

IMC EVALUATION



***OF THE
MV-22B OPSPREY***

Purpose:

- **Evaluate the Operation and Effectiveness of the MV-22B in Instrument Meteorological Conditions (IMC)**

- **Recommend Procedures for Operational Pilots**



Aircraft

A white military transport aircraft, likely a C-17 Globemaster III, is shown in flight from a low angle. The aircraft has four large propellers mounted on its wings, which are blurred due to motion. The fuselage is white with some dark markings. The aircraft is flying over a layer of white, fluffy clouds against a clear blue sky. The word "Aircraft" is overlaid in large, bold, dark blue letters at the top of the image.

Description

V-22 Osprey Technology



*Triple Redundant
Fly-By-Wire Flight Controls*

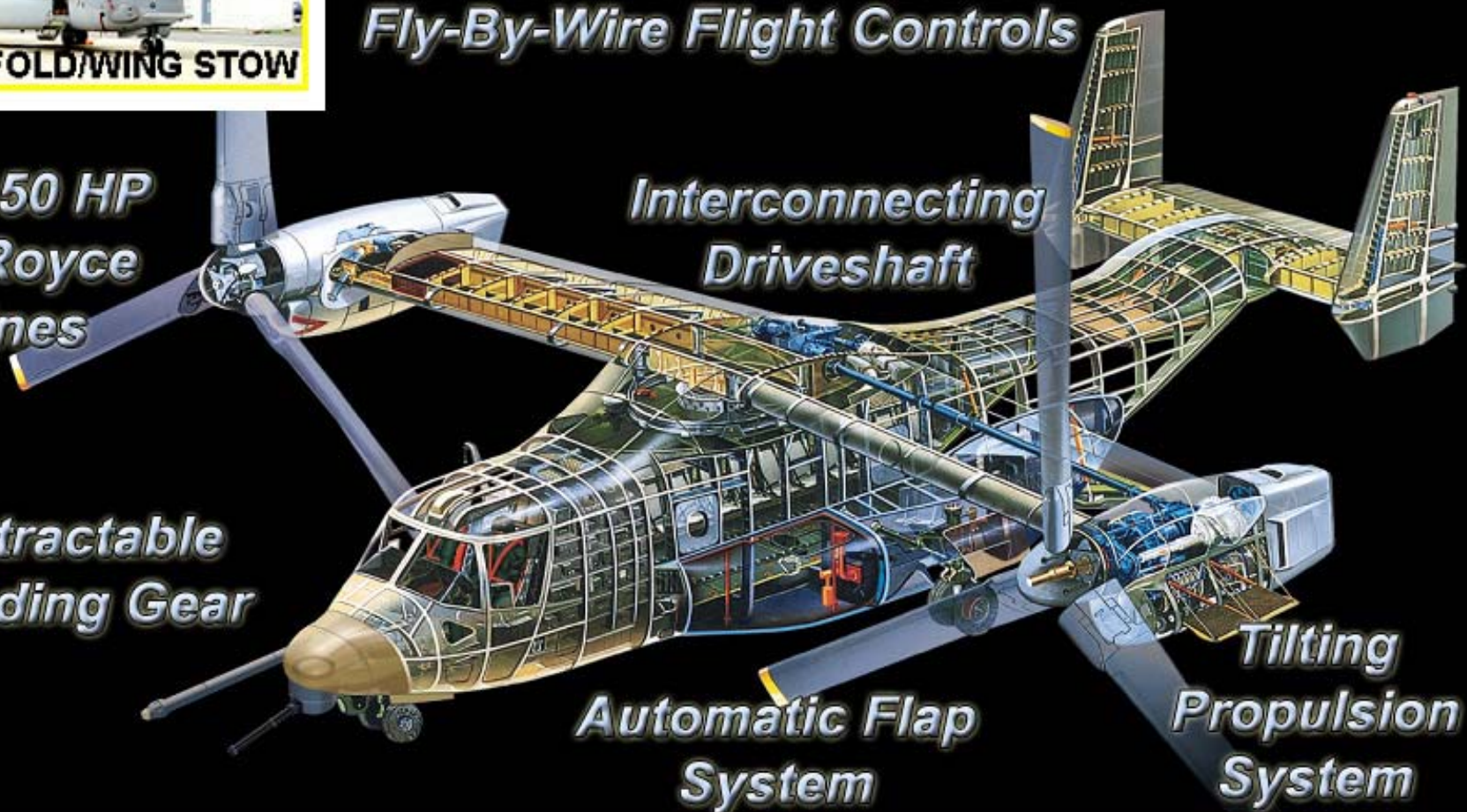
*Two 6150 HP
Rolls Royce
Engines*

*Interconnecting
Driveshaft*

*Retractable
Landing Gear*

*Automatic Flap
System*

*Tilting
Propulsion
System*



V-22 FUNDAMENTALS AND UNIQUE CHARACTERISTICS

-3 Different Operating Modes

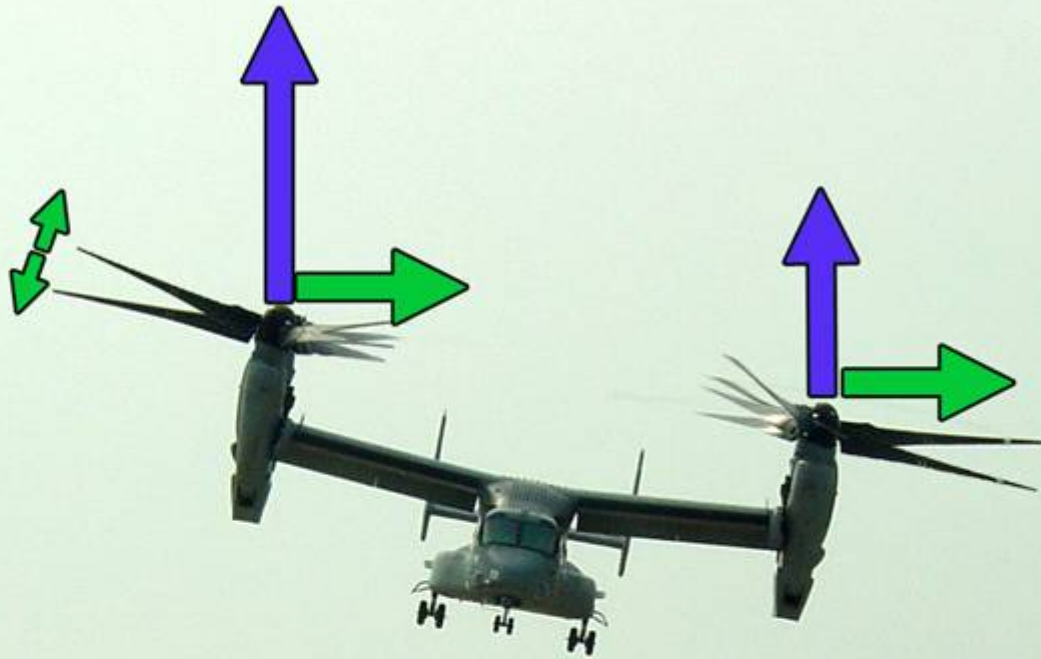
- VTOL Mode
Helicopter like
(with a Tilt)

-Conversion Mode
Permissive and Carefree Handling
with Boundry Protection

How Do You
Control Nacelles?

