FLIGHT TEST SAFETY WORKSHOP

First Flight Into Category III Weather

Presented to: **Flight Test Safety Workshop**

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References

- FAA Advisory Circular 20-57A
- FAA Order 8400.13D
- C-141 All Weather Landing System (AWLS) Flight Test Report: Optimization and Pre-Experimental Phases
- C-141 All Weather Landing System Engineering Support


"CAT ZERO THREE"
C-141

The Program

- Airplane was a C-141A modified to be able to accurately track a Category III Beam
- Air Force program working with the FAA Technical Center developing requirements and procedures for Category III operations
- Category III ILS was only available at the FAA Technical Center
- Category II beams were usable, but had some limitations

Primary Test Sites

- FAA Technical Center, Atlantic City, NJ
- Wright-Patterson Air Force Base, OH
- Dayton-Cox Municipal Airport, OH
- New Orleans International Airport, LA

ILS Categories for precision instrument approach and landing

Approach category	Decision height or alert height	RVR	Visibility minimum	Notes
I	200 feet	2400 ft	1600 ft	Either visibility not less than 2400 ft or a runway visual range not less than 1,800 ft on runway with touchdown zone and centerline lighting. FAA Order 8400.13D allows for special authorization of CAT I ILS approaches to a decision height of 150 feet with RVR >= 1,400 feet. The aircraft and crew must be approved for CAT II operations and a heads-up display in CAT II or III mode must be used to the decision height. CAT II/III missed approach criteria apply.
II	100 feet	1200 ft	N/A	RVR (1,200 ft) (ICAO and FAA)
IIIa	50 ft < DH < 100 ft	700 ft	N/A	
IIIb	0 < DH < 50 feet	300 ft < RVR < 600 ft	N/A	RVR > 160 ft (ICAO and FAA). This is currently the best in operation.
IIIc	No DH	No RVR	N/A	Requires guidance to taxi in zero visibility.

Historical Perspective

- **ILS Developed in 1939**
- **Blind Landing Experimental Unit (BLEU)**
  - Formed in 1945 at RAF Woodbridge
  - First autoland with passengers – 1965
- **FAA / USAF Interagency Working Agreement signed October 11, 1969**
  - Initial flight testing: 1968-69 by Lockheed
  - USAF (First Stage): Dec 13, 1969 – Apr 11, 1972
  - USAF (Second Stage): Sep 12, 1973 – Feb 20, 1974
  - USAF Validation: Feb 1974 ----

Results

- Lockheed testing was to obtain data to define minimum performance and equipment criteria
- First Stage testing objectives not obtained because of poor performance of the system
- Second Stage required modifications and was a follow-on to Stage 1 for system optimization
- Validation was to conduct operations in actual weather using the optimized system and the procedures developed in the Second Stage

Avionics Modification

- **Pilot & Copilot Flight Director Computers**
- **Sperry AD350 Attitude Director Indicators**
- **Electronic Attitude Director Indicator (EADI)**
- **Approach Landing Radar (ALR)**
- **Maxon Independent Landing Monitor**
- **ME-1A Synchro Amplifiers**
- **Automatic Flight Control System mods:**
  - Coupler modified for flare optimization
  - Yaw damper
  - Aileron computer

Avionics Modification

- AWLS configured as separate but dual systems
- Excessive lateral and vertical annunciation system
- Runway Distance Remaining (RDR) indicator

Second Stage Objectives

a) Determine basic flyability (at NAFEC)

b) Determine effects of beam switching and course shifting on the airborne system

c) Gather baseline data for CAT III system performance

d) Establish system reliability and repeatability

e) Gather data on ILS interference between Cat III aircraft and other large aircraft

f) Determine abort criteria and procedures

g) Train and requalify FAA subject pilots

Flight Test Procedures

- **Standard ILS approaches with qualified test pilots in both seats**
- **Safety pilot (right seat) callouts:**
  - LOC Capture
  - Glideslope Capture
  - Approach Arm Clear (no fault lights after preland test)
  - Land Arm
  - Flare
  - Decrab
  - Rollout

