



# AARD - Autonomous Airborne Refueling Demonstration



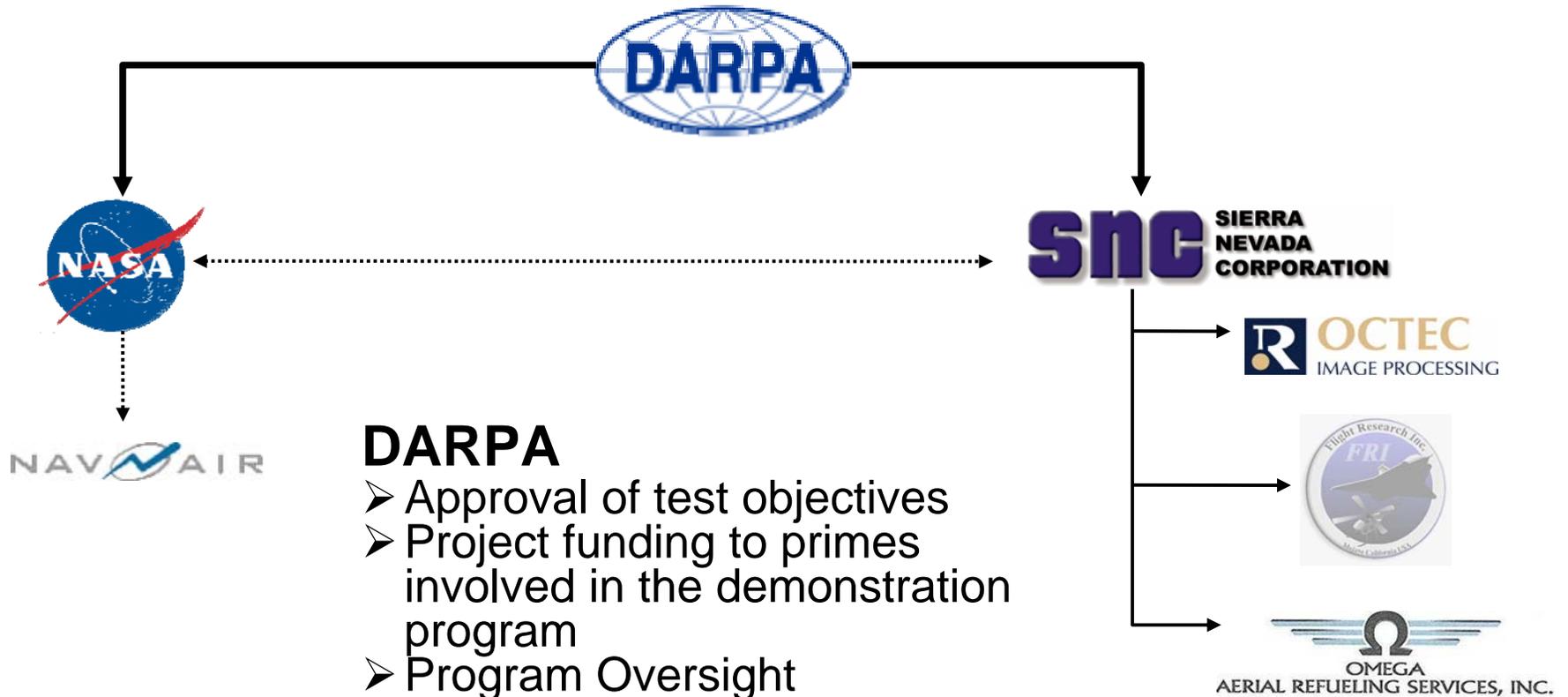
**Dick Ewers**  
DFRC, NASA

**East Coast**  
**SETP**  
**Symposium**  
20 April 2007



**snc** SIERRA  
NEVADA  
CORPORATION





## DARPA

- Approval of test objectives
- Project funding to primes involved in the demonstration program
- Program Oversight

## DFRC

- Responsible Test organization
- Lead system integrator
- Responsible for system airworthiness
- Responsible for flight safety

## SNC Development Team

- Overall test leader
- AARD Controller development
- Responsible for mission success
- Responsible for contracting Omega tanker activities.
- Support integration, airworthiness and flight test activities.



# Program Goals

## ➤ Primary Objective

⇒ To make one **fully automatic** probe-to-drogue engagement using the AARD system.

