APPENDIX 3-B
Airplane Upset Recovery Briefing

Figure 3-B.1

Figure 3-B.2

Causes of Airplane Upset

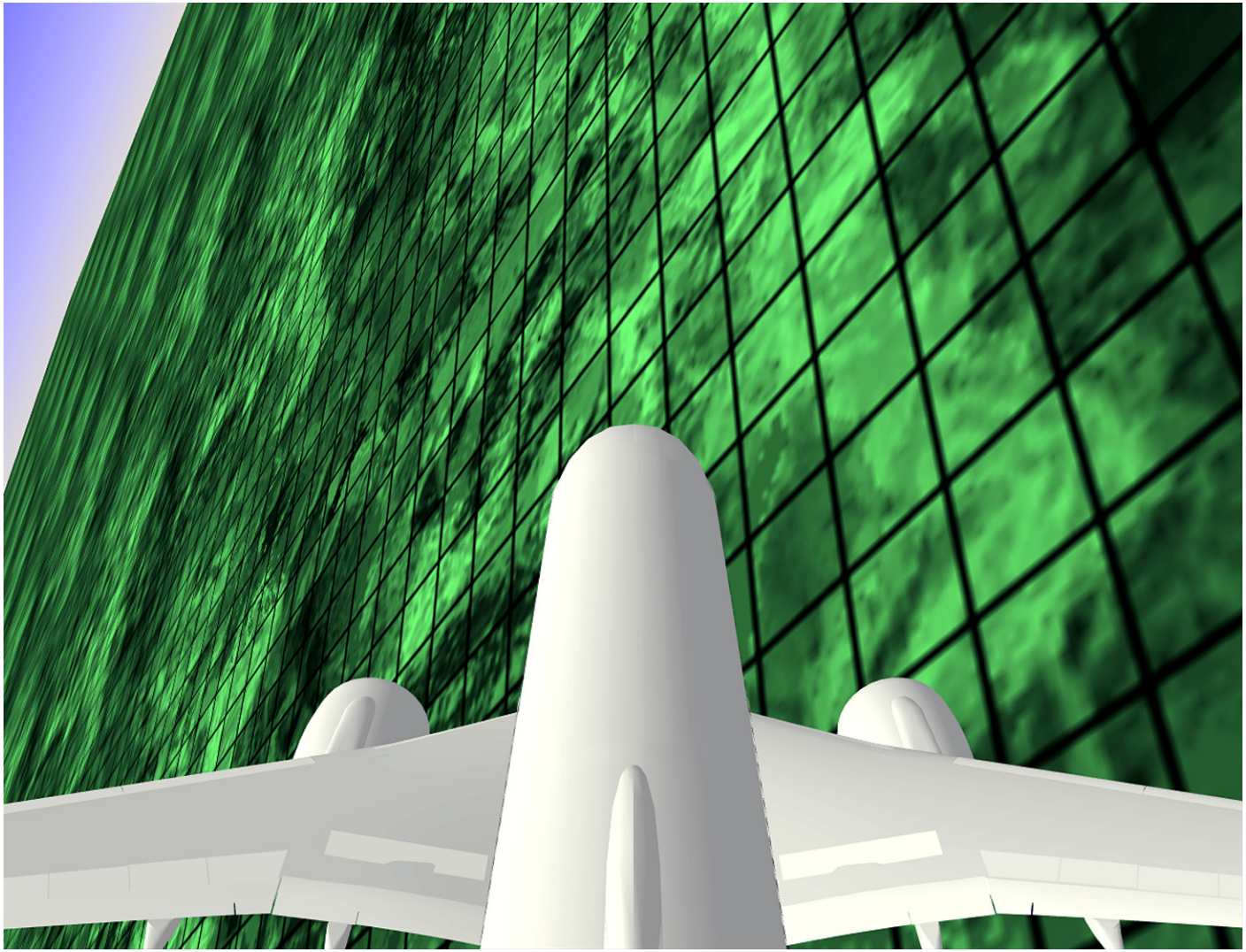


Figure 3-B.3

Airplane Upset Recovery

Figure 3-B.4

Upset Recovery Training Objectives

- To increase the pilot's ability to recognize and avoid upset situations.
- To improve the pilot's ability to recover control, if avoidance is not successful.

Figure 3-B.5

Upset Recovery Training Will Review

- The causes of airplane upsets
- Swept-wing airplane fundamentals
- Airplane upset recovery techniques

Figure 3-B.6

What is “Airplane Upset?”

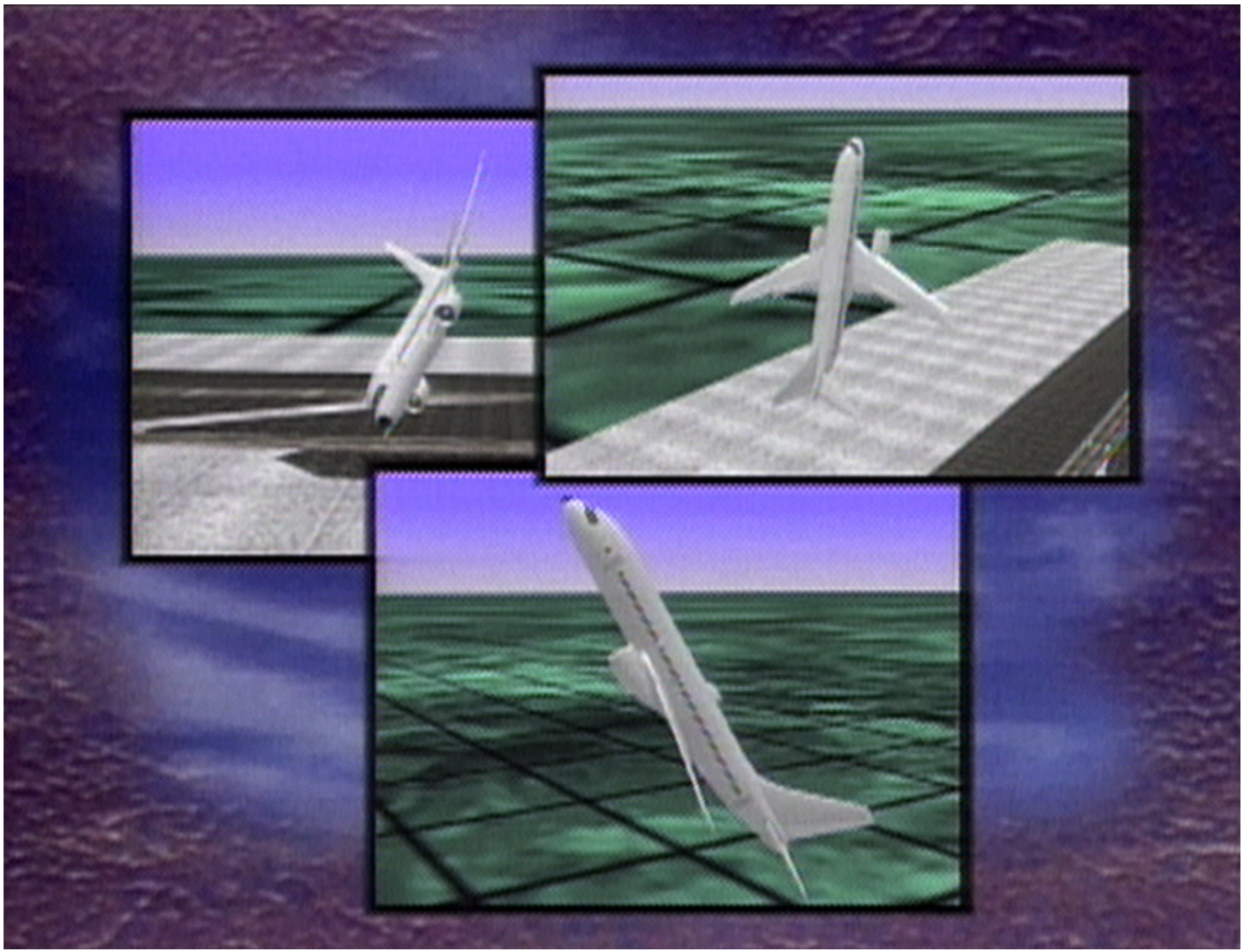


Figure 3-B.7

Causes of Airplane Upset Incidents Are

- Environmentally induced
- Systems-anomalies induced
- Pilot induced
- A combination of all three

