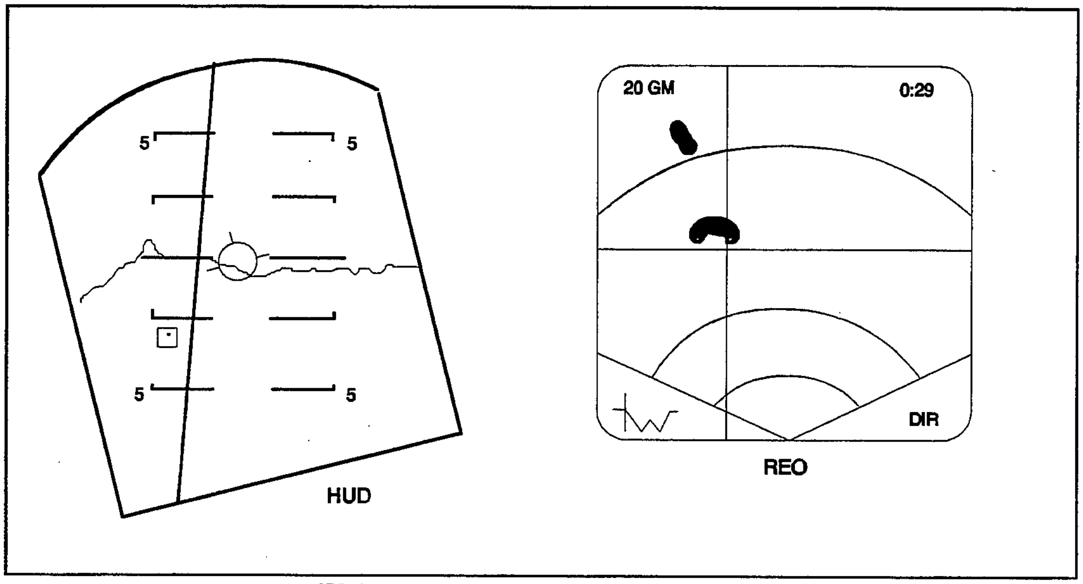

FIGURE 3.13 CCRP Symbology

b. Operating Procedures for Dir Aim CCRP (RLD event)

(1) FCNP. Data Knob not in DEST and Thumbwheel to destination. Ensure you are in Dir Aim with the Fire Control Radar (FCR) in auto or GM. On the SCP select AG, weapon profile, and CCRP. Put Master Arm in SIM or ARM (on range only.)

(2) Employment.

(a) Range is BARO ranging because you are in CCRP and AGR is not available. So, check your system altitude and do an ACAL if necessary.

(b) Select the lowest radar scope range that will show the steerpoint. Use the HSI DME initially, and then keep the cursors in the top-half of the scope. Check for DIR in the lower right corner of the REO.

(c) With the antenna elevation knob in the detent, the radar should be pointing directly at the thumbwheel coordinates and the radar cursors should be close to the steerpoint. As you get closer, the FCC will automatically control tilt to keep the steerpoint illuminated (elevation knob in the detent).

(d) You must control receiver gain to get the best return. Go big to small and bright to dim. Don't jump onto the first bright spot you see on the REO and move the cursors to it.

(e) Once you locate the steerpoint return or its area, move the cursors over its center. RTN-TO-SRCH to see more detail in EXPAND.

(f) As you get closer you'll probably have to reduce gain and the radar range to keep the cursors in the top half of the REO. Use of "hands on" radar gain control on the throttle is highly recommended.

(g) Fly the FPM to the CCRP steering line and look for the steerpoint in the TD box. Time to release is available in the HUD and REO. The time in the REO is always time <u>to</u> release.

(h) Two seconds before you arrive at max toss range (where a 5 g pull up to 45° will loft the bomb to the steerpoint), you will get a 100 mil circle in the HUD. This is the max toss anticipation cue. It will begin to flash at max toss range and the FCC will put a solution cue high on the steering line. The 100 mil circle will flash for two seconds and disappear. The solution cue will drop towards the FPM as you get closer to the computed release point.

(i) If you're going to bomb the steerpoint, you have a choice of delivery g and pitch. You can pull up to 45° and loft the ordnance, continue in level flight across the target, or anywhere in between.

<u>1</u> Check for RDY in the upper-left corner of the SCP and pickle and hold prior to the solution cue reaching the FPM or before time-to-go equals zero. When the solution cue reaches the FPM, the bomb will release and the FPM will begin to flash and continue flashing until you release the pickle button.

2 After release, turn to crosswind if you're going to stay in the bombing pattern. On downwind, set up the radar (20 mile scope and gain up), SCP for the next attack, and Master Arm out of Arm if necessary.

c. You may use offsets to help find the steerpoint. In some cases, the point might not be radar identifiable so an OAP would be mandatory for a non-visual attack. In other cases, the steerpoint might be definable, but another point might provide better resolution, e.g., you might select an OAP to the side of your ingress track so you could use DBS.

Enter OAP data in DEST. (This should be done in the CHOCKS)

(1) Place the steerpoint you wish to associate with the OAP under the thumbwheel.

(2) Push the appropriate OAP button on the FCNP.

(3) Enter true bearing (to the nearest 0.1 degrees) from the steerpoint to the OAP in the LMD.

(4) Enter the distance (to the nearest foot) between OAP and steerpoint in the RMD.

(5) Data OPT to E/N then enter the OAP elevation.

d. Radar work with an OAP is essentially the same as without one. In fact, it's so similar that it's easy to get confused.

(1) You must insure the return you're putting under the cursors and the DIR AIM-OAP button you've pushed correspond or else you'll be in for a rude surprise. For example, on many ranges a radar reflector is in close proximity to the target. In such a case, it would be very easy to be in DIR AIM but refine on and bomb the reflector.

(2) Always look at the big picture first. If your DR was any good at all, you should be heading right at the steerpoint. Thus, the cursor intersection is going to be on the REO centerline. While in a non-expanded mode, select OAP1 and OAP2 and see if the cursors jump approximately where they're suppose to go. If you see a jump in the wrong direction, you better check the FCNP data. Once you're certain you're looking at the right return, expand the presentation. If you expand without first checking for cursor jump, it's sometimes difficult to catch an error because the cursors remain in the center when you change DIR AIM-OAP selection in expand.

(3) Remember, whether or not you're in DIR AIM or OAP with the Master Arm out of OFF, HUD and REO steering is always to the steerpoint (corrected for any cursor inputs).

4. LOFT DELIVERIES. LOFT delivery profiles are compatible with air-burst freefall weapons or when attempting to deliver freefall weapons in a standoff manner.

a. Introduction. Target and OAP selection and radar sighting same as for CCRP delivery.

(1) When using the LOFT delivery mode, you must enter a planned release angle (PRA) and a minimum release altitude (MRA) into the SMS via the SCP. If the MRA above ground level (AGL) is a nonzero value, a release will not occur below the entered value of altitude (AGL). The PRA for this event will be 30 degrees and MRA of 500 ft AGL.

(2) The HUD LOFT display includes a target symbol that represents the target location and a diamond symbol that represents the offset aimpoint location (if selected). The FCC computes azimuth and elevation steering commands and transmits them to the HUD and REO displays. The pilot uses these azimuth and elevation commands to fly the aircraft toward the release point. At 10 seconds to go to pullup, the pullup anticipation cue is displayed on the HUD and moves toward the FPM. The solution cue is displayed at the top of the Bomb Fall Line (BFL) and indicates the relative time to release. If a low-drag weapon is selected, the release angle scale (RAS) is also displayed, offsetting the altitude scale. To the left of the RAS a horizontal line is positioned at the planned release angle. A caret is also displayed that represents the angle that release would occur if a 4g pullup was initiated at that moment. When time to go to pullup equals zero the pullup anticipation cue resets below the FPM and becomes the pullup steering cue. A 30-milliradian circle is positioned half the distance between the PRA and the FPM as a guidance to the PRA.

(3) If the pilot depresses and holds the WPN REL (pickle button) switch, the FCC will generate an automatic release signal when calculated conditions are obtained and the altitude is greater than the entered value of the minimum release angle. LOFT symbology is illustrated in Figure 3.14.

b. Operating Procedures - LOFT.

(1) Program MRA and PRA into SMS. Ensure the data knob is not in Destination and the Thumbwheel is on target. Ensure you are in DIR AIM with the FCR in Auto or GM on the SCP select AG, weapon profile and LOFT. Put Master Arm in SIM or ARM (on range only).

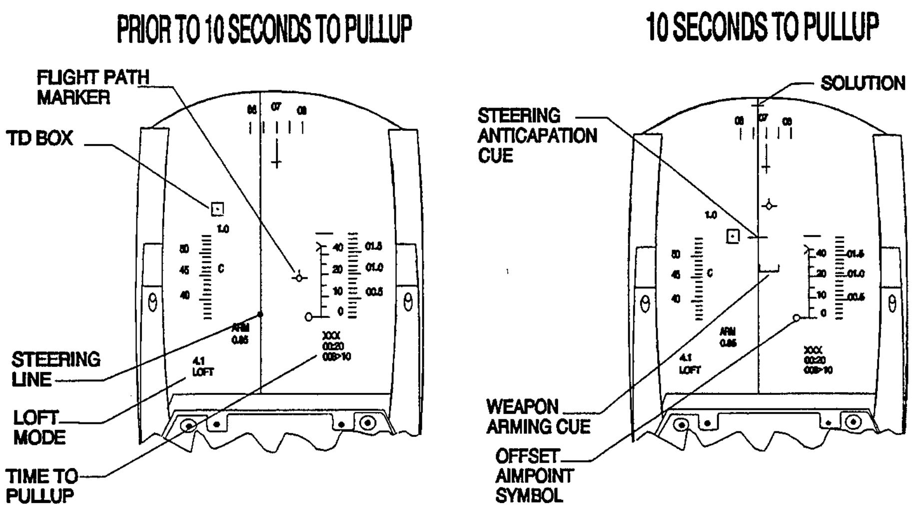

FIGURE 3.14 Loft Mode Symbology

(2) Employment.

(a) The use of the radar is the same as in CCRP RLD.

(b) Fly the FPM to the steering line on the HUD. At 10 seconds to pullup, the LOFT pullup anticipation cue is displayed and approaches the FPM.

(c) Initiate a 4g pullup to the planned release angle when time to pullup equals zero. Note the LOFT pullup anticiation cue on HUD becomes the pullup steering cue. And a 30-milliradian circle is positioned halfway between the planned release angle and FPM.

(d) Maintain FPM on steering cues displayed on HUD.

(e) Depress WPN REL switch on the Side Stick Controller (SSC) prior to time-to-release of zero and hold until automatic weapons release. When solution cue reaches center of FPM, time-to-release will be zero and bomb will be released automtically. 30-milliradian circle and pullup steering cue are turned off 2000 feet after target flyover.

NOTE: The letters "LO" are displayed and flashed to indicate an unsafe condition when the aircraft is 300 feet radially below the computed maneuver profile. Before 10 seconds to pullup and after weapon release, a flashing "LO" will indicate improper fuse arming.

(3) Special Operating Considerations - LOFT.

(a) Release Angle Caret. When the caret is displayed at the 45-degree tic on the release altitude scale, the maximum toss point is reached. When the caret is at the zero-degree tic, the aircraft is at level release conditions. The aircraft will no longer be within release conditions for a release when the caret is limited to the zero-degree tic. The path of the caret is limited at zero degrees.

(b) HUD Sighting. The A/G TD box displayed on the HUD can be used for target designation since the cursor slew commands update both the radar and the HUD sighting cursors. However, in this mode the cursor movement is optimized for REO operation unless the FCR is placed in STBY via the RCP MODE knob. The offset aimpoint symbol (a diamond) or the reference point symbol (a circle) on the HUD can also be used for sighting.

(c) Altitude Calibration. Since altitude error is a significant contributor to weapon delivery error, accomplishment of an altitude calibration as near to the target location and release conditions as practical will minimize this contribution to miss distance.

(d) Unsafe Conditions. A flight path 300 feet radially below the flight path model will cause a flashing "LO" to be displayed in the center of the HUD indicating an unsafe flight path. A flashing "LO" before 10 seconds to pullup or after weapon release indicates improper fuse arming.

(e) FCC Inhibit. The FCC will inhibit weapon release if the aircraft is below the entered minimum release altitude and LOFT has been selected.

(f) Software Code Restrictions. If the same target is reattacked, a 5 mile run-in is needed to reset the parameters used to condition the software. If this cannot be achieved exit A/G and reenter the mode.

5. COMPUTED DIVE BOMBING ERROR MANAGEMENT. (OPTIONAL)

Eons ago when computed delivery systems first arrived in the USAF, there were those who said they would only bet on manual bombs. Their reasoning was sound, for surely the magic boxes would make all pilots equal and the bets would be between "systems" not the pilots. It did not, and has not turned out that way. The same people keep dropping the best bombs and winning the money whether the bet is on manual or computed bombing. Why? They know more about the system and thus are able to apply error analysis prior to and on the range. While the complexity of the system does not allow for easy error analysis, there is a way to organize computed error analysis which will not only improve your bombs, but also result in better write-ups. And, better systems lead to better bombs. There are three main sources of error when the F-16 drops a bomb: you, the INS, or ranging.

a. You. Before you blame the INS or change the ranging mode, look within yourself.

(1) Did you really designate/pickle with the TD box/CCIP pipper stabilized on the desired aimpoint?

(2) Were you pushing and pulling on the pole after designation? True, the system is supposed to handle ham fists, but some modes/systems just can't handle them as well as other systems.

b. Make sure you are not the problem before you delve further into the mystery of that "50 meter at 12 bomb." Be consistent on all your passes. Accurate error analysis depends on having similar parameters on each pass.

c. Once satisfied you are not the problem, there are some things you can do to determine whether the INS or the ranging mode is at fault. The first step is to understand these basic principles:

- Ranging errors cause 6/12 o'clock misses only.
- INS errors may be in any direction.
- The magnitude of an INS error depends on the time from designation to bomb impact and will, in general, be small for visual bombing.

With these principles in mind let's look at some simple examples. To observe the effect of errors, it is necessary to have ground stabilized symbology to look at. Let's first look at DTOS.

(1) First pass. The TD box was on the truck--bomb hit 60 at 12, release was in either a smooth dive glide or at a constant g. Eliminating "You" as the problem, the bomb hit 60 at 12 either because of an INS problem, a ranging problem, or a combination INS/ranging problem.

(a) FIRST: Leave the target designated (DTOS).

(b) As you roll in on your second pass you see the TD box 40 feet at 12 o'clock (Figure 3.15). Any INS error will affect the bomb impact in the direction of TD box drift. As a rule of thumb the INS drift will affect the bomb by approximately 10 percent of the drift distance between passes. In this case the INS affected the bomb

4-5 feet. That leaves the other source of error--the ranging mode. Your correction is either aim short (60/6) or change the ranging.

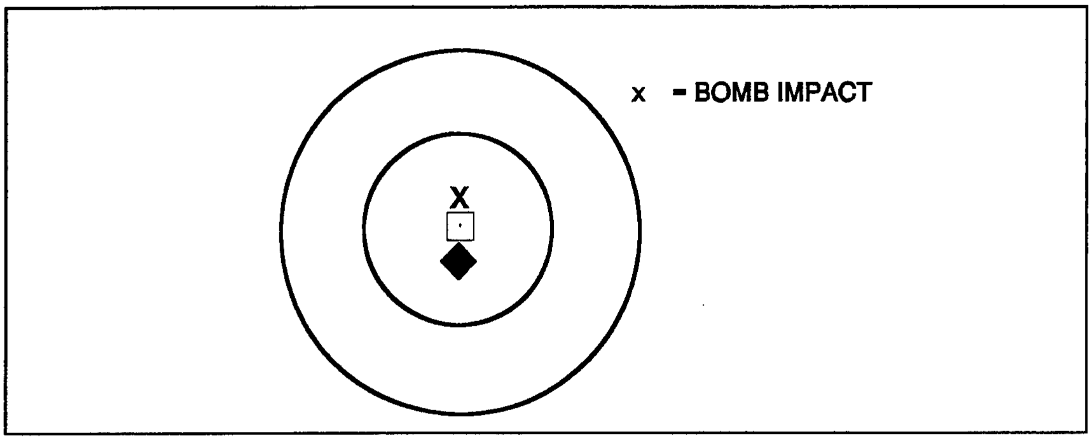

FIGURE 3.15 Error Analysis I

(2) Okay, that was easy. Now try this one. You aimed at the truck and the bomb impact was 60/12. The second pass shows the TD box 200/6 (Figure 3.16).

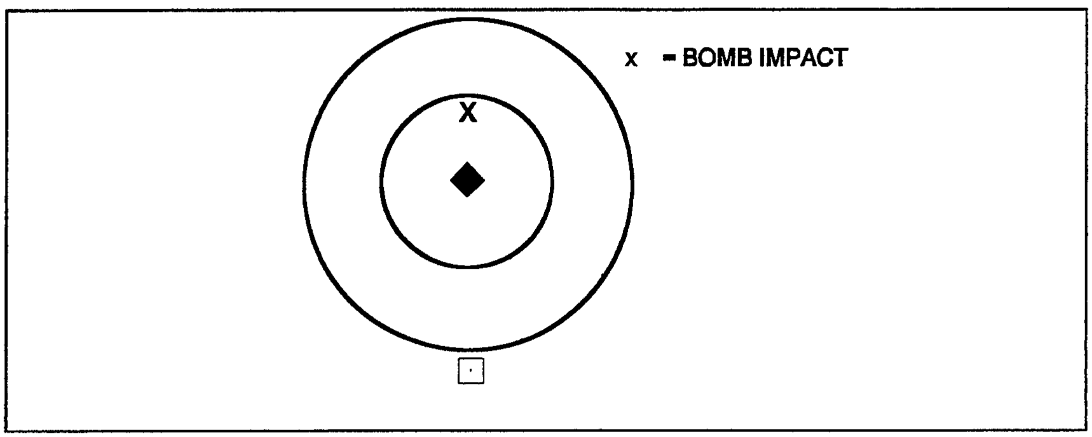

FIGURE 3.16 Error Analysis II

(a) Again, the INS error affects the bomb in the direction of drift. By applying the 10 percent rule the bomb should have hit 20/6; but it did not. The bomb hit long. Again, bad ranging is the problem. Had there been no INS drift the bomb would have been 80/12. Your correction is either aim short (60/6) or change the ranging mode.

(b) Next example: The bomb impact is 60/12. The second pass shows the TD box 600 feet at 12 o'clock (Figure 3.17). This one is easy. 10 percent of 600 feet is 60; thus, INS error is responsible. With an INS error you have two choices:

1 Aim opposite the direction of drift by 10 percent of the amount of drift between passes.

2 Go manual when aiming symbol drift is more than you can or want to compensate for.

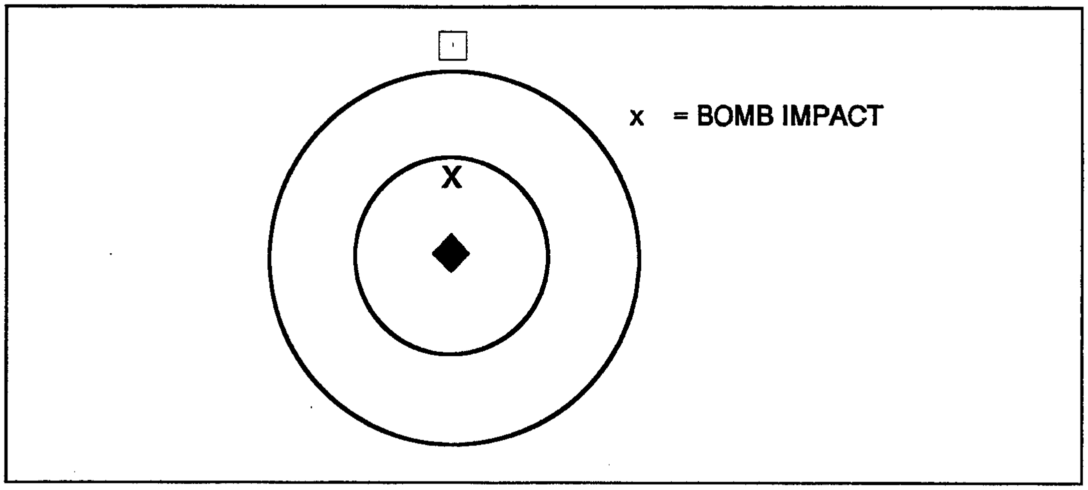

FIGURE 3.17 Error Analysis III

(3) In another example; bomb impact is again 60/12. The TD box is only 300 feet at 12 on the second pass. Ten percent of 300 feet is 30, so it appears that the error would be equally divided between the INS and the ranging mode.

(4) So far, the TD box has been conveniently at 6 and 12. Let's progress to a more common problem.

(a) The bomb hit 50/6. Eliminating "You" from the problem, this is what you see when you roll in the second time. The TD box is 400 feet at 4-5 o'clock

(Figure 3.18). A quick eyeball shows that the aiming symbol is about 200 feet <u>short</u> on the run-in, thus accounting for about one-half the impact error.

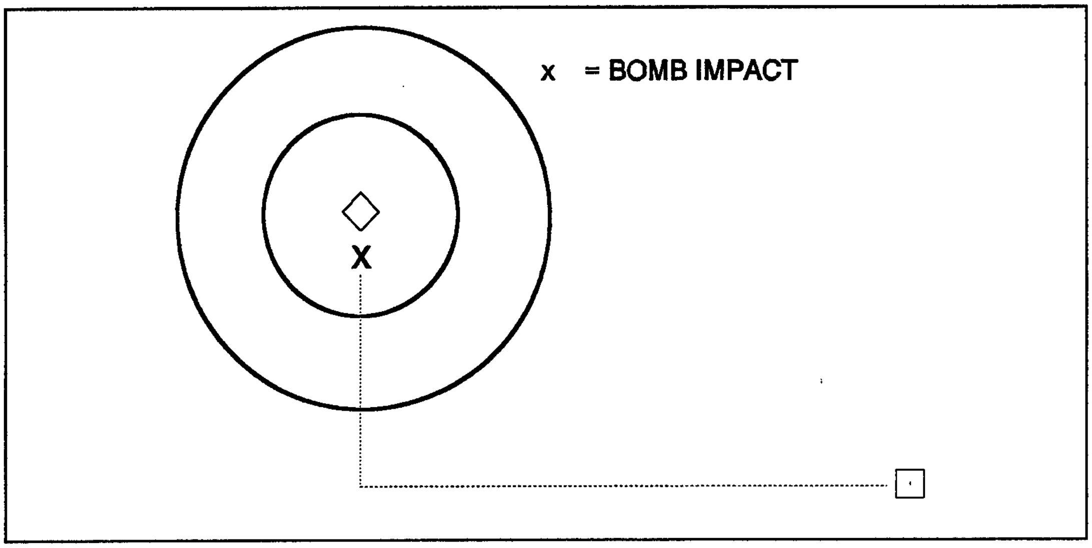

FIGURE 3.18 Error Analysis IV

(b) Why didn't the bomb hit to the right? Only if you follow the steering line will TD box azimuth drift affect the bomb. You'll probably get more bulls in low angle events by aiming at 6 or 12, as appropriate, and flying over the target disregarding the steering line. Strong crosswinds or long slant ranges will require you to use the steering line more.

(c) CCIP Analysis: The most common method for CCIP error analysis is the actual bomb impact versus the pipper placement at pickle. INS error and ranging errors affect the problem just as in DTOS, but CCIP minimizes INS errors. In CCIP you have one way to tell drift. Assuming the target is in the selected thumbwheel position, you should have a diamond over the target (or close by) in CCIP (or DTOS) which can be observed for INS drift. By remembering the basic principles you can get a good idea of the problem. Misses left or right are normally due to INS problems. Large misses short or long are probably a ranging problem. Small misses short or long could be either.

(d) The previous discussion should serve to give you an awareness of the types of errors and their symptoms, but the main thing you need to know is what to do in order to get the "bull". You may have noticed in the previous discussion no matter what the source of error was, the solution for the next pass was to adjust your aim point. This applies to CCIP as well as DTOS. You simply "go to school" on your first bomb.

RULE OF THUMB: To correct a known error simply aim that distance in the opposite direction.

d. When what is happening to your bombs bears no resemblance to anything that has been covered, the best advice would be to:

(1) Make your passes consistent.

(2) Try to eliminate sources of error. It's easier to get the exact cause if you narrow the choices.

(3) Collect as much data as possible so your writeup can be as meaningful as possible. (This is what being a tester is all about.)

(4) Go manual.

e. Let's look at a few other considerations to maximize our "target" potential.

(1) Ranging error may or may not be constant. System altitude will usually be consistent. Radar ranging will often vary with slant range (boresight error). Taking a constant system altitude error for example, it is a fairly simple problem to figure out how much to move your aimpoint as you change events. If in 30-degree DB you're aiming 50 feet short for a pure ranging problem (and getting shacks), you need to aim to 1.7 X 50 or 85 feet short when you go to LALD.

(2) Impact error due to INS drift will be primarily a function of bomb time of flight.

(a) The average time-of-fall for both: LALD and DB is 7 seconds.

(b) Let's assume you started with a 30 degree DB and had to aim 50 feet at 6 to get a bull due to the INS error. If your next event was 15 degree LALD which has considerable less bomb TOF (4 seconds vs 7 seconds), you should move your aimpoint to 30 feet at 6 o'clock.

(3) To summarize, if all you did was aim opposite the last bomb impact, you would probably get good bombs, but you're going to suffer as you change events and the analysis of bombing results will be meaningless if you don't know the source of bomb error. If possible, view the TD box drift between passes, compare bomb impact with drift and use the 10 percent rule to tell you whether the INS or the ranging is at fault.

6. COMPUTED DIVE BOMBING AND RANGING/METHODS CONSIDERATIONS

a. Ranging. Your selection of a ranging mode is critical when it comes to optimizing your hit probability. There are several factors which affect your choice of a ranging mode. What type of pattern will you be flying: box, pop, or curvilinear? Over what kind of terrain will you be flying? How about the dive angle? Will it be steep or shallow?

(1) Radar. Assuming all modes are operating properly, radar is the primary ranging mode. If using point-blank aiming, do not designate early unless you plan to slew for refinement because the last ranging sample will have been at designation.

(2) System Altitude. If you suspect AGR is in error or is inconsistent, BARO ranging may be preferable to radar ranging particularly in steep dive angles, curvilinear, or pop-up patterns over rough terrain. Better bombs using the BARO ranging occur with steep, rather than shallow dive angles.

(3) In any case, prior to dropping for quarters:

(a) Analyze each ranging mode for system operation.

(b) Analyze the events.

(c) Analyze the terrain.

(d) Plan a mode that optimizes your hit probability.

(e) Determine the method of weapon (bomb) delivery.

b. Method.

(1) The F-16, with its sophisticated avionics package, gives the pilot several visual bomb delivery options. Specifically, the ordnance can be released in the following ways:

(a) Computed Delivery.

1 CCIP

2 DTOS

(b) Manual Delivery.

1 Manual Delivery with HUD and computer.

2 Manual Delivery with HUD and without computer.

3 Manual Delivery without HUD or computer.

The preceding list makes it obvious the method of delivery is dependent upon the equipment available. To determine the method to be used, consider the following:

(2) Full computed delivery is usually preferred due its inherent accuracy and independence from precalculated dive angles, airspeeds, altitudes, and winds. Computed delivery is dependent, however, upon the following:

(a) An operable computer.

(b) Accurate INS fine alignment (good INS velocities).

(c) An accurate ranging reference (radar or system altitude).

(3) Should any of these three prerequisites be unavailable, some degraded method of delivery is in order. If all are available and accurate, there is little or no reason to deliver in other than computed mode.

(a) If the FCC computer is inoperative, there is no choice other than to deliver manually. This can be done with the help of the HUD, which will still provide airspeed and altitude scales along with pitch lines and FPM.

(b) If the computer is operable and ranging is accurate, but inertial velocities are inaccurate, computed delivery may be extremely difficult or impossible. Consider going manual.