## ➤ Success Criteria

- ⇒ One successful automatic engagement from the trail position (planned 100 ft from drogue) to basket connection
- ⇒ Hold connected to simulate a complete refueling sequence (planned for 5 minutes) then automatically disconnect and return to trail
- ⇒ Record on video – ( with Pilot's hands in the air!!)



- The Basket Can Strike Back





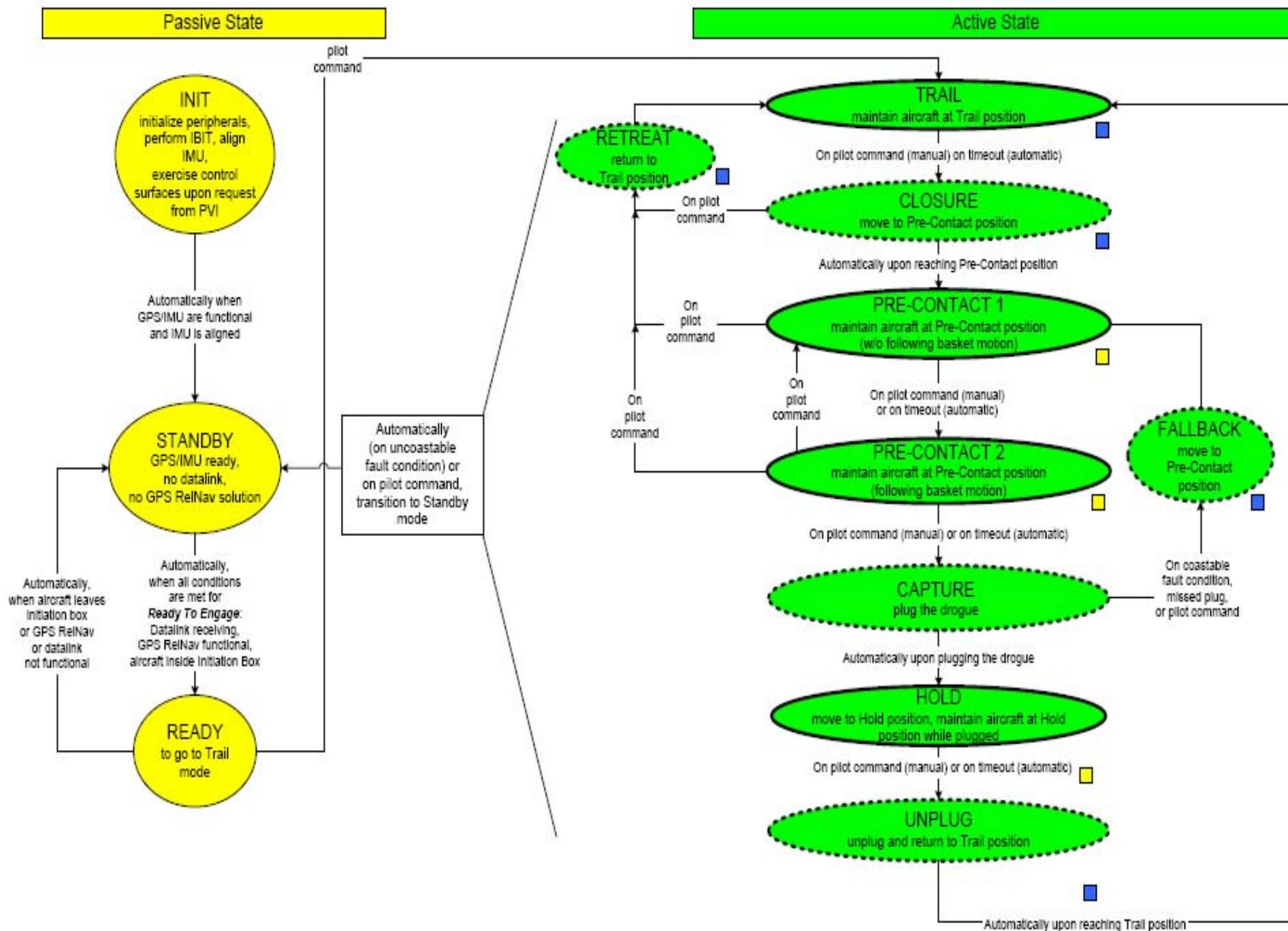
# System Design

## ➤ Tanker System

- ⇒ GPS Pallet Transmitting Position & Velocity
- ⇒ **No** Modifications to Drogue Refuel System