-Airplane Mode
Transport Aircraft

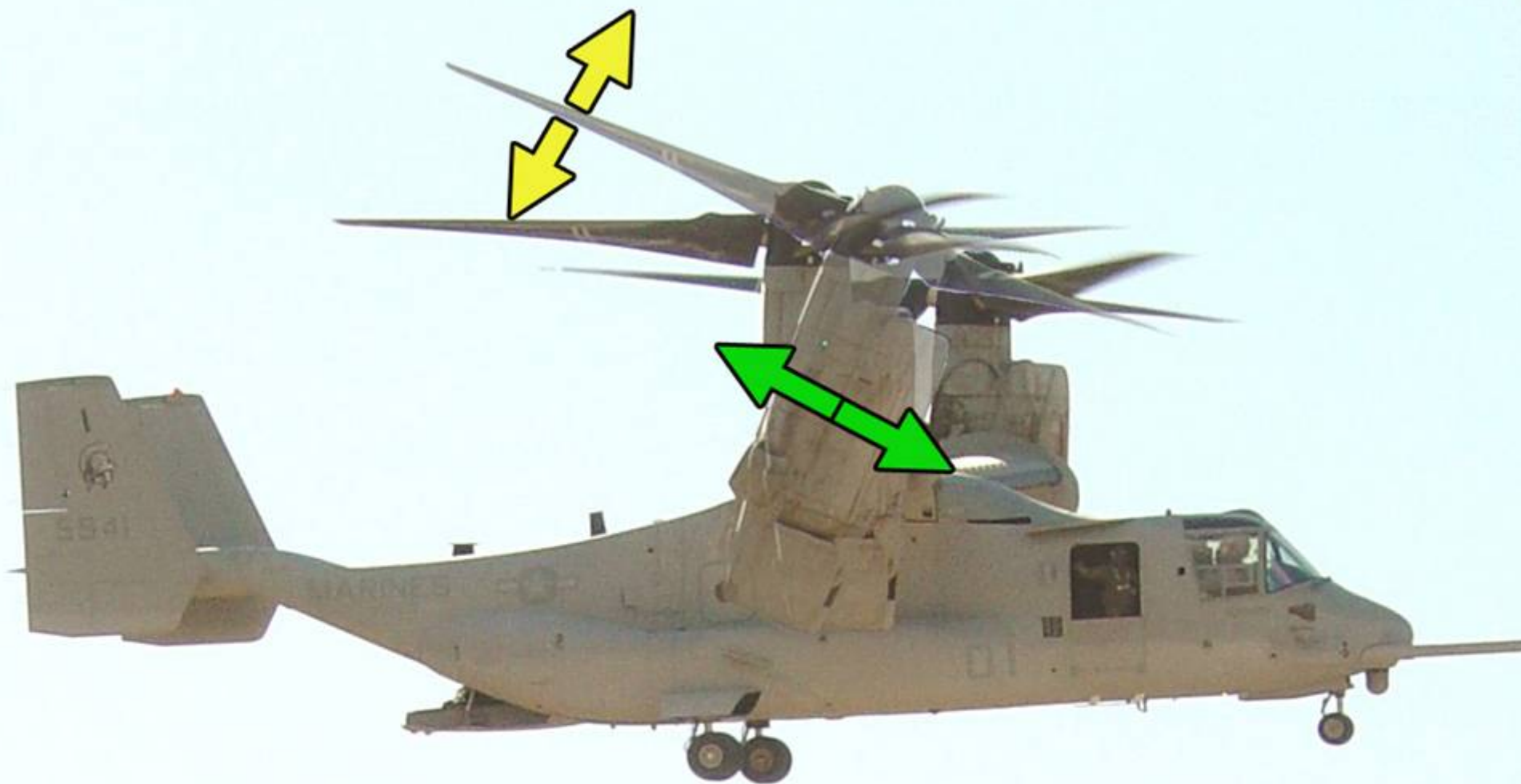




Differential Collective Pitch = Roll

***Lateral Swashplate Gearing =
Lateral Displacement***





**A Combination of
Nacelle Angle + Longitudnal Swash Plate =
Airspeed and Nose Attitude**

TYPICAL TAKEOFF PROFILE

**VERTICAL TAKEOFF
(VTO) TO HOVER AT
30 FT AGL**



**EASE NACELLES FORWARD
WITH AIRSPEED, ESTABLISH
CLIMB RETRACT LANDING
GEAR, AFTER TAKEOFF CHECKS**

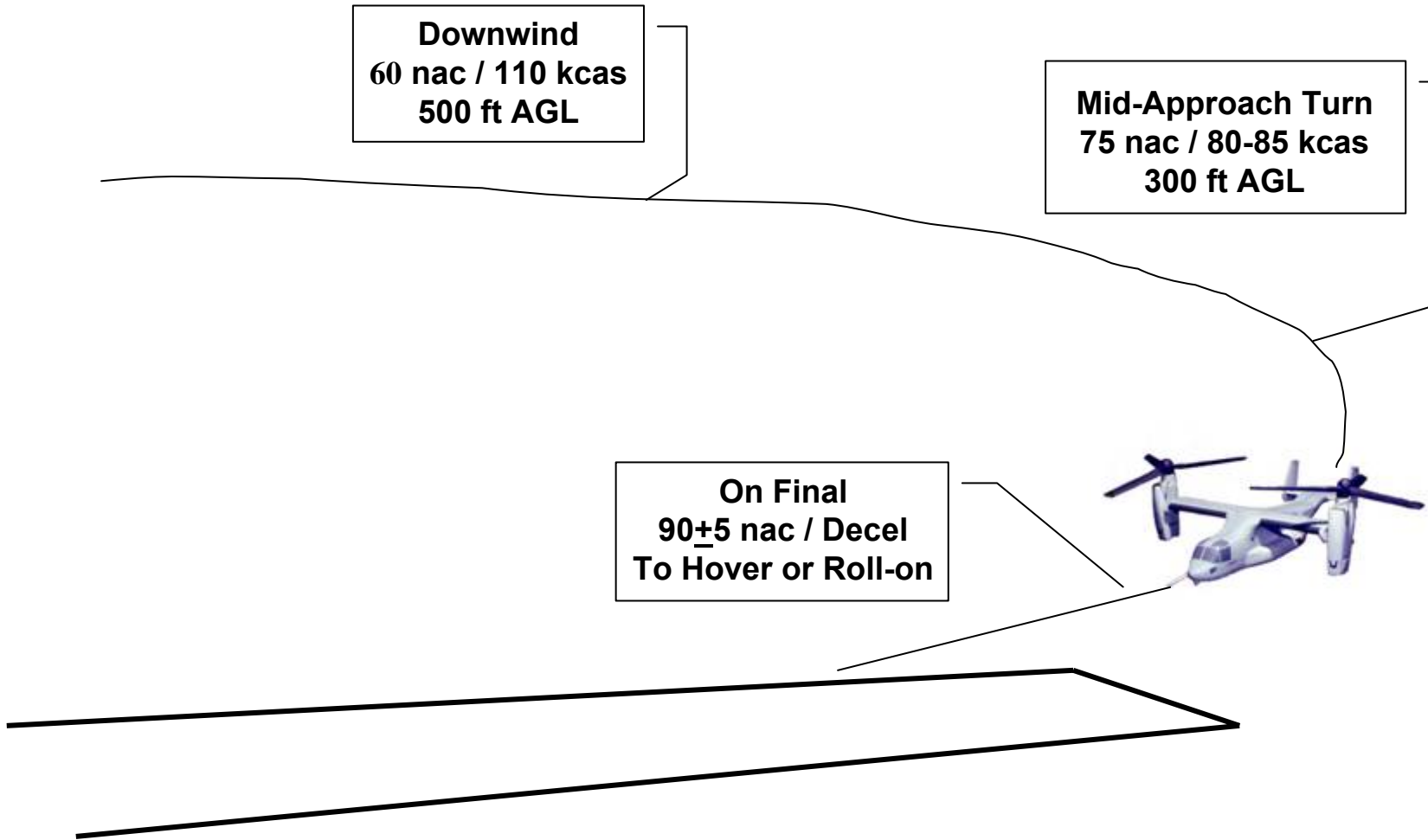


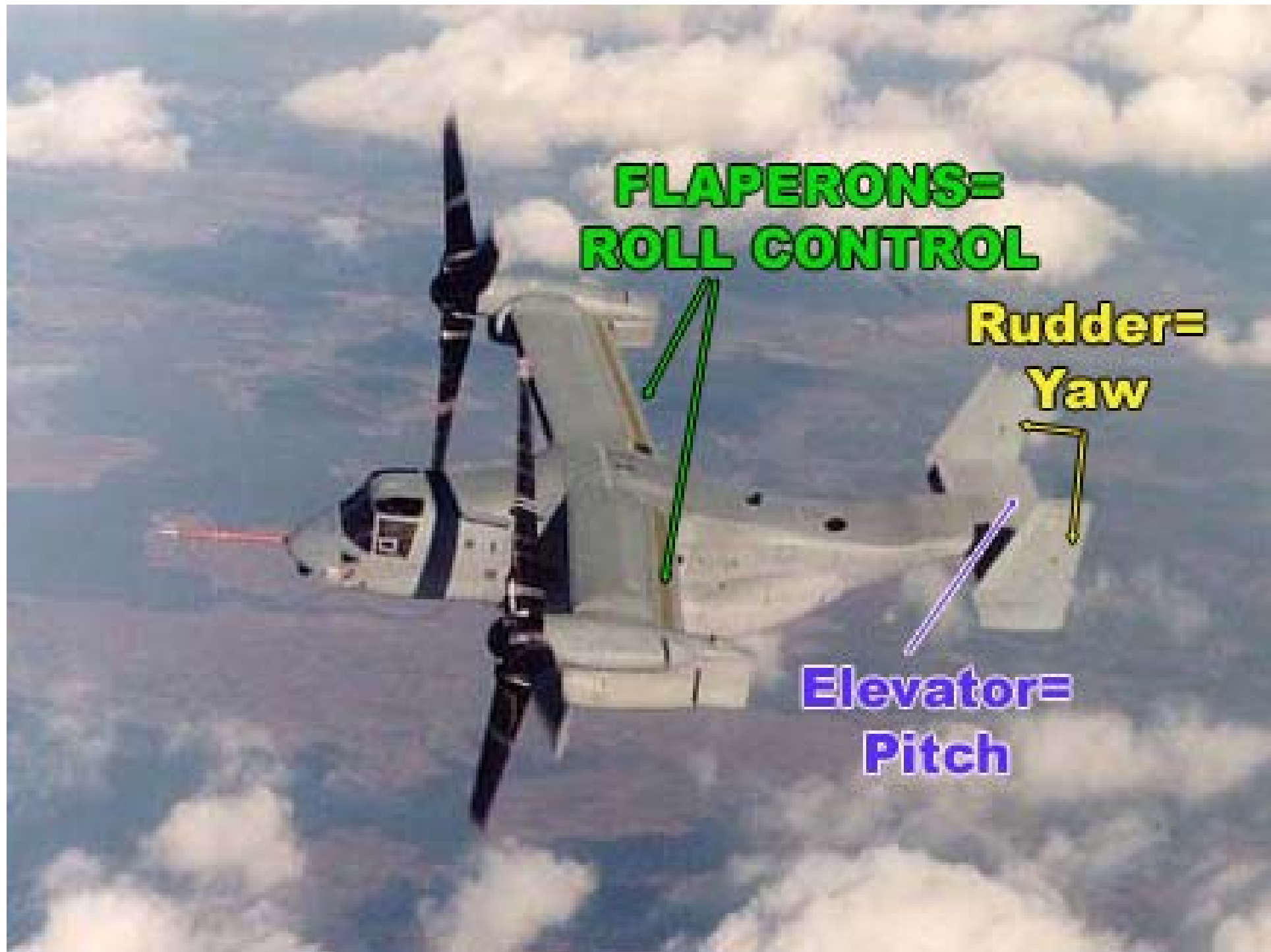
TYPICAL LANDING PATTERN APPROACH

Downwind
60 nac / 110 kcas
500 ft AGL

Mid-Approach Turn
75 nac / 80-85 kcas
300 ft AGL

On Final