(c) If AGR is bad, go BARO by turning the radar to STBY. The FCC will now be using the CADC system altitude in its bombing calculations. The accuracy of the bombs now depends on the accuracy of the system altitude. If the system altitude is correct, your bombs will be as good as with good AGR. If it is incorrect, the 6-12 error will be consistent for each type of delivery. Correct for these errors as discussed in the previous pages.

(4) In determining the method of weapon delivery:

(a) Confirm the computer status.

(b) Determine the accuracy of your INS alignment.

(c) Appraise the accuracy of the radar and barometric ranging.

(d) Choose a computed delivery if all systems are good.

(e) Choose a computed delivery without the HUD if the HUD has failed but computer is good (backup DTOS).

(f) Choose manual delivery aided by the HUD if the computer is inoperative.

(g) Choose manual delivery without the HUD if it has failed and the computer is also inoperative.

(5) Practice these various methods of delivery often since each involves special unique procedures.

LIMITATIONS AND PARAMETERS:

1. After two fouls, the crew will leave the range and RTB. The RCO/IP will issue fouls for any of the following reasons:

a. Recovering below minimum; i.e., foul altitude.

b. Abrupt or dangerous recoveries.

c. Delivery on the wrong, or unauthorized target.

d. Any dangerous pass or act deemed unsafe.

e. Releasing without clearance.

2. RELEASE PARAMETERS:

EVENT	RELEASE AIRSPEED	REL/MIN RELEASE	FOUL ALTITUDE
30° DB	480 KTAS	3.5/2.9K AGL	1500 FT AGL
15° LALD	480 KTAS	2.0/1.6K AGL	1000 FT AGL
RLD	480 KTAS	1000 FT AGL	-------
30° LOFT	480 KTAS	1400 FT AGL	-------

3. BASE LEG PARAMETERS:

EVENT	DISTANCE FROM TARGET	AIRSPEED	ALTITUDE, AGL
30° DB	11,900 FT	400 KTAS	7900 FT
15° LALD	12,900 FT	400 KTAS	4200 FT
RLD	6 NM	350 KTAS	1000 FT
LOFT	6 NM	350 KTAS	1000 FT

4. Minimum airspeeds in bombing pattern: F-16 250 KIAS

5. The mission will be flown on a conventional range, either single ship or as a flight of two.

6. A range officer must control the mission while on the controlled range. If SPORT acts as the RCO, the minimum altitude on the range is 300 FT AGL.

7. At least one dry practice pass per event will be flown for familiarization prior to releasing the first bomb for that event.

8. The weapon system should be fully operational prior to takeoff (HUD, SMS, INS, FCC and FCR).

9. Hung ordnance is defined as ordnance that has not been released, although an attempt was made to release.

10. Unexpended ordnance is defined as ordnance where no attempt to release has been made.

MISSION EVENTS: (Gradesheet, pg A.7)

NOTE: ALTITUDES ARE AGL SO ACTUAL TARGET ELEVATION MUST BE APPLIED TO ALL ALTITUDES.

1. MISSION PREPARATION. The student will compute the mil settings to be used for 30° DB, 15° LALD, and 1000 ft AGL LEVEL (RLD backup) events, using the mission planning procedures contained in the appropriate weapons delivery manual. The student will review the preflight of the weapons load and the in-flight procedures for weapons release and jettison. Obtain winds aloft from base weather.

2. FTNs will plan the mission to concentrate on radar deliveries; however, the IP will demonstrate at least one of each type of visual delivery.

3. BRIEFING. The IP will review the mil settings, weapons procedures and brief the mission, including range procedures, delivery parameters, foul altitudes, bombing techniques and hung or unexpended ordnance procedures. A telephonic or face-to-face briefing of the RCO on events to be flown is highly desirable.

4. TAKEOFF. A normal single ship takeoff or a minimum 8 sec spacing departure (2 ship formation) will be performed.

5. RANGE/ENTRY HOLDING. Range entry for the PIRA will be made along the bomb run in line via the Alpha Corridor at 1000 ft AGL minimum when cleared by the RCO. Brief the RCO on the events to be flown, if not already accomplished. Use your assigned mission frequency. Call "Cobra _____ up for 30° dive bomb" after passing over the target and initiate a climbing turn to downwind leg. On this initial pass, accomplish an altitude calibration on the Fire Control Navigation Panel (FCNP). Select all bomb switches, leaving the Master Arm switch off until on final for bomb release and specifically cleared by RCO. If using Superior Valley refer to the range regulation for proper procedures.

6. 30 DEGREE DIVE BOMB. The objective in this delivery is to arrive at a particular point in space with specific conditions of flight. They are the desired dive angle, slant range to the target, airspeed, g, pipper (aiming index) on the aim point

and in coordinated unaccelerated flight. The following description describes manual bombing events. Computed bombing is based on the principles of manual bombing.

a. Base Leg. The placement of base leg is very important. Use visual references to help establish base leg position. This position and the roll in technique will determine the dive angle. Double check switchology and "wire" the desired base altitude and airspeed.

b. Roll In. Start the turn slightly before passing abeam the target and call "COBRA ______ in hot (or dry)." With a head wind on base, start the turn later than normal; with a tailwind on base, start the turn earlier than normal. During the turn to final, maintain visual reference with the target. DO NOT ATTEMPT TO FLY THE SIGHT TO THE TARGET. If you do, pendulum effect will cause an overshoot. A common error is to relax the turn rate during the latter portion of the turn and lose an excessive amount of altitude prior to reaching wings level. This will reduce tracking time on final. Roll out wings level so as to fly over the target with the aircraft flight path pointed beyond the target by the planned aim off distance (about 1600 ft for 30° dive bomb). Power may need to be added during the roll in, especially heavy weight, but reduce power to a preplanned power setting when on final.

c. Final. Place the pipper short of the target by the planned amount. This may be estimated in feet by reference to the target circle or in mils by using the sight. Check the dive angle on the ADI. The reading should be slightly steep at this time. For dive angles of 20° or more, the release slant range will be determined by an indicated altitude. Check the altimeter and note when the needle passes the hundred foot marker corresponding to release altitude, then continue to cross check the altimeter. The pipper should drift forward at a rate that will place it on release aim point as release parameters are reached. If the pipper is not moving toward the release aimpoint in a straight line, you will need to make an azimuth correction. These corrections are made with quick aileron inputs by referencing the longitudinal axis of the aircraft, NOT the pipper. Halfway down final, azimuth corrections should be completed and a final airspeed check made. A typical final will last no more than 5 seconds. The pipper should drift to the release aim point at release altitude. Accept pipper errors of less than 50 ft. Trying to correct pipper error at the last second will produce larger impact errors. Do not "arm" or release unless "cleared hot" by the RCO or Sport.

d. Recovery. Apply smooth, positive back pressure to make a wings level pullout, obtaining 4 gs in 2 seconds. As the nose comes through the horizon, apply full mil power and let the nose come up 10° to 20° above the horizon before turning. Safe the

Master Arm switch and call "COBRA _______ off hot (dry), switches safe." Turn to downwind, check fuel, record the score, critique the pass and determine necessary adjustments to improve the score. During the recovery ensure you do not exceed the store limit of the aircraft.

e. Wind Correction. For headwind or tailwind on final, adjust the base leg into the wind. Movement of the roll in and release aim points, sometimes called combat offset, may be used to correct for wind. With this method, you release with the manual pipper offset directly into the wind by an amount equal to the wind speed times the bombing table wind correction factor. The initial pipper placement should be adjusted 2-3 times this offset distance into the wind (assumes tracking time is 2-3 times bomb time of fall).

f. This event will be flown twice each using CCIP and manual bomb modes.

7. LALD BOMBING. The 15° dive, 1000 ft AGL (or above) release is very similar to the 30° delivery. Rate of airspeed buildup will be low compared to 30° dive bomb. Basic principles of instrument crosscheck and wind correction remain the same. This event will be flown in both CCIP and DTOS modes. Refer to 1F-16A-34-1-1 for differences in CCIP and DTOS symbology.

8. RADAR LAYDOWN (LEVEL) DELIVERY (RLD). The radar level delivery is flown using the CCRP delivery mode. The pattern is very similar to the dive bomb pattern however the base turn is flown farther away. To ensure adequate time to identify the target and get on conditions the recommended minimum base distance is 6NM. Fly downwind at 1500 AGL with a descent on base to 1000 AGL. Identify the target on radar (use offsets if desired) accelerate to 480 KTAS. When cleared to ARM, depress the weapon release button and fly out of the weapon release cues. At weapon release (FPM flashes also) "safe" up the system and proceed with the next pass. This event will be flown twice.

9. LOFT DELIVERY. The pattern is flown identical to the RLD pattern. For a little additional time on final, the base may be stretched out to 7-8NM as the loft maneuver will occur well prior to the target. Ensure the weapon, mode, and parameters are set. PRA of 30 degrees and MRA of 500 feet must be confirmed if not previously accomplished. As the steering anticipation The following descriptions are expansions and general techniques that can be used during the sortie. Each individual leg and the appropriate switch settings are described in the System Eval Cards. These cards are to be noted and any extra mission events approved by the IP prior to flight. Cue

reaches the FPM, initiate the loft maneuver ensuring the weapons release button is depressed. At bomb release, "safe" up the system and initiate a roll to 90° allowing the nose to track down the horizon and recover to level flight. Proceed with the next pass. This event will be flown twice.

10. CONTROLLED WEAPONS DELIVERY: (MANUAL DELIVERY)

LEVEL DELIVERY. Parameters for the level delivery are 3000 ft AGL, level at 480 KTAS, bomb range of 9800 ft, and time of fall of 13.6 sec. Tolerances are ±50 ft, VVI= 0, and ±2 kts. A rehearsal run will be made prior to the "hot" pass. The IP will demo the first rehearsal run. The FTT for this type of pass is like combining a GCA with tower flyby techniques. Power and trim must be set as early as possible and then concentrate on small heading changes from the ground controller. Do not put the Master Arm Switch to "Arm" until "cleared to arm" from the ground. On the hot run, the ground controller will give countdown calls at 2 mins, 1 min, 30 secs, cleared to arm, 10 secs and 5, 4, 3, 2, 1, release. The call from anyone to abort the pass is "skip it, skip it." After a release, call "off hot, switches safe" (after turning the Master Arm - OFF).

30 DEG FLIP-FLOP DELIVERY. The initial part of the pattern is much like the level delivery. Ground references can be used to roughly get established on final but then the controllers guidance should be used for the fine corrections. The ingress parameters for the maneuver are 8300 ft AGL and 400 KTAS. Again, a rehearsal is normally flown prior to going "hot". At the appropriate spot, the ground controller will say "push in 10 secs" then "ready push" at 15,800 ft from the target. At the "ready push" call, you should smoothly roll at a moderate rate to inverted and then smoothly pull down at 2 - 2.5G to 30 degrees of dive. Then, unload slightly (so you don't pull off the line) and roll upright. The release parameters for this delivery are 30 degrees of dive, 4000 feet AGL, bomb range of 5025 feet, time of fall of 7.8 secs, and 480 KTAS. Tolerances are ±2 degrees and ±5 kts. Remember altitude is dependent on the controller, but check it! The variables for you are entry airspeed, throttle technique, and altitude at the pushover point. The controller will give you right/left corrections and above/below the line corrections. Remember that like a GCA you have to put in a correction and then take it out when you are back on the line. Pull off smoothly with 4 Gs until the nose is above the horizon, then Mil power.

11. RANGE EXIT. Call off with switches safe after the last bomb is released. Safe all bomb switches and exit the range in accordance with applicable procedures. For the PIRA, exit the range to the north, avoid overflying the Phillips Lab and proceed to R-2515 or RTB, as fuel permits.

12. LANDING. Make a normal full stop landing. If ordnance is hung or unexpended, make a straight in approach (IAW AFFTCR 55-2 and In-flight Guide). De-arm on the center taxiway or other designated de-arm area prior to proceeding to the parking area.

13. DEBRIEF. The student will critique his bombing patterns. The IP will critique the mission and debrief bombing techniques as required.

INSTRUMENTATION:
HUD video, video bomb scoring or equivalent, tracking radar.

REPORTS:
Individual Daily Written within 3 days.

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F-15 AIR-TO-AIR SYSTEMS EVALUATION (PILOTS/FTE/FTN)

REFERENCES:

1. T.O. 1F-15A-1, *F-15 Flight Manual.*
2. T.O. 1F-15A-34-1-1, *Nonnuclear Weapons Delivery Manual.*
3. T.O. 1F-15A-34-1-1-1, *Nonnuclear Weapons Delivery Manual.* (Classified)

PURPOSE:

To familiarize the student with the F-15 air-to-air systems and to qualitatively evaluate the system controls, displays, and cockpit interface for the Air Superiority mission. The evaluation will include the following systems:

a. Radar
b. Inertial Navigation System (INS)
c. Heads-Up Display (HUD)
d. Central Computer (CC)
e. Armament Control System (ACS)
f. Lead Computing Gyroscope (LCG)
g. Vertical Situation Display (VSD)
h. Air-to-Air Interrogation System (AAI).
i. Video Tape Recorder (VTR) system.

AIRCRAFT:

F-15B, F-16 target with ECM pod. (T-38 backup)

GENERAL:

1. This is a demanding sortie designed to familiarize the student with air superiority fighter systems. Every effort should be made to qualitatively evaluate all the systems and their displays and controls. This sortie will require a significant effort in student preparation, with the primary objective being systems evaluation.

2. In-flight data cards will be prepared by each student for both the IP and the target aircraft.

3. This mission will require a briefing 2 hours before takeoff, and will have a typical duration of 1.2 hours.

LIMITATIONS:

1. Minimum altitude for intercepts will be 1000 ft AGL for the target aircraft and 2000 ft AGL for the F-15. The F-15 may complete a stern intercept on a non-maneuvering target at 1000 ft AGL when adequate turn room is available and the target is visual, so as not to go below 1000 ft AGL.

2. Standard intercept rules will be briefed and adhered to, including the establishment of altitude blocks to ensure safe separation. Particular attention must be given to maintaining safe separation during electronic countermeasures (ECM) intercepts, since some radar information may or may not be present.

3. If at any time safety of flight is compromised during an ECM intercept, "STOP MUSIC" or "SAFETY, SAFETY" will be broadcast on the working frequency and the target aircraft will terminate use of the ECM.

4. Minimum airspeed for the F-15 during any intercepts below 5000 ft AGL will be 350 KCAS to maintain maneuvering capability. Limit nose low descent angles to less than 30 degrees during low altitude intercepts below 5000 ft AGL.

SYSTEM SPECIFICS:

ACS Panel Setup

With MRM selected on the weapon select switch, check HUD window 2 (lower left corner) for either an M0M or an M0F indication. If M0F is shown, then you need to reprogram the jet as follows:

1. Select program 1 (PROG 1) on the ACS panel A/G select knob
2. On the INS NCI panel, select
   Data Select Knob- CCC
   Destination- M1
   Weapon Select Switch- MRM
   NCI Panel- Press UPDATE to change F to M (on HUD)

Radar BIT

With the radar power switch in standby (STBY), select RDR on the BIT control panel (BCP) and initiate BIT after the radar times in (starts to sweep on VSD). Ensure G-TEST is displayed in the BIT window (lower left corner of VSD) before proceeding, since this verifies that the jet will not radiate (and burn the crew chief!) when operate is selected. Once verified, terminate the STBY BIT by depressing the auto acq switch on the stick grip, and then select OPR (operate) on the radar control panel. After the radar completes the TUNE cycle, (TUNE will disappear on the VSD and altitude elevation will reappear in the upper left corner) select initiate on the BCP. G-TEST will appear again, followed by TK TST in 7.5 seconds. Initiated BIT (I-BIT) can then be entered by moving the auto acq switch FWD or AFT on the stick while TK TST is displayed. When in I-BIT (as a minimum), lock on to a high PRF target (at 24 NM) and a medium PRF target (any of the 9 targets inside 15NM), letting the track stabilize each time and then breaking lock (depressing the auto acq switch) in between. Also test the auto acq modes of super search, boresight, vertical scan and auto guns. Then, break lock and get back into a search mode (not auto guns) and then depress the initiate button on the BCP.

The radar will go into an auto test mode to finish the BIT (about 3 minutes long). When it completes the I-BIT (when the radar starts to sweep again), select STBY on the radar control panel and initiate another BIT on the BCP. Record the I-BIT and CM-BIT faults (if other than the normal 12--D readout) and the BIT is finally complete!

Intercepts

Briefing an Air to Air Tacan and a Mode 1 squawk is always a good idea to get range info to the target for each intercept. If Cords road is cold, it makes a good visual reference to use also. (i.e., precoordinate with Sport) Plan each intercept with at least a 30 NM set-up initially. As proficiency improves (hopefully!) during the sortie, you might be able to reduce the ranges slightly.

At the start of each intercept, place the acquisition symbols at the target range and adjust the elevation to center up the target altitude. Typically, 60° azimuth sweep and 4-bar elevation is a good sweep pattern to begin with, and can later be narrowed down in both az and el as your comfort factor improves with using the radar.

When a raw radar return shows up, interrogate the target squawk by depressing the AAI button (front of right throttle) and verifying the appropriate VSD symbology (diamond for modes 1, 2, 3; circle for mode 4). Refer to the AAI system description in the F-15A-34-1-1. Lock-on to the target by depressing and releasing the TDC with the target between the acquisition symbols. A full system lock-on should now be displayed. The objective now is to get enough turning room on the target to be able to complete a stern conversion by going pure pursuit (center up the target designator box over the aircraft waterline in the HUD) at 10 NM. This allows you to see the target in the HUD, as well as keeping the pointy end of the F-15 towards the target to deny him seeing your large profile. To get this turn room, you need to achieve a 13 aspect angle (AA) at 10 NM from the target.

Aspect angle is the angular difference between the target's tail and the line of sight from the F-15 to the target.

The F-15/target relationship in Figure 3.19 shows a 7L (70 degree) left aspect. The L or R term means that the F-15 is looking at the Left or Right side of the target. For example, if the aspect angle is increasing, the F-15 will pass in front of the target: if decreasing, behind the target. If the displayed aspect angle remains constant, the F-15 and target are on a collision course or are co-speed and co-heading.

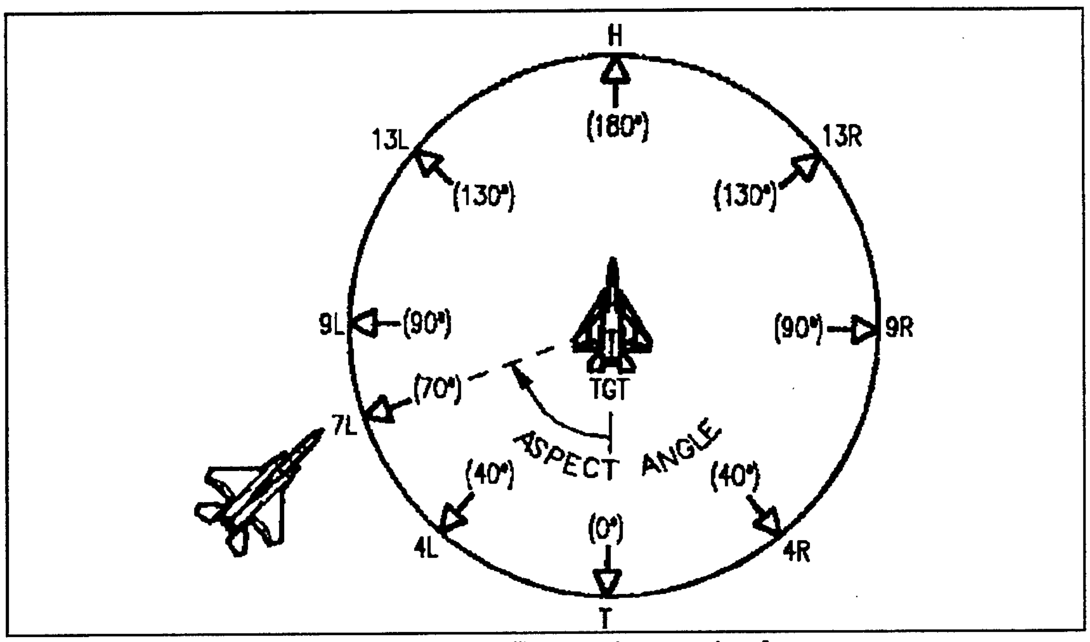


FIGURE 3.19 Target Aspect Angle

Because of the larger angular displacement at longer ranges, a 13AA at 10 NM gives the same turning room laterally as a 14AA at 15 NM, or a 15AA at 20 NM. Whenever any of these aspect angles are met at the appropriate ranges, you're on the "pure pursuit curve" and can center up the target in the HUD.

Typically, you'll see either an "H" or a 17L or 17R at initial lock-on. Always turn "away" from the aspect angle displayed for your turning room (i.e., if you see a 17L, turn the aircraft to the Right). For an "H", turn in either direction. Turn to offset the target 50° from the nose on the VSD, ensuring you do not exceed 60° and gimbal the radar. (The display flashes at 55° as a cue to roll out!) Hold the target at 50° offset angle until reaching the pure pursuit curve as previously described, then center up the target in the HUD and get ready to fire.

For a visual identification (VI) intercept, obtain a radar lock-on, and then select the VI master mode (to the right of the main ADI) while in either MRM or SRM on the weapon select switch. Refer to the VI Steering section of the F-15A-34-1-1. Recommend doing the VI intercept as the second or third intercept.

The CC off intercept will give you an appreciation for the information that the computer provides to the pilot (and also show you what the F-4 WSO was good for, among other things!). Turn the computer off (CC switch, left subpanel behind throttles) before turning inbound for the intercept. You'll still have raw az and el displayed as the radar sweeps, but you'll need to calculate in your head where to point the radar to cover the target altitude at the appropriate range. Remember that 1° down in elevation at 1 NM range is 100 ft. below your altitude. So a target at 30 NM range (on your A/A TCN) that you briefed to be 5000 ft. below your altitude should be about 2° below the horizon. (At 30 NM, 1° down would be 3000 ft. below your altitude.) Remember to keep your decreasing range to the target in mind if you don't get a quick lock-on.

Your IP will discuss the ECM intercept cues with you.

<u>Weapons Employment</u>
Plan on doing a front-stern reattack on each intercept in which you plan to accomplish a stern conversion. In layman's terms, shoot the target in the face with an AIM-7M on the way in, and then shoot him from behind with an AIM-9P after completing the stern conversion, followed by a gunshot for good measure. When inside of R_{max1} for the AIM-7M, pull the AIM dot inside the ASE circle on the HUD, verify a shoot cue, (triangle under the TD box) and launch an AIM-7M with the pickle button. Pull back off the target to keep getting turn room (unless you're already on the pure pursuit curve), and then select SRM, since that'll be your next weapon used. (It also commands medium PRF to help maintain lock through the beam) However, wait at

least 2 seconds after launching the AIM-7M before selecting SRM to prevent hanging the missile. The pure pursuit curve should roll you out within 1.5 NM behind the target and in range for an AIM-9P launch. Crosscheck the target's airspeed, and plan on being co-speed to 50 knots faster than he is. Take the missile shot when within 45° of the target's tail and in range by centering the missile seeker circle on the target's tailpipe(s). Call Fox 2 on the radio, and the target will turn 180° into you. Thumb back to guns on the weapon select switch, pull a little lead (put the reticle above the target) in the target's plane of motion, and squeeze the trigger with the pipper on the target, shooting for between 1500-2000 ft. slant range. Come off the target inside of 1500 ft. range with an out of plane rolling pull to keep sight of the target AT ALL TIMES and do NOT get within 1000 ft. of the target at any time!!! (Review target mils vs wingspan for 1000 ft. before the sortie) Violations or dangerous maneuvers near the target will result in you losing the privilege of assessing the gun in subsequent intercepts.

Plan on the target completing the 180° turn and going back to his start point for the next intercept. After the last intercept, plan on following the target towards home and evaluate the automatic acquisition modes of the radar and any other incomplete items.

MISSION EVENTS: (Gradesheet, pg A.8 & A.9)

1. Mission Preparation:

A thorough understanding of systems and cockpit switchology is required along with a detailed set of test cards. A suggested format is one card per intercept, detailing changes in radar modes and switchology for each new area analyzed.

2. Briefing:

The pilot will brief the general and specific briefing guide and the systems which he is going to evaluate on the mission. The FTE/N will brief only the specific items that he will evaluate on the mission. The IP will brief ECM specific items and clarify any areas the student has questions in.

3. Preflight:

The preflight will be accomplished by the IP and observed by the student. Scramble takeoff procedures including cockpit setup will be discussed concerning the F-15.

4. Before Taxi Checks:

Program the ACS with AIM-7M missiles for proper HUD symbology. (AIM-9P missiles come up automatically) Perform a radar BIT.

5. Takeoff:

A scramble takeoff and climb will be simulated. Have the target aircraft takeoff 2 minutes prior to the F-15 and proceed to Harper's Lake to hold. After coordinating an unrestricted climb with tower, the F-15 will accomplish a flight manual afterburner takeoff avoiding overflight of the hospital and housing areas. Climb to FL200 and proceed to overhead Mojave as the simulated CAP point. Upon reaching Mojave, both fighters will turn inbound to start the first intercept.

6. Intercepts:

The type of intercepts accomplished will obviously be determined by the target and whether or not ECM is available. As a minimum, the following intercepts will be planned:

a. Three different medium altitude ECM mode intercepts (specifics classified).

b. A look down-shootdown front aspect intercept with an altitude of 1000 ft AGL for the target and at least 10000 ft altitude delta for the F-15.

c. A visual identification (VI) mode intercept on a medium altitude target.

d. A CC off intercept on a non-maneuvering target.

e. An intercept on a target that does a 360 turn followed by a loop while the F-15 has a radar lock-on.

f. Other student determined intercepts as fuel allows.

All intercepts (except the low altitude intercepts below 5000 ft AGL and any front aspect only intercepts) will be accomplished to a stern conversion and a simulated AIM-9P launch, followed by a target 180 degree turn allowing the F-15 to close for a gunshot to a knock-it-off call. The AAI system will be examined during any of the intercepts to include modes 1, 2, 3, and 4 (dependent upon target capability) and target squawk requirements will be listed for each intercept on the data cards provided by the student. LCG capability will be examined during the gunshot portion of the intercept to include normal operations, reticle stiffened mode, and CC off operations. Any LCG requirements not accomplished during the intercepts may be seen during canned visual setups after the last intercept or during RTB. Automatic radar acquisition modes can be evaluated at this time also. (Supersearch, boresight, vertical scan, and auto guns)

7. RTB:
Plan on flying an ADI mode ILS back to the pattern, examining HUD symbology.

8. Debriefing:
The student will debrief the mission, concentrating on F-15 suitability for the Air Superiority mission.

INSTRUMENTATION:
1. VTR tape for onboard recording. The tape will be classified confidential if weapons ranges are recorded, and secret with any ECM cues recorded.

2. Tape recorder. (optional)

DATA REDUCTION AND REPORT:
None.

F-16 SYSTEMS EVALUATION (GRADED MISSION, PILOTS)

REFERENCES:

1. T.O. 1F-16A-1, *F-16 A/B Flight Manual.*
2. T.O. 1F-16A-34-1-1, *F-16 A/B Nonnuclear Weapons Delivery Manual.*
3. F-16 Air-to-Ground Systems Ground School.
4. F-16 Weapons Delivery Familiarization, Systems PPG
5. F-16 Systems Sample Evaluation Mission Cards (Appendix B).
6. AFFTC Reg 55-2, Vol 1, *Aircrew Operations.*
7. AFMC Reg 55-7, *Fighter and Trainer Aircrew Procedures.*

PURPOSE:

1. To evaluate the student test pilot's knowledge of systems Flight Test Techniques. The student test pilot should consider the three types of systems tests during this evaluation. Early in the mission you will perform functional/performance checks, gathering rough quantitative data and checking the operation of sensors (INS, Radar, Radar Altimeter etc). Tests will then be expanded to include the evaluation of sensor integration. Multiple sensors will work together to provide the pilot with useful information during the integrated systems tests (A-G Weapons Deliveries, Radar Freeze Mode). Near the end of the mission, three legs will be dedicated to an integrated systems evaluation (ISE), where systems will be used with operational considerations in mind.