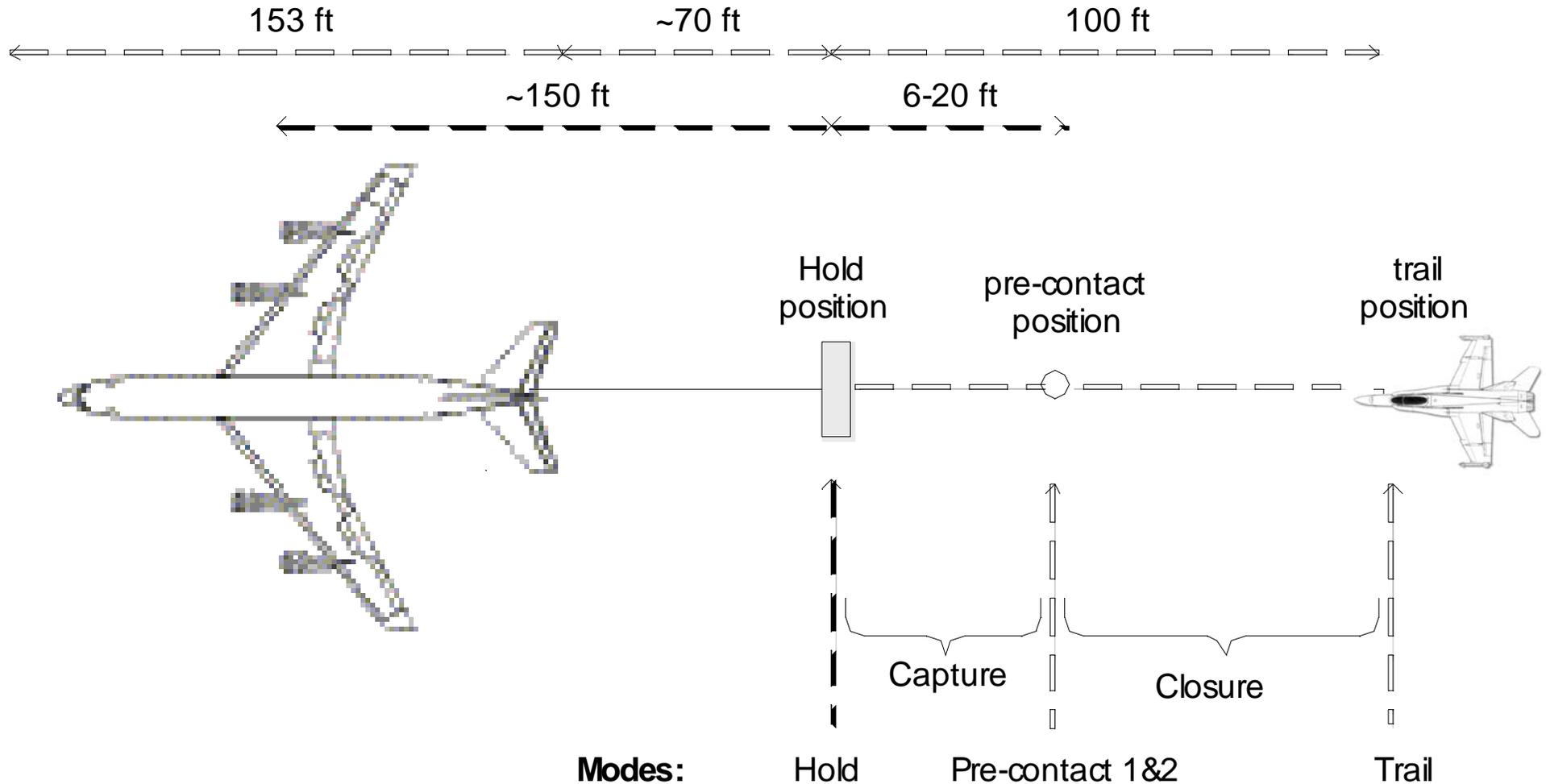
## ➤ F/A-18 System

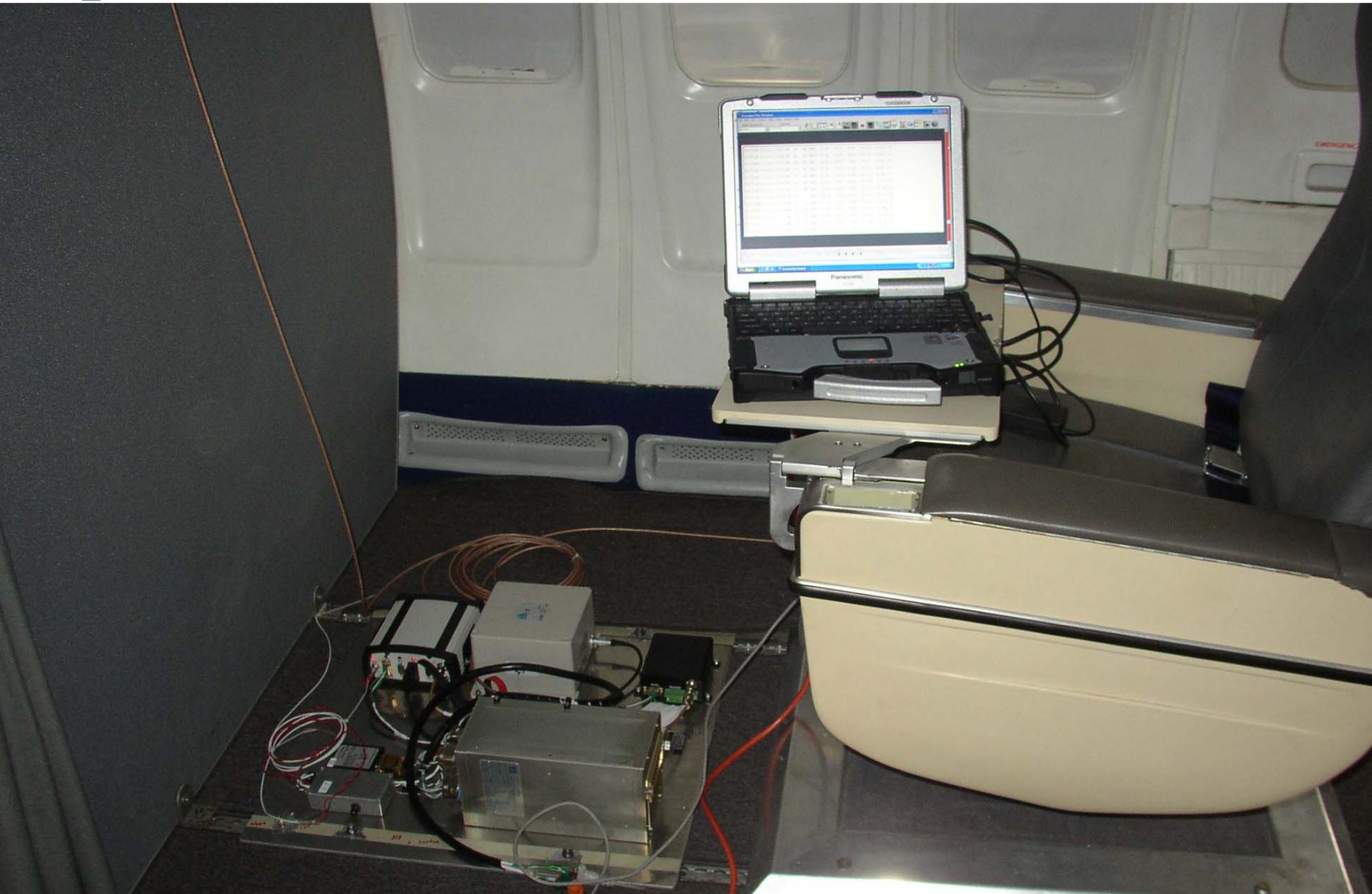
- ⇒ GPS & Receiver; "Rel-Nav" Solution
- ⇒ Optical Tracker; Basket Capture Solution
- ⇒ AARD Computer to Replace Pilot Inputs
- ⇒ PVI Panel





# Pictorial View







# AARD Controller





# Rear Cockpit PVI





# PVI Controller

- Eight active push tiles with information

Stndby	Close
X: xxx Y: xxx	Z: xxx
Forcef Off	Manual
AARD OK	Trail



# Front Cockpit

- Canopy bow status lights
- Optical tracker camera
- Video selector
- DDI RFCS control





**snc** SIERRA  
NEVADA  
CORPORATION





# Validation Flights

- 4 Flights with Sabreliner Surrogate Tanker: 16 – 29 June 2006
- 3 Flights with Sabreliner in second phase: Nov 2006 – Mar 2007





# Omega Tanker Flights

## 9 Flights with Omega tanker:

- ⇒ 11 July '06: Optical tracker problems
- ⇒ 27 July '06: Optical tracker problems
- ⇒ 17 Aug '06: Data Link problems, Optical tracker OK
- ⇒ 30 Aug '06: **SUCCESS**
  