90 \pm 5 nac / Decel
To Hover or Roll-on





**FLAPERONS =
ROLL CONTROL**

**Rudder =
Yaw**

**Elevator =
Pitch**

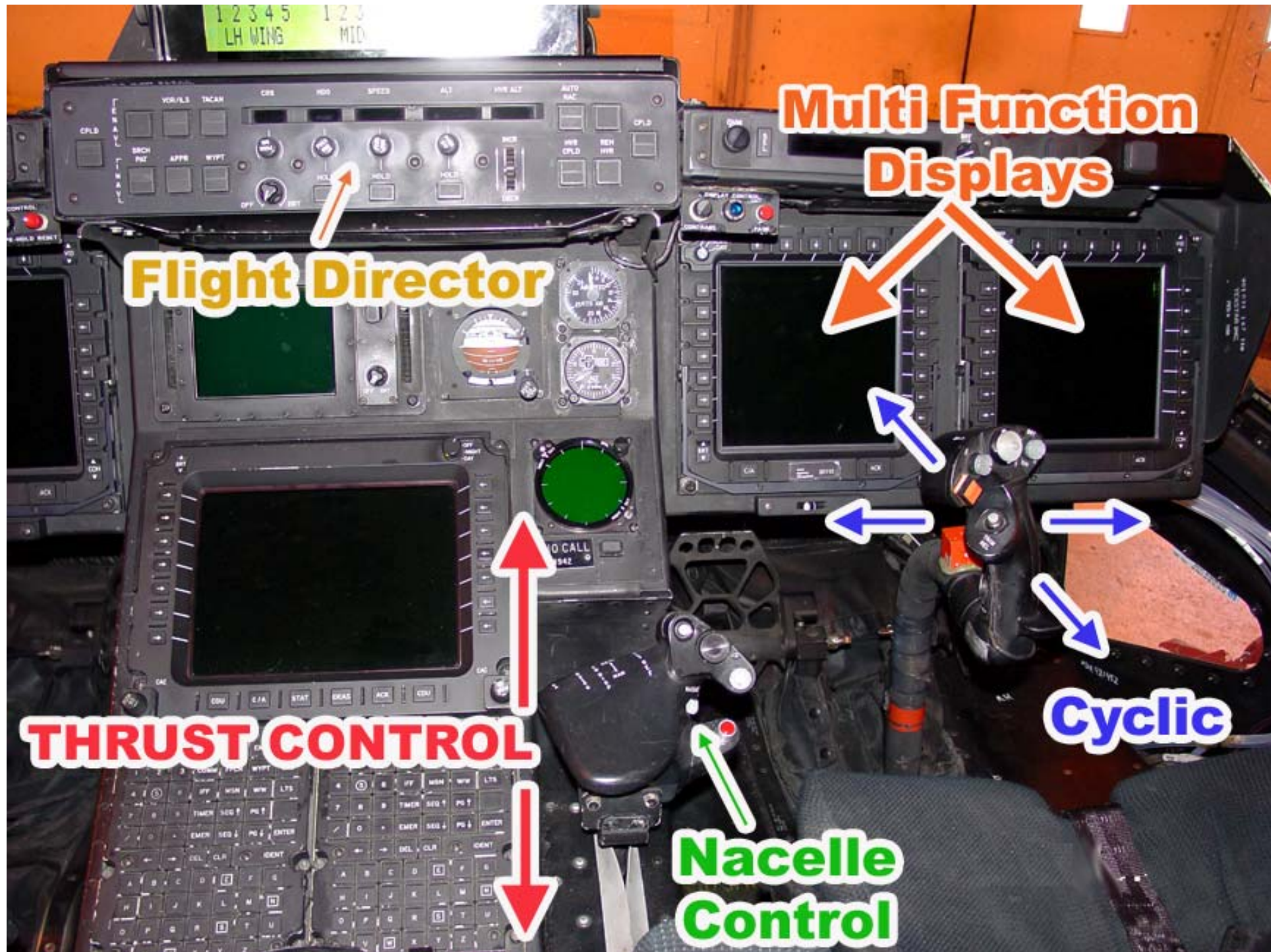
CONVERSION MODE



- **Mixed Control Strategy**
- **Non-Linear Flight Control Changes**



0-96 Degree Nacelle Motion



Flight Director

Multi Function Displays

THRUST CONTROL

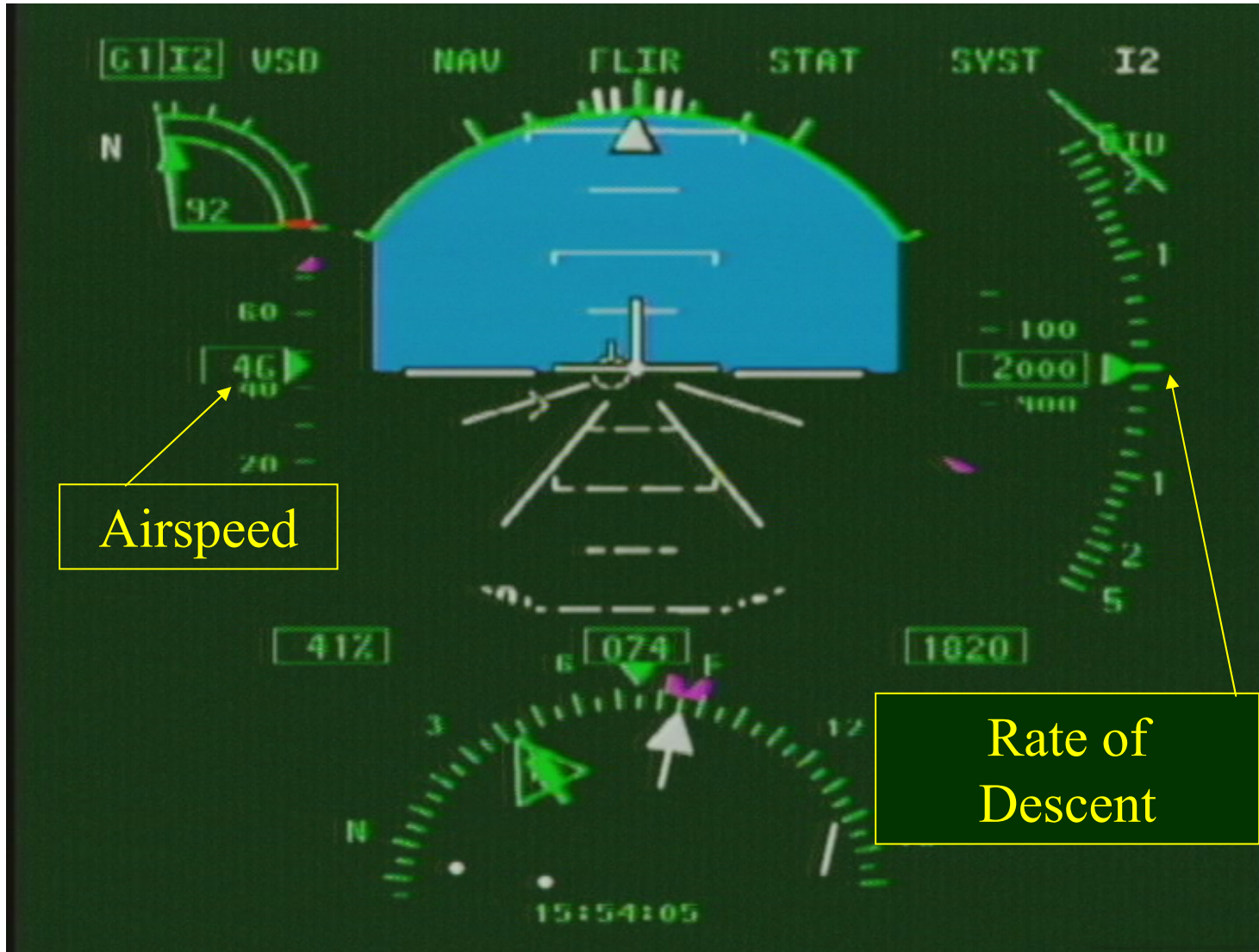
Nacelle Control

Cyclic

Total Aircraft Systems Integration in the Cockpit

- Dual 1553 Avionics Data Busses
- Four Multifunction Displays (MFD)
- CDU / EICAS / Two Keyboards
- System Schematics
- Integrated Diagnostics
- Flight Director Control Panel
- Radio Frequency Indicator Selection