2. On this test mission, evaluate the F-16A for the Battlefield Air Interdiction (BAI) role. Evaluate the function, performance (rough order), controls, displays, systems integration, cockpit arrangement, Hands-on Throttle and Stick (HOTAS), and human factors of the following avionic systems:

   a. Inertial Navigation System (INS)
   b. Fire control computer (FCC)
   c. Heads-Up Display (HUD)
   d. Stores Management System (SMS)
   e. Radar Altimeter
   f. APG-66 Radar

AIRCRAFT:
F-16B or 2 X F-16As with centerline or wing tanks (flight time limited to 1.5 hrs). Simulated stores will be entered in the SMS on stations not occupied by external tanks. The orange low level route will be scheduled.

GENERAL:
1. This is an interesting and demanding mission that will demonstrate the students knowledge of systems test techniques. Due to the variety and complexity of systems in the F-16, the student is cautioned to prepare for the mission by being thoroughly familiar with navigation and weapons system operations, controls and displays. F-16 systems operation will be reviewed during the FTT briefing to include a preview of the profile; however, this review will not be comprehensive. Study of the references for this mission will be required. As questions arise during preparation, you're encouraged to ask the F-16 staff IPs for help. Plan ahead to have your questions answered prior to the flight briefing.

2. The primary objective of this mission is to conduct a systems evaluation, not simply flying the planned profile and making the systems perform. Comprehensive flight data cards will be prepared by each student. Example data cards are contained in Appendix B. Mission events/profile will be approved by the IP prior to flight.

3. This mission will require a briefing 2 hours before takeoff and the nominal mission duration will be 1.5 hours. Low level route scheduling necessitates timely adherence to the scheduled times.

LIMITATIONS:
1. The route is normally flown at or above 1000 ft AGL.

NOTE: Descent to 500 ft AGL is authorized for briefed updates or weapon deliveries over sparsely populated/unobstructed terrain.

2. Low level airspeeds: Minimum - 400 KIAS (for engine restart capability) Maximum - 450 KGS for planning purposes (AFFTC 55-2).

3. Simulated or training store weapon deliveries will be discontinued with any weapon systems malfunction.

4. Release altitudes for simulated or training store weapons are 3500 ft AGL (30°)

and 1000 ft AGL (10°). Minimum recovery (FOUL) altitudes are 1500 ft AGL (30°) and 500 ft (10°). Minimum airspeed for simulated releases is 420 KIAS. These restrictions will be STRICTLY adhered to!

MISSION EVENTS: (Gradesheet, pg A.10)

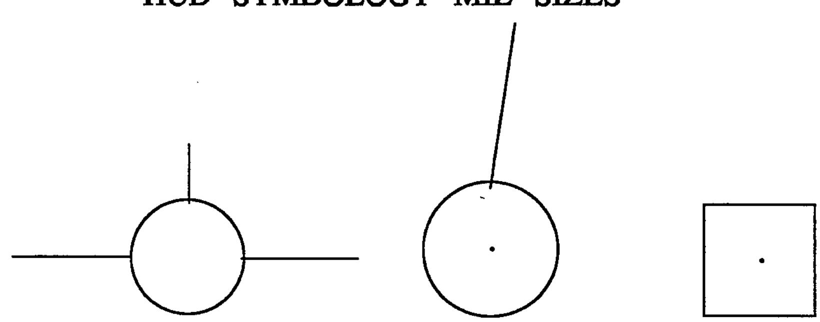
1. Mission Preparation:

a. Thorough study, mission planning and detailed cards are required. Data cards should include a realistic fuel/time line and appropriate bingo fuels. A partially loaded DTC will be available from the IP to decrease ground time and allow evaluation of DTC loading. A printout of the partial DTC load will be handed out during the FTT briefing. The student should be prepared to load and/or verify all data manually if required.

b. A video tape should be available prior to the briefing. The flight brief should include SI procedures. During the mission record voice and the appropriate video (HUD or REO) for post flight review and for a reference during report writing. Run FCC time in the HUD if desired. Good data procedures are essential on this mission.

c. Knowing the size of HUD symbology will be helpful in determining distance errors inflight and during video review. Remember that the distance subtended by 1 mil at a range of 1000" is 1 foot (Figure 3.2).

HUD SYMBOLOGY MIL SIZES



FPM

DIAMETER: 10 MILS
WINGS: 10 MILS
TAIL: 5 MILS

PIPPER

DIAMETER: 12 MILS

TD BOX

10 MILS / SIDE

FIGURE 3.20

2. Preflight:

The preflight checks will be accomplished by the student and monitored by the IP.

3. Before Taxi Checks:

a. After engine start the following destination and bombing data will be entered into the Fire Control Navigation Panel (FCNP) and SMS.

Destination/Name	Coordinates	Altitude	Time-On-Target
0 EOR, RWY 22 Spot 2	N34 55.108 W117 52.041	2280	----
1 Cal City/Cords Rd	N35 05.250 W117 55.000	2290	A/D
2 Isabella West Dam	N35 38.780 W118 28.820	2605	A/D
3 Monache Mtn	N36 12.320 W118 11.710	9410	A/D
4 Tinemaha Dam NW Corner	N37 03.380 W118 13.580	4000	A/D
5 IP-Dry Lake	N36 53.200 W117 51.200	2500	A/D
6 TGT - W Side Lake Nooch's Return	N36 42.180 W117 49.300	1200	A/D
7 Crossroads	N36 20.400 W117 25.281	1575	00:00
8 Lake	N36 02.000 W117 14.600	1200	02:54
9 IP - Factory	N35 42.300 W117 23.850	1650	05:57 07:15 TOT

10 - 19 AS DESIRED

Vip Data: 192.2°/52000 ft/2020 ft

Bingo: 2200 lbs

Planned Release Angle (PRA) - 30 degrees

Minimum Release Altitude (MRA) - 1000 ft

b. Simulated weapons (B49 high drag and MK84 low drag general purpose bombs) will be entered into the SMS.

c. Localizer front course (224°)

d. Verify the FCR, FCC, SMS and HUD operational flight programs (OFPs).

4. Taxi.

Complete checklist items and evaluate the ability to adjust/verify the aircraft's systems during taxi. Title the video tape.

5. Before Takeoff.

Complete appropriate test cards and all required checklist items. Refer to the F-16 Weapons Delivery Familiarization mission for suggested checks. With the INSTR MODE switch in NAV, verify all INS steerpoint bearing and ranges on the HSI from an appropriate ground checkpoint.

6. Takeoff.

Just before brake release perform a "Mark" (MKA). Perform a normal Mil power takeoff (Max power if required at high aircraft gross weights). Record takeoff data. Complete normal checks and fly towards steerpoint 1, California City/Cords Road intersection, while setting up for the Air-to-Ground Ranging exercise.

7. Air-to-Ground Ranging (AGR) Qualitative Evaluation (Cloverleaf Check)

a. This test will give a rough estimate of the aircraft's AGR accuracy and ensure the student understands the three dimensional nature of the FCC's NAV solution (The angle to the TD box is determined by horizontal position and altitude). The DTOS mode uses AGR and INS/FCR angles to ground stabilize the TD box. By using DTOS to place the TD box on a point, followed by noting the TD box location when flying perpendicular to the original flight path, a rough estimate of the AGR accuracy can be evaluated. When flying perpendicular to the original flight path, an air-to-ground ranging error would show as 3/9 error in the TD box location.

b. The F-16 System Eval Cards(Appendix B) contains a test card for this point. Select A-G DTOS on the SMS and start the run 5 nm south of the intersection of Cords Road and the north/south road leading from highway 58 to California City. Fly a heading of 345° with an initial altitude of approximately 5000' MSL. When the intersection gets near the bottom of the HUD, start a 10 degree dive toward the intersection. Slew and ground stabilize the TD box on the intersection. Recover NLT 3500' MSL and turn to the right (away from California City). Do not reset DTOS or move the cursor. Set-up to make another run from the east, heading 255° along Cords Road. Fly at 3000' MSL and note the position of the TD box. If the radar ranged long on the previous pass, you would see the TD box north of the intersection, whereas if the radar ranged short, the TD box would be south of the intersection. Realize that any INS drift during the time you maneuver back toward the target will introduce additional error in the TD box location.

8. Entering the Orange Low Level

Turn toward Mojave and climb above the Mojave Airfield Class D airspace. Approaching Mojave Airfield perform a "Mark" when over-flying a prominent landmark. This Mark Point (MKB) will be used at the end of the sortie as a destination. Coordinate to enter the orange low level and turn on course to Isabella Dam (DEST #2).

9. Mojave Airport through DEST # 4

a. During this portion of the mission you will perform functional tests and integrated systems tests. In general, use the routing of the orange low level; however, adjust airspeed and altitude as required to perform your tests. Maneuvering along the low level route and at INS destinations will be required to verify avionic functions. Always adhere to mission limitations, particularly the minimum airspeed at low altitude.

b. The following paragraphs contain the minimum evaluations you are expected to perform. The ride will be quite busy, so again the need for pre-flight study and good flight test cards is emphasized. You should arrange the test points in the most logical and efficient order while keeping fuel considerations in mind. In considering mission planning, you may wish to perform some of the evaluations in R2515 the end of the mission. Additional steerpoints, OAPs, or VRPs may be used if desired.

c. Navigation and Timing Cues:

(1) Evaluate the navigation and timing cues presented in the HUD and HSI. Primary concern should be with low level navigation but medium altitude navigation may also be addressed. Specific areas to evaluate include:

- (a) Navigation accuracy to the desired destination
- (b) Cues to maintain a specific course to a destination
- (c) Cues to correct back to course after a deviation
- (d) TOT guidance accuracy
- (e) Cues to correct timing after a deviation
- (f) Utility of the wind position on the FCNP
- (g) Navigation cues in the air-to-air mode

(h) Radar Altimeter

(2) Navigation accuracy will be assessed throughout the mission, but easily identified point targets are best for this evaluation. It is important to understand the difference and interaction between the INS solution and the FCC's slewable NAV solution. Cursor zeroize (C/Z) is available to erase FCC NAV slew inputs when required.

(3) Calculate leg times for the portion of the mission where you intend to evaluate the TOT clock. Start the TOT clock on the FCNP and Mode Select to get HUD symbology. To check your ability to correct TOT timing, recommend that you simulate a counteroffensive level or climbing turn, then evaluate your ability to resume low level navigation and TOT timing.

d. Fixtaking:

(1) Accurate fixtaking is important to correct errors which build over time in most navigation systems. Test to ensure the avionics function properly during fixtaking and evaluate the switchology and symbology associated with each type of update (See OFLY FIX card in Appendix B). Note that for these functional checks you will need to take a great deal of data to roughly determine INS errors and then return to the point to ensure proper function of the update. <u>Chair flying the test cards can not be overemphasized!</u> Specific areas to evaluate include:

(a) Overfly Fix - Perform at an easily located point target

(b) Radar Fix - Perform on a highly radar reflective point target

(2) Recommend performing one of the fixes approximately midway through the mission and the other near the end of the mission. This will give the INS time to drift between the initial alignment, the first fix and the second fix. The time between your alignment and fixes should be recorded in order to qualitatively evaluate drift.

(3) Overfly Fix: Select an easily identified point target for this test. Approaching the turnpoint (5-8 NM out), select Overfly with the FCNP function knob and descend to a minimum of 500' AGL when the turnpoint is in sight. Prior to overflying the point, evaluate what happens if the radar is in AIR mode versus any other mode. C/Z prior to the fix to erase FCC NAV slews and note the distance and relative bearing between the INS (TD box) and the turnpoint. Designate over the turnpoint and note the position error on the FCNP, then designate a second time to accept the fix. After getting 2-3 NM spacing on the target, steer back to the turnpoint and note the INS/FCC NAV position to verify that the avionics functioned correctly. C/Z to ensure FCC slews were deleted when the fix was accepted. In report writing use caution with your terminology, remembering that the TD box moves

opposite the direction of INS drift (i.e. if the TD box is north of the turnpoint, the INS has drifted south). Apparent TD box location is also a function of system altitude inaccuracies in 6/12 positioning.

(4) Radar Fix: Identify the INS point on radar and slew the cursors over the point. Select RDR with the FCNP function knob and complete the radar update at approximately 4-5 NM. Verify the location of the TD box in the HUD and evaluate the accuracy of your radar update.

e. Altitude Calibration (ACAL):

(1) System altitude is calculated by an algorithm in the FCC based on pilot, CADC, and INS inputs. System altitude is very important for accurate blind bombing and apparent 6/12 positioning of the TD box during navigation.

(2) An ACAL test card is provided in Appendix B. Note the difference between barometric altitude and system altitude before starting the test by positioning the FCNP data knob to POS and looking under E/A. For the ACAL, position the FCNP function knob to ACAL and Mode Select. As you approach the destination, slew the TD box over the destination, verify AGR accuracy and designate as the TD box reaches the bottom of the HUD field of view. Verify that the avionics functioned properly by completing the test card.

f. Cruise Modes:

(1) With the FCNP data knob, select the CRUISE position. The first information is for Range Mode (See RNG MODE EVAL test card in Appendix B). Mode select to put the max range speed cues in the HUD and stabilize on speed. Evaluate the usefulness of the information and its presentation. Take data to validate differences between FCC calculations inflight, flight manual performance data, and truth data (actual test day FF, GS & Distance). When you have finished, data opt to the HOM and EDR modes and complete an evaluation of each. In the HOM mode, check a portion of the programmed climb and descent. Fuel and time will not permit a complete HOM profile.

(2) Complete the CRUISE mode evaluations at a medium altitude. The auto pilot may be useful for maintaining aircraft control.

g. Fuel Usage/Bingo Warnings:

Verify appropriate fuel flows for your configuration and the function and utility of the bingo warning.

h. Autopilot Evaluation:

The Altitude Hold, Pitch and Roll Attitude Hold, and Heading Select functions should be investigated. Complete the autopilot evaluation at a medium altitude. The autopilot may be used in the Altitude Hold and Heading Select functions to ease your workload during the mission.

i. Ground Map Radar (GM):

(1) GM radar is required for accurate blind weapon deliveries and should be one of the primary areas of interest for the BAI mission. Work to properly adjust the display and radar gain before starting the formal evaluation. Qualitatively evaluate radar resolution in each of the modes, as well as your ability to accurately slew and refine the cursors. Evaluate all HOTAS features, symbology and switchology. Specific areas to evaluate include:

(a) GM PPI presentation
(b) Expand (EXP)
(c) Doppler Beam Sharpening (DBS)
(d) Freeze (FRZ)
(e) Offset Aim Points (OAP)
(f) HOTAS (Gain, Cursor Control, Range Scale, Elevation)

(2) Evaluate the GM radar against a variety of targets, including large cultural returns and manmade targets of various sizes. In each mode (GM, EXP & DBS) refine as you get closer to the target, determine the earliest identification range, and evaluate the best inflight resolution (10 NM scale). Consider what type of ordnance you could effectively deliver in a blind mode based on the radar resolution (conventional, area (CBU) or nuclear). Ensure the radar elevation thumbwheel on the throttle is in the detent position if you want the radar elevation looking at the selected destination. Verify the position of the FCC NAV solution after slewing by crosschecking the radar picture with the position of the TD box on the ground.

(3) FRZ the radar at a range of approximately 10 NM and evaluate the ability to slew the cursors and the indications of present position on the radar scope.

j. Air-to-Air Radar:

(1) While air-to-air is not a primary objective of this evaluation, look at the radars ability to detect and allow you to offensively engage threats enroute to your target area. Specific areas to evaluate include:

(a) NAM
(b) ACM (20X20, 10X60, Boresight, Slewable)

(2) Evaluate radar/HUD symbology and switchology. Many other air-to-air radar controls may be evaluated as time permits (i.e. High/Low Notch, Expand, Air vs GM time sharing, etc). If the mission is flown as a two ship, the IP may be used

as a target.

10. Leg 5 (Dam to IP Dry lake, 1000 ft AGL).
Complete navigation and timing tasks as required. Adjust the radar picture as required and identify the IP. Slew as necessary. Select the air-to-ground mode on the SMS and verify the low-drag MK-84 weapon and LOFT with a 30 degree Planned Release Angle (PRA) are displayed. Evaluate the HUD attack symbology and identify the distance and time-to-go displays. Follow the HUD steering to overflight.

11. Leg 6 (IP Dry Lake to Target - Radar reflective metal frame on west side of lake).

a. The following air-to-ground delivery evaluations are integrated systems tests which require the proper operation of multiple sensors integrated through the FCC. The processed information must then be effectively displayed to the aircrew. Refer to the "F-16 Weapons Fam FTT" for delivery procedures and techniques. To the maximum extent possible, you should verify proper operation of each sensor and that the integrated delivery mode functions IAW T.O. 1F-16A-34-1-1. Fly precise parameters to allow a rough quantitative evaluation of delivery accuracy. For example, in CCIP you should verify that the radar is in AGR and compare the position of the CCIP pipper with the standby reticle at release. HUD video review will be essential to check parameters and data that you may miss inflight.

DELIVERY PARAMETERS (MSL: DEST #6, TGT ELV 1200')
RELEASE AIRSPEED: 450 KIAS

EVENT	BASE - 350 KIAS (7 SEC FINAL) ALT	DIST	REL ALT	ALT LOSS (4G)	MIN ALT	MILS	AOD IPP
30° CCIP	10.0	13.0	4.7	1330'	2.7	137	1400' 42
DTOS (10-20°)	7.0	15.0	9000' SLANT RANGE	700' @ 20°	2.2	N/A	N/A
30° LOFT	1000' AGL (2.2 MSL) @ 450 KIAS		3024'	N/A	MRA 1000'	N/A	N/A

b. 30° LOFT DELIVERY, MK-84: Descend to 2200 ft MSL and accelerate to 450

KIAS. Refine your radar picture and follow the steering presented in the HUD. Evaluate all symbology and switchology associated with this attack. After release, commence a 135° pitchback recovery to downwind. The recovery can be terminated to continue on downwind and attain the parameters for the 30° dive bomb pattern.

c. CONTINUOUSLY COMPUTED IMPACT POINT (CCIP) 30° DELIVERY, MK-84: See CCIP A-G Weapons Eval test card in Appendix B. Leave the SMS in Loft mode and look at the target position information in the HUD. As you roll in on final in 30° of dive, select the CCIP mode of delivery using the (HOTAS) NWS button on the stick. Evaluate all symbology and switchology associated with this attack.

NOTE: ATTACK HEADING SHALL BE BASICALLY NORTH-SOUTH AVOIDING A WESTERLY HEADING TOWARD THE RIDGE LINE DURING OR AFTER ATTACKS. DO NOT ATTEMPT TO FLY THE PATTERN TOO TIGHT. ALLOW TIME ON FINAL TO LOOK AT THE SYMBOLOGY. IN CCIP MODE, THE BOMB/PICKLE BUTTON IS "HOT".

d. DIVE TOSS (DTOS) 10-20° DELIVERY, MK-84: Setup again on downwind and select DTOS on the SMS. Note the position of the TD box superimposed on the FPM and fly a normal box pattern. Plan the delivery to commence a smooth pull up achieving a computed release at approximately 9000' slant range (Note: It is necessary to hold the weapon release button during the pull). Recover, climb up for a repeat of this pattern without exiting A-G mode or resetting the TD box. As you roll-in on the re-attack, evaluate the TD box location and the re-attack cues in the HUD. Analyze why it has moved from the target if it does not overlay the target (Recommend using a point target to help accurately assess TD box drift). Update the TD box and perform the delivery as before. Recover to level flight and continue to the next destination.

12. <u>Leg 7 (TGT to Road Intersection, 1000 ft AGL Minimum).</u>
Complete the navigation tasks. Select Gun with Strafe selected on the SMS. Evaluate the symbology and perform several simulated attacks at 10° dive angle along the road which parallels your course. Minimum altitude is 500 ft AGL. You may not get an in-range cue.

13. <u>Leg 8 - 10 Integrated Systems Evaluation (ISE)</u>

a. Destinations 7-9 will be used for a short ISE of the air-to-ground capabilities of the F-16 using the VIP mode for weapon delivery. During this portion of the route you should fly the aircraft as it is intended to be flown operationally with an objective of getting bombs on target on time! From an avionics point of view, this will be the most demanding part of the mission. Multiple systems will be working in real time which may force higher throughput and memory loads on the systems than on previous tests. Evaluate the sensors and integrated systems performance under the high ISE workload, look for design problems that could decrease combat capability, and stress human factor considerations. As a minimum the following areas should be evaluated:

(1) Navigation Cues
(2) Timing Cues (Time on Target ± 30 seconds)
(3) Aids to Situational Awareness
(4) Self Protection (Display of Air and Ground Threats)
(5) VIP Delivery (Symbology, Switchology & Accuracy)

b. Before starting the ISE portion of the mission from DEST 7, ensure your navigation solution and system altitude are accurate. Setup the A-G mode to delivery a high drag B49 in VIP, then return to the mode you wish to use for navigation to the target area. Put your route start time, 00:00, in the TOT clock and enter as you overfly DEST 7 at 420 KGS headed toward DEST 8. Mode select to get HUD timing cues. Along the route you may want to use NAM programmed under MSL OVRD to allow HOTAS control of your radar mode.

14. Leg 9 (Dry Lake to VIP, 1000 ft AGL Minimum).
Complete the navigation tasks. Select A-G on the SMS and verify B49 and VIP. Attempt to identify the IP (factory complex) with the radar. If you can't identify the factory don't slew the cursors. As the factory is identified visually, overfly the factory and designate at overflight (avoid Trona and Trona Airport IAW AFFTCR 55-2). Follow the steering and evaluate the symbology and the accuracy of the mode. After the target is identified, switch to CCIP via the NWS button and drop a level high drag bomb between 500 and 1000' AGL. The target is a road/railroad intersection.

15. Leg 10 (VIP tgt to MARK B, 15,000 ft MSL).
Start a right turn to avoid restricted airspace and begin a climb to 10,000 ft MSL. Set MKB as the destination and complete navigation tasks. Continue to follow the steering towards MKB and evaluate the usefulness of this function. Identify the Mark point in the TD box. Complete other avionics tests enroute if desired.

16. In-flight Reconnaissance.
Enroute to MKB, the IP will give a set of coordinates to the student. The student

will:

a. Evaluate ease of destination entry inflight.

b. Fly to these coordinates.

c. Identify the area and/or any man-made structures.

d. Evaluate the procedure for determining the RECCE point elevation.

e. Debrief the IP on the location, elevation, prominent land-marks/structures, etc.

17. Approaches to Edwards.

After completing the visual identification of the reconnaissance target, proceed to base using the MKA destination, and perform the following approaches (time and fuel permitting):

a. ILS using HUD presentation and cross checking ADI steering bars. Ensure that the localizer course is set in the FCNP and mode selected. Evaluate the ILS command steering in the HUD.

b. SFO

c. Normal pattern/full stop landing.

The purpose of these approaches is to evaluate how the various systems aid in their accomplishment. They may be flown in any order.

18. Post Flight.

Accomplish post flight checks in chocks prior to shutdown.

a. Recall all MFL's. Evaluate usefulness of this function.

b. Record INS data: coordinates, system elevation, groundspeed, DATA 128, 134, 135, 150, 151, 152. Using the deltas from the updates compare how this data supports or not what appeared to happen in-flight.

c. Download DTC data

19. Debrief.

a. Pilot will debrief the IP on his first impressions of the systems evaluation to include all functions, symbology, switchology, etc.

b. If the mission is flown in an A-model, the IP will review the students video immediately after the mission to evaluate data gathering procedures.

c. IP will debrief student on his mission accomplishment after all evaluations have been flown and reports turned in.

INSTRUMENTATION:

Tape recorder, appropriate video tape, prepared data cards

REPORT: (IAW "TPS Reports Requirements," Test Management Phase Planning Guide).

An Individual Daily Written report should be written within 24 hours of the flight, but may be attached to the report due to the IP five working days after the flight.

GRADING:

The student will receive a numerical grade based on the following areas:

1. Mission Preparation (30%)
   a. Systems Knowledge
   b. Data Cards
   c. General & Specific Mission Briefing
   d. Specific Mission Briefing

2. Preflight Ops, Avionics Setup, Ground Test Points (4%)

3. Functional Evaluations & Navigation Tests (8%)
   a. Navigation Cues / Timing / Mark
   b. Over Fly Update
   c. Radar Update
   d. ACAL Update
   e. GM Radar
   f. Cruise Modes Eval
   g. Auto Pilot Eval
   h. RALT Eval

4. Integrated Systems Tests (8%)
   a. AGR Ranging
   b. LOFT 30° Attack
   c. CCIP Attack
   d. DTOS Attack / Reattack
   f. Inflight Reconnaissance

5. Integrated Systems Eval (5%)
6. ILS Eval (2%)

7. SFO Pattern, Normal Pattern, and Landing (P/F)
8. Inflight Data Procedures (3%)
9. Debriefings and Evaluation (40%)
   a. Data (Δ's, Dive Angles, Airspeeds)
   b. Eval of HUD (Navigation, Weapons Delivery, ILS, Other)
   c. Eval of INS/FCNP/SMS
   d. Eval of Radar Altimeter
   e. Eval of Radar
   f. Eval of Cockpit Layout
   g. Eval of Cursor Controller
   h. Eval of Update Functions
   i. Eval of Autopilot
   j. Integrated Systems Eval

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SYSTEMS EVALUATION
(FTN GRADED; FTE NON-GRADED MISSION)

REFERENCES:

1. Appropriate Flight Manual.
2. "Integrated Systems Evaluations," *Systems Phase Planning Guide.*
3. "F-16 Systems Evaluation," *Systems Phase Planning Guide.*
4. "F-16 Weapons Delivery Familiarization," *Systems Phase Planning Guide.*
5. F-16 Systems Sample Evaluation Mission Cards (Appendix B).
6. T.O. 1F-16A-34-1-1, *F-16 A/B Nonnuclear Weapons Delivery Manual.*
7. F-16 Air-to-Ground Systems Ground School.

PURPOSE:

To allow the student an opportunity to design and execute an evaluation of the avionics systems on the F-16B, or other aircraft (as available). Evaluate the systems for suitability in the all-weather, ground attack role as the primary mission, with a secondary role of self-defense in the air-to-air arena.

AIRCRAFT:

Any F-16B with a captive AIM-9, or other aircraft as selected by Chief, Systems Phase. One T-38 for an air-to-air target.

GENERAL:

The primary objective of this mission is to evaluate the total avionics suite of the aircraft. Primary emphasis should be placed on the weapons delivery systems, but all comm/nav systems should be investigated. Items that should be considered in the evaluation are INS performance/updates, the resolution of the air-to-air and air-to-ground fire control radar, systems integration, and HOTAS suitability for the air intercept and air-to-ground weapons delivery missions. A brief Integrated Systems Evaluation (ISE) should be planned for both the air-to-air and air-to-ground mission (See reference 3). These suggested areas are not all inclusive but are items that might be evaluated during this mission.

LIMITATIONS:

Adhere to the limitations specified in the "Integrated Systems Evaluations" mission outline in the Systems Phase Planning Guide.

MISSION EVENTS: (Gradesheet, pg A.11 & 12)

1. Mission Preparation.

Prepare a mission profile using the framework outlined in the "Integrated Systems Evaluations" mission. Concentrate on the major weapon systems used for the primary mission of all-weather, ground attack, but include tests of the secondary mission systems as well.

2. Cockpit Evaluation.

Evaluate the cockpit layout, system turn-on, and BIT checks prior to flight. This can be done either just prior to the evaluation flight or during a separate session the day prior. Look at both cockpits.

3. Briefing.

The student will conduct the entire mission briefing except for required safety of flight items which will be briefed by the instructor.

4. In-flight.

The specific flight profile is left as a planning exercise for the student. Use the Cords Road area for doing air-to-air evaluations with the T-38 target and the Blue Low Level route for air-to-ground systems evaluation.

5. Debriefing.

Conduct a thorough, organized debriefing of all the systems that were evaluated. Use the on-board video tape to review comments and show system operation.

INSTRUMENTATION:

Tape recorder and on-board video tape recorder.