- ⇒ 13 Dec '07: Plugs
- ⇒ 22 Feb '07: Plugs in a turn
- ⇒ 23 Mar '07: Plugs in turbulence
- ⇒ 16 Apr '07: Plugs in turbulence
- ⇒ 17 Apr '07: Plugs in turns





**snc** SIERRA  
NEVADA  
CORPORATION





**snc** SIERRA  
NEVADA  
CORPORATION





**snc** SIERRA  
NEVADA  
CORPORATION





**snc** SIERRA  
NEVADA  
CORPORATION



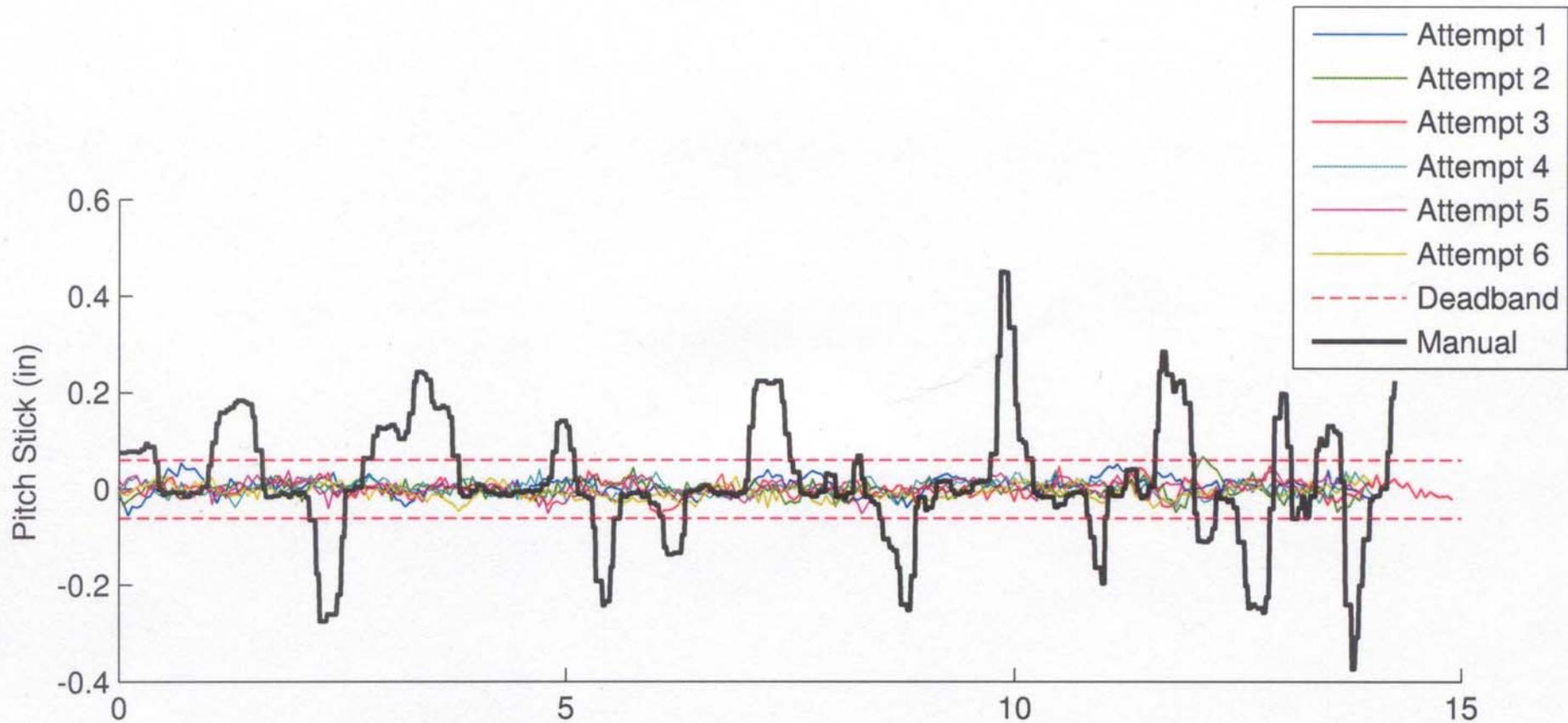


# Turbulence





# “Stick” Measurements





# Lessons Learned

- **Early Pilot Involvement**
- **Computers Remove “Human” Problems**
- **Shortcuts Seldom Work**
- **“SHIT” Happens: (*S*oftware / *H*ardware *I*nduced *T*rauma)**