Figure 3-B.8

Environmental Causes of Airplane Upset Include

- Turbulence
- Clear air turbulence
- Mountain wave
- Windshear
- Thunderstorms
- Microbursts
- Wake turbulence
- Airplane icing

Figure 3-B.9

Turbulence Is Primarily Caused by

- Jet streams
- Convective currents
- Obstructions to wind flow
- Windshear

Figure 3-B.10

Clear Air Turbulence (CAT) Is Characterized by Marked Changes in

- Pressure
- Temperature
- Wind direction
- Wind velocity

Figure 3-B.11

Mountain Wave Turbulence

Figure 3-B.12

Windshear

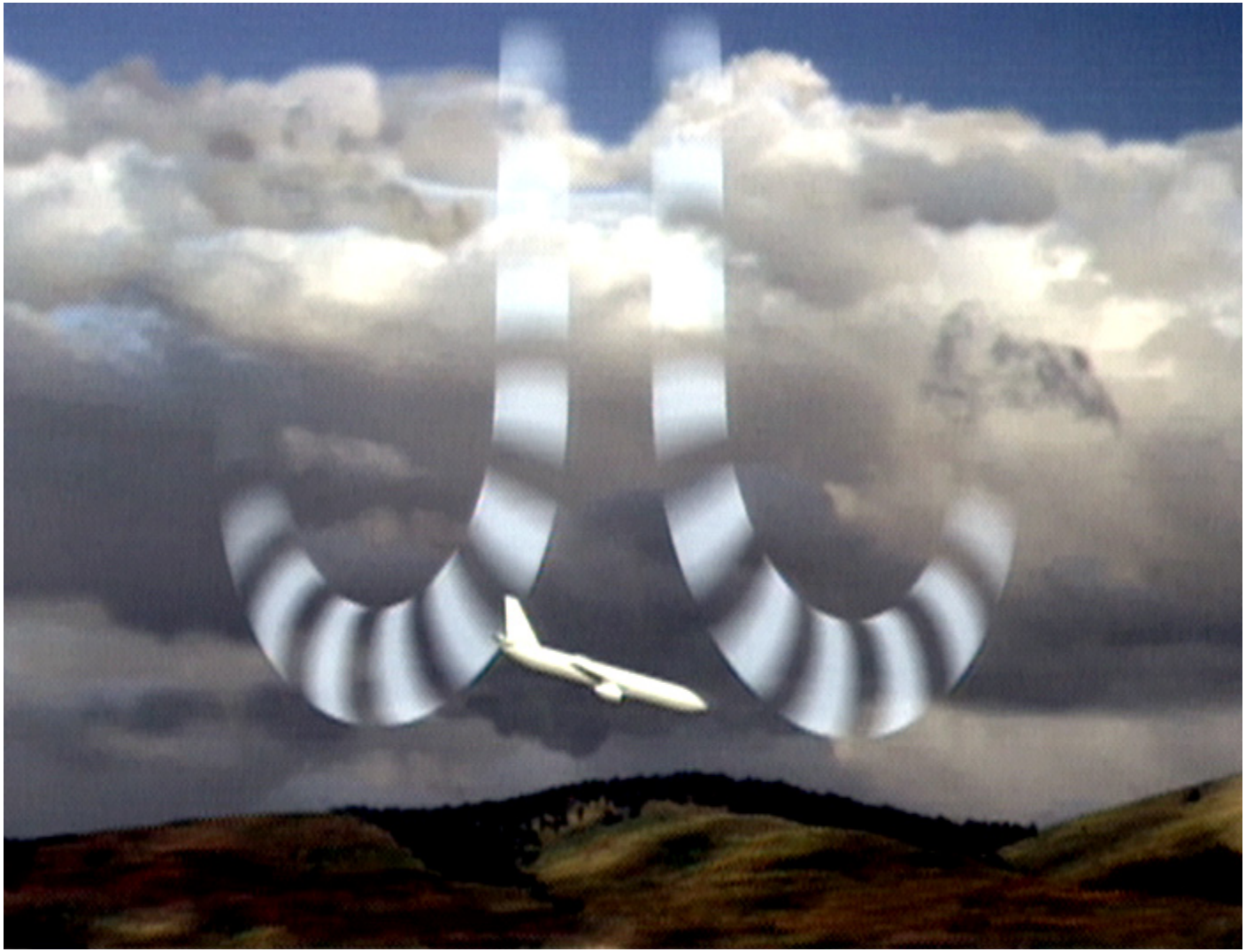


Figure 3-B.13

Thunderstorms

Figure 3-B.14

Microbursts

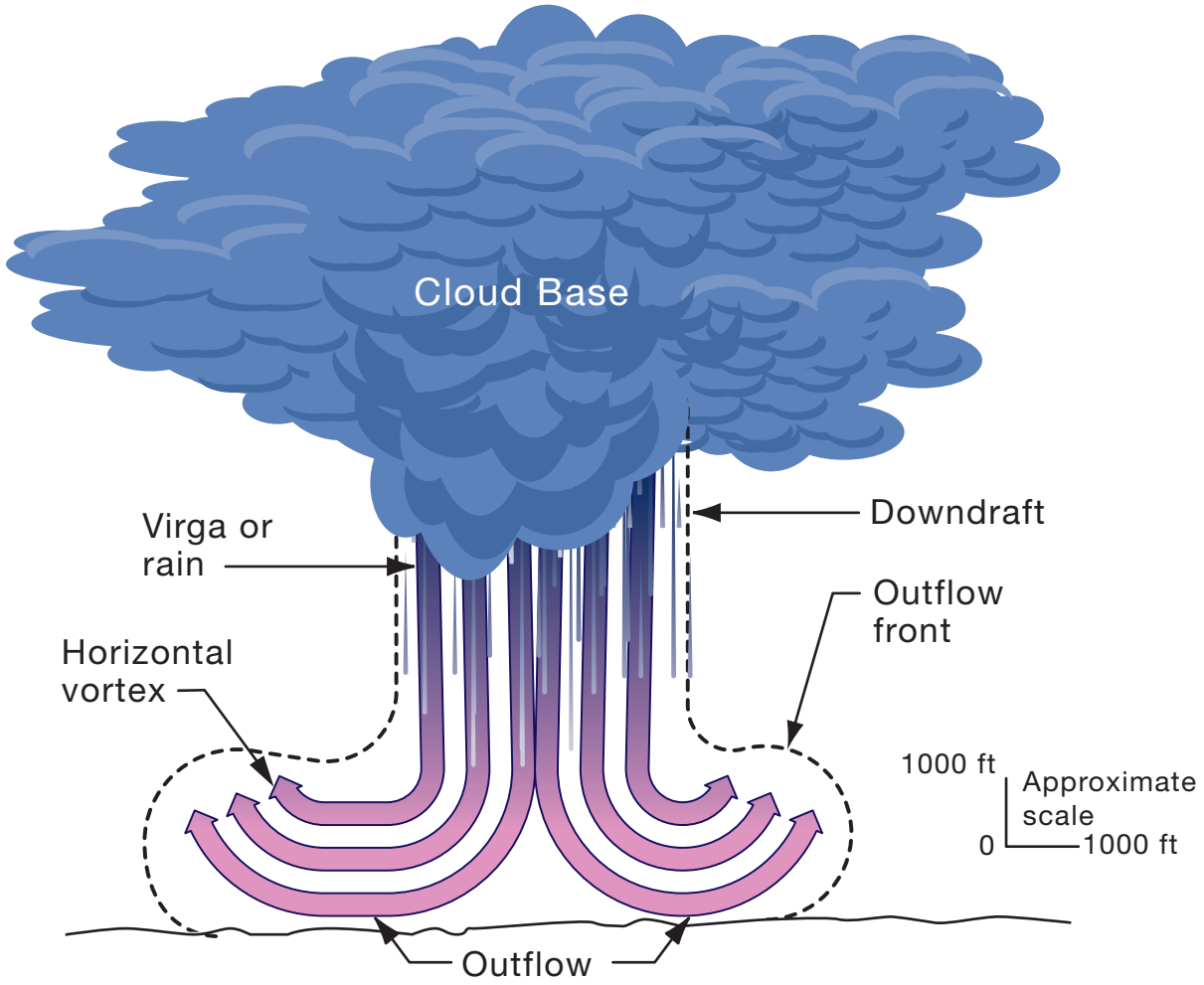


Figure 3-B.15

Wake Turbulence

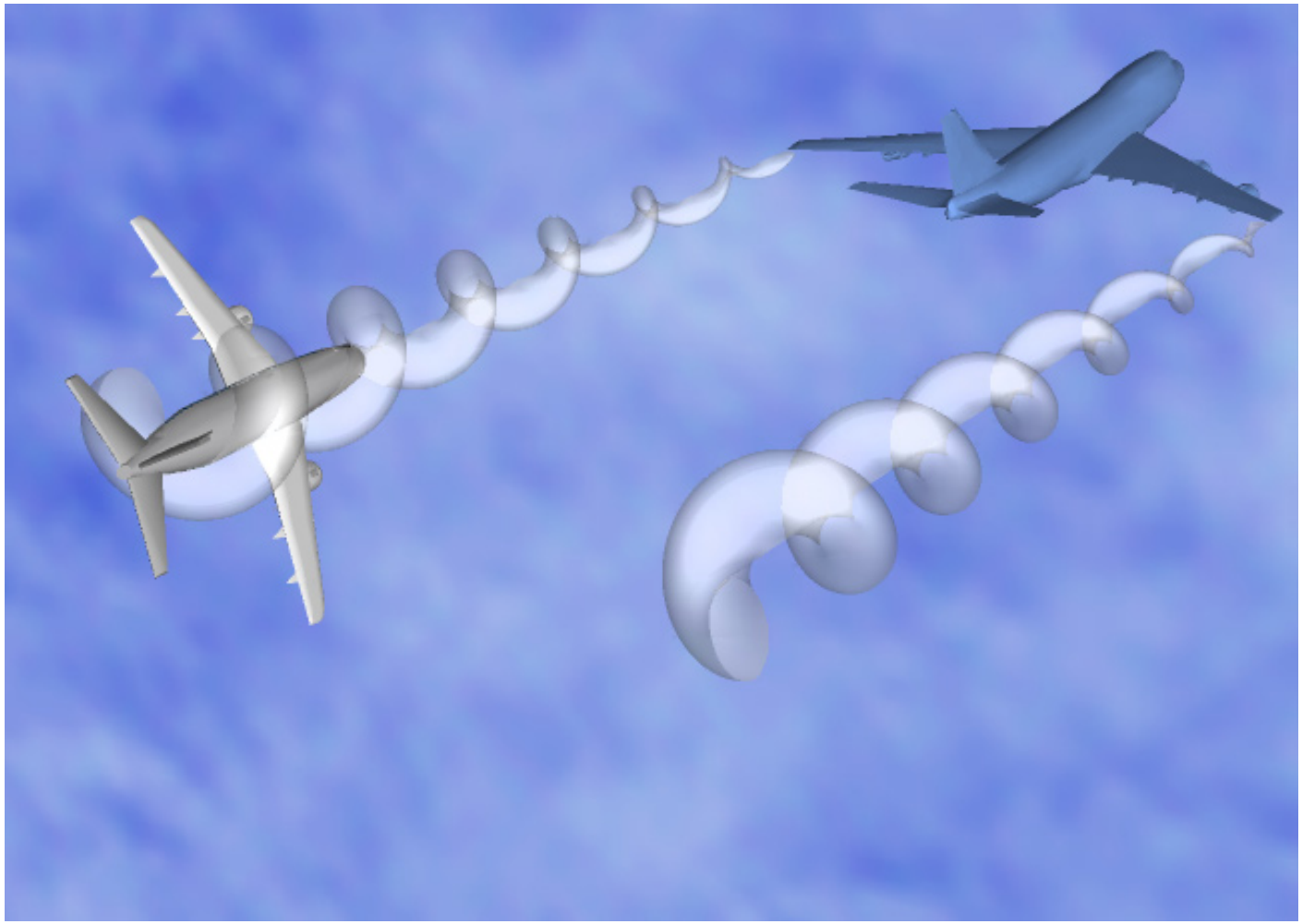