GRADING:

The FTN student will receive a numerical grade based on the following areas:

1. Mission Preparation (30%)
   a. Organization of profile
   b. Data cards
   c. Briefing
   d. Knowledge of Systems Flight Test Techniques

2. Mission Conduct (30%)
   a. Thoroughness of cockpit eval
   b. Control of mission events

(1) Directive
(2) Prioritized
(3) Efficient
(4) Knowledge of test procedures

3. Mission Debriefing and Evaluation (40%)
   a. Cockpit layout/HOTAS
   b. Navigation systems
   c. Communication systems
   d. Fire control systems
      (1) Radar
      (2) HUD
      (3) Armament control
      (4) Systems integration

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F-15 CAPTIVE COMPATIBILITY DEMO/ASYMMETRIC STORES (PILOTS/FTNS)

REFERENCES:

1. F-15A/B/C/D Flight Manual.
2. MIL-F-1797A, *Flying Qualities of Pilot Aircraft.*
3. MIL-HDBK-244, *Guide to Aircraft/Stores Compatibility.*
4. MIL-STD-1763, *Aircraft/Stores Certification Procedures.*
5. AFR 80-54, *Aircraft/Stores Certification Program (Seek Eagle).*
6. *Systems Test Theory and Flight Test Techniques,* Chapter 8, "Stores Certification."
7. Flight Clearance (FC) 92-052-A1: 610 Gallon Fuel Tank in an Asymmetric Configuration on AFMC F-15A/B/C/D Aircraft (Atch 1).

PURPOSE:

1. To demonstrate the proper conduct of a captive compatibility flight profile (CFP) sortie.

2. To demonstrate the degradation in flying qualities with an asymmetric store.

3. To compare the asymmetric load flying qualities with the basic F-15 aircraft.

AIRCRAFT:

F-15B/D, with a full 610 gallon tank on station 2 or 8.

GENERAL:

This sortie follows a typical envelope expansion profile (as described in MIL-HDBK-244A and MIL-STD-1763A) for certification of a new stores configuration. The test starts at a "heart-of-the-envelope" condition and expands out from there, accomplishing all checks required by Part I/First Sortie (structural integrity and handling). Inclusive in the sortie profile is the Part II/Second Sortie (vibration and endurance) requirement, which accomplishes a speed soak on the store. The sortie is extremely fuel critical, so a timely accomplishment of the test points is required to complete the entire profile.

When called for, the full data set under MIL-STD-1763A TEST 251 normally includes:

Steady Heading Sideslip	To full deflection, both left and right direction, CAS on and off. No steady heading sideslips in PA configuration.

Rolls	Both directions (away from store first), 1g load, build-up approach (for expediency, TPS sortie will only use 1/4 and 1/2 deflection from trim inputs) not to exceed maximum roll rate (120°/sec), both CAS on and off.
Dynamics	Evaluate short period pitch oscillations and Dutch roll with both CAS on and off.
Maneuvering Flight	Wind-up turn in direction opposite of store, up to dictated symmetrical load limit.

Structural integrity (MIL-STD-1763A TEST 252) evaluations will be accomplished as requested with the CAS on. Roll inputs should be to 1/2 deflection from trim to achieve maximum roll rate. Evaluation consists of a positive load factor symmetric pull, followed by a loaded roll. The aircraft is then unloaded symmetrically, followed by a unloaded unsymmetric roll. Roll limits are as noted in Table 3-1. Load levels requested at the data point are normally noted as a percentage of the test limits, and are computed using a baseline of +1.0 g (80% values are calculated using the difference between the maximum value and 1.0).

Table 3-1. TPS Test Limitations

PARAMETER	CRUISE (CR)	POWER APPROACH (PA)
Maximum Acceleration (g) --Symmetric --Unsymmetric	 +4/-0.5 +2.5/+0.5	 Flight Manual Flight Manual
Angle of Attack (AOA)	25 Units	25 Units
Airspeed	600 KCAS	Flight Manual
Mach	1.4M	Flight Manual
Roll Rate (p)	120°/SEC	120°/SEC
Roll (ϕ Change During Rolls)	180°	90°
Control Augmentation System	On > 500 KCAS	Not Applicable

Data band limits are ± 2,000 ft, ± 10 KCAS, ± 0.05M.

LIMITATIONS:

1. Jettison procedures, asymmetric flying qualities, external tank failure to feed and sortie limitations will be briefed in detail.

2. Crosswind limits for takeoff and landing will be 10 kts from the side opposite the store and 15 kts from the side with the store.

3. The normal takeoff trim setting will be used.

4. All points will be performed at or above 10,000 ft AGL when above 21 units AOA with the exception of the takeoff and landing evaluation.

5. Any emergency aggravated by an asymmetric load condition will require immediate feeding of external fuel or jettison of the tank prior to landing.

6. The external tank must be entirely full prior to engine start to prevent fuel sloshing during flight. The external tank fuel reading should be 3,950 ± 250 lbs for JP-4 (4,090 ± 250 lbs for JP-8).

7. The tank and pylon will be specifically checked to ensure ejection cartridges are installed.

8. The aircraft must have an operative AOA gauge and g-meter in the rear cockpit.

9. Maneuver abort criteria and procedures will be briefed, and will consist of the following:

10. Flight manual restrictions for carriage and jettison of the store will be observed. As this is not an authorized operational configuration for the F-15, a copy of the AFSC Form 4839 is attached (Fig. 3.21) showing aircraft carriage and jettison limitations. Reference the "AEOL and Waiver" book in operations for the Flight Clearance. The TPS test limitations for this sortie are as shown in Table 3-2. For instances where TPS has added no further restriction, flight clearance or flight manual limitations, whichever are most restrictive, will be used.

Table 3-2. Maneuver Abort Criteria and Procedures

MANEUVER	ABORT CRITERIA	ABORT PROCEDURE
Steady Heading Sideslip	- Any unpredicted decrease or reversal of aileron deflection (stick force) with increased rudder application. - Any decrease or reversal of rudder pedal force with rudder deflection. - Any uncommanded increase in β.	- Reengage CAS. - Smoothly return control surfaces to neutral. - Apply opposite rudder (if required).
Short Period	- Oscillations increase in amplitude.	- Reengage CAS. - Quickly dampen with appropriate pilot input.
Dutch Roll	- Oscillations increase in amplitude.	- Reengage CAS. - Quickly dampen with appropriate pilot input.
Rolls	- Excessive adverse/proverse yaw. - Excessive slow/unpredicted roll rate.	- Terminate roll and decrease AOA. - If airspeed is: -- Slow - increase airspeed -- Fast - decrease airspeed
Man. Flight	- Unpredicted stick force or reversal.	- Quickly neutralize or decrease g with pilot input.
Struc. Integrity	- Unpredicted store vibration - Any compromise of store integrity - Excessive slow/unpredicted roll rate. - Excessive pitch sensitivity.	- Reestablish 1.0g - If airspeed is: -- Slow - increase airspeed -- Fast - decrease airspeed - Dampen oscillations with appropriate pilot input
Stall Investigation	- Classic indications of stall/approach to stall limit AOA or airspeed	- Decrease AOA and increase airspeed
Speed Soak	- Unusual noise or vibrations - Any compromise of store integrity	- Decrease airspeed and increase altitude.

MISSION EVENTS: (Gradesheet, pg A.13)

1. Mission Preparation.

The pilot is responsible for the planning and flying of an efficient mission profile with special emphasis on moving efficiently from point to point and observing the appropriate mission limitations. The pilot should have thoroughly developed and studied the data cards for the mission including specific limitations for each event.

2. Briefing.

The student will brief the entire mission to include test techniques, mission limitations and F-15 asymmetric store flight characteristics.

3. Preflight/Ground Ops.

Check the AFTO Form 781 for proper fueling (approximately 15,200 lbs). Ensure the tank and pylon jettison cartridges are installed. Perform a flying qualities ground block and mark stick positions for in-flight reference. 3/4 stick deflection from ground neutral will be used in data point #2; however stick deflections during rolls will be 1/4 and 1/2 displacement from airborne neutral, and need not be marked on the ground. Run aileron trim full deflection left and right and note stick position and aileron deflections. Review the tank jettison procedures prior to takeoff. Note that there are no jettison controls available to the IP in the rear cockpit.

Properly set up the Armament Control Panel for the sortie. This includes selecting "FUEL" for the appropriate station and placing the selective jettison controls to "STA/JETT-R" or "STA/JETT-L" on A/G SELECT knob and "R/MSL-AFT" on the SELECT JETT knob. (With the jettison knobs set up in this manner, an inadvertent push of the JETT button will not jettison the store. To selectively jettison the fuel tank, the SELECT JETT knob must be rotated one position clockwise to "STORES" before pushing the JETT button.) In addition, the WING TANK switch on the fuel control panel must be placed to "STOP TRANSFER" to ensure the tank will not feed. Finally, set the bingo bug to 3,500 lbs. This will provide sufficient fuel to accomplish the first touch and go and land should the tank fail to transfer. Realize the total fuel amount will be approximately 7,500 lbs (3,950 lbs unused in the wing tank).

4. Taxi.

Note the effects of an asymmetric load on the taxi characteristics and qualitatively evaluate controllability. Items to note include ease of tracking the centerline and acceleration/deceleration effects.

5. Takeoff.

Perform a military power takeoff in accordance with the flight manual recommended procedure. Note handling qualities effects on the initial portion of the roll, during liftoff, and climbout.

6. Envelope Expansion.

Data will be acquired at selected test points using the flight test techniques defined in MIL-HDBK-244, paragraph 6.2.1.7.6. These points have been selected to provide maximum exposure to the CFP profile with the limited fuel available. Between points, note the speed stability during the acceleration to the next point. The trim should not be changed during this evaluation, although the "series trim" feature of the Pitch Trim Controller and Pitch Ratio Changer (essentially an auto trim feature) will obviously mask some of the effects of acceleration/decelerations and configuration changes.

a. Data Point #1 - 15,000 ft MSL, 350 KCAS. This is the "heart-of-the-envelope" starting point. Perform a full data set analysis of flying qualities of the aircraft/store combination (both CAS on and CAS off). Perform a structural integrity demonstration to 80 percent of the test limits. Complete the test point with a throttle chop.

b. Data Point #2 - 20,000 ft MSL, Airspeed as Required. This is the investigation of high angle of attack characteristics in the CR configuration. Trim the aircraft at the speed corresponding to full lateral trim opposite the store (cease trimming when reaching 21 units AOA). Increase the AOA in one unit increments until 25 units AOA or 3/4 lateral stick travel from ground neutral aileron deflection is reached. Use rudder to maintain the ball centered and the wings level throughout the maneuver. Note the sideslip angle as the AOA is changed. Specific items to note are buffet and flying qualities. Perform only with CAS on.

c. Data Point #3 - 20,000 ft MSL, Airspeed as Required. This is the investigation of the PA configuration. The test series demonstrates the nature of the asymmetric stores landing problem and the potential effects of sideslip on approach speed and controllability.

(1) Establish the PA configuration, noting trim changes required for each surface. Perform a trim shot at full lateral trim (cease trimming when reaching 21 units AOA). If the external tank does not have a full fuel load, AOA is limited to 18 units AOA. Note the airspeed and fuel weight.

(2) Slow the aircraft to establish 21 units AOA. Note the airspeed for use in

the touch and go evaluation. Perform a data set to include short period, Dutch rolls and rolls. No steady heading sideslips in PA configuration. These points should be accomplished both CAS on and CAS off.

(3) Slow the aircraft to establish 25 units AOA with the CAS on. Make gentle (20°-30° ϕ) turns. Note the cross-coupling that occurs during turns.

(4) (Optional) Establish a 21 unit AOA simulated approach with approximately 700-800 ft/min descent rate. Pull the heavy side engine to idle, and perform a go-around with the light side engine in afterburner and note the handling characteristics. Ensure the aircraft is below 20,000 ft MSL to avoid Region II afterburner operation.

d. Data Point #4 - 30,000 ft, 0.9M. Perform a trim shot and accomplish a full data set analysis of flying qualities and structural integrity at 100 percent of the test limits. Complete the test point with a throttle chop. Perform the flying qualities analysis with CAS on.

e. Data Point #5 - 520 KCAS and 1.3M (Altitude will be approximately 30,000 ft MSL). This is the end point for the test. The objective is to hit the KCAS and Mach simultaneously. Open the air refueling door prior to this test point to prevent the wing tank from feeding. Perform a trim shot and accomplish a full data set and structural integrity demonstration to 100 percent of the test limits. At the completion of this point, accomplish a throttle chop and trim change with speed brake evaluation. Perform the flying qualities analysis with CAS on. Close the air refueling door prior to descending.

CAUTION

Descending with the air refueling door open could collapse the wing tank.

7. Straight In Touch and Go.

Using the computed approach speed for 21 units AOA, perform a touch and go at Edwards AFB. (Straight in will be flown at 18 units if tank is partially full.) If possible, the crab method should be evaluated up to the limit crosswind values of 10 kts from the light wing and 15 kts from the heavy wing. Observe handling characteristics and flight control inputs required (Review tech order procedures for expected handling qualities with asymmetries during approach, landing, and rollout). These observations will be compared to landings once the tank has emptied.

CAUTION

During the flare to landing. Experience has shown that the β increases 2° for each 1° of AOA increase. Consequently, rapid AOA increases above 21 units can result in a large yaw rate development just prior to touchdown.

Coordinate rudder during landing to hold sideslip to a minimum.

8. Speed Soak. (500 ft AGL min, lesser of 550 KCAS or 0.9M).
This speed soak simulates the second sortie specified by MIL-HDBK-244 and MIL-STD-1763. Duration is limited in this sortie by fuel state.

9. Drag Characteristics Investigation Subsonic.
After the fuel tank is completely empty return to envelope expansion point #1, 350 KCAS/15,000 MSL (100 percent of test limits) and repeat maneuvers as desired to examine tank empty flight characteristics.

10. Drag Characteristics Investigation Transonic.
Perform a level acceleration at 20,000 ft. MSL from 0.9 Mach to 1.05 Mach to examine asymmetric drag effects without any fuel in the tank to examine the flight characteristics.

11. Straight-In Full Stop.
Fly a straight-in approach observing handling characteristics and flight control input changes from an asymmetrically loaded jet.

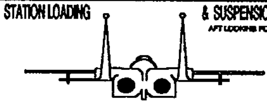
12. Debrief.
The student should be prepared to debrief the FTT's flown with respect to desired tolerances, as well as observations of the flying qualities and cross-coupling effects.

INSTRUMENTATION/DATA REDUCTION:
VTR, tape recorder, stopwatch, etc., as desired.

REPORT: (IAW "TPS Reports Requirements," Test Management Phase Planning Guide).

F - 15A/B/C/D EXTERNAL STORES LIMITATIONS WITHOUT CFT

EXPIRATION DATE: 30 DEC 96

STORE	LINE NUMBER	STATION LOADING & SUSPENSION (AFT LOOKING FORWARD) 					MAXIMUM KCAS OR IMN (WHICHEVER IS LESS)			MAXIMUM ACCELAERATION "G"				MAX DIVE FOR DELIVERY (DEG)	MINIMUM RIPPLE INTERVAL	RELEASE MODE
										CARRIAGE						
		2	3/4	5	6/7	8	CARRIAGE	EMPLOYMENT	JETTISON	SYM	UNSYM	EMPLOYMENT	JETTISON			
610 GALLON FUEL TANK REMARKS 1, 2, 9	1	+		|		+ (F)	660 1.5	NA	600 1.5	-1.0 TO +5.0 REM 4	0.0 TO +3.0 REM 4	NA	+0.5 TO +2.0	NA	NA	NA

REMARKS

1. CARRIAGE OF AIRCRAFT PYLONS AND AIR-TO-AIR MISSILE LAUNCHERS ARE OPTIONAL. NO OTHER STORES ARE AUTHORIZED.
2. MIRROR IMAGE IS AUTHORIZED.
3. AOA IS LIMITED TO MAXIMUM OF 30 UNITS. AOA IS THEREFORE LIMITED TO 30 UNITS.
4. CARRIAGE G LIMITS ARE FOR FULL OF PARTIALLY FULL 610 GALLON FUEL TANK. WITH NO FUEL IN THE EXTERNAL TANK, CAN BE INCREASED TO - 1.0 TO + 6.0 G SYMMETRIC, AND 0.0 TO + 5.0 G UNSYMMETRIC. FULL EXTERNAL TANK ASYMMETRICAL FLIGHT IS AUTHORIZED, BUT DEPARTURE / SPIN SUSCEPTIBILITY INCREASES AT AOAs ABOVE 30 UNITS. AOA IS THEREFORE LIMITED TO 30 UNITS.
5. ANY LIMITATIONS SPECIFIED BY T.O. 1F-15A-1 NOT SPECIFICALLY ADDRESSED BY THIS FC, WHICH APPLY, MUST BE ADHERED TO.
6. TAKEOFFS AND LANDINGS ARE LIMITED TO 15 KNOTS OF CROSSWIND
7. SUPERSONIC FLIGHT PROHIBITED BELOW 15,000 FEET MSL.
8. THE MINIMUM AIRSPEED LIMIT IN T.O. 1F-15A-1SS-124, 20 MAY 93, DOES NOT APPLY TO THIS CONFIGURATION.
9. ROLL RATE IS LIMITED TO 120 DEG/SEC FOR ROLL RATE INSTRUMENTED AIRCRAFT WITH FULL OR PARTIALLY FULL WING-MOUNTED TANKS. ROLL RATE IS LIMITED TO 1/2 LATERAL STICK FOR NON ROLL RATE INSTRUMENTED AIRCRAFT WITH FULL OR PARTIALLY FULL WING-MOUNTED TANKS. A FOLLOW-ON FULL LATERAL STICK CHECK INPUT IS ALLOWED IN BOTH CASES.

AFSC FORM 4839, AUG 85 REPLACES FORM 639, OCT 82 WHICH WILL BE USED W0029501-FC01 ATCH 1 COMPUTER GENERATED

FIGURE 3.21 F-15 Stores Limits

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F-16 LIMIT CYCLE OSCILLATION FTT
(PILOTS FLY, FTE/N TM ROOM)

REFERENCE:
AFFTC-TIH-90-001, *Structures Flight Test Handbook,* Capt William J. Norton, November 1990.

PURPOSE:
To demonstrate and practice FTTs used in flutter/limit cycle oscillation (LCO) testing. The student test pilot will practice the FTTs with a qualified Instructor Pilot in the aircraft and a student FTE/N controlling the flight by monitoring critical parameters via telemetry.

LIMIT CYCLE OSCILLATION:
1. Definition.
The LCO is a self-sustained airframe structural response characterized by a constant amplitude sinusoidal motion. The LCO is a result of the interaction of the aeroelastic properties of the airframe and the aerodynamic effects of the flight conditions. This phenomenon differs from classical flutter in that LCO typically is non-divergent and non-catastrophic.

2. Measurement.
Maximum allowable LCO amplitude is expressed in terms of the sustained wingtip peak acceleration in G's and the associated oscillation frequency in hertz. These limits are established in the Uniform Abort Policy for the F-16 Limit Cycle Flutter Flight Testing and are uniquely defined for the F-16.

3. LCO Modes.
Two different modes of LCO can be expected: symmetric and antisymmetric. Both modes involve a coupling of the wing torsion and bending modes. The most common LCO mode is antisymmetric and is characterized by a lateral acceleration felt in the cockpit. The symmetric mode is characterized by a pitch acceleration.

GENERAL:
1. The aircraft will be loaded with external stores: 2 AIM-9s with instrumented 16S210 launchers on stations 1 and 9, 2 partially filled (1,500 lbs in fore and aft tank sections) and blocked 370 gallon wing tanks on stations 4 and 6, 1 full 300 gallon

centerline tank on station 5, and 4 CBU-87s slant loaded on TERs on stations 3 and 7. The configuration has known repeatable LCO characteristics. Instrumentation for the mission consists of the normal TPS F-16 DAS parameters and wingtip accelerations. The accelerometers are mounted in the 16S210 AIM-9 launcher rails and provide z-axis accelerations of the forward and aft sections of each wingtip.

2. The mission will be conducted as if it were an initial captive stores certification flight. Assume that this aircraft with this stores configuration has never been tested for flutter and that this is an envelope expansion test.

3. The student pilot will proceed through the test cards as directed by the FTE/N. The FTE/N will clear the pilot through a build-up until LCO limits are achieved or store limits are reached. Maneuvers may be demonstrated at the IP's discretion.

4. The takeoff weight is close to maximum allowable takeoff weight. Carefully check the weight and balance and calculate the takeoff data. During any emergency, consider jettisoning stores.

LIMITATIONS:

1. Aircraft and weapons load flight manual restrictions and limits will apply to all phases of flight.

2. Test limits for this mission are:

a. Maximum sustained wingtip oscillation value of 80% for an associated oscillation frequency as defined in the Uniform Abort Policy for F-16 LCF Flight Testing is attained.

b. Minimum altitude for testing will be 8,000 ft MSL or 5,000 ft AGL, whichever is higher.

c. Any situation in which aircrew comfort level is exceeded from longitudinal or lateral oscillations which impair the ability to read displays, actuate switches, or precisely maneuver the aircraft.

d. Until cleared by TM, load factor and airspeed test limits are:

0 to +2.0 G
Below 15,000 ft MSL: 300 KCAS / 0.5 Mach
At or above 15,000 ft MSL: 300 KCAS / 0.6 Mach

3. Follow the munitions procedures in AFFTCR 55-2, Vol 1, Attch 4. Do not overfly populated areas. Do not fly overhead patterns.

4. Instrumentation Go/No Go: Operating telemetry with minimal data drop outs is required for this mission. Operational data parameters required in the control room for this mission are: at least three of the four wingtip accelerations, normal acceleration (at the CG), Mach, and altitude. Operational UHF radio communications with the control room is required.

5. An IFTE who has been checked out on LCO telemetry will assist the student FTE/N in the control room.

6. A safety chase aircraft is optional. The safety chase will provide "clean and dry" calls prior to and after each LCO flight regime.

MISSION EVENTS: (Gradesheet, pg A.14 & A.15)

1. Mission Preparation.

a. The test points included in the mission profile were planned to provide a build-up to fly in LCO conditions. The build-up approach for LCO/flutter testing consists of a slow increase in Mach and movement from low dynamic pressure to high dynamic pressure (start at high altitude). Data and mission cards will be prepared by the FTE/N with assistance of the student pilot.

b. Knowledge of all test limits and aircraft limits is essential. All personnel involved with the mission will be knowledgeable of recovery procedures in case of flutter. The procedure for terminating a test point due to limit LCO or diverging oscillations is:

(1) Reduce airspeed by first retarding the throttle.
(2) Unload the aircraft if in an elevated -g maneuver.
(3) If necessary, activate speed brakes.

c. The FTE/N should review the control room strip chart and display set-up prior to the mission. Any changes the FTE/N desires to make to the set-up must be requested of test support personnel no later than 24 hours prior to the mission.

2. Briefing.
The student test team will brief the mission. The pilot will give the general briefing, which will include recovery techniques. The FTE/N will brief the specific mission, concentrating on communication, clearance to next points, build-up approach, and data gathering techniques. Specifically, the test team will brief terminology for holding current flight conditions, terminating because the point is satisfactorily completed, aborting because a limit is about to be or has been exceeded or other safety related problems, and proceed to the next point.

3. Ground Ops.

a. During preflight, pay special attention to security of panels, fasteners, leaks, stress points, and weapons load.

b. Make survival seat straps and lap belts as tight as possible. Police the cockpit for loose items and foreign objects.

c. The engineer will conduct a ground check of the TM and calibration of the instrumentation. This should include control sweeps as in the flying qualities ground block.

4. Takeoff/Climb.

a. If chase is provided, perform an airborne pick-up.

b. During takeoff, use afterburner to 300 KCAS.

c. During climbout, perform a calibration check of instrumentation with TM. This check should include a +2 G and zero G normal acceleration check in the pitch axis.

d. Test points should be accomplished within a 40 NM radius of the base to insure adequate TM reception.

e. Set altimeters to 29.92 inches of Hg.

5. LCO Testing (CBU-87 Load).

a. Trim at 20,000 ft PA and 0.6 Mach and advise when stabilized. Wait for clearance from the control room before performing any maneuver.

(1) Slowly accelerate (0.01 Mach per 2 seconds) until 0.05 Mach faster. The acceleration will be performed in straight and level flight when possible, but can be accomplished while in a dive, if necessary. The pilot will call out Mach number at 0.01 increments.

(2) Stabilize at 1 G flight and maintain altitude and new Mach number; inform the control room when stabilized. The FTE/N will examine any LCO indications based on analysis of any LCO frequency and amplitude.

(3) When directed, the pilot will perform a roll pulse (stick rap) to determine aircraft response to abrupt pilot-induced control surface inputs. This simulates a flutter panel input.

(4) When cleared by the FTE/N, perform an incremental G wind-up turn at 0.25 G/sec stabilizing at 1 G increments. The pilot can adjust power as required to maintain Mach number within ± 0.02 Mach and altitude within ± 1000 ft. The normal acceleration tolerance is ± 0.2 G for Nz. Terminate the maneuver if target conditions can not be attained due to aircraft performance limitations or aircraft carriage limits are reached. Watch rolling G limits during recovery.

(5) Make qualitative comments throughout each maneuver commenting on aircraft handling, response, and potential operational concerns.

(6) Repeat steps (1) through (5) until limit LCO or other test limits are reached.

b. Safety chase will concentrate on clearing the test aircraft's flightpath and provide a checkover of the test aircraft after limit LCO or test limits are reached.

c. Repeat the procedures at 10,000 ft PA starting at 0.5 Mach. During the descent from 20,000 ft PA closely watch test limits.

6. Traffic Pattern and Landing.
A straight-in approach and landing will be flown.

7. Debriefing.

a. The FTE/N will debrief the mission using the strip chart data. Areas of concentration will be data quality, problem areas, and general mission conduct.

b. The student pilot will provide qualitative comments, discuss maneuver quality, and comment on mission conduct.

c. The instructors will debrief the test team on their planning and conduct of the mission and the quality of the data.

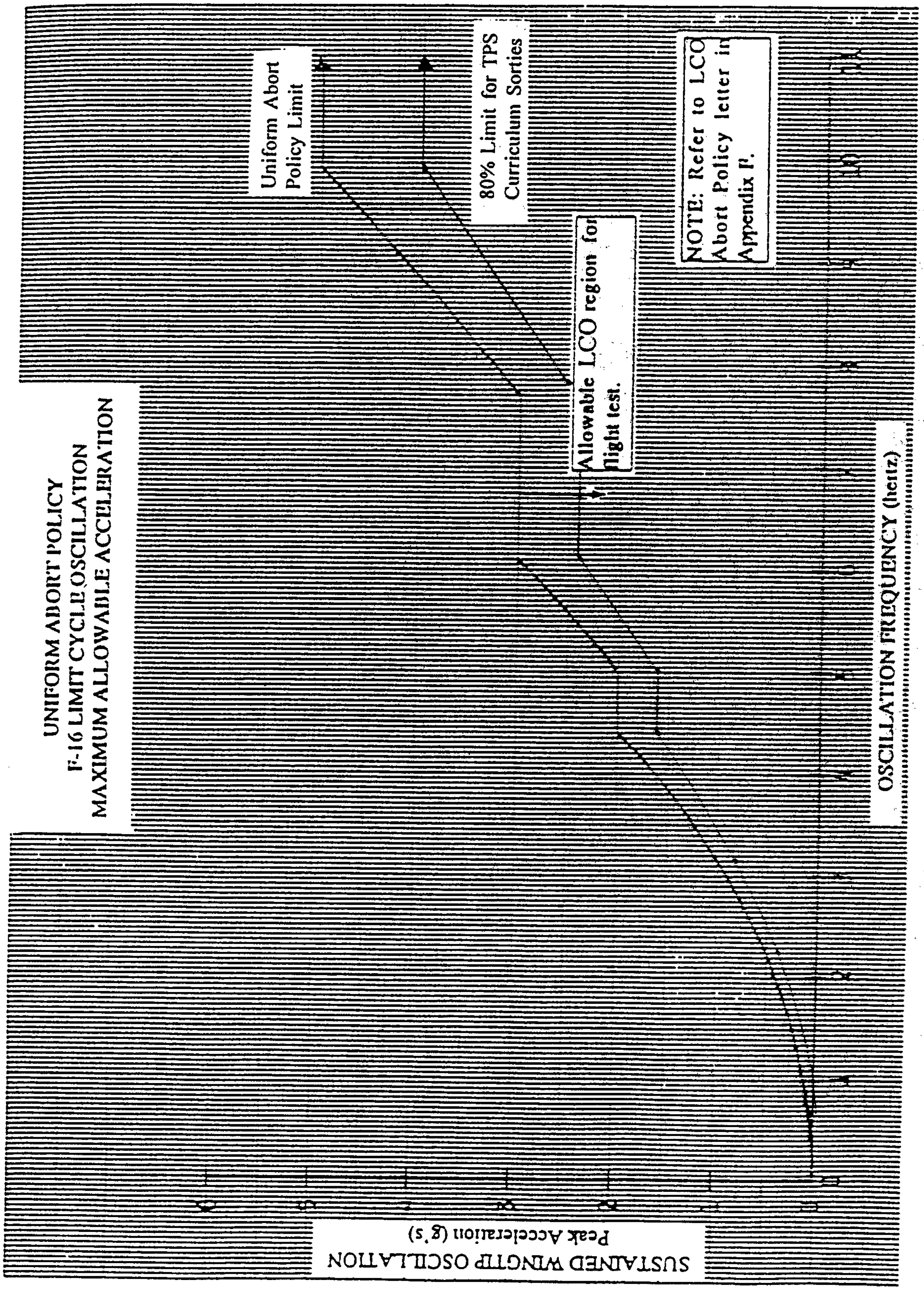
d. Any limits exceeded will be discussed.