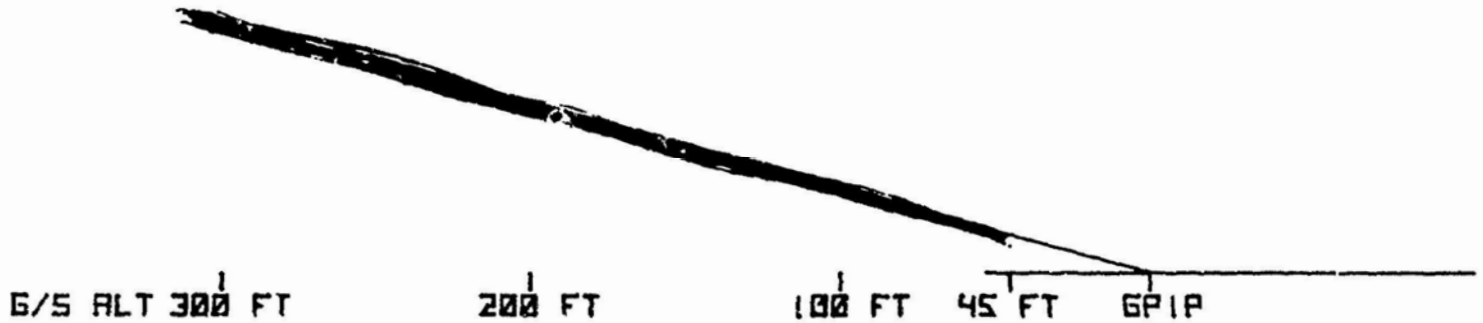
Flight Test Procedures (cont'd)

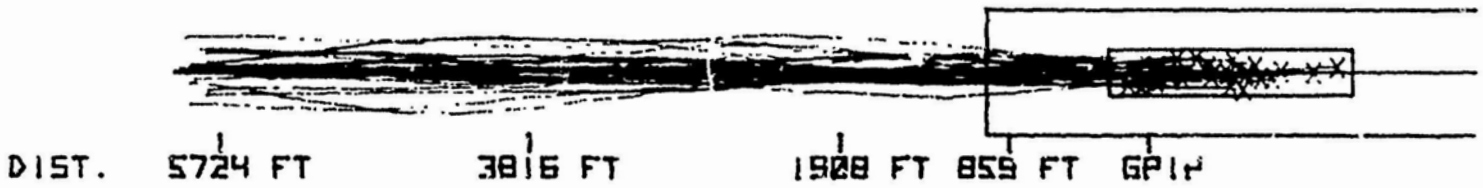
- **Third person familiar with the system in the jump seat**
  - Failure in No. 2 system, call "Go-around"
  - Failure in No. 1 system, call "Manual 1, Go-around"

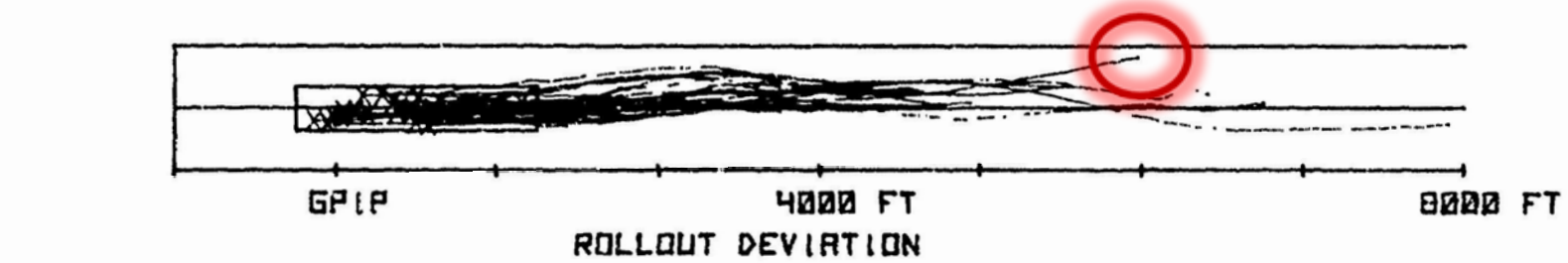
- **A pilot-in-the-loop computer simulation and limited flight test / degraded performance analysis completed to ensure safety**

Baseline Data

- **51 Approaches at the FAA Technical Center in Sep 1973**
- **Data Sources:**
  - On-board Advanced Digital Data Acquisition System (ADDAS)
  - Theodolite
- **Category III ILS on Runway 13; Category II ILS on Runway 31.**