Figure 3-B.16

Airplane Icing

Figure 3-B.17

System-Anomalies Induced Airplane Upsets Primarily Involve

- Flight instruments
- Autoflight systems
- Flight controls and other anomalies

Figure 3-B.18

System-Anomalies Induced Airplane Upsets

Figure 3-B.19

Flight Instruments

Figure 3-B.20

Autoflight Systems

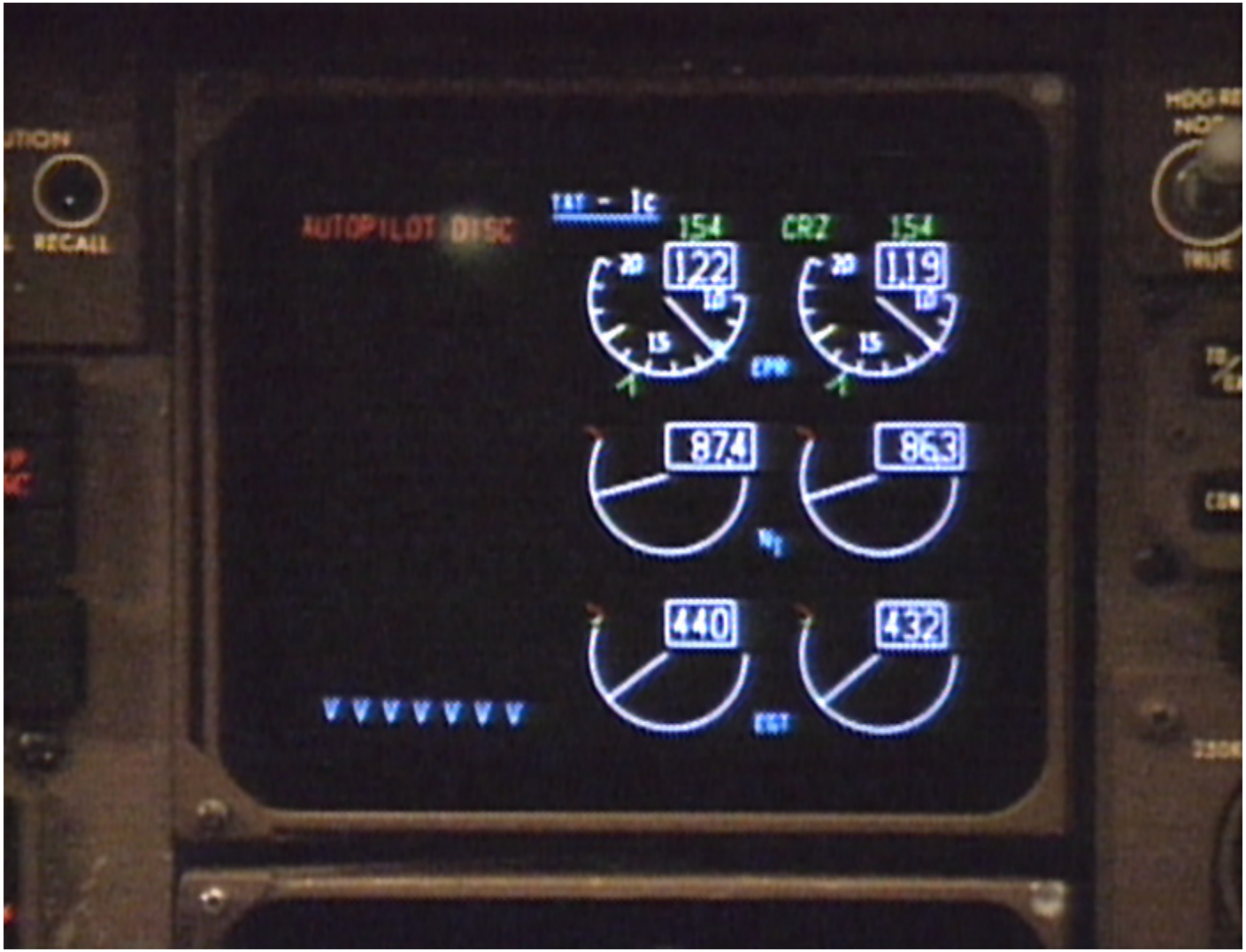


Figure 3-B.21

Flight Control and Other Anomalies

Figure 3-B.22

Pilot-Induced Causes of Airplane Upset Include

- Instrument misinterpretation or slow cross-check
- Inattention and distraction from primary cockpit duties
- Vertigo or spatial disorientation

Figure 3-B.23

Instrument Cross-Check

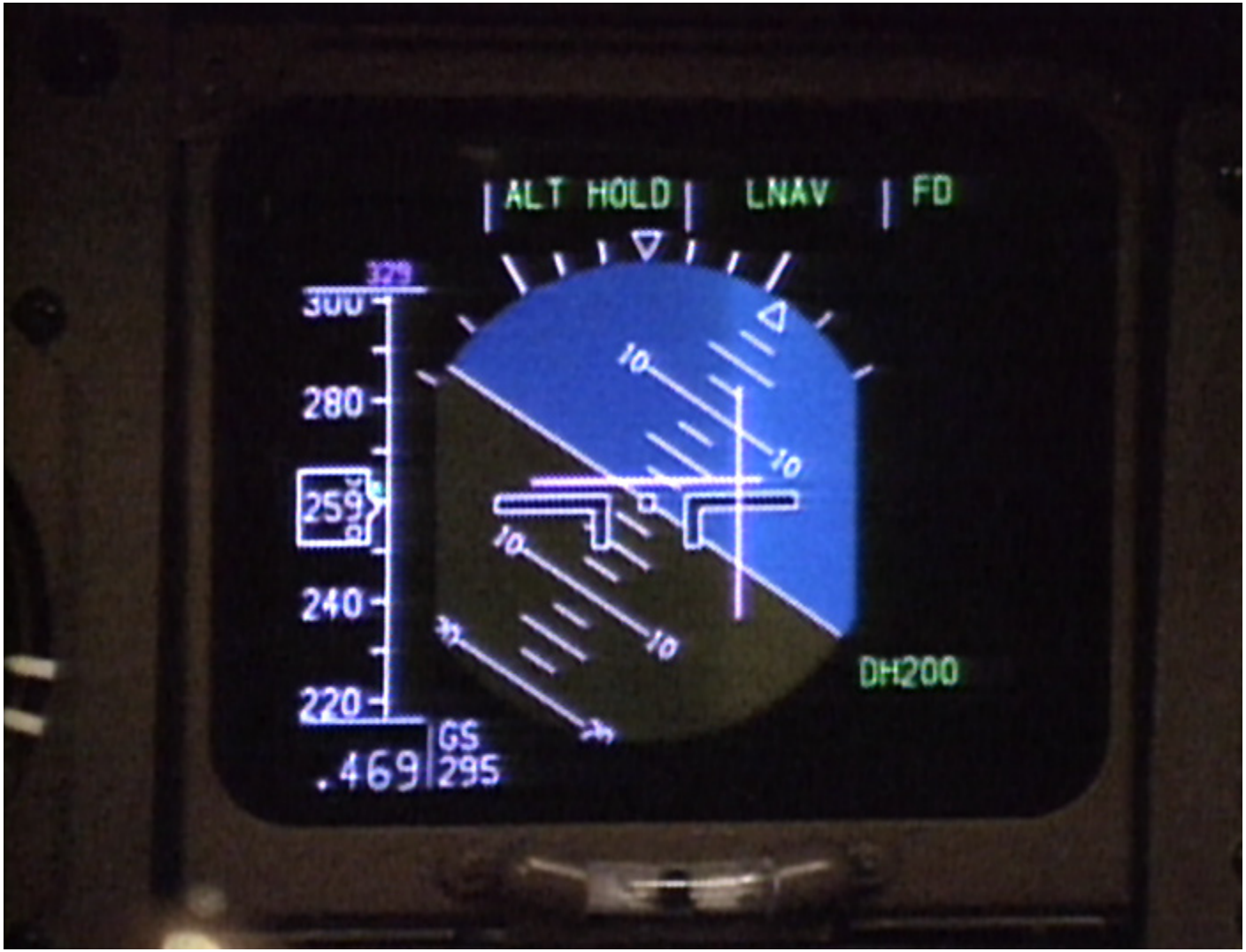


Figure 3-B.24

Distraction

Figure 3-B.25

Vertigo or Spatial Disorientation

Figure 3-B.26

Improper Use of Airplane Automation

Figure 3-B.27

Causes of Airplane Upsets—Summary

1. **Environmental:**

   Turbulence, CAT, mountain wave, windshear, thunderstorms, microbursts, wake turbulence, and airplane icing

2. **Systems anomalies:**

   Flight instruments, autoflight systems, and flight control anomalies

3. **Pilot induced:**

   Instrument cross-check, inattention and distraction from primary cockpit duties, vertigo or spatial disorientation, and improper use of airplane automation

Figure 3-B.28

Swept-Wing Airplane Fundamentals Will Overview

- Flight dynamics
- Energy states
- Load factors
- Aerodynamic flight envelope
- Aerodynamics