INSTRUMENTATION:
Required aircraft parameters as well as instrumented wingtip launcher accelerometer readings.

HUD videotape desirable.

DATA REDUCTION/REQUIRED PLOTS:
None.

REPORT:
None.



LCO-Wingtip Peak Acceleration

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F-16 STRUCTURAL LOADS FTT
(PILOTS FLY, FTE/N TM ROOM)

REFERENCES:

Primary:

1. MIL-A-8871A, *Airplane Strength and Rigidity, Flight and Ground Ops Tests.*
2. MIL-A-8860A, *Airplane Strength and Rigidity, General Spec For.*
3. T.O.1F-16A-1 Flight Manual, Section V, T.O. 1F-16A-1-3, 1F-16-1-4.

Secondary:

4. MIL-A-8861B, *Airplane Strength and Rigidity, Flight Loads.*
5. MIL-A-8862, *Airplane Strength and Rigidity, Landing and Ground Handling Loads.*
6. MIL-A-8865, *Airplane Strength and Rigidity, Miscellaneous Loads.*
7. MIL-A-8867, *Airplane Strength and Rigidity, Ground Tests.*
8. MIL-A-8868, *Airplane Strength and Rigidity, Data and Reports.*

PURPOSE:

To demonstrate the FTTs for testing aircraft to structural load limits. The student test pilot will practice the FTT's with a student FTE controlling the flight by monitoring simulated critical parameters via telemetry.

GENERAL:

1. This mission is designed to introduce the student test pilot to the required test techniques for testing to the structural load limits of an aircraft. The student FTE will practice controlling the flights progression through designated test points. He will monitor simulated critical flight parameters and clear the pilot to each test point.

2. Do not confuse structural load testing with flutter testing. The flutter test points may be flown at identical trim points on a test mission; however, the flutter test techniques will neither be discussed nor practiced on this mission.

3. Structural loads testing varies greatly with each aircraft tested. The structural engineers at the contractor, procuring activity or systems program office (SPO), and/or test center will review the engineering analysis for the aircraft to be tested. According to the appropriate mil spec (many mil specs in addition to the list above exist), a test plan is organized, primarily by the contractor and SPO, to enable testing the critical loads as determined by analysis. Each design will have different critical

loads, for example, longitudinal fuselage bending moment may be critical for large aircraft, wing spar bending moments for a fighter, or vertical tail loads for cargo aircraft. Additionally, each aircraft may have different critical loads for different flight conditions. For example a low dynamic pressure point may have a high load on the stabilator actuator and a high dynamic pressure point may have a high torsional load on the aileron actuator.

4. The test plan designates FTTs. In fact, many of the FTT's used for structural testing are exactly identical to performance or S&C FTT's. Engineers may simultaneously collect data for each type test from a single test point. Each test plan will have a different combination of the fundamental FTT's depending on which critical load is being tested. The buildup technique is used and typically load limits are reached before G limits are explored.

5. Many mil specs have been written to specify loads testing. Due to the specialties of each aircraft the mil specs are used more as a guide with some requirements and FTTs waived, modified, or added to satisfy new requirements. For instance, new construction materials such as epoxygraphites or new flight control systems with programmable limits will possibly require modification. Some of the basic definitions from the mil specs are in order.

6. MIL-A-8871A (USAF), paragraph 3.7 states the requirement for all loads testing to be limited to 80% of design limit load on primary structural components. Paragraph 3.7.2 states "the structural flight test airplane only shall proceed with testing at the 100% limit load level upon completion of the 80% structural flight test program and ultimate load static tests subject to the approval of the procuring activity." Some definitions are in order and MIL-A-8860A defines:

a. 6.2.3.4. Limit load factor as the maximum load factor normally authorized for operations.

b. 3.4. Ultimate loads are obtained by multiplying the limit loads by the ultimate factor of safety. Failure shall not occur at the ultimate load. The ultimate factor of safety shall be 1.5, except where a higher number is deemed necessary.

c. 3.5. Deformations. The cumulative effects of elastic, permanent, or thermal deformations, acting singly or together, which result from application of landing loads, fatigue loads and limit loads shall not:

(1) Inhibit or degrade the mechanical operation of the airplane,

(2) Affect the airplane's aerodynamic characteristics to the extent that

performance guarantees or flying qualities requirements cannot be met,

(3) Require repair or replacement of parts. Thus, not only must testing be included for basic structure with a buildup from 80% to 100% loads, but areas as listed in the deformations paragraph must be tested. Examples would include DC-9 landing tests where the entire tail section broke off, F-18s lack of roll performance at high G due to wing torsion and F-111 weapons failing to separate under load because of bending in the bomb bay area.

d. Waivers to the mil spec are not uncommon. The F-16XL was cleared directly to 100% load factors due to prior F-16 testing; however, caution is always warranted as the higher gain in rudder feedback in the F-16XL cracked the rear spar in the vertical tail during flight test.

7. The instrumentation requirements for structural load testing are extensive and are generally specified in section 3.4 of MIL-A-8871A. Paragraph 3.2.1 states that unless otherwise designated, the second aircraft built is instrumented for loads testing. Accelerometers are placed at critical points specified by the procuring activity to determine inertial load distributions. Strain gages, aero pressure survey, or both are used to measure bending moments, shear and torsion on the primary load carrying surfaces. Other devices such as flaps, landing gear, and control surfaces must be instrumented also. The calibration of such a system of gages that usually have crossfeed between strain gage bridges is difficult and lengthy and involves computer analysis using matrix algebra techniques. Three months is not an unusual amount of time needed just to calibrate the instrumentation.

The viewing of data traces, real time, is essential to protect the pilot and aircraft from exceeding critical limits. Usually an odd shaped envelope involving two critical parameters, such as main spar torsion and vertical tail bending moments during roll tests, will be constructed. The engineer will monitor these parameters as the pilot builds up to maximum limits usually by increasing airspeeds for a single FTT. By monitoring the trends as the airspeed increases, the engineer is better able to predict whether a parameter will be exceeded at the next planned test speed. If there is any doubt, the test point will be canceled and a limit established at that point.

8. Extensive static and dynamic ground loads testing must be accomplished before the complete aircraft envelope may be cleared. This testing is not always done before the flying is started. Static testing is done in a rig to ultimate loads. Dynamic (taxi) testing is done using cosine bump or dip tests at speeds designed to excite the

particular critical load commensurate with operationally experienced taxi conditions. A C-5 designed to land on unprepared surfaces would be tested over rougher courses than a T-46 that will be taxied on prepared surfaces only. Arrestments, braking, turning, pivoting, engine run up, and towing tests are accomplished over surfaces with varying degrees of roughness. Landing tests are also considered ground tests with various landing attitudes, gross weights and sink rates being critical.

9. Dynamic response flight tests (not flutter) are conducted through turbulence having a minimum root mean square (rms) true gust velocity of 2 ft per sec. The test time period of 3 minutes is specified. In-flight refueling tests are also conducted. The landing and taxi tests along with the two mentioned may be combined with flight and ground ops loads survey testing.

10. The flight ops load survey is divided into initial and final phases. MIL-A-8871A, paragraphs of section 4.2 state:

a. The initial flight phase is that limited to 80% design limit load on any primary structural component. The maneuvers accomplished at high, medium and low altitude shall include normal symmetrical pull up and pushdown, normal uncoordinated rolling pullout and 360° roll, and steady state yaw maneuvers. These maneuvers will be defined later. Minimum altitude will be 5000 ft AGL. Five test speeds at each altitude are required. Lowest test speeds are minimum design speed for limit load factor at the test altitude and gross weight. The highest speed is maximum design speed. The minimum speed for the steady state yaw maneuver is limit flaps-down speed.

b. The loadings and configurations for the pull up, pushdown and rolling pullout maneuvers shall be critical for the wing in the clean configuration, unless fixed external stores or pylons are a part of the design, and with loadings considered to significantly affect the wing or horizontal tail loads. The 360° roll maneuver shall be conducted with loadings considered critical for vertical tail loads. The yaw maneuver shall be conducted with internal loadings considered critical for vertical tail loads in the clean configuration and with such external store configurations and loadings considered to significantly affect the sideslip angles. If dive brakes, flaps, etc., are considered to produce significant changes in the loads, the maneuvers shall be repeated with these control devices extended.

c. The final phase flight tests shall be performed after completion of the initial phase flight tests, the ultimate load static tests and with the specific approval of the procuring activity. Buildup maneuvers shall be flown as necessary to insure not exceeding the 100% design limit load of the aircraft. Conditions indicated to be critical by analytical calculations, static test data and initial phase flight test data shall be included in this phase.

11. The test maneuver requirements are stated in section 4.5 of MIL-A-8871A. These paragraphs have been paraphrased below. First a few definitions to explain terminology where used in the maneuver descriptions:

a. 6.2.2 Normal maneuver. A relatively smooth maneuver in which acquisition of basic data is a primary requirement.

b. 6.2.3 Abrupt maneuver. A maneuver in which the abrupt application of control forces is a primary requirement.

c. 6.2.4 Maximum tolerable buffeting. Buffeting which produces an incremental load factor (half amplitude) at the center of gravity of the airplane equivalent to 5% of the required test load factor. This definition shall be verified by the procuring activity after a study of the test data has been made (4.6.4).

d. 4.6.3 Rate of roll requirements. For rolling maneuvers, the maximum rate of roll shall be that obtained within the specified angle of bank by applying either a 60-lb lateral control force (2 equal and opposite 48-lb forces applied at the circumference of the control wheel), full stick or wheel displacement, or full aileron or spoiler design roll rate of the airplane. The roll rate shall be the maximum design roll rate of the airplane. The roll shall be checked with an opposite directed force so that the specified angle of bank will not be exceeded. The rate of application of the aileron force shall be as specified in 4.6.5.

e. 4.6.5 Abrupt application of control forces. As follows:

(1) For pitching maneuvers:

0.2 secs on A, F, TF, T, and O types.

0.3 secs on U, B and C assault types.

0.4 secs on all others.

(2) For rolling maneuvers:

0.1 sec on stick-type controls.

0.3 secs on wheel-type controls.

(3) For yawing maneuvers:

0.3 secs on C and some B types.

0.2 secs on all others.

The maneuvers are now explained with reference to the above definitions.

f. 4.5.1 Normal Symmetrical Pull up. A pullup to obtain the required test load factor, or if less, the maximum load factor within the maximum tolerable buffeting. Stabilize at the specified flight conditions and trim control forces to zero just prior to starting the pullup.

g. 4.5.2 Normal symmetrical pushdown. A pushdown to obtain the required test load factor, or if less, the maximum load factor within the maximum tolerable buffeting. When this maneuver is required at flight altitudes below 10,000 ft, a pull up to a sufficient climb angle shall be performed first in order to avoid excessive dive angles after carrying out the pushdown. Stabilize at the specified flight conditions and trim control forces to zero just prior to starting the pushdown.

h. 4.5.3 Normal uncoordinated rolling pullout. Stabilize at the specified flight conditions (may be loaded) and trim control forces to zero in a steady, right turn at a bank angle which corresponds to the required test load factor, the pullout shall be to the left. The maneuver may be required in both directions depending on both wings being instrumented. The airplane shall be rolled through an angle equal to two times the initial bank angle. Aileron control forces shall be applied until the rate of roll is built up to a maximum. The roll shall be checked by the application of oppositely directed control forces so that the specified bank angle will not be exceeded. During the initial phase tests, the rate of application of aileron control forces shall be the maximum but shall not exceed that which placed 80% of the limit load on the major structural components of the airplane. The rudder shall be held fixed in its trim position as established by the maneuver entry speed. The elevator or stabilator position shall be held constant, unless change is required to avoid exceeding the required test load factor.

i. 4.5.4 Normal uncoordinated 360° roll (fighter and trainer aircraft only). The initial load factor shall be 1.0 with the wings level. The roll shall be performed to the left unless total load instrumentation is not provided on the left wing, then the roll shall be performed in both directions. Aileron control forces shall be applied until the rate of roll is built up to a maximum. The roll shall be checked by the application of oppositely directed control forces to avoid exceeding 360° of roll. During the initial phase tests, the rate of application of aileron control forces shall be the maximum but shall not exceed that which placed 80% of the limit load on the major structural components of the airplane. The rudder shall be held fixed in its trim position as established by the maneuver entry speed. The elevator or stabilator position shall be held constant, unless change is required to avoid exceeding the required test load factor.

j. 4.5.5 Steady state yaw maneuver. Stabilize at the specified flight conditions and trim control forces to zero just prior to application of the rudder. A level yaw maneuver to maximum steady state sideslip angle shall be performed. A rudder pedal force of 300 lbs, full rudder deflection, or maximum output of the power control system shall be used while maintaining the airplane at a wings level flight attitude throughout the maneuver.

k. 4.5.6 Abrupt symmetrical pull up. Stabilize at the specified flight conditions and trim control forces to zero just prior to starting the pull up. An abrupt application of control forces will be as in 4.6.5. To avoid exceeding the maximum tolerable buffeting, the pilot may check this maneuver as soon as the movement applied to the control surfaces is equal to that required for the specified test load factor.

l. 4.5.7 and .8 Abrupt symmetrical pull up and pushdown with abrupt checking. Stabilize at the specified flight conditions and trim control forces to zero just prior to starting the pull up or pushdown. For this maneuver, the rate of elevator motion shall be the maximum obtainable, without exceeding the test load factor. The maneuvers shall be performed IAW MIL-A-8861.

m. 4.5.9 , .10, and .11 are abrupt coordinated rolling pullout, abrupt uncoordinated rolling pullout with abrupt checking and abrupt coordinated 180° roll (fighter and trainer aircraft only).

n. 4.5.12 and .13 Abrupt uncoordinated 180° and 360° roll (fighter and trainer aircraft only). Starting with a load factor of +1.0 and wings level flight attitude, the airplane shall be rolled to the left by an abrupt application of the aileron control force and then checking the roll with an abrupt application of an oppositely directed control force to avoid exceeding the specified bank angle. Aileron control forces shall be abruptly applied until the rate of roll is built up to a maximum. During the roll, rudder shall be held fixed in its trim position as established by the maneuver entry speed. The elevator or stabilizer position for entry shall be held constant and only changed as necessary to avoid exceeding the unsymmetrical or test load factors.

o. 4.5.14 and .15 are landing approach pull up and rolling pullout maneuvers.

p. 4.5.16 Rudder maneuver for high-speed steady sideslip with rudder reversed (fighter and trainer aircraft only). Stabilize at the specified flight conditions and trim control forces to zero just prior to applying the rudder. A maximum steady sideslip maneuver with an abrupt reversal of the rudder shall be performed. A pilot effort of 180 lbs or full rudder deflection, whichever occurs first, shall be initially applied to the left rudder control. Full reversal of the rudder completes this maneuver and to avoid excessive loads on the airplane, the rudder should be returned to neutral position for immediate recovery. During this maneuver, the aileron or spoiler controls shall be used to keep the airplane in a wings level flight attitude.

q. 4.5.17 is a rudder kick maneuver with abrupt return.

r. 4.5.18 is a rudder kick maneuver for landing approach configuration.

s. 4.5.19 is a unsymmetrical power simulation maneuver for the vertical tail.

t. .5. is a deceleration device extension maneuver. Variations of these maneuvers with more recognizable names of roller coasters and windup turns are not uncommon and are defined in the mission events section.

LIMITATIONS:

1. Flight manual restrictions will apply to all phases of flight.

a. The mission will be conducted as if it were an initial phase test flight. You should assume that this aircraft has never been to the artificial limits before and this is a loads expansion test. Artificial positive load limits will be 6 Gs symmetric and 4 Gs unsymmetric. The artificial symmetric negative load limit will be -2 G. The artificial unsymmetric lower limit will be -0.8 Gs.

b. The FTE will monitor the data traces to determine the pilot's performance. Differences between telemetered and cockpit data will occur because of placement of the accelerometers. Use the most conservative data.

2. In addition to Flight Manual limits, artificial limits have been established to simulate load limits on critical load members. Instrumentation is not available or practical for actual load telemetry. Limits are as follows:

a. +18° to -7° AOA,

b. one 360° roll with full aileron deflection,

c. 80°/sec roll rate,

d. 8° sideslip,

e. 15°/sec yaw rate.

3. A telemetry (TM) system must be available with UHF communications. TM voice (HOT MIC) is desirable but not required.

4. An IP will occupy the rear seat.

5. Minimum altitude for the flight will be 10,000 ft MSL or 5000 ft AGL whichever is higher.

MISSION EVENTS: (Gradesheet, pg A.16 A.17 & A.18)

1. Mission Preparation.

a. The test points included in the mission profile were planned using the information given in the General section and criteria listed below. Data and mission cards will be prepared by the FTE with assistance of the pilot for the pilot, IP and engineer that will facilitate communication between air and ground. They should be easily interpreted by the pilots.

b. The profile will attempt investigation at two airspeeds at a medium altitude and one at a low altitude, similar to the guidelines of the initial phase in the mil spec. There is no requirement to finish all the test points. The primary goal is to expand as much of the envelope as possible by practicing each maneuver with appropriate buildup techniques to avoid exceeding established limits.

c. The buildup technique must be used for any point where the limits may be reached. This is especially true of the negative load factor and abrupt maneuvers where rates to limits are important. A buildup technique will help avoid overshoots and create an awareness for any anomalies such as short period transients.

d. Buildup techniques may be made in load factor, percentage of full control deflection, and/or rates to full deflection. A particular FTT or test point may require one or both of the particular buildups depending on the critical parameters approached. Some techniques are directed in following paragraphs.

2. Briefing.

The student test pilot will brief the instructor on the conduct of the flight to include the crew coordination and FTTs. The student FTE/N will brief the mission profile and air-to-ground communication procedures. The FTE/N should brief the terminology to be used for aborting a maneuver for approaching a limit.

3. Ground Ops.

a. A proper preflight is a must. Pay special attention to security of panels and fasteners, leaks, stress points, etc.

b. Proper strap in to the ejection seat is essential. Survival seat straps and lap belts will have to be as tight as possible. Police cockpit for loose items, foreign objects, etc.

c. The engineer will conduct a ground check of the TM and calibration of the instrumentation while the aircraft is in the chocks, if radio reception allows. This should include control sweeps as in a flying qualities ground block. Control input timing will be critical during all abrupt maneuvers. Close coordination between ground crew and aircrew is necessary to ensure the proper rate of strip chart speed is set for each maneuver. Chart speed may be increased in an attempt to measure the time response.

d. The FTE must be very familiar with the limitations imposed on the flight. His/her grade will be based upon his/her ability to control the flight conduct to expand the envelope without exceeding limits.

4. Takeoff/Climb.

Will be accomplished in a timely manner to the initial test altitude. The proximity to the TM antenna will be a determining factor as to direction. A 40 NM circle will be sufficient for reception at both altitudes. A semicircle formed by Tehachapi, Koehn, Cuddyback and Harpers Lake will usually enable good reception of the TM. Active spin areas will reduce the maneuvering area.

5. Structural Load Test Points.

The pilot will proceed through the card supplied by the engineer. Since the maneuvers are slight variations of maneuvers already taught at the school, they may or may not be demonstrated at the discretion of the IP. Primarily the instructor will serve as safety pilot and will be aware of the flight regions and maneuvers that will cause safety limits to be approached. The IP should not be relied on for data acquisition. At any maneuver or test point the FTE or pilot should determine the necessity for a buildup to the full deflection or limit. Any decisions to require further build-up maneuvers before reaching a limit will be made real time by the IP. The test team of pilot and engineer will proceed through as many test points as fuel will allow. With IP's approval the test points may be flown out of sequence for fuel considerations. Otherwise, the test points should be flown in the order listed:

a. Trim at 25,000 ft H_c and 0.7 M (±200 ft and ±0.02 M). Data band for the maneuvers are ±2000 ft and ±0.02 M. These tolerances may be reduced by the engineers at the flight briefing.

(1) Normal Pull up - Accomplished identically as a stabilized pull up maneuvering flight point except the only critical parameter is load factor. Stabilized airspeed is not necessary. For lower load factors a pull up from level flight may be

used. For higher load factors the bleed off of airspeed is quick and entry in a descent may be necessary to remain in the data band. Simulated critical parameters are 6 Gs and 18° AOA.

(2) Normal Pushdown - Can be practiced several ways. Check for proper strap in and tighten up the lap belt and survival seat straps. In erect flight, establish a climb into the specified data band at the specified speed. Approaching the test altitude adjust trim power and begin the pushover. Nose attitude will be low at the end of the maneuver. Dust in the cockpit will be a problem so expect to squint so it doesn't get in your eyes. Close monitoring by the FTE will be necessary to avoid overshooting the negative limits. Use a buildup technique of two or three increments to adjust to the control motions necessary. Simulated critical parameters are -2 G or -7° AOA. The load factor achieved is most important ... not the rate to reach it. Alternative methods involve initiating the pushover from wings level inverted flight or from 90° of bank. The Mach number may have to be higher to begin the maneuver in either case. Approval from the procuring activity to use these methods will be required and would depend on the desired data. The worst case is the erect flight pushdown. Watch your positive limits on the recovery.

(3) Normal Rolling Pullout - Establish a 2 G, trimmed, level, right turn at test conditions. If a change in G is experienced during the roll such that limits are approached, adjust stabilator as necessary to avoid a limit. Otherwise stabilator position shall be held constant. Smoothly apply aileron until maximum roll rates are reached. Do not exceed a left bank angle equal to the initial right bank angle. Lead will be required proportionate to the rate of lateral control input. Simulated critical parameters are roll rate, yaw rate and unsymmetrical load limits for the aircraft. If roll coupling is present a G overshoot during roll or undershoot on rollout may be present. Position of the accelerometers with relation to the z-axis center of gravity will also be a factor.

CAUTION: THE ACTUAL UNSYMMETRIC LOAD LIMIT OF THE AIRCRAFT IS MINUS 1 G. THIS LIMIT MAY BE EXCEEDED WITH FULL AILERON DEFLECTION ROLLS.

(4) Abrupt Pullup - Begin from trimmed level flight and apply the appropriate stick force(w/i 0.2 secs) that will result in the load or AOA limit being reached. There may be a delay before the AOA or load factor will be realized so the stick force will have to be held for a short period until the desired limit is reached. Maintain this same short delay time from pull up to pull up. The stick force is then released in 0.2

secs to neutral. Buildup in load factor or AOA is required to avoid overshoot of limits. Countdown for the rear seat occupant and FTE is desired. The AOA or load limit will be the critical parameters. The load factor may lag the control input and TM readout may be different than cockpit data requiring self calibration of the cockpit meter to avoid exceeding limits. Use the most conservative instrument indication.

(5) Abrupt Pushdown - Identical to the abrupt pull up. A stick bump due to hand/arm dynamics may be present that can cause overshoots. A buildup to limits is critical.

(6) Abrupt uncoordinated 360° roll - From 1 G, level flight, abruptly roll with a buildup deflection and "check" abruptly to avoid exceeding 360° of roll. Use care to avoid over-checking. Use at least one buildup of half deflection first. Lead for the rollout is determined by the roll rate and stop time. Stabilator will be fixed, except to avoid exceeding a G limit. Rudder will be fixed. Roll rate and yaw rate are the critical parameters. Approach full deflection at a rate determined by the FTE.

b. Trimmed condition at 25,000 ft H_c and .58M (± .2).

(1) Normal steady state yaw - A steady sideslip with wings level will be flown. Use up to full rudder pedal deflection and use this maneuver to judge deflections necessary for partial deflection buildups for abrupt maneuvers. Eight degrees sideslip is the critical parameter.

(2) Abrupt Rudder Reversal - The goal of this maneuver is to apply loads to the vertical tail and rudder by abruptly reversing the rudder from a full deflection steady state wings level sideslip. Begin the test point by setting up in an 8 degree steady wings level sideslip. Abruptly reverse the rudder (within 0.2 seconds) and immediately neutralize the rudder after the reversal. Critical parameters are yaw rate and sideslip. A build up approach would involve varying the amount of opposite rudder applied.

c. Trimmed condition at 25,000 ft H_c and 0.9M.

(1) Normal 2 G Rolling Pullout - Same as a(3) above.

(2) Roller Coaster - A variation of the pull up-pushdown maneuvers where G onset rate is of primary importance. Stabilize at the specified flight conditions and trim control forces to zero just prior to starting the maneuver. A slight pull up is started, then a pushdown to a specified symmetric G limit is initiated at 2 secs per G. At this limit initiate a pull to the specified symmetric limit at 1 sec per G. The rates mentioned are only those recommended for this mission. Other rates may be required for different aircraft and critical parameters. Flight conditions will vary slightly but try to remain close to the desired conditions. Do not overshoot prescribed

loads. If TM data traces indicate higher readings, close crew coordination will be necessary to avoid overshooting limits.

(3) Windup Turn - Stabilize at the specified flight conditions and trim control forces to zero. Conduct a constant Mach coordinated turn with a "G" buildup rate of 3 secs per G. Decrease altitude and utilize power, if necessary, to hold constant Mach. Discontinue the turn at the "G" limit or AOA limit, whichever occurs first. Due to the quicker G onset rate than the standard maneuvering flight FTT, the maneuver may be completed in a 2000 ft data band.

(4) Abrupt 360° 1 G Roll - Same as a(8) above.

d. Trimmed condition at 15,000 ft H_c and 0.9M.

If time doesn't allow completion of all maneuvers at this point, at least attempt the abrupt pull up and pushdown maneuvers to see the effects of the PIO tendency on overshooting aim load limits.

The following maneuvers as described above:

(1) Normal pull up

(2) Normal pushdown

(3) Abrupt pull up, start with low buildup loads

(4) Abrupt pushdown

PLUS:

(5) Abrupt uncoordinated 180 °roll at -0.5 G - The aircraft will be placed in the required condition either erect or inverted. Using a buildup technique, the stick will abruptly be applied in 0.1 sec to reach maximum roll rates. The roll will be abruptly stopped not to exceed 180° of roll. The rudder will be fixed and the pitch will be held constant unless load limits will be exceeded.

CAUTION: THE ROLL RATE AND -0.8G UNSYMMETRICAL LOWER LOAD LIMIT MAY BE EXCEEDED WITH FULL DEFLECTION ROLLS.

6. For pilot training requirements the following priorities are places on the individual test points.

Priority 1: All 25,000 0.7M test points, roller coaster and windup turns at 25,000 0.9M, and the -0.5G 180° abrupt roll at 15,000 0.9M.