# Possible Users





# Questions???



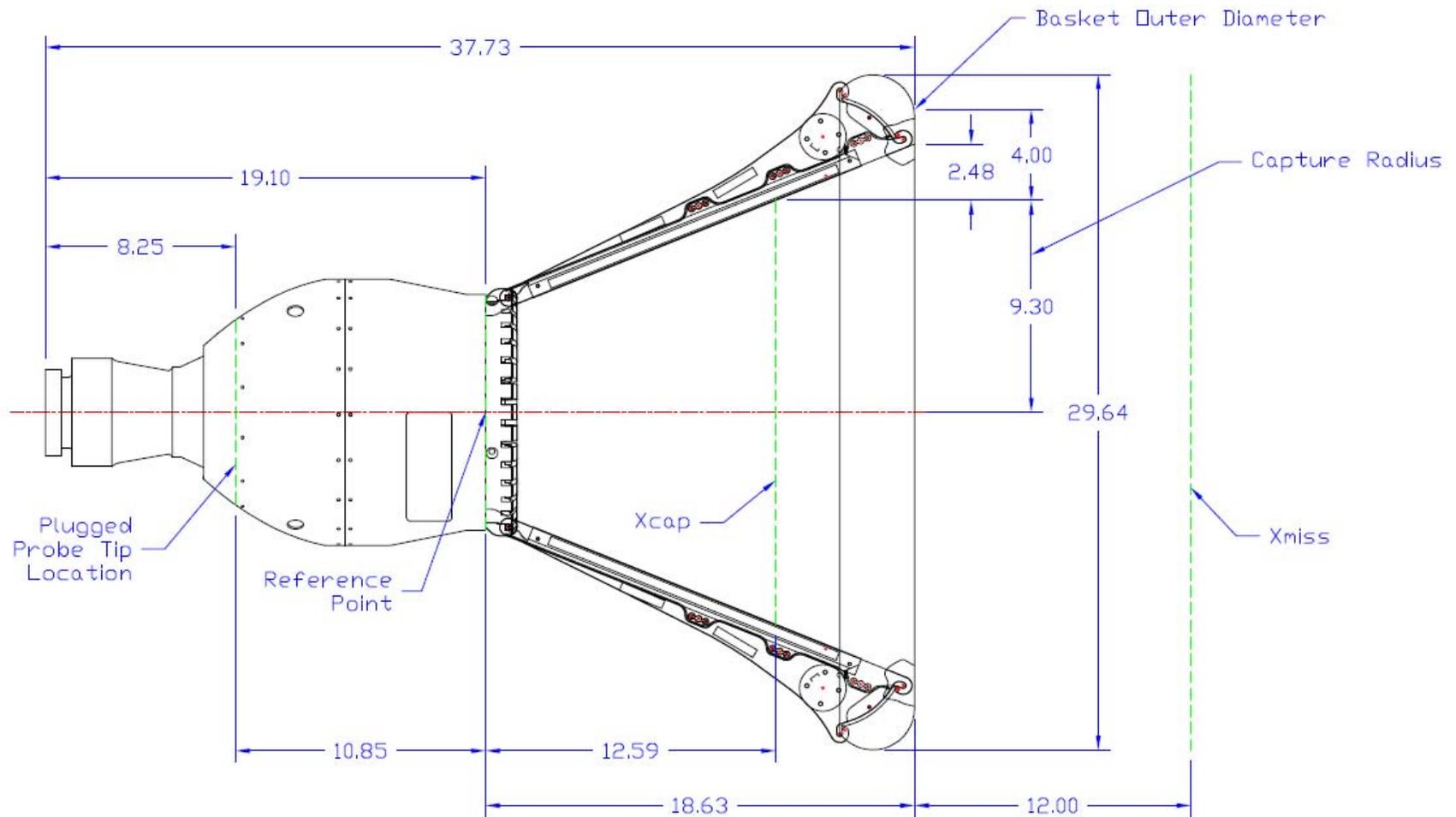




**snc** SIERRA  
NEVADA  
CORPORATION









**snc** SIERRA  
NEVADA  
CORPORATION

A-013.82° E+003.74° R+136.77ft AM02 TM10 S P0

BACUB MTT-B1 TRK:AARD

2008-17-30-05-206



**snc** SIERRA  
NEVADA  
CORPORATION





**snc** SIERRA  
NEVADA  
CORPORATION





# PSFCC's





**snc** SIERRA  
NEVADA  
CORPORATION