Figure 3-B.29

Flight Dynamics

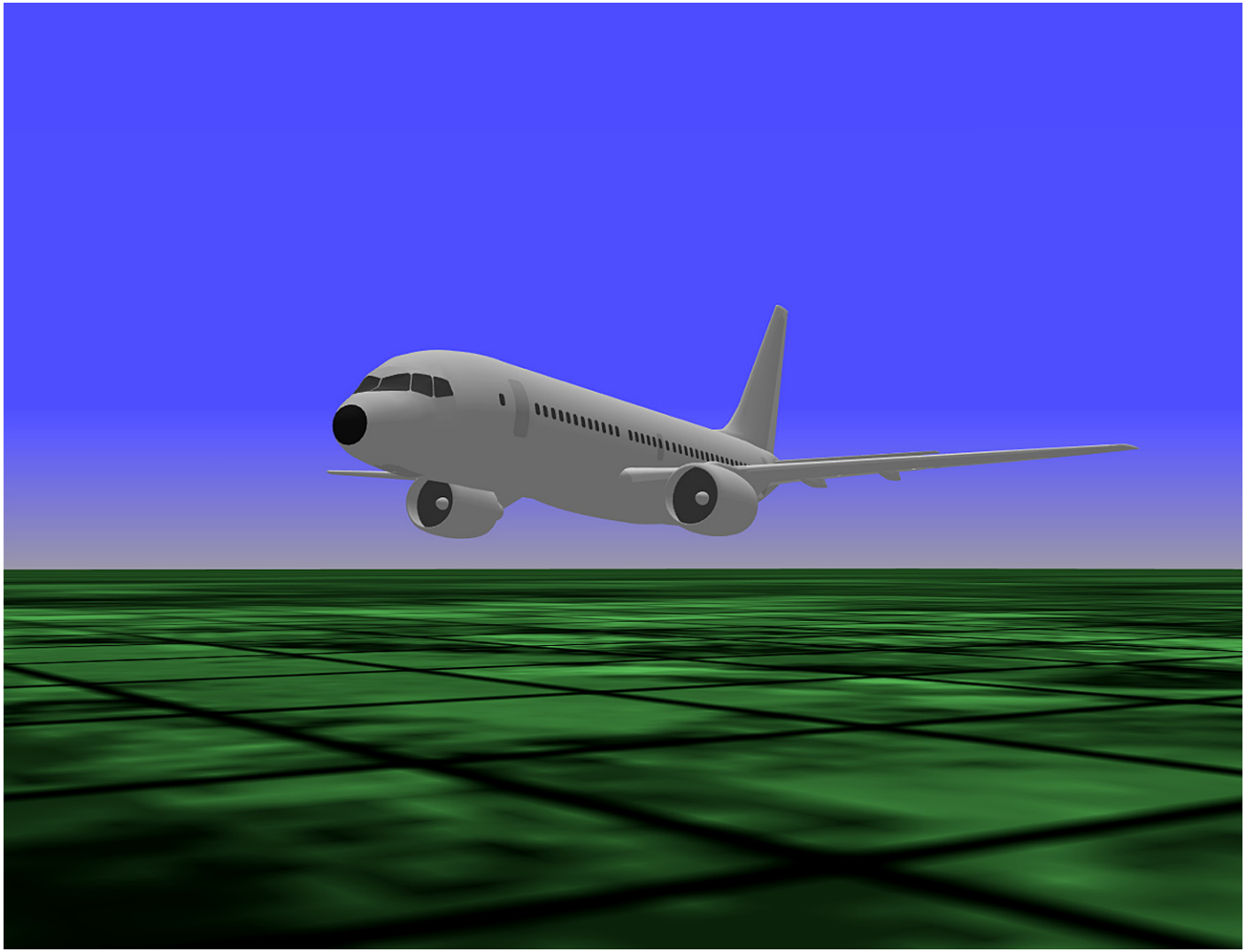


Figure 3-B.30

The Three Sources of Energy Available to the Pilot Are

1. Kinetic energy, which increases with increasing speed
2. Potential energy, which is approximately proportional to altitude