Priority 2: One of the normal maneuvers either pull up or pushdown at 15,000 0.9M and one of the abrupt maneuvers either pull up or pushdown at 15,000 0.9M.

Priority 3: All other remaining test points.

7. Traffic Pattern and Landing.
At bingo fuel, return to Edwards for approach and landing.

8. Debrief.

a. The FTE will debrief the strip charts to the crew pointing out any problem areas noted with the quality of data. Any mission conduct items will also be debriefed.

b. The pilot will discuss the difficulty of maneuvers and any mission conduct items noted.

c. The instructors will debrief the test team on their planning and conduct of the mission and the quality of the data.

d. All limits exceeded will be discussed. The number of exceeded limits will help determine grade for FTE.

INSTRUMENTATION:

1. TM

2. Flight data cards

3. Data Traces

DATA REDUCTION/REQUIRED PLOTS:

None.

REPORT:

None.

SECTION IV
LIST OF ACRONYMS AND ABBREVIATIONS

ACAL - Altitude Calibration

ACM - Air Combat Maneuvering

ADI - Attitude Direction Indicator

AGL - Above Ground Level

AFCS - Automatic Flight Control System

AFFTC - Air Force Flight Test Center

AFFTCM - Air Force Flight Test Center Manual

AFMC - Air Force Materiel Command

AOA - Angle of Attack

ASR - Area Surveillance Radar

ASTTA - Avionics Systems Test Training Aircraft

BAI - Battlefield Air Interdiction

BFL - Bomb Fall Line

BUC - Back Up fuel Control (F-16)

CAS - Close Air Support

CCIP - Continuously Computed Impact Point

CCRP - Continuously Computed Release Point

comm - communications

DAS - Data Acquisition System

DB - Dive Bomb

DEFT - Display Evaluation Flight Test

demo - demonstration

DME - Distance Measuring Equipment

DTOS - Dive Toss

ECM - Electronic Counter Measure

EGT - Exhaust Gas Temperature

EPU - Emergency Power Unit (F-16)

E-O - Electro-Optic

FAC - Forward Air Control

fam - familiarization

FCC - Fire Control Computer

FCNP - Fire Control Navigation Panel

FCS - Fire Control System

FLCS - Flight Control System (F-16)
FLIR - Forward Looking Infrared
FPM - Flight Path Marker
FOL - Forward Operating Location
FOV - Field of View
FTE - Flight Test Engineer
FTE/N - Flight Test Engineer/Navigator
FTT - Flight Test Techniques
GCA - Ground Control Approach
GMP - Ground Map Pencil
GMS - Ground Map Search
HADB - High Altitude Dive Bomb
Hc - Pressure Altitude
HOTAS - Hands-On Throttle And Stick
HSI - Horizontal Situational Indicator
HUD - Heads-up Display
IAW - In Accordance With
ICU - Interface Control Unit
IFF - Identify Friend or Foe
IFOV - Instantaneous Field of View
IFR - Infrared Radar
ILS - Instrument Landing System
IMS - Inertial Measuring System
INS - Inertial Navigation System
IP - Instructor Pilot or Initial Point
IR - Infrared
IRDS - Infrared Detecting Set
KCAS - Knots Calibrated Airspeed
KIAS - Knots Indicated Airspeed
KTAS - Knots True Airspeed
LAB - Low Angle Bomb
LALD - Low Angle Low Drag
LCO - Limit Cycle Oscillation
LOS - Line Of Sight
MN - Mach Number
mil - military

MRC - Minimum Resolvable Contrast
MRTD - Minimum Resolvable Temperature Difference
MR%H - Minimum Resolvable percent resolution
MSLP - Mean Sea Level Pressure
NFOV - Narrow Field of View
NM - Nautical Mile
ODO - Operations Duty Officer
Ops - Operations
PA - Power Approach
PAR - Program Assessment Review
PIRA - Precision Impact Range Area
PIO - Pilot Induced Oscillation
PLA - Power Lever Angle
MDS - Projected Map Display Set
PRF - Pulse Repetitious Frequency
Qual Eval - Qualitative Evaluation
RAT - Ram Air Turbine
RCO - Range Control Officer
R&D - Research and Development
rms - root mean square
ROE - Rules Of Engagement
RTB - Return To Base
S&C - Stability and Control
SF_{co} - Spatial Cutoff Frequency
SFO - Simulated Flame Out
SHSS - Steady Heading Sideslip
SI - Special Instrumentation
SIP - Systems Integration Package
SMS - Stores Management System
specs - specifications
SPO - Systems Program Office
STRF - Strafe
TACAN - Tactical Area Navigation
TD box - Target Designator box
TF - Terrain Following
TLF - Thrust for Level Flight

TM - Telemetry

TOT - Time On Target

TPS - Test Pilot School

TRB/SRB - Technical Review Board/Safety Review Board

TV - Television

USAFTPSOI - United States Air Force Test Pilot School Operating Instruction

VTR - Video Tape Recorder

WFOV - Wide Field of View

SECTION V

SAFETY REVIEW BOARD DOCUMENTATION

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TE[...] ROJECT SAFETY REVIEW (INITIAL AND AMEN[...]ENT)
(Refer to AFFTCR 127-3 for complete instructions)

I. PROJECT INFORMATION

IAL PROJECT TEST TITLE	INITIAL RISK LEVEL	CONTROL NUMBER	TEST AGENCY
USAF Test Pilot School Systems/Test Management Phase	LOW	94-04	USAF TPS
SUBJECT OF AMENDMENT	AMENDMENT RISK LEVEL	CHANGE NUMBER	PROJECT JON P9307000

PROJECT MANAGER (Typed Name and Grade)	SIGNATURE	PHONE NUMBER	DATE
Randal G. Abraham, Maj	Randal Abraham	7-4565	19 JAN 94
UNIT TSO (Typed Name and Grade)	**SIGNATURE**	**PHONE NUMBER**	**DATE**
Ronald G. Joseph, Maj	Ronald G. Joseph	7-4565	20 Jan 94

II. SAFETY REVIEW MEMBERS

	NAME, GRADE, AND TITLE	SIGNATURE AND DATE		NAME, GRADE, AND TITLE	SIGNATURE AND DATE
a.	Mr. David Lazerson SRB Chairman	David A. Lazerson 20 JAN 94	f.		
b.	Mr. Tracey Redd Structural Dynamics Eng.	L. Tracey Redd 20 Jan 94 (SEE COORD. COMMENTS)	g.		
c.	Mr Paul Kirsten Flight Dynamics Engineer	Paul W. Kirsten 21 JAN 94	h.		
	Maj Mike Gerzanics Pilot Member	[signature] 21 Jan 94	i.		
e.			j.		

III. COORDINATION AND APPROVAL

POSITION TITLE	SIGNATURE	DATE	ACTION (COORD, APPROVE, INFO, OR N/A)	COMMENTS ADDED YES	COMMENTS ADDED NO
TEST SAFETY OFFICER Vincent Caterina, Maj	Vincent Caterina	26 Jan 94	COORD	✓ SRB	
DIRECTOR OF SAFETY Will R. Stewart, Col	Will R Stewart Col	26 Jan 94	COORD		✓
SQUADRON COMMANDER OR EQUIVALENT TPS/ED	James M Payne	1994 JAN 27	COORD		✓
TEST WING ENGINEERING OR EQUIVALENT 412 OG/DOE	Robert W Ryan	2 Feb 94	COORD		✓
GROUP COMMANDER OR EQUIVALENT USAF TPS/CC	Harold J. Stittmatter	4 Feb 94	APPROVE	[initials]	✓
GROUP COMMANDER OR EQUIVALENT N/A			N/A		
TEST WING COMMANDER OR EQUIVALENT ~~Ted M. McFarland, COL~~ [handwritten name]	[signature]	7 Feb 94	INFO		✓
nard L. Engel, BGEN	[signature]	9 Feb 94			✓

RETURN TO AFFTC/SET

AFFTC FORM 5028 APR 93 (EF) Replaces AFFTC Forms 5028, Sep 89, and 5028b, Feb 91, which will not be used

IV	PROJECT DESCRIPTION

INSTRUCTIONS: Include the following sections: Background, Test Objectives, Test Item Description, System Maturity, Types of Tests, Differences from Previous Tests and Scope. An amendment will incorporate changes inherent within these sections. Use additional sheets if necessary,

V	SAFETY REVIEW SUMMARY

INSTRUCTIONS: Include the following sections: Review Synopsis, References, Mishap Responsibilities, General Minimizing Considerations, Special Considerations, Action Items, Risk Assessment, and Coordination Comments. An amendment will incorporate changes inherent within these sections. Use additional sheets if necessary.

SECTION IV: PROJECT DESCRIPTION:

1. BACKGROUND: The Systems Phase of instruction is part of the formal training provided by the USAF Test Pilot School (TPS). Also covered by this documentation is the Qualitative Evaluation Flight Program which is taught under the Test Management Phase of instruction at TPS.

2. TRAINING OBJECTIVES: Teach student test pilots, flight test engineers and flight test navigators the principles and techniques used in testing aircraft systems.

3. TEST ITEM DESCRIPTION: Systems test techniques are taught in the A-37, F-15 and F-16 aircraft. Additionally, training is given in an NC-131 aircraft, which are operated by CALSPAN. Qualitative evaluations can be performed in any type of air vehicle.

4. SYSTEM MATURITY: All curriculum sorties discussed in this documentation have been proven to be safe through previous flights.

5. TYPES OF TRAINING: Testing includes all aspects of an aircraft's RADAR, INS, HUD and electro-optics systems, as well as avionics integration and human factors. Structural loads, Limit Cycle Oscillations (LCO) and assymmetric stores carriage flight test techniques are also flown. Inert weapon deliveries are flown as well. Overall aircraft performance, flying qualities and systems are evaluated on one-time flights during qualitative evaluations.

6. DIFFERENCES FROM PREVIOUS TESTS: This documentation incorporates all changes from the previous Systems Phase safety documentation, control number 90-59, and adds the Limit Cycle Oscillation sortie to the curriculum and deletes the NT-33 HUD evaluation sortie. Test Management Phase flights remain unchanged from the previous SRB. Several previous THA's have been deleted and the applicable minimizing precedures were incorporated into the GMC section. The updated THA's replace all previous.

7. SCOPE: Thirteen sortie types are described in the Systems Phase Planning Guide. Student test pilots will fly approximately twelve sorties while student FTE/Ns will fly about eight sorties. Also, FTE/Ns will control two flights from a control room. Additionally, there will be approximately 8 - 10 qualitative evaluation sorties per student.

SECTION V: SAFETY REVIEW SUMMARY:

1. REVIEW SYNOPSIS:

TRB: The technical review of the Test Pilot School's curriculum for the Systems and Test Management phases are accomplished internally to the Test Pilot School with input from the 412 OG/DOE. As such, no formal TRB was accomplished.

SRB:

1. The safety board met on 13 January 1994 to review the subject safety planning. Both the Systems and Test Management Phases of instruction were reviewed. The board reviewed the entire contents of the Phase Planning Guides, but emphasized the changes since the last review. The major changes were the transition to F-15 and F-16 aircraft along with the new F-16 Limit Cycle Oscillation (LCO) curriculum sortie.

2. The majority of the discussion centered around accomplishing the LCO sorties. The following is provided as a brief summary of the discussion so that future reviews will know why the safety planning was written as it is presented here.

a) Although the LCO sortie is flown within current flight manual limits, the experts at the board felt, based on their experience, that the initial curriculum development missions were closer to test activities then operational flying. The board also felt that the SPO had made compromises with respect to safety when clearing LCO flight, in order to provide a required combat capability. The board was also concerned with repeatability of the LCO phenomenon among different F-16 tail numbers and repeatability from flight to flight. That is why the board required that a flutter expert monitors the LCO curriculum development flights.

Section V continued

b) Because of the repeatability concerns, the board also required the TPS staff to provide an annual review of the LCO characteristics versus each aircraft and test points. This would help the TPS staff in determining when the aircraft are changing enough to warrant additional development flights, or warrant additional curriculum changes for the student test points. The board also felt that as more data become available the periodic review could also be used to relax, if appropriate, the board's restrictions on the LCO mission.

c) Additionally, the board required that during the curriculum development sorties for each F-16 tail number the instructors evaluate the potential to overshoot 80% of the Uniform Abort Policy for each test point. Those test points that had a medium probability of exceeding 80% of the Uniform Abort Policy will be eliminated form the student's test cards. This may involve also providing test point result summaries for each aircraft to the instructor who monitors the students in the control room.

d) Additionally, the minimum required instrumentation for real-time monitoring was specified for this sortie. It was determined that the LCO sortie would not be accomplished if a control room was not available or the Go/No-Go parameters were not available. An action item was generated to provide the Uniform Abort Policy plot with the 80% limit drawn on it in the Systems Phase Planning Guide.

e) The board also required that, during the LCO test points, aircraft will not be flown above 80% of the Design Load Limit as specified in the flight manual carriage limits for the weapons loading. This is to avoid inadvertently performing structural loads testing during an LCO investigation.

2. REFERENCES:

a. USAFTPS Systems Phase Planning Guide, December 1993.
b. USAFTPS Test Management Phase Planning Guide, December 1992.
c. AFSC/TAC MOU, Flight Mishap Accountability.
d. AFFTC 55-2.
e. AFMCR 55-7.
f. USAFTPS 51 series regulations and operating instructions.
g. 416 Test Squadron flight briefing guide.
h. AFSC Form 5028, USAF TPS Systems Phase, control number 90-59, and changes.
i. MIL-STD-1783A, Aircraft/Stores Certification Procedures.
j. MIL-HDBK-244A, Guide to Aircraft/Stores Compatibility.

3. MISHAP RESPONSIBILITIES:

a. For AFFTC aircraft and CALSPAN aircraft (ASTTA), AFMC has mishap accountability and AFFTC has mishap investigation and reporting responsibility.

b. Mishap investigation, reporting and accountability for non-AFMC aircraft rests with the owning command. Mishap responsibility for qualitative evaluation flights are specified in the AFMC/ACC MOU.

4. GENERAL MINIMIZING CONSIDERATIONS:

a. General minimizing considerations for all curriculum sorties:

(1) Changes to the Systems and Test Management Phase Planning Guides require approval of the TPS Commandant. The Commandant will determine which changes warrant coordination with AFFTC/SET. Major changes to the Phase Planning Guides will be via AFFTC Form 5028.

(2) All Systems Phase syllabus flights will be conducted under the direct supervision of a TPS instructor.

(3) Test Pilot School IPs must receive the applicable systems flight test techniques briefing (every six months) prior to instruction students.

(4) All syllabus flights will be conducted in accordance with the applicable aircraft's flight manual, AFFTC 55-2, and applicable aircraft guides and within the local flying area (except for qualitative evaluation flights flown at other locations).

(5) All Systems Phase syllabus flights will be flown in day VMC, except for the night ASTTA mission, which will be flown in night VMC.

(6) All flights will be conducted in accordance with the USAFTPS 51 series regulations/operating instructions.

(7) For missions involving air-to-air or air-to-ground events, the applicable portions of the air-to-air or air-to-ground rules of engagement (ROE) will be briefed before each mission. USAFTPS Operations division will ensure each school briefing room maintains current copies of the ROE (AFMCR 55-7 ROE will be used).

b. <u>Cockpit Evaluation</u> general minimizing considerations:

(1) The ground evaluation will be conducted under daylight conditions.

(2) Emergency ground egress procedures will not be evaluated.

(3) All ejection and jettison safety pins will remain in place throughout the evaluations.

(4) A crewmember familiar with the aircraft will accompany students during the cockpit evaluation.

(5) Ground power will not be used unless a qualified crew chief or technician is available to connect the power and a crewmember has briefed the students on aircraft systems restrictions.

c. Integrated Systems Evaluations (qual) general minimizing considerations:

(1) Ground training in the aircraft will be completed IAW USAFTPS OI 51-9.

(2) See also the following THAs: Ground Impact During Low Level Flight and Weapon Deliveries and Mid-air Collision Between Test Aircraft and Target Aircraft.

d. F-16 Electro-Optical Evaluation Demo general minimizing considerations:

(1) All maneuvering will be conducted above 1,500 ft AGL. For momentary periods, as the target is approached, the aircraft may be descended to 1,000 ft AGL if it is required to stay within guidance unit gimbal limits.

(2) No simulated weapons will be loaded on the aircraft for this mission, except for simulated AIM-9 which may be loaded on stations 1/9.

(3) See also the following THA: Ground Impact During Low Level Flight and Weapon Deliveries.

e. ASTTA (NC-131H) Demo/Data general minimizing considerations:

(1) The aircraft will be flown by fully qualified CALSPAN aircrews during all missions, and these aircrew members will perform primary safety observer duties during the systems evaluations.

(2) The systems demonstrations and evaluations will be conducted under the direct supervision of an USAFTPS instructor.

(3) See also the following THAs: Ground Impact During Night ASTTA; Inadvertent Radiation of Ground Personnel (ASTTA); and Ground Impact During Low Level Flight and Weapon Deliveries; Mid-air Collision Between Test Aircraft and Target Aircraft; and Bird Strike During Night ASTTA Mission.

f. F-16 Weapons Delivery Familiarization general minimizing considerations:

(1) Minimum airspeed in the bombing pattern is 250 KIAS.

(2) The mission will be flown on a conventional range, either single ship or as a flight of two.

(3) At least one dry practice pass per event will be flown for familiarization prior to releasing the first bomb for that event.

(4) An operable HUD is required.

(5) See also the following THA: Ground Impact During Low Level Flight and Weapon

Deliveries.

g. A-37 Controlled Weapons Delivery general minimizing considerations:

(1) Minimum airspeed in the bombing pattern is 180 KIAS.

(2) The mission will be flown on a conventional range, either single ship or as a flight of two.

(3) At least one dry practice pass per event will be flown for familiarization prior to releasing the first bomb for that event.

(4) See also the following THA: Ground Impact During Low Level Flight and Weapon Deliveries.

h. F-15 Air-to-air Systems Evaluation general minimizing consideration:

(1) Minimum altitude for intercepts will be 1,000 ft AGL for the target aircraft and 2,000 ft AGL for the F-15. The F-15 may complete a stern intercept on a non-maneuvering target at 1,000 ft AGL when adequate turn room is available and the target is visual, so as not to go below 1,000 ft AGL.

(2) Aircraft will maintain 1,000 ft separation until visual during electronic countermeasures (ECM) intercepts, since some radar information may not be present.

(3) If at any time safety of flight is compromised during ECM intercepts, "STOP MUSIC" or "SAFETY, SAFETY" will be broadcast on the working frequency, and the target aircraft will terminate use of the ECM.

(3) Minimum airspeed for the F-15 during any intercept below 5,000 ft AGL will be 350 KCAS to maintain maneuvering capability. Limit nose low descent angles to less than 30° during low altitude intercepts below 5,000 ft AGL.

(4) See also the following THAs: Ground Impact During Low Level Flight and Weapon Deliveries and Mid-air Collision Between Test Aircraft and Target Aircraft.

i. F-16 Systems Evaluation (Pilot and FTE/N) general minimizing considerations:

(1) Minimum airspeed for the F-16 during any intercept below 5,000 ft AGL will be 350 KCAS to maintain maneuvering capability. Limit nose low descent angles to less than 30° during low altitude intercepts below 5,000 ft AGL.

(2) Simulated or training store weapon deliveries will be discontinued with any weapon systems malfunction.

(3) Simulated intercept air maneuvers against targets of opportunity will be flown to the

rear quadrant and will be terminated at 6,000 ft spacing.

(4) See also the following THAs: Ground Impact During Low Level Flight and Weapon Deliveries and Mid-air Collision Between Test Aircraft and Target Aircraft.

j. F-15 Captive Compatibility Demo/Asymmetric Stores general minimizing considerations:

(1) Sortie will be flown with a qualified TPS F-15 instructor.

(2) The external 610 gallon tank will be fuel feedable.

(3) Limitations for the mission are listed in Table 3-1 of the Systems Phase Planning Guide. IP checkout will be authorized to use up to flight clearance limits.

(4) Jettison procedures, asymmetric flying qualities, external tank failure to feed, sortie limitations, and abort procedures will be briefed in detail.

(5) Normal takeoff trim setting will be used.

(6) Any emergency aggravated by an asymmetric load condition will require immediate feeding of external fuel or jettison of the tank prior to landing.

(7) The external tank must be entirely full prior to engine start to prevent fuel sloshing during flight. The external tank fuel reading should be 3,950 ±250 lbs for JP-4 (4,090 ±250 lbs for JP-8).

(8) The tank and pylon will be specifically checked during preflight to ensure ejection cartridges are installed.

(9) The aircraft must have an operative AOA gauge and g-meter in the rear cockpit.

(10) Cross-wind limits are 10 kts from the side opposite the store and 15 kts from the side with the store.

(11) Maneuver abort procedures will be briefed in detail.

(12) All test points above 21 units AOA will be flown above 10,000 ft AGL with the exception of takeoff and landings.

(13) See also the following THAs: Departing Controlled Flight during F-15 Asymmetric Stores Investigation; and Aircraft Overstress During Structures Flight Test Techniques.

k. F-16 Structural Loads FTT general minimizing considerations:

(1) Minimum altitude for the flight will be 10,000 ft MSL or 5,000 ft AGL whichever is higher.

(2) Proper strap-in and cockpit FOD check are required prior to negative g maneuvers.

(3) Artificial test limits (within the flight manual aircraft limits) will be observed.

(4) See also the following THA: Aircraft Overstress During Structures Flight Test Techniques.

l. F-16 Limit Cycle Oscillation Demo general minimizing considerations:

(1) The test team will review LCO predictions during the preflight briefing. All personnel involved with the mission will be knowledgeable of recovery procedures in case of flutter.

(2) The minimum test point altitude will be 10,000 ft PA. Minimum altitude for testing will be 8,000 ft MSL or 5,000 ft AGL, whichever is higher.

(3) Up to 20° dives are permitted for test points at or above 10,000 ft PA.

(4) A maneuver will be terminated if any situations develop in which aircrew comfort level is exceeded from longitudinal or lateral oscillations, which impair the ability to read displays, actuate switches, or precisely maneuver the aircraft.

(5) See also the following THA: Structural Failure (Limit Cycle Oscillation Demo).

m. **Test Management Curriculum Sorties (Qual Program)** general minimizing considerations:

(1) Minimum run landings will not be performed due to potential for hot brakes and blown tires. The flight manual min-run approach procedures may be flown up to the touchdown point.

(2) For missions involving air-to-air or air-to-ground events, the applicable portions of the air-to-air or air-to-ground rules of engagement (ROE) will be briefed before each mission. USAFTPS Operations division will ensure each school briefing room maintains current copies of the ROE (AFMCR 55-7 ROE will be used).

(3) All Technical Order limitations and restrictions, as well as service, MAJCOM, and unit regulations will be followed. Further limitations and restrictions imposed by TPS OI 51-9 and the Test Management Phase Planning Guide will be followed.

(4) Mission qualitative evaluations may be flown at night at the discretion of the TPS Operations Officer and Chief, Test Management Branch.

(5) See also the following THAs: Ground Impact During Low Level Flight and Weapon Deliveries and Mid-air Collision Between Test Aircraft and Target Aircraft.

n. A-37 qualitative evaluation mission general minimizing considerations:

(1) No external stores will be carried except for pylon wing tanks.

(2) For stalls:

(a) No asymmetric fuel load (a maximum of 70 lbs difference in wing fuel reading).

(b) Recovery will be initiated when the pilot has a clear indication of a definite g brake or a rapid uncommanded angular motion, the aft stick stop having been reached and AOA not increasing, or sustained intolerable buffet.

(c) Recovery will be completed by 10,000 ft AGL.

(d) Ensure both engines advance together during recovery in order to prevent a yawing moment due to asymmetric thrust.

(e) Abrupt stalls and vertical stalls will be avoided.

(f) IP will brief spin recovery and engine rollback procedures.

(3) Engine RPM will not be reduced below 65% at airspeeds below 150 KIAS above 15,000 ft MSL, except for engine rollback demonstration. Engine RPM will be set at 65% minimum for all stall investigations.

(4) No intentional flight with an engine shutdown below 10,000 ft AGL.

(5) External tanks will be empty prior to starting simulated bombing events. No abrupt aileron rolls will be flown with tip tank fuel above 280 KIAS.

(6) See also the following THA: Ground Impact During Low Level Flight and Weapon Deliveries.

5. TEST ARTICLE RESTRICTIONS: No unique restrictions.

6. SPECIAL CONSIDERATIONS:

Special considerations for the LCO curriculum development sorties:

1. Curriculum development must be done for each F-16 that is modified for the LCO mission.

2. Initial curriculum development for each F-16 that is modified for the LCO mission will be under the supervision of a flutter expert designated by 412 OG/DOES. – See additional DOES comment.

3. For any given aircraft, any test point found to exceed 80% of the Uniform Abort Policy Letter limits will be deleted from the student test cards for that aircraft. Also, the aircraft will not be flown above 80% of the Design Load Limit during the LCO investigation.

4. The TPS staff monitor for LCO missions will perform an annual review of LCO data for each aircraft to determine if the LCO characteristics change over time.

7. ACTION ITEMS:

1. Where appropriate, specify the minimum release altitude for weapons delivery.

2. There is a contradiction between speeds specified for flight on low level routes. Determine which is appropriate and specify when applicable.

3. F-16 LCO sorties:

a) Add the Uniform Abort Policy to the Systems Phase Planning Guide.

b) Include a limit of 80% on the Uniform Abort Policy for curriculum sorties.

c) Add control room procedures for plotting wing tip acceleration amplitude and frequency in real-time and for attempting to extract damping information in real-time for each sortie.

d) Ensure none of the proposed test points exceed 80% of the Design Limit Load.

e) Determine the g onset rate to be used for wind-up-turns, and specify it in the Systems Phase Planning Guide.

4. F-16 Loads FTT:

a) Verify that the MIL-STD requirement for 60 lbs lateral load, as stated in the Systems Phase Planning Guide, is appropriate.

b) Verify that the MIL-STD requirement for 180 lbs rudder load, as stated in the Systems Phase Planning Guide, is appropriate.

8. RISK ASSESSMENT:
Curriculum Sorties -- LOW
Curriculum Development Sorties -- LOW (see Special Considerations, above)

9. COORDINATION COMMENTS:

T T HAZARD ANALYSIS (THA)	PAGE 1 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY I/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE Robert A. Eslinger
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Ground Impact During Low Level Flight and Weapon Deliveries

CAUSE: 1. Pilot inattention
2. Visual illusion/misjudgment
3. Pilot task saturation/distraction
4. Target fixation

EFFECT: Damage/loss of aircraft and crew

MINIMIZING PROCEDURES:

1. (1,2,3,4) An IP will fly with the students on each sortie requiring low level flight and practice off range weapon deliveries.

2. (1,2,3,4) An IP will brief and, if required, demonstrate the proper weapons delivery techniques prior to student practice .

3. (1,2,3,4) Simulated and actual release altitudes must be adjusted so as not to descend below the specified minimum altitudes during the dive recovery.

4. (1,2,3) Low level ride and systems assessment will be flown on an approved low level route. Minimum altitude is 500 ft AGL; however, navigation legs will normally be flown at or above 1,000 ft AGL.

5. (1,2,3,4) Maximum planned dive angle is 45 degrees.

6. (1,2,3,4) Minimum recovery altitude for dive attacks are:

Planned Dive Angle	Minimum Altitude (AGL)
0 - 14 degrees	500 ft
15 - 24 degrees	1,000 ft
25 - 45 degrees	1,500 ft

7. (1,2,3) Minimum airspeed for F-16 low level flight is 400 KIAS.

8. (1,2,3) Maximum airspeed on AFFTC colored low level routes is 450 ground speed.

9. (1,2,3) Minimum airspeed during weapons deliveries are 180 KIAS for the A-37 and 250 KIAS for the F-16.

10. (1,2,3,4) No straight ahead attacks below 5,000 ft AGL for the A-37, except for the Controlled Weapons delivery sortie.