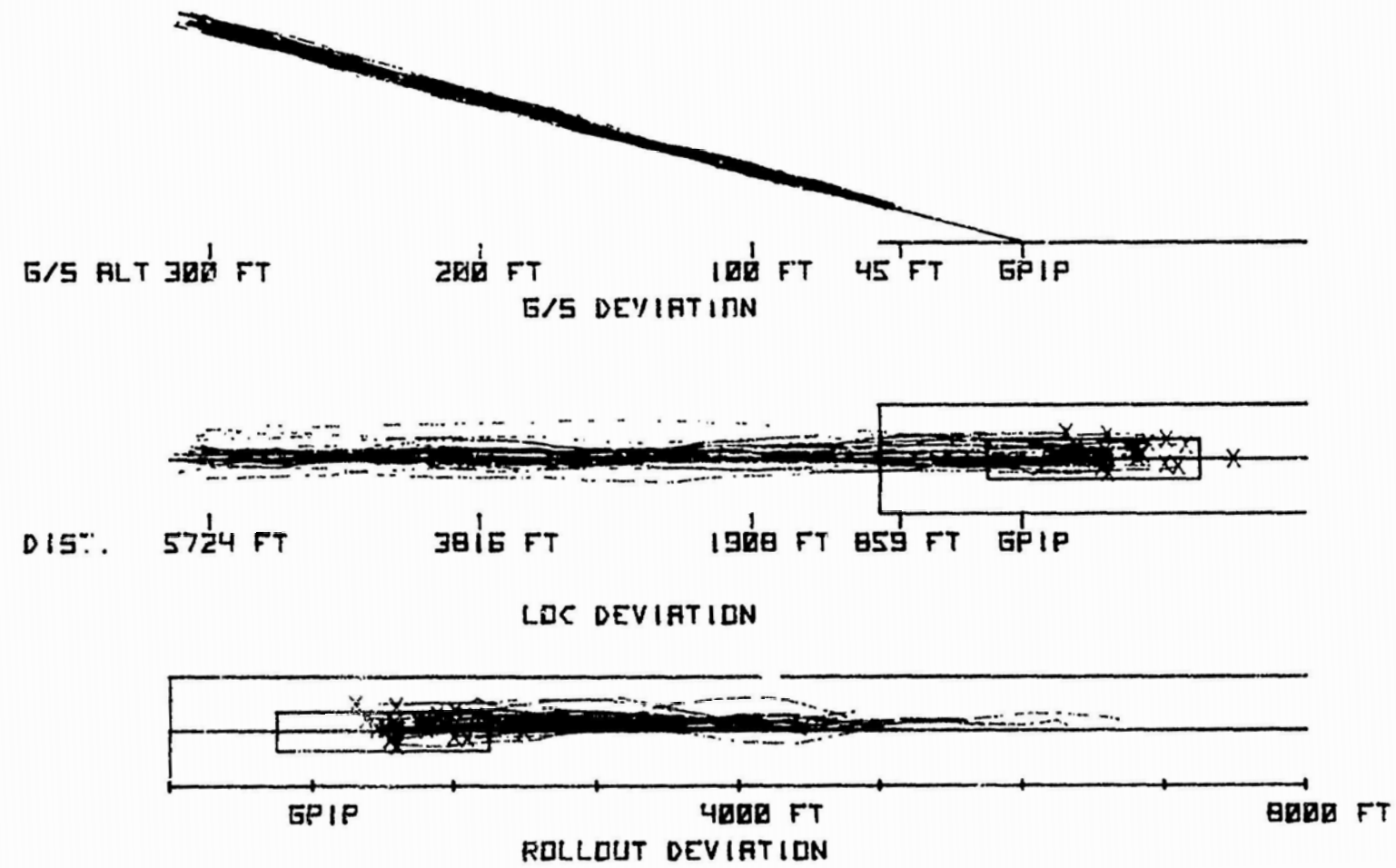






RUNWAY 13 ADDAS DATA

Figure B-1



RUNWAY 31 ADDAS DATA

Figure B-2

Touchdown Box

- **Size: ±27’x1500’**
- **Location:**
  - Begins at least 200’ from threshold
  - Far end no further down than where the pilot can see at least 4 bars of the 3000’ touchdown zone lights

Problems Encountered

- Flare computation did not work properly
- Decrab allowed excessive drift rates
- Autopilot rollout not precise enough

Optimization & Pre-Experimental Phase Recommendations

- **Capable of safe flight into Category III Weather with restrictions**
  - Touch & go only until Runway Distance Remaining display is installed
  - Initially use a decision height to determine lateral rate
  - Prior to zero visibility install lateral rate warning
- **INS mode should be used as primary mode for CAT III approaches**

Follow-On Testing

- **Various facilities visited and briefed in preparation for weather**
  - Airport Management
  - Air Traffic personnel
  - Fire Departments
- **First flight into Category III weather was a New Orleans in spring of 1974**
- **Successful program that ushered in Cat III for airline operations**

To be remembered

- **Expect interruptions and unplanned events**
- **Establish safety procedures at every airport involved**
- **Be fastidious about established procedures**
  - You can never check the gear too many times!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Type III ILS Facility

- Meets of exceeds ICAO Standards
- Dual frequency localizer that meets CAT III requirement to at least 3000’ from the approach end
- Glideslope that meets CAT III requirements to the threshold
- Executive integrity monitors which identify any degradation of signal integrity exceeding CAT III standards

Type III ILS Facility (cont'd)

- **Far field monitor to identify critical area incursions or signal variations in the far field which may affect signal integrity**
- **Backup transmitters**
- **Backup power**
- **Typically also includes ancillary equipment:**
  - Full runway edge, end and in-pavement lighting
  - TDZ lights
  - Full approach lighting system (ALSF-2)
  - Power changeover requirements for critical lighting


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