Figure 3-B.31

Energy Relationships

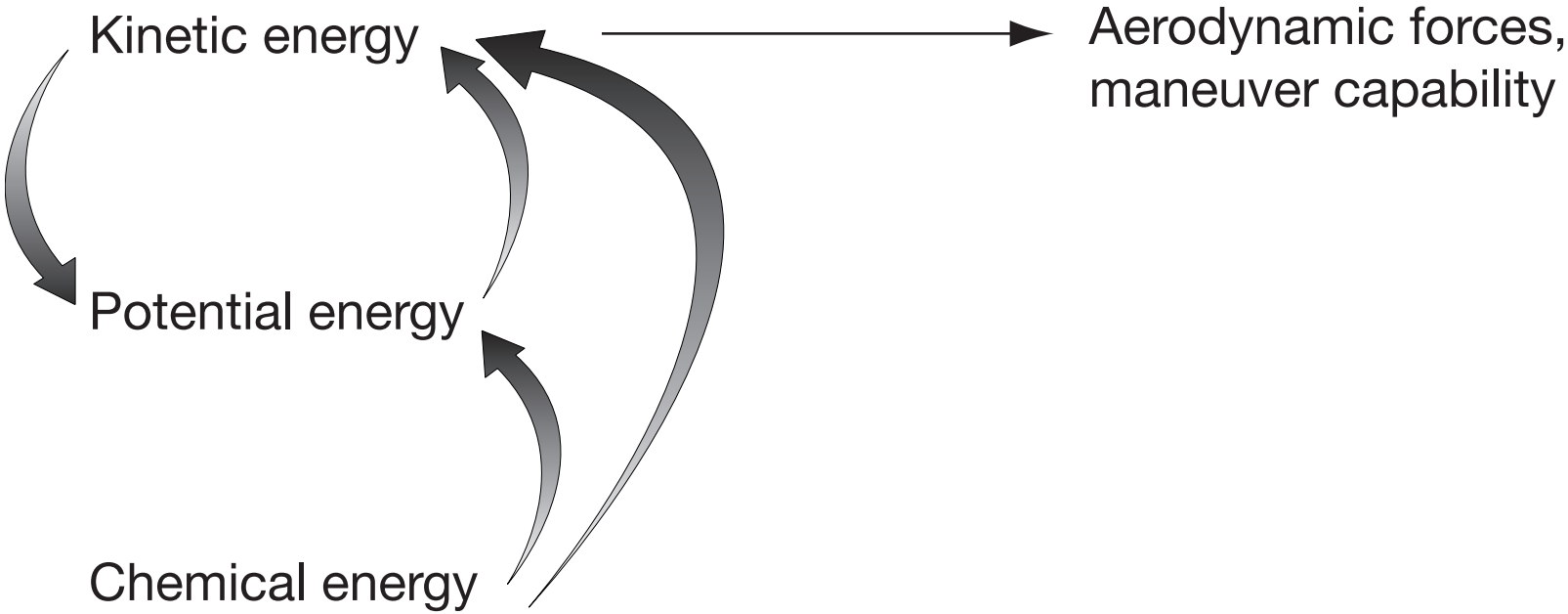


Figure 3-B.32

Load Factors—Four Forces of Flight

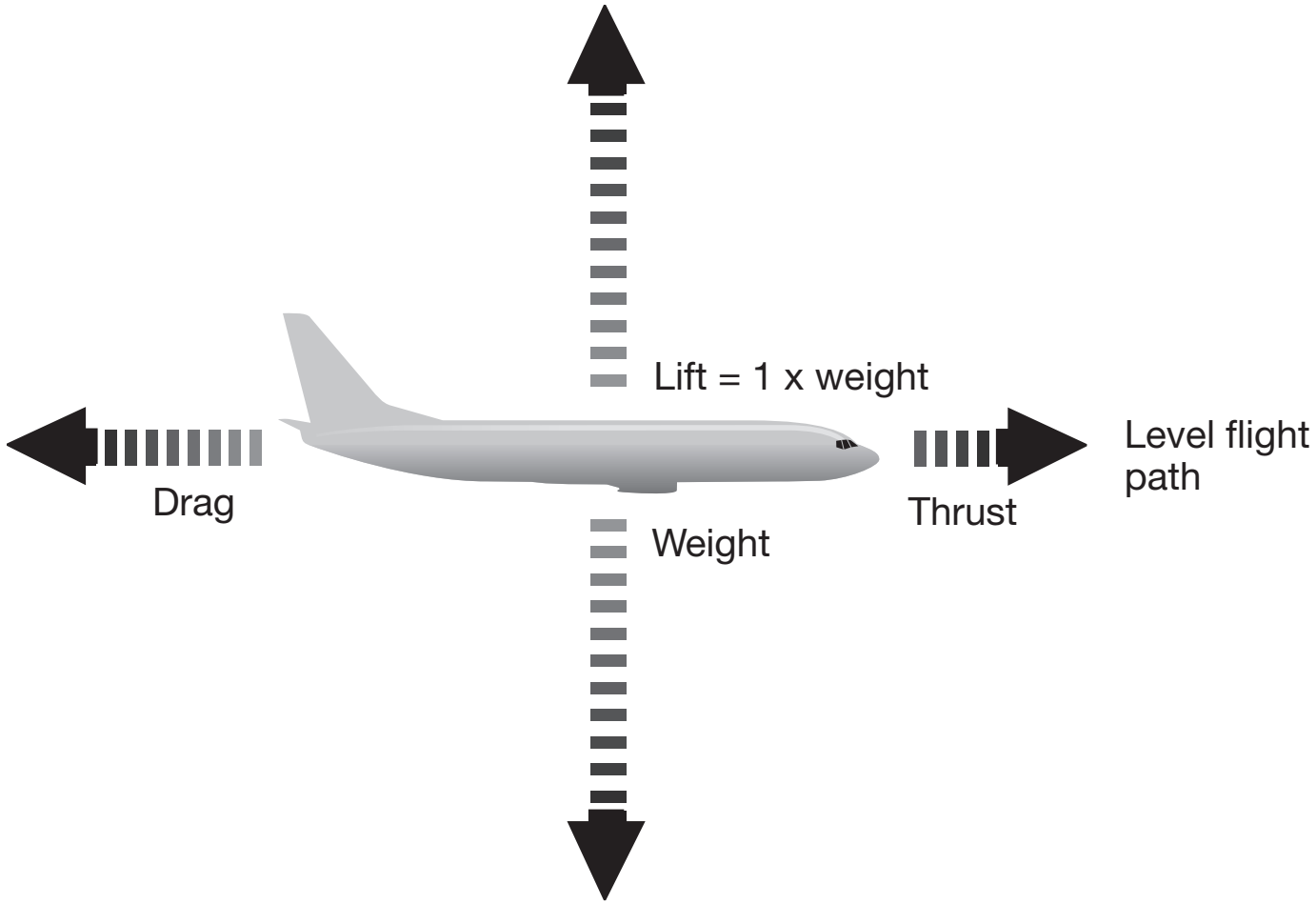


Figure 3-B.33

Load Factors—Airplane in Pull-Up

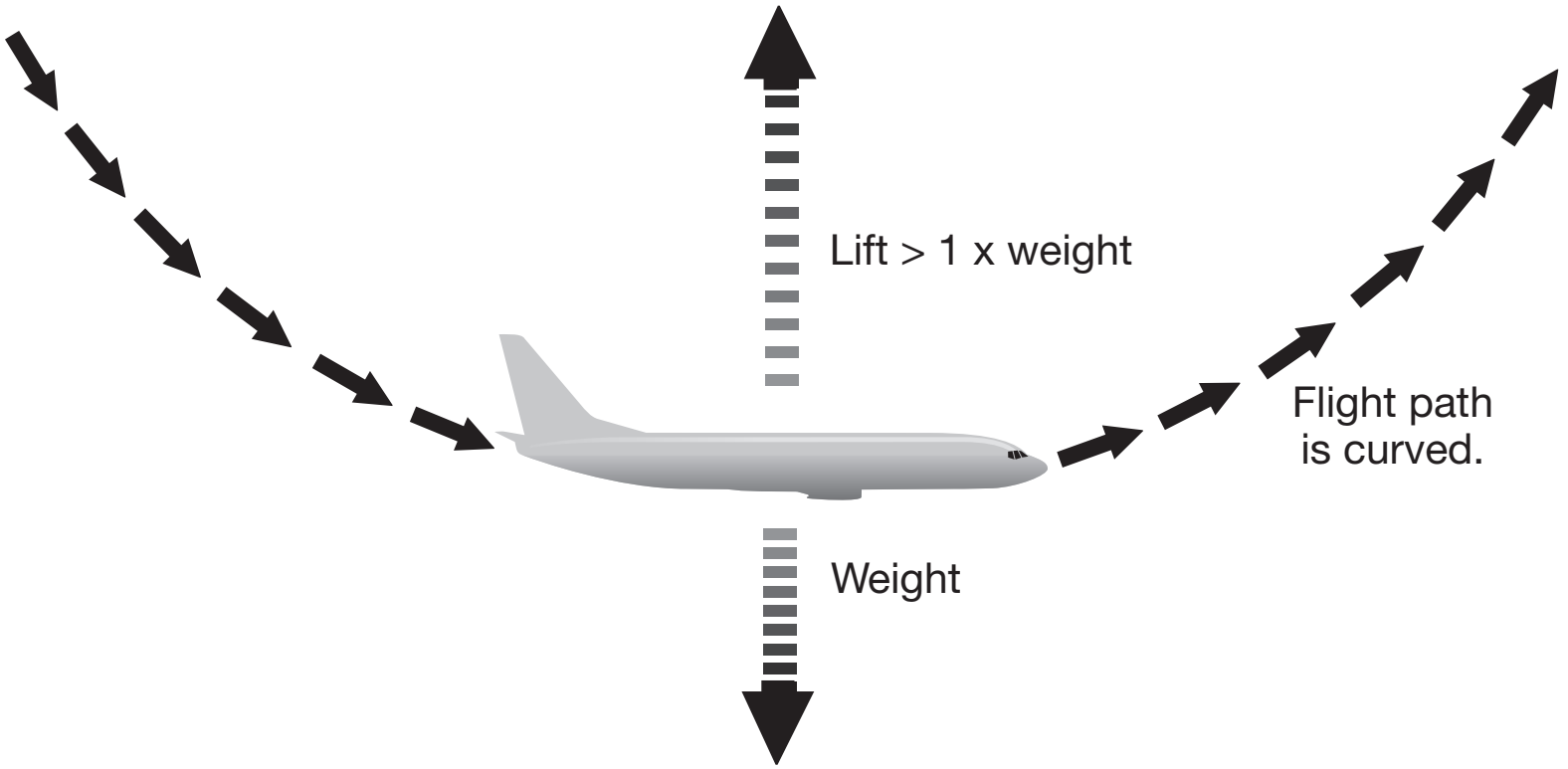
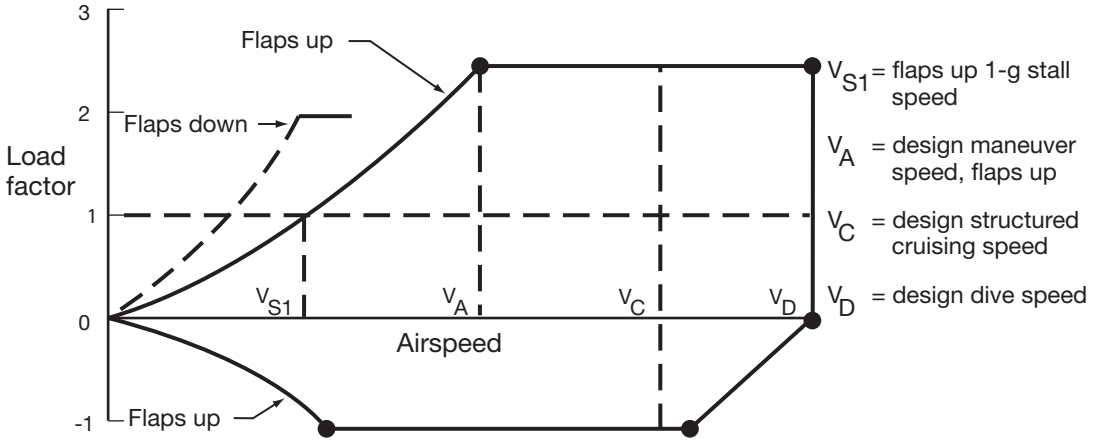


