

### Flying Qualities Short Course

This course includes 16 academic hours and three in-flight simulator (IFS) Learjet 25 flights per student. Each flight lasts approximately 1.8 hours. The students will fly each sortie from the evaluation pilot position.

#### Objectives

1. Be able to identify the longitudinal dynamic modes of motion using standard flight test techniques.
2. Be able to identify the lateral-directional modes of motion using standard flight test techniques.
3. Understand how various open loop characteristics can influence closed loop flying qualities.
4. Recognize the effects of feel system and control system nonlinearities such as friction and preload, pre-filters, and time delay on flying qualities.
5. Be able to perform a handling qualities evaluation using meaningful descriptive comments and appropriate use of the Cooper-Harper scale.
6. Review key longitudinal and lateral-directional flying qualities factors and relate them to MIL-HDBK-1797 requirements.
7. Provide the opportunity to determine fixes for a deficient airplane and evaluate the effects of those fixes.
8. Understand the difference between alpha-command, pitch rate command, and g-command flight control systems.
9. Understand the effects of control surface rate limiting and time delay on handling qualities.

#### Classroom Instruction (16 hours)

- Course Introduction
  - o How the Learjet Variable Stability System (VSS) Works
  - o Emergency Training Certification
- Longitudinal Stability & Control
  - o Longitudinal Static Stability ( $M_\alpha$ )
  - o Short Period Variations ( $\omega_{sp}$ ,  $\zeta_{sp}$ )
  - o Control Stick Characteristics (force, deflection, friction, breakout)
  - o Pre-filters (lead, lag)
  - o Time Delay
  - o Center of Gravity (CG) Variations



- Lateral Directional Stability & Control
  - o Directional Static Stability ( $N_{\beta}$ )
  - o Dihedral Effect ( $L_{\beta}$ )
  - o Roll Mode ( $L_p$ )
  - o Spiral Mode ( $L_{\beta} N_r - N_{\beta} L_r$ )
  - o Dutch Roll Characteristics ( $\omega_{DR}, \zeta_{DR}, \Phi/\beta$ )
  - o Adverse/Proverse Yaw ( $N_{\delta a}, N_p$ )
- Handling Qualities Evaluations
  - o Comment Cards and Communication Techniques
  - o Cooper-Harper Rating Scale
  - o PIO Rating Scale
- Advanced Flight Control Systems
  - o Flight Control System Design
  - o Alpha-Command Flight Control Systems
  - o Pitch Rate Command Flight Control Systems
  - o G-Command Flight Control Systems
  - o Control Surface Rate Limiting Effects on Handling Qualities

#### Flight #1 – Longitudinal Stability & Control (1.8 Hours)

- Exploration of Longitudinal Modes of Motion
- Demonstration of the Effects of Natural Frequency and Damping
- Center of Gravity Effects on Longitudinal Stability
- Effects of Control System Nonlinearities (Friction and Preload, Time Delay)

#### Flight #2 – Lateral-Directional Stability & Control (1.8 Hours)

- Exploration of Directional Static Stability
- Exploration of Dihedral Effect
- Exploration of Lateral-Directional Modes of Motion
- Demonstration of effects of Adverse Yaw and Dihedral Effect

#### Flight #3 – Advanced Flight Controls (1.8 Hours)

- Review of Flight Control Feedback Loop Responses in Different Configurations
  - o Pitch Rate
  - o Normal Acceleration
  - o Angle of Attack
- Rate Limiting Effects on Handling Qualities
- VSS Landing Evaluation