T HAZARD ANALYSIS (THA)	HAZARD CAT/PROBABILITY
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	I/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Mid-air Collision Between Test Aircraft and Target Aircraft

CAUSE: 1. Failure to see and avoid
2. Loss of situational awareness between test and target aircraft

EFFECT: Damage/loss of aircraft and crew

MINIMIZING PROCEDURES:

1. (1,2) Aircraft will maintain 1,000 ft altitude separation inside of 10 miles unless visual contact is maintained between the aircraft

2. (1,2) Aircraft will maintain a 1,000 ft safety bubble except for standard departure, fingertip, close trail, or rejoins which will be prebriefed.

3. (2) Detailed profile and procedures briefings will be conducted with target pilots.

4. (1,2) Appropriate ATC will be used and briefed on desired aircraft separation

T T HAZARD ANALYSIS (THA)	PAGE 3 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY I/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Ground Impact During Night ASTTA

CAUSE: 1. Aircrew inattention
2. Improper ground track

EFFECT: Loss of aircraft and crew

MINIMIZING PROCEDURES:

1. (1,2) Minimum altitude for night operations is 2,000 ft AGL, except for run-ins to the IR board.

2. (1,2) All operations will be conducted in VMC.

3. (1,2) The following restrictions apply to run-ins to the IR board:

a. The ASTTA front cockpit will have an operable radar altimeter.

b. Missions will be under SPORT control.

c. Descent to 500 ft AGL minimum will only be on an eastbound run-in to the IR board and within the PIRA/Alpha corridor.

d. A positive means will be used to align final run-in to be perpendicular to the IR board.

e. A climb to 2,000 ft AGL will be accomplished immediately after crossing over the IR board.

REMARK: Currently, LORAN is used to align final flight path perpendicular to the IR board. Also, a vehicle is parked near the IR board with its headlights illuminated in the direction of the run-in to aid visual identification.

T[illegible]T HAZARD ANALYSIS (THA)	PAGE 4 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY I/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE Robert A. Eslinger
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE Ronald G. Joseph

HAZARD: Bird Strike During Night ASTTA Mission

CAUSE: 1. Low altitude flight
2. Flight in areas of known bird congregation

EFFECT: Damage/loss of aircraft and crew

MINIMIZING PROCEDURE:

1. (1,2) Bird strike contingency plans will be a preflight briefing item.

CORRECTIVE ACTION:

In the event of a bird strike the crew will:

a. Climb to a safe altitude.
b. Perform the associated emergency procedures.
c. The test mission will be terminated and the aircraft will RTB.

REMARKS:

The NC-131 aircraft may operate within +/- one hour of sunset/sunrise near the evaporating ponds due to mission requirements. The radome was designed to take a hit by a bird the size of a Canadian goose at normal operational speeds.

T[illegible] HAZARD ANALYSIS (THA)	PAGE 5 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY III/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Inadvertent Radiation of Ground Personnel (ASTTA)

CAUSE: Inadvertent intrusion of ground personnel while radar is transmitting

EFFECT: Injury to personnel

MINIMIZING PROCEDURES:

1. All flight and maintenance personnel will be briefed on proper use of equipment and hazards of radiation.

2. Checklists will provide procedures to prevent inadvertent turn-on of equipment.

3. Danger zone will be marked at parking spot and monitored by a safety observer.

4. Aircraft strobes will be illuminated when intentionally radiating.

CORRECTIVE ACTION: If personnel enter the danger zone, radar will be shut down.

REMARKS: Danger zone is an area 75 feet, +/- 70 degrees off the nose of the aircraft. The squat switch override is a red guarded toggle switch.

T[illegible] HAZARD ANALYSIS (THA)	PAGE 6 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY I/REMOTE
PREPARED BY (TYPE NAME AND TITLE) Robert A. Eslinger, Capt	SIGNATURE
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Departing Controlled Flight During F-15 Asymmetric Stores Investigation

CAUSE: 1. Exceeding roll authority
2. Departure while maneuvering

EFFECT: Loss of aircraft/crew

MINIMIZING PROCEDURES:

1. (1) "TEST 251, Handling Qualities Test" found in MIL-STD-1763A, Aircraft/Stores Certification Procedures and MIL-HDBK-224A, Guide to Aircraft/Stores Compatibility, will be used for building-up to test points.

2. (1,2) Maximum maneuvering AOA will be limited to 30 units. The Systems Phase Planning Guide limits students to 25 units.

3. (1) Maximum crosswind for takeoff will be 10 knots from the side opposite the store and 15 knots from the side with the store if any fuel remains in the tank.

4. (1,2) Simulated single engine approaches will be practiced at altitude.

5. (2) All data points will be performed at or above 10,000 ft AGL when above 21 units AOA, except takeoff and landing.

6. (1,2) The CAS will be ON during structural integrity checks.

CORRECTIVE ACTION:

In the event controlled flight cannot be maintained:

1. If roll authority is lost, unload to 1G, roll upright, aft stick to recover from dive (if required)

2. If a departure occurs, follow the Flight Manual Recovery Procedures.

T HAZARD ANALYSIS (THA)	PAGE 7 OF 8 PAGES
TEST SERIES USAF Test Pilot School Systems/Test Management Phase	HAZARD CAT/PROBABILITY II/REMOTE
PREPARED BY (TYPE NAME AND TITLE) obert A. Eslinger, Capt	SIGNATURE
UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE) Ronald G. Joseph, Maj	SIGNATURE

HAZARD: Aircraft Overstress During Structures Flight Test Technique

CAUSE: 1. Lack of pilot proficiency
2. Inattention to accelerometer
3. Roll coupling

EFFECT: Damage to aircraft

MINIMIZING PROCEDURES:

1. (1) All practice structures flight test techniques will be under the direct supervision of a TPS instructor.

2. (1,2,3) The artificial g limits for student training for the F-16 Structural Loads FTT will be +6 to -2 symmetric and +4 to -0.8 unsymmetric.

3. (1,2,3) The artificial g limits for student training for F-15 Captive Compatibility Demo/Asymmetric Stores FTT, when carrying a full 610 gallon tank on station 2 or 8, will be +4 to -0.5 symmetric and +2.5 to +0.5 unsymmetric in the cruise configuration.

4. (1) A build up from 80% of the above limits will be accomplished prior to 100% of the artificial limits.

5. (1) Rapid rudder reversals or rapid release of rudder command in the F-16 will not be performed above 300 Kts/0.6 Mach.

CORRECTIVE ACTION: If an actual aircraft overstress occurs, a controllability check will be accomplished and the mission will be terminated.

REMARK: The F-15 Captive Compatibility Demo/Asymmetric Stores mission will be flown in accordance with the current flight clearance provided at the TPS operations desk and in the Systems Phase Planning Guide.

T[illegible]T HAZARD ANALYSIS (THA)

TEST SERIES
USAF Test Pilot School Systems/Test Management Phase

HAZARD CAT/PROBABILITY
I/REMOTE

PREPARED BY (TYPE NAME AND TITLE)
Robert A. Eslinger, Capt

SIGNATURE

UNIT TEST SAFETY OFFICER (TYPE NAME AND GRADE)
Ronald G. Joseph, Maj

SIGNATURE

HAZARD: Structural Failure (Limit Cycle Oscillation Demo)

CAUSE: 1. Aircrew inattention to test limits
2. Control room personnel inattention to test limits

EFFECT: Damage/loss of aircraft and crew

MINIMIZING PROCEDURES:

1. (1) An LCO upgrade flight program will be established for IPs.

2. (2) An Instructor FTE/N who is checked out in LCO control room operations will assist the student FTE/N in the control room.

3. (1) Test conditions and wing tip accelerometer outputs will be monitored in real time in the control room. The following instrumentation is required for the LCO mission:
(1) Operating telemetry with minimal data drop outs
(2) At least three of the four wingtip accelerometers
(3) Normal acceleration at the CG
(4) Mach and altitude
(5) Operational radio communications between the aircraft and control room

4. (1,2) Test conditions will build-up to an LCO condition. A safety margin will be added to the requirements of the Uniform Abort Policy letter, which will be adhered to in making terminate calls. 80% of the Uniform Abort Policy limits will be used.

5. (1) Pilots will be throughly briefed on test conditions to be flown and on any adverse conditions which may be encountered should test limits be exceeded. Procedures for aircraft recovery, emergency calls, and crew egress will also be briefed.

CORRECTIVE ACTIONS:

The terminate procedure is:

(1) Reduce speed by first retarding the throttle
(2) Unload the aircraft if in an elevated g maneuver
(3) If necessary, actuate the speed brakes

REMARKS:

1. LCO charactistics of the configuration have been tested on an F-16A and were found to be predictable. The configuration is an approved loading for the F-16.

2. Mass properties of all stores will be determined prior to flight to ensure they meet specified weight, center-of-gravity, and inertia tolerances.

3. Wind up turns will not be flown to above 80% of the aircraft's design limit load.

APPENDIX A

GRADESHEETS

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USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

STUDENT	INSTRUCTOR PILOT	MISSION ELECTRO-OPTIC FTT (PILOT/FTE/N)	CLASS	DATE
		AIRCRAFT TYPE/NO F-16B	FLIGHT TIME	GRADE

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION EVENTS

1. MISSION PREPARATION
   A. TEST CARDS
   B. WEATHER/TIME-OF-DAY EFFECTS
2. BRIEFING
3. GROUND OPS
   A. INS/FCNP/RADAR/TGM-65/SMS POWERUP
4. TAKEOFF
5. SENSOR / TGM-65 OPERATION
   A. ADHERENCE TO LIMITS
   B. REO TUNING
6. SENSOR COMPARISON
7. INFLIGHT ANALYSIS
8. RECOVERY / LANDING
   A. TGM-65 POWERDOWN
9. DEBRIEF
   A. VTR REVIEW
   B. POSTFLIGHT ANALYSIS

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED. USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION ASTTA-O DEMO (PILOT/FTE/N)	CLASS	DATE		
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO NC-131H/793	FLIGHT TIME	GRADE

MISSION EVENTS	Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. MISSION PREPARATION	**MISSION PREPARATION**
2. BRIEFING	
3. INS, RADAR, IR/EO, INSTRUMENTATION POWER-UP	
4. AIR-TO-AIR RADAR TESTING	**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
A. BLIP SCAN	
B. MAX RANGE LOCK-ON	
C. TARGET RESOLUTION	
D. NOTCH INVESTIGATION	
E. CLUTTER INVESTIGATION	
5. GROUND MAP RADAR TESTING	
A. REFLECTOR ARRAY RESOLUTION	
(1) ALL RADAR GROUND MAP MODES	
(2) ROSAMOND LAKE ARRAY	
(3) RADFAG ARRAY	
(4) TARGETS OF OPPORTUNITY	
6. OPERATIONAL SYSTEMS TESTING	
A. NAV ROUTE	
(1) RADAR TURN POINT I.D.	
(2) IR/EO TURN POINT I.D.	
(3) INS NAV AND UPDATE	
(4) GPS ORIENTATION	
B. SYSTEMS INTEGRATIONS EVALUATION	
C. HUMAN FACTORS EVALUATION	
7. INFRARED ORIENTATION	
A. POWER-UP AND TUNING	
B. IR BOARD	
8. DATA PROCEDURES	
9. CREW COORDINATION	**AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)**
10. DEBRIEFING	
NOTE: THIS FLIGHT IS FLOWN WITH THE STUDENT AS AN OBSERVER/	
ASSISTANT TO THE STUDENTS ON ASTTA 1. CAN BE WAIVED DUE TO	
OPERATIONAL EXPERIENCE	

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

STUDENT	INSTRUCTOR PILOT	MISSION ASTTA-1 DEMO/DATA (P/FTE/N)	CLASS	DATE
		AIRCRAFT TYPE/NO NC-131H/793	FLIGHT TIME	GRADE

MISSION EVENTS

1. MISSION PREPARATION
2. BRIEFING
3. INS, RADAR, IR/EP, INSTRUMENTATION POWER-UP
4. AIR-TO-AIR RADAR TESTING
   A. INSTRUCTOR DEMO BLIP SCAN
   B. STUDENT PRACTICE AND DATA
      (1) BLIP SCAN MAX DETECT/HOLDS
      (2) MAX LOCK-ON RANGE
      (3) TARGET RESOLUTION
      (4) NOTCH INVESTIGATION
      (5) CLUTTER INVESTIGATION
5. OPERATIONAL SYSTEMS TESTING NAV ROUTE
   A. IR/EO TURN POINT I.D.
   B. RADAR TURN POINT I.D.
   C. INS NAVIGATION AND UPDATING
6. HUMAN FACTORS EVALUATION
7. SYSTEMS INTEGRATION EVALUATION
8. DATA PROCEDURES
9. CREW COORDINATION
10. DEBRIEFING

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

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USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION ASTTA-2 DEMO/DATA NIGHT (P/FTE/N)	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO NC-131H/793	FLIGHT TIME	GRADE

MISSION EVENTS

1. MISSION PREPARATION
2. BRIEFING
3. INS, RADAR, IR/EP, INSTRUMENTATION POWER-UP
4. IR TESTING
   A. INSTRUCTOR DEMO - IR BOARD TEST RUN
      (1) MAX DETECT RANGE
      (2) MAX IDENTIFICATION RANGE
   B. STUDENT QUALITATIVE SYSTEM EVALUATION
      (1) MAX DETECT RANGE
      (2) MAX IDENTIFICAITON RANGE
   C. STUDENT QUALITATIVE SYSTEM EVALUATION TARGETS OF OPPORTUNITY
5. GROUND MAP RADAR TESTING
   A. IP DEMO - REFLECTOR ARRAY RESOLUTION
   B. STUDENT PRACTICE AND DATA
      (1) ALL RADAR GROUND MAP MODES
      (2) ROSAMOND LAKE REFLECTION ARRAY
      (3) RADFAG REFLECTOR ARRAY
      (4) TARGETS OF OPPORTUNITY
6. INS TESTING
7. HUMAN FACTORS EVALUATION
8. SYSTEMS INTEGRATION EVALUATION
9. DATA PROCEDURES
10. CREW COORDINATION
11. DEBRIEFING

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 256, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION: WEAPONS DELIVERY FAM (PILOTS)	CLASS	DATE		
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO: F-16	FLIGHT TIME	GRADE

MISSION EVENTS

1. MISSION PREPARATION
   A. MIL PREPARATION
   B. WEAPONS PREFLIGHT
   C. WEAPONS RELEASE PROCEDURES
2. BRIEFING (IP)
   A. REVIEW MIL SETTING, PREFLIGHT, RELEASE PROCEDURES
   B. RANGE PROCEDURES/FREQUENCIES
   C. DELIVERY PARAMETERS/TECHNIQUES
   D. FOUL ALTITUDES
   E. HUNG/UNEXPENDED ORDANCE PROCEDURES
   F. BRIEF RANGE CONTROL OFFICER/SPORT
3. TAKEOFF
4. RANGE ENTRY
5. MANUAL DELIVERY 30 DEGREE (1 EACH)
6. 30 DEGREE DB (CCIP) (2 EACH)
7. 15 LALD (CCIP AND DTOS) (2 EACH)
8. RADAR LAYDOWN (CCRP) (1 EACH)
9. 30 DEGREE LOFT (LOFT) (2 EACH)
10. CONTROLLED WEAPONS DELIVERY (2 EACH)
11. RANGE EXIT
12. LANDING / POST FLIGHT
13. DEBRIEFING (STUDENT)
14. EMERGENCY PROCEDURES
15. JUDGEMENT

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

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USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION F-15 Systems Evaluation (Pilot)		CLASS		DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-15/	FLIGHT TIME	GRADE

MISSION EVENTS

1. MISSION PREPARATION
   a. SYSTEMS KNOWLEDGE
   b. DATA CARDS
   c. GENERAL BRIEFING
2. PREFLIGHT, INTERIOR CHECK, ENGINE START, AVIONICS SETUP/BIT
3. INTERCEPTS
4. WEAPONS EMPLOYMENT
5. ILS PATTERN
6. NORMAL PATTERN AND LANDING
7. MISSION DEBRIEFING/EVALUATION
   A. EVALUATION OF HUD (NAVIGATION, WEAPONS DELIVERY, ILS OTHER)
   B. EVALUATION OF INS/ACS
   C. EVALUATION OF RADAR
   D. EVALUATION OF COCKPIT LAYOUT
   E. EVALUATION OF CURSOR CONTROLLER
   F. EVALUATION OF DESIGNATE FUNCTIONS
   G. EVALUATION OF AUTO ACQ MODES
   H. EVALUATION OF AUTOPILOT

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION F-15 FTN/FTE Systems Evaluation	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-15/	FLIGHT TIME	GRADE

MISSION EVENTS	Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. Mission Preparation	**MISSION PREPARATION**
a. Organization of profile	
b. Data Cards	
c. Briefing	**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
2. Mission Conduct	
a. Thoroughness of cockpit eval	
b. Control of mission events	
(1) Directive	
(2) Prioritized	
(3) Efficient	
3. Mission Debriefing	
a. Cockpit layout	
b. Navigation systems	
c. Communication systems	
d. Fire control systems	
(1) Radar	
(2) HUD	
(3) Armament control	
	AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

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ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION SYSTEMS EVAL (PILOT)	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-16/	FLIGHT TIME	GRADE

MISSION EVENTS		Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. MISSION PREPARATION	(30%)	**MISSION PREPARATION**
A. SYSTEMS KNOWLEDGE		
B. DATA CARDS		
C. GENERAL & SPECIFIC MISSION BRIEFING		**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
2. PREFLIGHTOPS, AVIONICS SETUP, GROUND TEST POINTS	(4%)	
3. FUNCTIONAL EVALUATIONS & NAVIGATION TESTS	(8%)	
A. NAVIGATION CUES / TIMING / MARK		
B. OVERFLY UPDATE		
C. RADAR UPDATE		
D. ACAL UPDATE		
E. GM RADAR EVAL		
F. CRUISE MODES EVAL		
G. AUTO PILOT EVAL		
H. RALT EVAL		
4. INTEGRATED SYSTEMS TESTS	(8%)	
A. AGR EXERCISE		
B. LOFT - 30 DEGREE ATTACK		
C. CCIP ATTACK		
D. DTOS ATTACK / REATTACK		
E. INFLIGHT RECONNAISSANCE		
5. INTEGRATED SYSTEM EVAL	(5%)	
6. ILS EVAL	(2%)	
7. SFO PATTERN, NORMAL PATTERN, LANDING	(P/F)	
8. INFLIGHT DATA PROCEDURES	(3%)	
9. MISSION DEBRIEFING/EVALUATION	(40%)	
A. DATA (Δ'S, DIVE ANGLES, AIRSPEEDS)		
B. EVALUATION OF HUD (NAVIGATION, WEAPONS DELIVERY, ILS OTHER)		
C. EVALUATION OF INS/FCNP/SMS		
D. EVALUATION OF RADAR ALTIMETER		
E. EVALUATION OF RADAR		**AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)**
F. EVALUATION OF COCKPIT LAYOUT		
G. EVALUATION OF CURSOR CONTROLLER		
H. EVALUATION OF UPDATE FUNCTIONS		
I. EVALUATION AUTOPILOT		INSTRUCTOR PILOT / SECTION CHIEF / CHIEF, OPERATIONS BR
J. INTEGRATED SYSTEM EVALUATION		

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USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION FTN Systems Evaluation	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-16/	FLIGHT TIME	GRADE

MISSION EVENTS		Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. Mission Preparation	(30%)	**MISSION PREPARATION**
a. Organization of profile		
b. Data Cards		
c. Briefing		**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
d. Knowledge of Systems Flight Test Techniques		
2. Mission Conduct		
a. Thoroughness of cockpit eval	(30%)	
b. Control of mission events		
(1) Directive		
(2) Prioritized		
(3) Efficient		
(4) Knowledge of Test Procedures		
3. Mission Debriefing	(40%)	
a. Cockpit layout / HOTAS		
b. Navigation systems		
c. Communication systems		
d. Fire control systems		
(1) Radar		
(2) HUD		
(3) Armament control		
(4) Systems Integration		
		AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)
		INSTRUCTOR PILOT / SECTION CHIEF / CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED. USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION F-16 FTE Systems Evaluation	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-16/	FLIGHT TIME	GRADE

MISSION EVENTS
1. Mission Preparation
a. Organization of profile
b. Data Cards
c. Briefing
2. Mission Conduct
a. Thoroughness of cockpit eval
b. Control of mission events
(1) Directive
(2) Prioritized
(3) Efficient
3. Mission Debriefing
a. Cockpit layout
b. Navigation systems
c. Communication systems
c. Communication systems
d. Fire control systems
(1) Radar
(2) HUD
(3) Armament control

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION	CLASS	DATE
CAPT COMP/ASYM STORES (PILOTS/FTNS)		

STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO	FLIGHT TIME	GRADE
		F-15/		

MISSION EVENTS

1. MISSION PREPARATION
2. BRIEFING
3. PREFLIGHT/GROUND OPS
4. TAXI
5. MIL POWER TAKEOFF
6. ENVELOPE EXPANSION
   A. PRECISION
   B. EFFICIENCY
   C. QUALITY OF DATA
7. NEAR STALL INVESTIGATION 20,000 FT/250 KIAS
8. CONTROLLABILITY CHECK 20,000 FT
9. STRAIGHT-IN TOUCH AND GO
10. SPEED SOAK
11. STRAIGHT-IN FULL STOP
12. DEBRIEF

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION	CLASS	DATE
LIMIT CYCLE OSCILLATION (PILOT)		

STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO	FLIGHT TIME	GRADE
		F-16B/		

MISSION EVENTS

1. MISSION PREPARATION
   A. PREPARATION/DATA CARDS
2. BRIEFING
   A. LIMITATIONS
   B. MISSION BRIEF
3. GROUND BLOCK
4. TAKEOFF/CLIMB
5. INFLIGHT COORDINATION
6. TEST POINTS
   A. 20,000 PA / 0.6 MACH
   B. 10,000 PA / 0.5 MACH
7. RECOVERY/LANDING
8. DEBRIEFING

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION F-16 LCO TM FTT		CLASS	DATE	
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO. (FTE)	FLIGHT TIME	GRADE

MISSION EVENTS
1. MISSION PREPARATION
A. TEST LIMITS, TIME-FUEL LINE, AIRCRAFT LIMITS
GO/NO-GO ITEMS
2. MISSION BRIEFING
3. TM TEST CONDUCT
A. GROUND BLOCK
(1) CONTROL SWEEP
(2) AIRBORNE CHECK
B. TEST POINTS
(1) 20,000 PA / 0.6 MACH
(2) 10,000 PA / 0.5 MACH
C. DATA ACQUISITION / ANALYSIS
D. COMPLETENESS / ACCURACY
E. RESOURCE MANAGEMENT
F. TIME / FUEL / SITUATION AWARENESS
4. FLIGHT TEST DIRECTOR DECISIONS

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION F-16 STRUCTURAL LOADS FTT (PILOT)	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-16/	FLIGHT TIME	GRADE

MISSION EVENTS	Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. MISSION PREPARATION/DATA CARDS	**MISSION PREPARATION**
2. BRIEFING	
3. GROUND OPS	
4. TAKEOFF/CLIMB/ SI CHECK	**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
5. STRUCTURAL LOAD TEST POINTS:	
A. 25,000 FT H_c/0.7MK, 220 KIAS) (All 25,000 ft points are required)	
(1) NORMAL PULLUP	
(2) NORMAL PUSHDOWN	
(3) NORMAL 2 G ROLLING PULL UP	
(4) NORMAL SIDESLIP	
(5) ABRUPT RUDDER REVERSAL	
(6) ABRUPT PULL UP	
(7) ABRUPT PUSHDOWN	
(8) ABRUPT 360 1 G ROLL	
B. 25,000 FT H_c/0.9M (Items 2 and 3 required; 1 and 4 are desired)	
(1) NORMAL 2 G ROLLING PULLOUT	
(2) ROLLER COASTER	
(3) WINDUP TURN	
(4) ABRUPT 360 1 G ROLL	
C. 15,000 FT H_c/0.9M (Item 5 and one of 1 or 2 & one of 3 or 4 are required)	
(1) NORMAL PULL UP	
(2) NORMAL PUSHDOWN	
(3) ABRUPT PULL UP	
(4) ABRUPT PUSHDOWN	
(5) ABRUPT UNCOORDINATED 180 -0.5 g ROLL	
6. TRAFFIC PATTERN/LANDING	
7. DEBRIEF	
	AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL
PILOT MISSION CARD/GRADESHEET

MISSION	CLASS	DATE
F-16 STRUCTURES TM CHECK (FTE)		
AIRCRAFT TYPE/NO: F-16	FLIGHT TIME	GRADE

STUDENT	INSTRUCTOR PILOT

MISSION EVENTS

1. MISSION PREPARATION	(25%)
A. MISSION DEFINITION	
B. TEST ENVELOPE DEFINITION, TIME-FUEL LINE AIRCRAFT/TEST LIMITS, FTTS, GO/NO GO	
2. MISSION BRIEFING/DEBRIEFING	(15%)
A. SPECIFIC MISSION BRIEFING	
B. CREW COORDINATION PROCEDURES (AIR TO GROUND COMMUNICATIONS)-	
3. DATA CARDS	(10%)
A. LEGIBLE, COMPREHENSIVE, CONCISE	
4. TM TEST CONDUCT	(35%)
A. GROUND BLOCK	
(1) CONTROL SWEEP	
(2) GROUND/AIRBORNE SENSOR CHECK (G, AOA, BETA)	
B. TEST POINTS-	
(1) 25,000 FT 0.7M	
(A) NORMAL PULLUP/PUSHDOWN	
(B) NORMAL 2G ROLLING PULLOUT	
(C) NORMAL SIDESLIP	
(D) ABRUPT PULLUP/PUSHDOWN	
(E) ABRUPT ROLL 360/ABRUPT RUDDER REVERSAL	
(2) 25,000 FT 0.9M	
(A) 2G ROLLING PULLOUT/WINDUP TURN	
(B) ROLLER COASTER	
(C) ABRUPT ROLL 360 1G ROLL	
(3) 15,000 FT 0.9M	
(A) NORMAL PULLUP/PUSHDOWN	
(B) ABRUPT PULLUP/PUSHDOWN/180 ROLL (-0.5 G)	
C. DATA ACQUISITION	
D. COMPLETENESS/ACCURACY	
E. RESOURCE MANAGEMENT	
F. TIME/FUEL/SITUATION AWARENESS	
4. FLIGHT TEST DIRECTOR DECISIONS	(15%)
DELIBERATE ACTION TO CONTROL TEST ADAPTABILITY	

Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.

MISSION PREPARATION

FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING

AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)

INSTRUCTOR PILOT	SECTION CHIEF	CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 265, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

USAF TEST PILOT SCHOOL PILOT MISSION CARD/GRADESHEET		MISSION F-16 STRUCTURES TM ROOM MISSION (FTN)	CLASS	DATE
STUDENT	INSTRUCTOR PILOT	AIRCRAFT TYPE/NO F-16	FLIGHT TIME	GRADE

MISSION EVENTS	Comment on the following areas. (Expand on any area that is particularly strong or below average/unsatisfactory.) Continue on reverse side if necessary.
1. MISSION PREPARATION	**MISSION PREPARATION**
A. MISSION DEFINITION	
B. TEST ENVELOPE DEFINITION, TIME-FUEL LINE AIRCRAFT/TEST	
LIMITS, FTTS, GO/NO GO	**FLIGHT TEST TECHNIQUES/DATA PROCEDURES/AIRCRAFT HANDLING**
2. MISSION BRIEFING/DEBRIEFING	
A. SPECIFIC MISSION BRIEFING	
B. CREW COORDINATION PROCEDURES (AIR TO GROUND	
COMMUNICATIONS)-	
3. DATA CARDS	
A. LEGIBLE, COMPREHENSIVE, CONCISE	
4. TM TEST CONDUCT	
A. GROUND BLOCK	
(1) CONTROL SWEEP	
(2) GROUND/AIRBORNE SENSOR CHECK (G, AOA, BETA)	
B. TEST POINTS-	
(1) 25,000 FT 0.7M	
(A) NORMAL PULLUP/PUSHDOWN	
(B) NORMAL 2G ROLLING PULLOUT	
(C) NORMAL SIDESLIP	
(D) ABRUPT PULLUP/PUSHDOWN	
(E) ABRUPT ROLL 360/ABRUPT RUDDER REVERSAL	
(2) 25,000 FT 0.9M	
(A) 2G ROLLING PULLOUT/WINDUP TURN	
(B) ROLLER COASTER	
(C) ABRUPT ROLL 360 1G ROLL	
(3) 15,000 FT 0.9M	
(A) NORMAL PULLUP/PUSHDOWN	
(B) ABRUPT PULLUP/PUSHDOWN/180 ROLL (-0.5 G)	**AIRMANSHIP (PLANNING/SAFETY/PROCEDURAL KNOWLEDGE)**
C. DATA ACQUISITION	
D. COMPLETENESS/ACCURACY	
E. RESOURCE MANAGEMENT	
F. TIME/FUEL/SITUATION AWARENESS	
4. FLIGHT TEST DIRECTOR DECISIONS	
DELIBERATE ACTION TO CONTROL TEST ADAPTABILITY	INSTRUCTOR PILOT / SECTION CHIEF / CHIEF, OPERATIONS BR

AFSC FORM 5228a, OCT 86 REPLACES AFFTC FORM 255, NOV 84, WHICH WILL BE USED.