Figure 3-B.34

Aerodynamic Flight Envelope



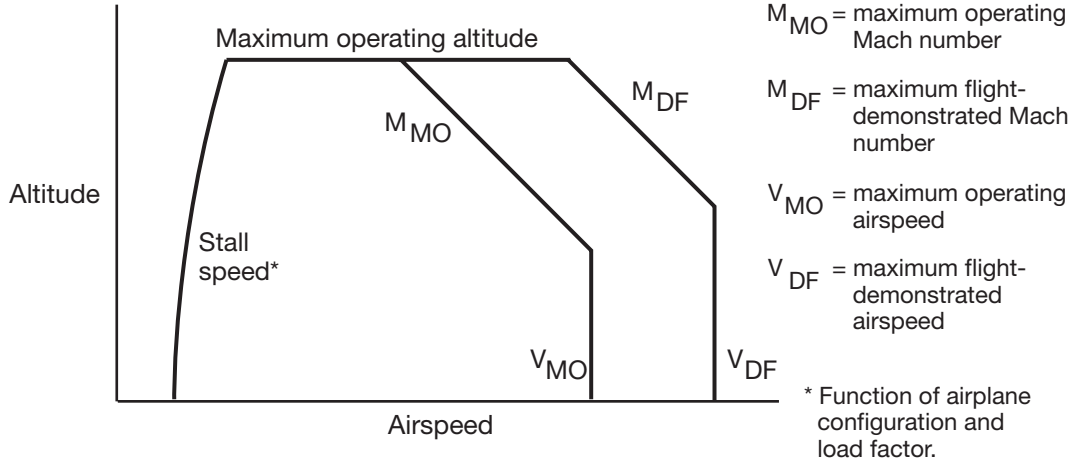


Figure 3-B.35

Angle of Attack

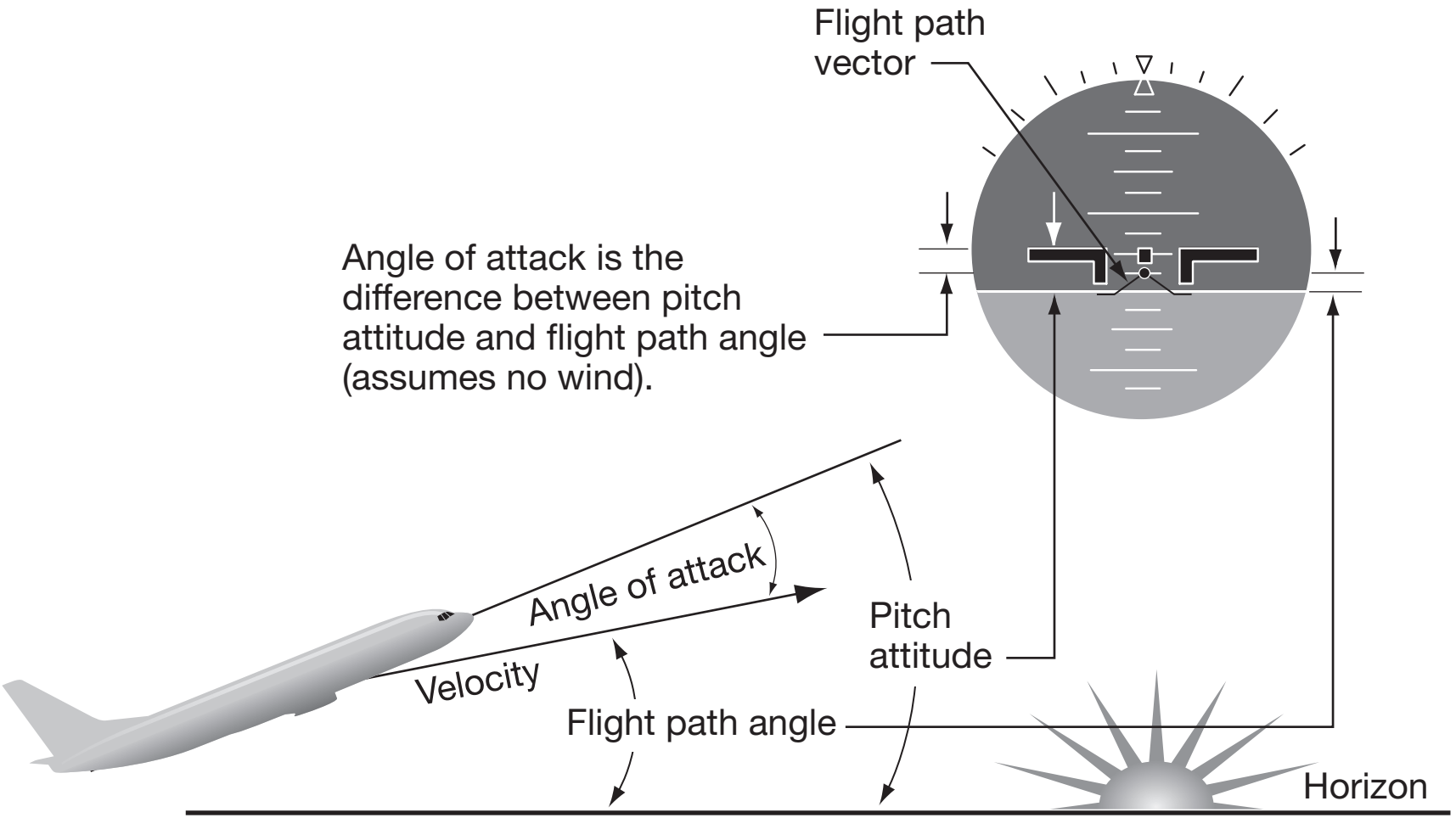


Figure 3-B.36

Stalls

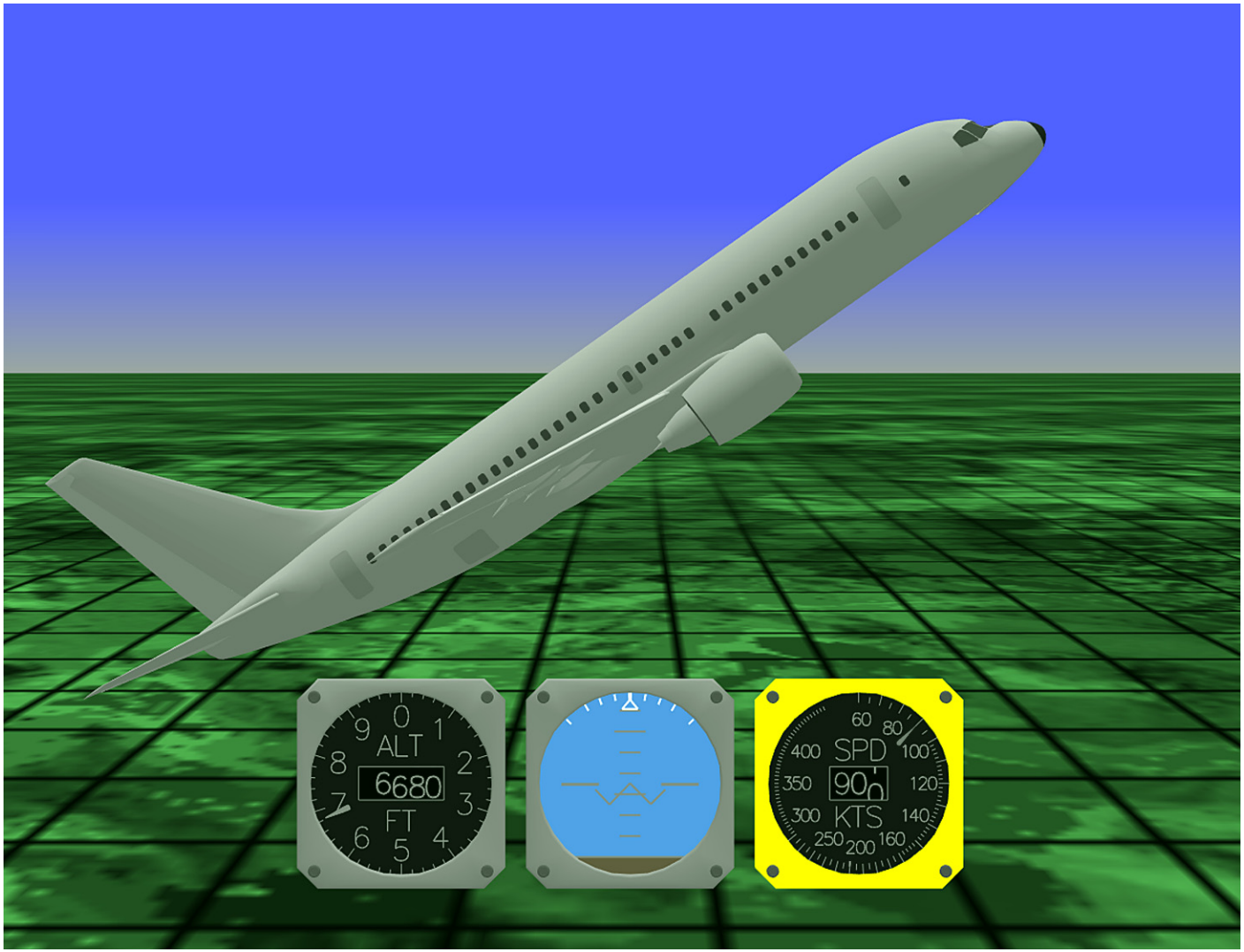
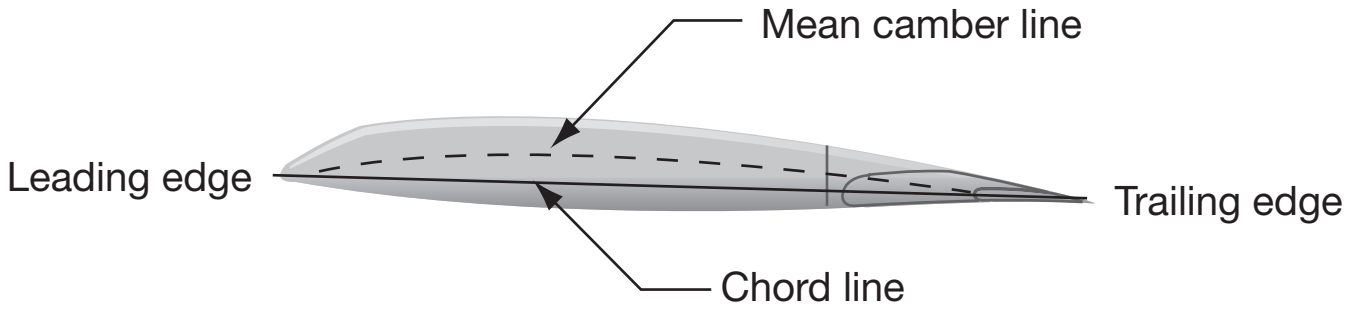