**snc** SIERRA  
NEVADA  
CORPORATION







**snc** SIERRA  
NEVADA  
CORPORATION





A-004.25° E+000.56° R+030.83ft AM03 TH30 T P0 F44



BACQ: MTT-B1 LINKBAARD

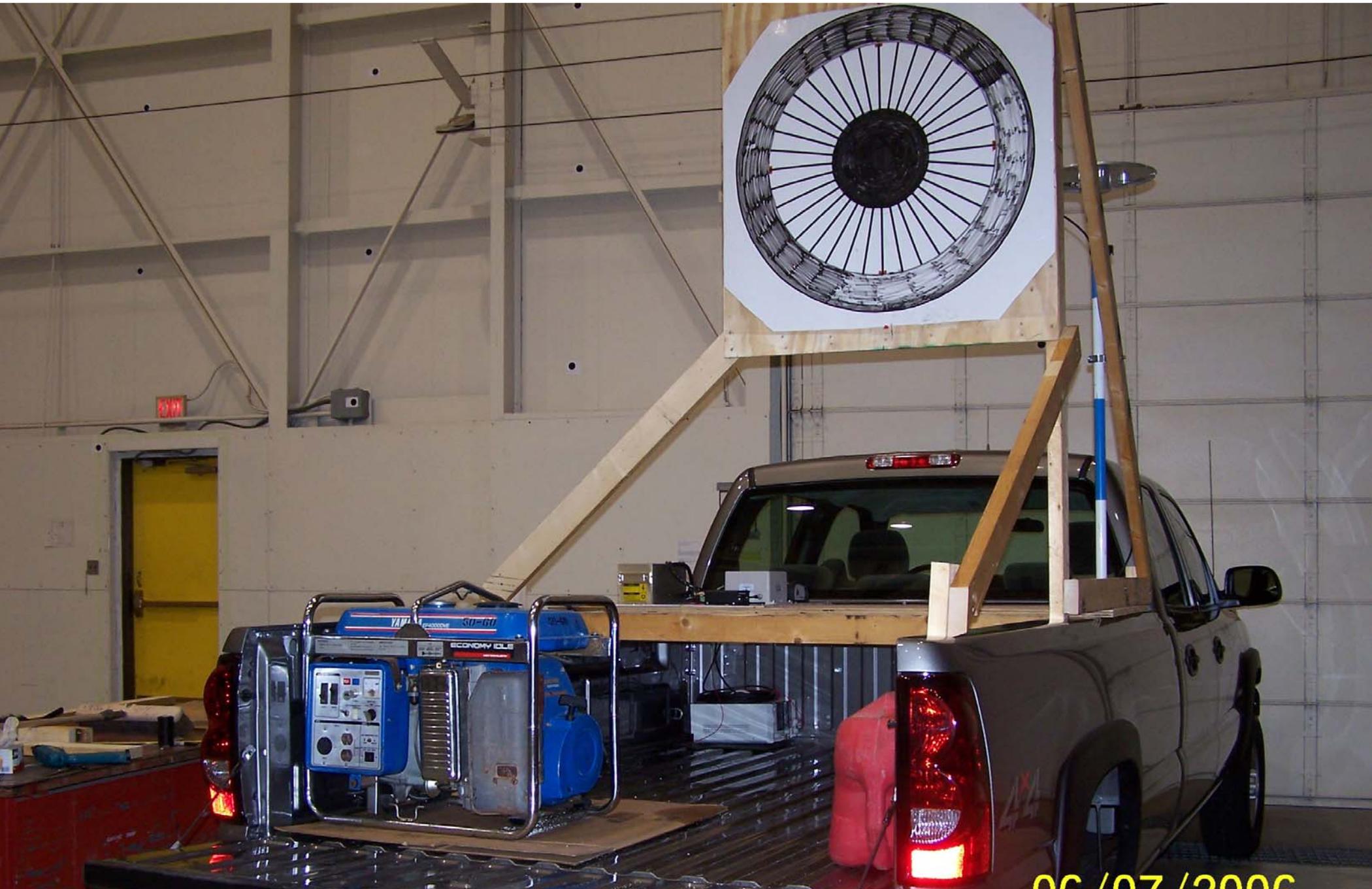
208:17:09:13.022





# Front Cockpit Glareshield





06/07/2006

A-005.54° E-002.40° R+016.101 AM03 TM30 T PO F511

BACQ: MTT-01 UJBAARD

229 16 30 12 791



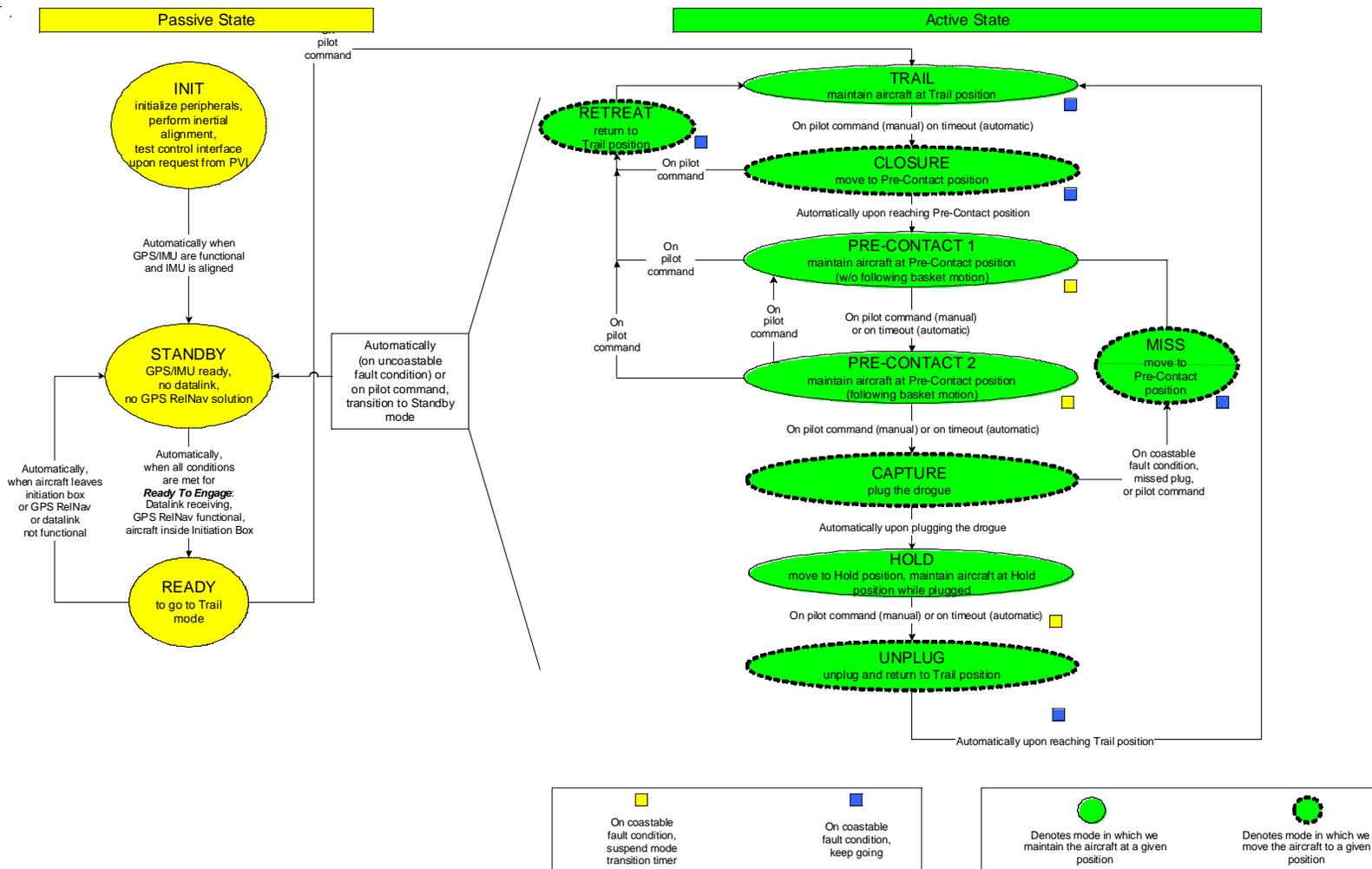


**snc** SIERRA  
NEVADA  
CORPORATION





# Receiver States and Modes



AARD Receiver States/Modes & Transitions: July 29, 2005



# AARD Test Program

- Background
- Participants
- Design
- Simulation and Ground testing
- Test Flights:
  - ⇒ With surrogate tanker
  - ⇒ With Omega tanker
    - Optical system problems
    - Rel-Nav problems
- 30 August 2006



**snc** SIERRA  
NEVADA  
CORPORATION