- Inertial & Electronic Navigation (INAV, ENAV)
- TACAN, VOR, ILS

Primary Flight Display



Horizontal Situation Display (HSD)

NAV Control Layer, Centered Mode, Digital Map Video with Key Legends



SYSTEM STATUS LAYERS



ENGINES / DRIVE



FLT CONT / HYD



FUEL



ICE PROTECTION



ELECTRICAL





TEST CONDUCT

Testing of the 96 Different Configurations for the Approach Phase was Narrowed Down to Four Nacelle Settings



75 Deg and 80 Knots
60 Deg and 110 Knots
45 Deg and 130 Knots
30 Nacelle and 150 Knots

TEST ASSUMPTIONS

- Stable Platform

Ensure Aircrafts Hardware
and Software are Proven
and Mature

- No Flight into Known Icing Conditions

- No Weather Radar

No Flight in or Around
Convective Weather



TEST METHOD



- Mission Relatable Maneuvers and Basic Instrument Maneuvers
- Radio Instrument Approaches in Daylight VMC
- Actual IMC Approaches

Mission Tasks

Determine Mission Tasks for
Engineering Review Prior to
Actual IMC Flight



- Level Accelerations
- Level Turning Deceleration
- Climbs and Descents
- Unusual Attitudes

Test Criteria

- Level 1 Flying Qualities = Pass
- Level 2 Flying Qualities = Pass
with Recommendations or
Restrictions
- Level 3 Flying Qualities = Fail



Tolerances for HQRs Established
using Manned Flight Simulator

RESULTS



- All Configurations were Safe and Predictable
- Changing Nacelle Angle while Performing Multiple Tasks will Increase the Pilots Workload

RESULTS



- 75 Degree Nacelle has Reduced Directional Stability and Increases Pilot Workload on Final Approach
- 60 Degree has Increased Vibrations, but Very Stable
- 30 Degree Nacelle has Pitch / Power Coupled Effects, and Interferes with Gear Down Speed

OTHER FINDINGS

Day VMC needs to be Validated with Actual IMC

- Pilot may be Unaware of External Cues such as Moving Shadows

Flight Director Reduces Pilot Workload

- Use of Cuing on the Multi Function Displays Aids Situational Awareness.

-2 Winters of Natural Ice Testing have Validated IMC Testing

Questions?