USAF TPS/ED OVERPRINT DATE: JAN 95

ADDITIONAL COMMENTS

APPENDIX B

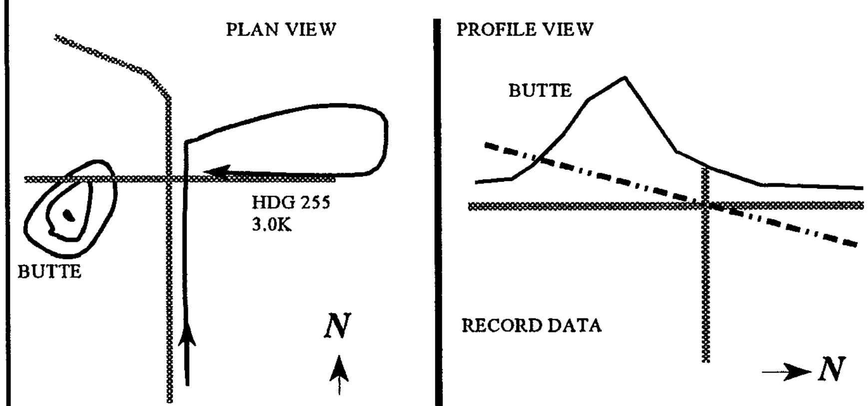
DATA CARDS

AIR-TO-GROUND RANGING EVAL

SETUP: STPT ______
5000' MSL / 350 KIAS
M. MODE:A-G / DTOS
FCR: GM
START RUN 5 NM SOUTH OF STPT ALIGNED WITH CAL CITY ROAD

PROCEDURES:

1. DATA ON (HUD)
2. FLY UP ROAD, HDG 345°
3. SLEW & GND STABILIZE TD BOX ON TGT
   -VERIFY AGR
4. DESCEND: AFTER GRAZE ANGLE > 10°
5. RECOVER @ 3.5K MSL
   - OFF RIGHT
   - DO NOT RESET OR SLEW DTOS!!!
6. RUN - IN FROM EAST: HDG 255° / 3.0K
   - NOTE TD BOX LOCATION



OBJ: DETERMINE IF GROSS AGR ERRORS EXIST

OVERFLY FIX

SETUP: STPT____, MIN ALT 500' AGL
DATA KNOB: OUT OF DEST
M. MODE: NAV
FCR: GM

PROCEDURES:

1. DATA ON (HUD)
2. C/Z (DATA KNOB; MISC, THEN MODE SELECT)
3. FUNCTION KNOB: OVERFLY
   - VERIFY: FIX IN LOWER RIGHT HUD
     FCNP: N/E & COUNTING
4. FCR: AIR (NOTE RESULTS)
5. FCR: GM
6. NOTE TD BOX LOCATION RELATIVE TO STPT
   BRG______ RNG_______
7. OVERFLY STPT & DESIGNATE
8. RECORD DATA: IRIG/FCC TIME_______
   N________ E________
9. DESIGNATE TO ACCEPT FIX
   - VERIFY M. MODE CHANGES TO NAV
10. RETURN TO STPT
    - VERIFY TD BOX CORRECTED TO STPT
      (MAY NOT OVERLAY DUE TO SALT ERRORS)
11. C/Z
    - VERIFY TD BOX DOES NOT MOVE
      (FCC SLEWS ZEROED)

OBJ: DETERMINE INS DRIFT RATES & VERIFY FUNCTION OF THE OFLY FIX IAW -34

ACAL

SETUP:
STPT_____, MIN ALT 500'AGL
M. MODE:NAV
FCR: GM
ALT________MSL (2000' ABOVE DEST)
USE AUTO PILOT IF DESIRED

PROCEDURES:

1. DATA ON (HUD)

2. DATA KNOB: POS, THEN DATA OPT TO E/A
   NOTE: SYSTEM ALTITUDE VS ALTIMETER
   ____________ ____________

3. DATA KNOB: ALT CAL, DATA OPT TO RDR
   - RECORD: STPT ELV / ALT ABOVE STPT(SYS ALT)
   LMD_________ / RMD_________

4. MODE SELECT (ENSURE LINE-OF-SIGHT TO STPT)
   - VERIFY: ACAL IN HUD
   FCR: AGR

5. VISUALLY SLEW TD BOX OVER DEST
   - RECORD: STPT ELV / ALT ABOVE STPT (AGR)
   LMD_________ / RMD_________

6. DESIGNATE WITH > 10° GRAZE ANGLE
   - VERIFY: M. MODE CHANGES TO " NAV"

7. VERIFY SYSTEM ALTITUDE CORRECTED
   - RTN TO STPT
   - VERIFY NO 6/12 DRIFT IN HUD
   - COMPARE CORRECTED SYS ALT TO RALT/ACAL
   RALT + STPT ELV = SYSTEM ALT
   _________ _________ _________

OBJ: DETERMINE SYSTEM ALTITUDE ERRORS & VERIFY PROPER FUNCTION OF ACAL.

RNG (CRUISE MODE)

SETUP:
STPT _____, START RUN > 20 NM FROM STPT
ALT (29.92) _____ (5000, 10000, 15000, 25000)
A/S 400 KIAS
M. MODE: NAV
USE AUTO PILOT IF DESIRED

PROCEDURES:

1. DATA ON (HUD, TISL)

2. DATA KNOB: CRUISE, DATA OPT RNG
   -RECORD: FUEL REMAINING / OPT. ALTITUDE
   LMD__________ / RMD__________

3. MODE SELECT
   - VERIFY A/S CARET IN HUD

4. TRIM SHOT @ A/S CARET
   - RECORD: FUEL REMAINING @ STPT

LMD	__________	LBS
AIRSPEED	__________	KIAS
FUEL QUANTITY	__________	LBS
DIST. TO STPT	__________	NM
G.S.	__________	KGS
FUEL FLOW	__________	LBS/HR

NOTE: LMD FUEL REMAINING SHOULD BE GREATER IN STEP 4 (MAX RNG) THAN IN STEP 2 (STABLE @ 400 KIAS)

OBJ: VERIFY OPERATION OF CRUISE MODE. COMPARE FCC CALCULATIONS WITH ACTUAL TEST DAY DATA AND FLIGHT MANUAL PREDICTIONS.

CCIP A-G WEAPONS EVAL (MK-84)

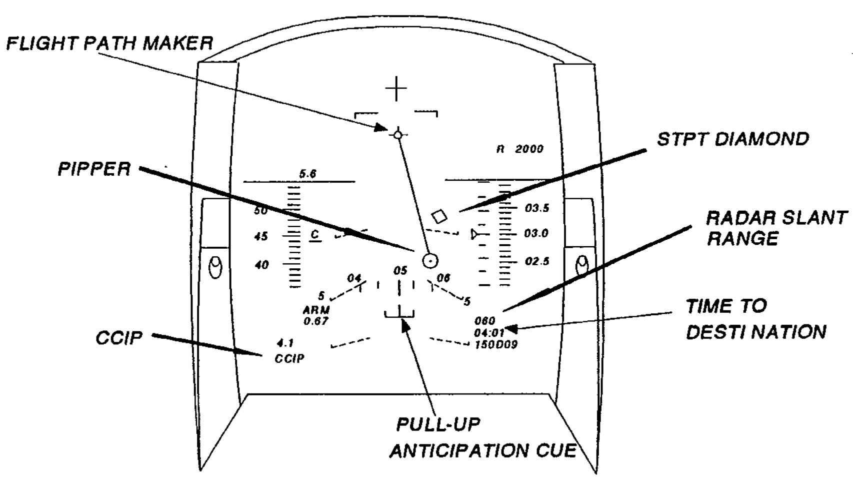
SETUP: STPT_____
M. ARM: SIM
M. MODE:A-G / CCIP, USE NWS BUTTON
STBY RETICLE: 137 MILS

SMS: RDY M84
A-G FRAG
NSTL SGL
CCIP
PGM 1

PROCEDURES:

EVENT	BASE - 350KIAS ALT	DIST	REL ALT-A/S	ALT LOSS	MIN ALT	AOD IPP
30° CCIP	8.8	13.0	3.5-450 TAS	1330	1.5	1400 42
MSL	___	13.0	___-450	1330	___	

1. VERIFY: FCR - AGR, IRON CROSS & DIAMOND
2. VERIFY: HUD SYMBOLOGY (SEE BELOW)
3. VERIFY: PIPPER & STBY RETICLE ALIGNED @ REL



ASTTA DATA CARDS

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ASTTA RADAR DATA

DATE ☐ OPS NO. ☐ RUN # ◯

ASTTA ALT	ASTTA A/S	ASTTA HDG	TARGET ALT	TARGET A/S	TARGET HDG

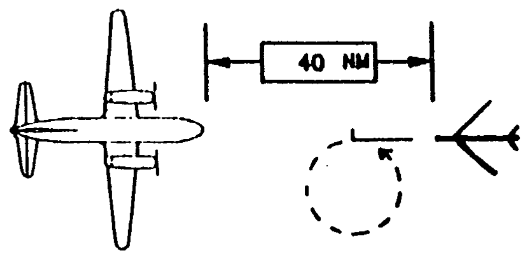
AZ SCAN ∓ 30

CHAN

EL BAR 1

PRF

RANGE



SEARCH ☒ TRACK ☐ ACM ☐ FWD ☐ UP ☐

FTT: MAX LOCK ON RANGE

TEST PT# ☐

PROCEDURES

TARGET

1. PROCEED INBOUND, NONMANEUVERING
2. BEGIN 360° TURN AT SPECIFIED G.

RADAR OPERATOR

1. SELECT ∓ 10° SCAN AFTER FIRST DETECTION
2. ATTEMPT LOCK ON UNTIL SUCCESSFUL
3. VERBALLY CALL OUT INDICATED TACAN RANGE
4. IF TIME PERMITS, BREAK STABLE TRACK AND REATTEMPT LOCK ON
5. IF STABLE TRACK AT 15NM, TRANSMIT "BEGIN MANEUVER"

ASTTA RADAR DATA

RUN # ◯ DATE ☐ OPS NO. ☐

MINICONSOLE RDR ☐ ICU ☐ STRIP CHART SPEED ☐ TYPE TARGET ☐

MACRO NAME: MAX RANGE

CHAN	WORD ID	DESCRIPTION	SCALE	
1	1E23	ACQ CURSOR RANGE POS		
2	1E62	SLANT RANGE AFTER LOCK-ON		
3	162B	DESIGNATE SWITCH ENABLE		
4	02BA	LOCK-ON INDICATOR		
5	0242	COAST FLAG		
6	0626	PRF		
7				
8				

PROCEDURES

DATA OPERATOR

1. ENSURE RADAR VIDEO RECORDER ON
2. RECORD SYSTEM TIME AND TACAN RANGES
3. MONITOR STRIP CHART AND MARK SUCCESSFUL LOCK ON
4. MONITOR STRIP CHART TRACE
5. CALL COAST FLAG

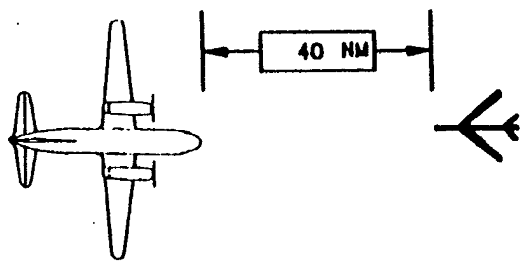
COMMENTS

ASTTA RADAR DATA

DATE ______ OPS NO. ______ RUN # ◯

ASTTA			TARGET		
ALT	A/S	HDG	ALT	A/S	HDG

AZ SCAN	∓30
CHAN	
EL BAR	1
PRF	
RANGE	



SEARCH ☒ TRACK ☐ ACM ☐ FWD ☐ UP ☐

MAX DETECTION RANGE FTT ______ TEST PT# ______

PROCEDURES

TARGET

1. PROCEED INBOUND, NONMANEUVERING

RADAR OPERATOR

1. CENTER SCAN AROUND TARGET
2. SELECT ∓ 10° AZ SCAN AFTER FIRST DETECTION
3. DO NOT ATTEMPT LOCK ON
4. KEEP ANTENNA ELEVATION AT TARGET ALTITUDE
5. VERBALLY CALL OUT INDICATED TACAN RANGE
6. QUALITATIVE EVAL OF SCAN-TO-SCAN AZIMUTH CORRELATION, CONTROL AND DISPLAY ADEQUACY

ASTTA RADAR DATA

RUN # ◯ DATE ______ OPS NO. ______

MINICONSOLE RDR ☐ ICU ☐ STRIP CHART SPEED ______ TYPE TARGET ______

MACRO NAME: BLIPSCAN

CHAN	WORD ID	DESCRIPTION	SCALE	
1	1E23	ACQ CURSOR RANGE POS		
2	1E64	ANTENNA AZIMUTH		
3	1E24	ANTENNA AZIMUTH POS		
4	1E65	ANTENNA ELEVATION		
5	1E25	ANTENNA ELEVATION POS		
6	0626	PRF		
7				
8				

PROCEDURES

DATA OPERATOR

1. ENSURE RADAR VIDEO RECORDER ON
2. RECORD SYSTEM TIME AND TACAN RANGES

COMMENTS

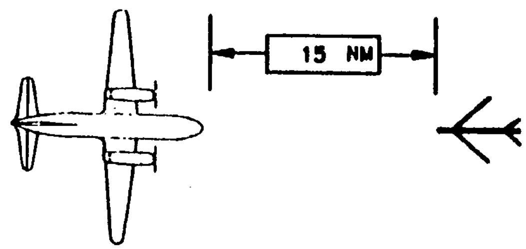
ASTTA RADAR DATA

DATE ______ OPS NO. ______ RUN # ◯

ASTTA ALT	ASTTA A/S	ASTTA HDG

TARGET ALT	TARGET A/S	TARGET HDG

AZ SCAN	N/A
CHAN	
EL BAR	N/A
PRF	,
RANGE	



SEARCH ☒
TRACK ☐
ACM ☒ FWD ☒ UP ☐

ACM MODE EVAL FTT

TEST PT# ______

PROCEDURES

TARGET

1. PROCEED INBOUND, ON AIRSPEED, NONMANEUVERING. TRANSMIT TRUE AIRSPEED

RADAR OPERATOR

1. ENSURE ANTENNA PAINTS TARGET.
2. VERBALLY CALL OUT DISTANCE AT WHICH TRACK IS ACHIEVED

ASTTA RADAR DATA

RUN # ◯ DATE ______ OPS NO. ______

MINICONSOLE RDR ☐ ICU ☐ STRIP CHART SPEED ______ TYPE TARGET ______

MACRO NAME: MAX RANGE

CHAN	WORD ID	DESCRIPTION	SCALE	
1	1E23	ACQ CURSOR RANGE POS		
2	1E62	SLANT RANGE AFTER LOCK-ON		
3	162B	DESIGNATE SWITCH ENABLE		
4	02BA	LOCK-ON INDICATOR		
5	0242	COAST FLAG		
6	0626	PRF		
7				
8				

PROCEDURES

DATA OPERATOR

1. ENSURE RADAR VIDEO RECORDER ON
2. MONITOR STRIP CHART TRACE

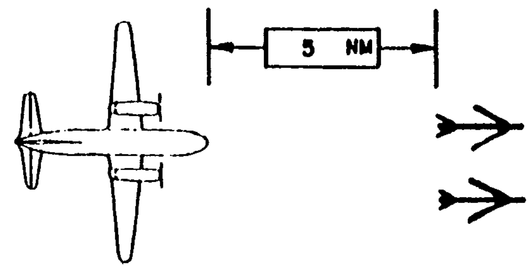
COMMENTS

ASTTA RADAR DATA

DATE ______ OPS NO. ______ RUN # ○

ASTTA				TARGET		
ALT	A/S	HDG		ALT	A/S	HDG

AZ SCAN	∓ 30
CHAN	
EL BAR	1
PRF	
RANGE	10



SEARCH ☒
TRACK ☐
ACM ☐ FWD ☐ UP ☐

AZIMUTH RESOLUTION FTT

TEST PT# ______

PROCEDURES

TARGET

1. PROCEED OUTBOUND, NONMANEUVERING. MAINTAIN CONSTANT LINE ABREAST SPACING.

RADAR OPERATOR

1. MANUALLY FOLLOW TARGETS WITH ACQUISITION SYMBOL UNTIL TARGETS MERGE. DO NOT ATTEMPT LOCK ON
2. SWITCH TO $\mp 10^{\circ}$ AZ SCAN WHEN FEASIBLE
3. VERBALLY CALL OUT INDICATED TACAN RANGES
4. CONTINUE UNTIL MAX DETECTION RANGE IF POSSIBLE

ASTTA RADAR DATA

RUN # ○ DATE ______ OPS NO. ______

MINICONSOLE RDR ☐ ICU ☐ STRIP CHART SPEED ______ TYPE TARGET ______

MACRO NAME: BLIPSCAN

CHAN	WORD ID	DESCRIPTION	SCALE	
1	1E23	ACQ CURSOR RANGE POS		
2	1E64	ANTENNA AZIMUTH		
3	1E24	ANTENNA AZIMUTH POS		
4	1E65	ANTENNA ELEVATION		
5	1E25	ANTENNA ELEVATION POS		
6	0626	PRF		
7				
8				

PROCEDURES

DATA OPERATOR

1. ENSURE RADAR VIDEO RECORDER ON
2. RECORD SYSTEM TIME AND TACAN RANGES

COMMENTS

ASTTA RADAR DATA

DATE | OPS NO. | RUN #

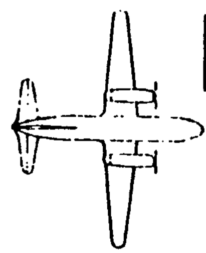
ASTTA

ALT	A/S	HDG

TARGET

ALT	A/S	HDG

AZ SCAN
CHAN
EL BAR
PRF
RANGE



NM

SEARCH ☐
TRACK ☐
ACM ☐ FWD ☐ UP ☐

FTT

TEST PT#

PROCEDURES

TARGET

RADAR OPERATOR

ASTTA RADAR DATA

RUN # | DATE | OPS NO.

MINICONSOLE RDR ☐ ICU ☐ STRIP CHART SPEED | TYPE TARGET

MACRO NAME:

CHAN	WORD ID	DESCRIPTION	SCALE	
1				
2				
3				
4				
5				
6				
7				
8				

PROCEDURES

DATA OPERATOR

COMMENTS

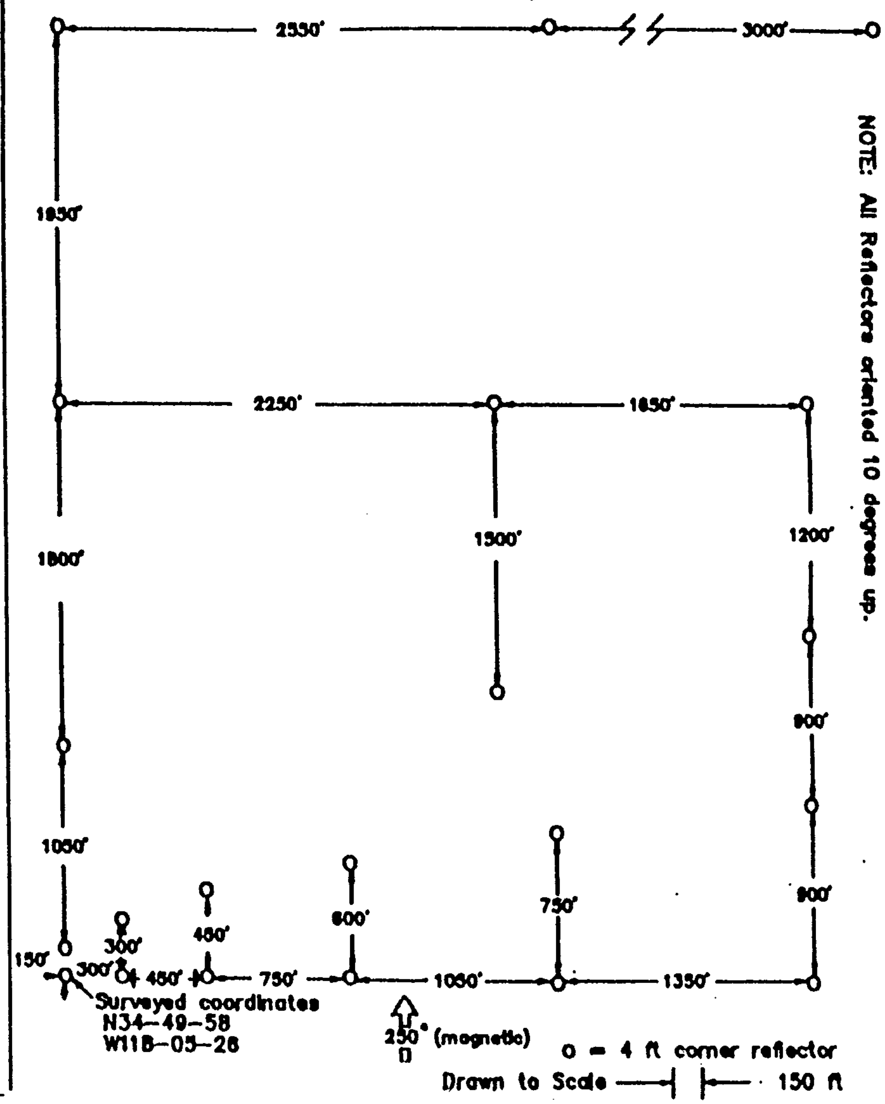
ASTTA AIR-TO-GROUND RADAR DATA

DATE ________ OPS NO ________ RUN# ○

TEST PT(s)	ALTITUDE	AIRSPEED	MODE	
	AIM	AIM	AIM	

TIME OF DAY	HEADING	DISTANCE	SELECTED RANGE/ MODE	# REFLECTORS RESOLVABLE		COMMENTS
				Range	Azimuth	

TEST PILOT SCHOOL
RADAR REFLECTOR ARRAY
Rosamond Dry Lake



NOTE: All Reflectors oriented 10 degrees up.

ASTTA INS DATA

DATE ____ OPS NO. ____

TIME OF DAY	INDICATED		REMARKS
	LATITUDE	LONGITUDE	

ASTTA INS DATA

DATE ____ OPS NO. ____

TIME OF DAY	INDICATED		REMARKS
	LATITUDE	LONGITUDE	

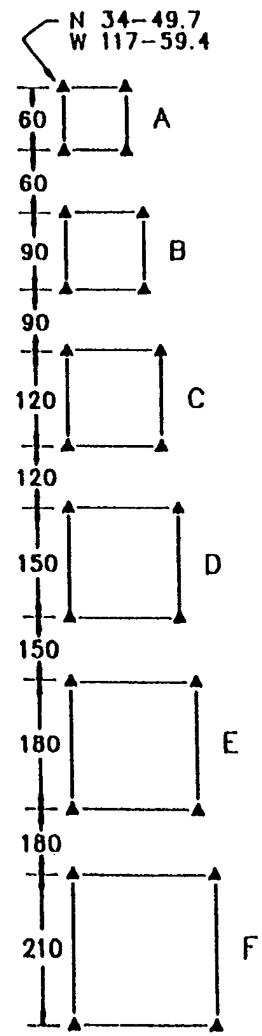
ASTTA AIR-TO-GROUND RADAR DATA

DATE | OPS NO | RUN# ○

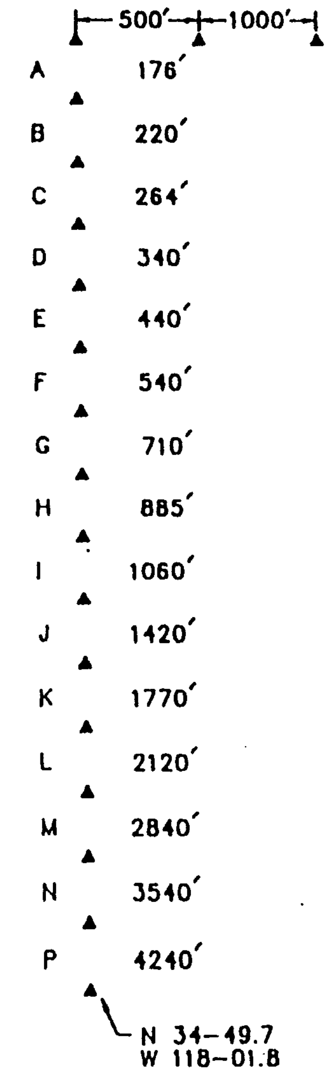
TEST PT(s)	ALTITUDE	AIRSPEED	MODE	
	AIM	AIM	AIM	

TIME OF DAY	HEADING	DISTANCE	SELECTED RANGE/ MODE	# REFLECTORS RESOLVABLE Range	Azimuth	COMMENTS

BUCKHORN LAKE



ROSAMOND LAKE



NOT TO SCALE!!

ASTTA IRDS DATA

DATE ____________ OPS NO. ______

RUN #	TEST PT. #	PLANNED		% HEAT OR ΔT	FOV	POLARITY
		ALT.	AIRSPEED			

ASTTA IRDS DATA

DATE ____________ OPS NO. ______

TEST PT. #	TIME OF DAY	ACTUAL			RANGE		REMARKS
		ALT.	AIRSPEED	ΔT/%H	DETECT	ID	

ASTTA SYSTEMS EVALUATION

DATE ______

MSN FREQ ______

AREA ALTM ______

A/A TACAN

ASTTA	TARGET

TIMES

T/O SCHED
T/O ACTUAL
LANDING

CALLSIGN	AIRCRAFT	CREW	OPS NO.

ASTTA FLIGHT CREW/INSTRUCTORS

WEATHER

	VIS	TEMP/DEW PT	W/V	ALTM	PA

ASTTA SYSTEMS EVALUATION

DATE ______ OPS NO. ______

INS REFERENCE COORDINATES

TPS PARKING RAMP	N 34-54.9	W 117-53.9	
RWY 23 QUICK CHECK	N 34-55.1	W 117-51.9	
RWY 04 QUICK CHECK	N 34-53.8	W 117-54.3	
TPS RADAR ARRAY	N 34-50.0	W 118-05.4	
ROSAMOND RADAR ARRAY	N 34-49.7	W 118-01.8	
BUCKHORN RADFAG	N 34-49.7	W 117-59.4	
IR BOARD	N 34-52.9	W 117-41.0	
EDWARDS TACAN	N 34-58.7	W 117-43.5	

INS ALIGNMENT DATA

☐ EXT POWER ALIGN ☐ FULL ALIGN

☐ INT POWER ALIGN ☐ RAPID ALIGN

AIRCRAFT HEADING ______

SYSTEM MAG VAR ______

EVENT	TIME OF DAY	INDICATED LAT/LONG	
TO STBY			
TO ALIGN			
STATUS 80			
70			
60			
50			
40			
10			
02			
TO NAV			
START TAXI			
QUICK CHECK			
ENG SHUTDOWN			