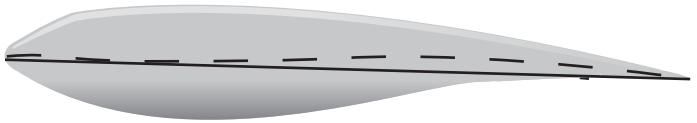
Figure 3-B.37

Camber



Cambered Airfoil

Symmetrical Airfoil



Modern Aft-Cambered Airfoil

Figure 3-B.38

Trailing Edge Control Surfaces

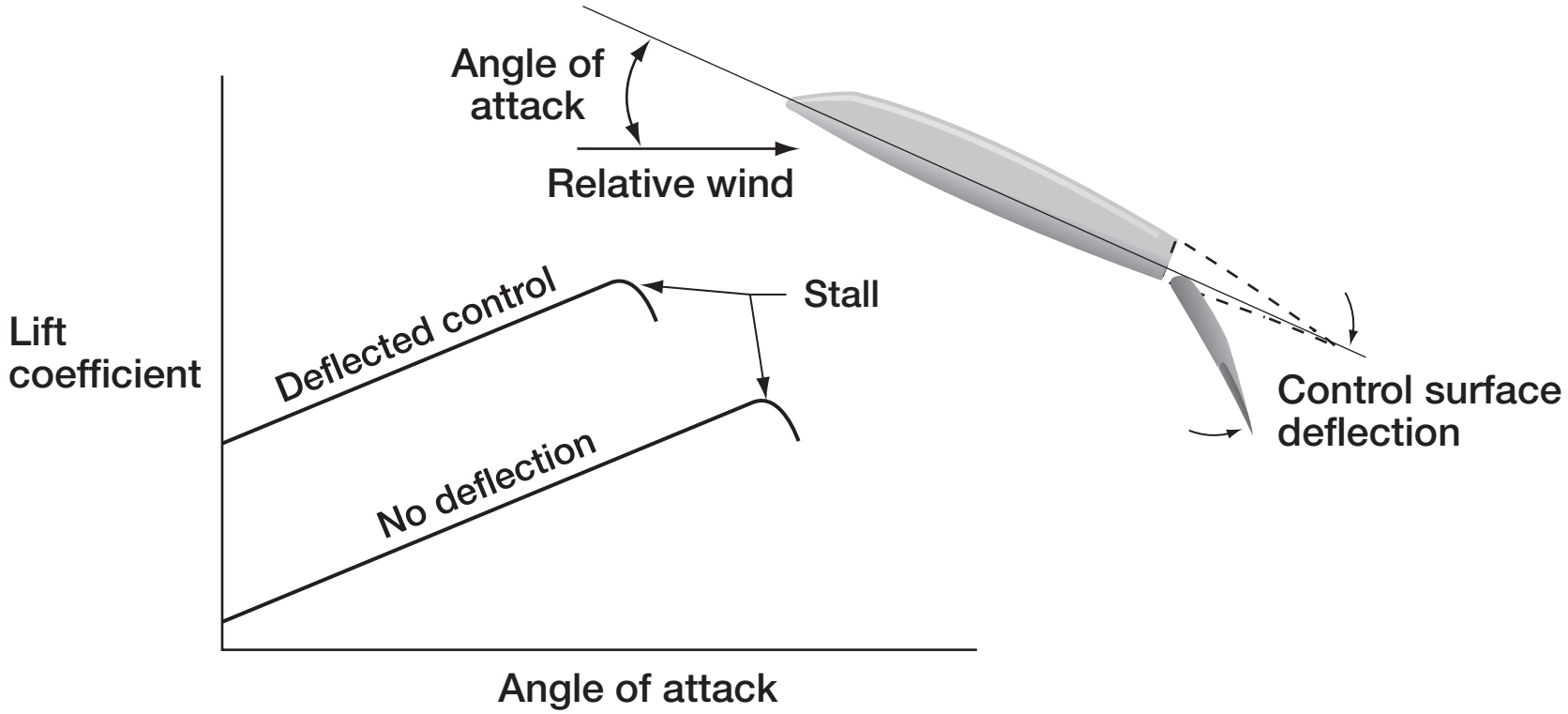


Figure 3-B.39

Spoiler Devices

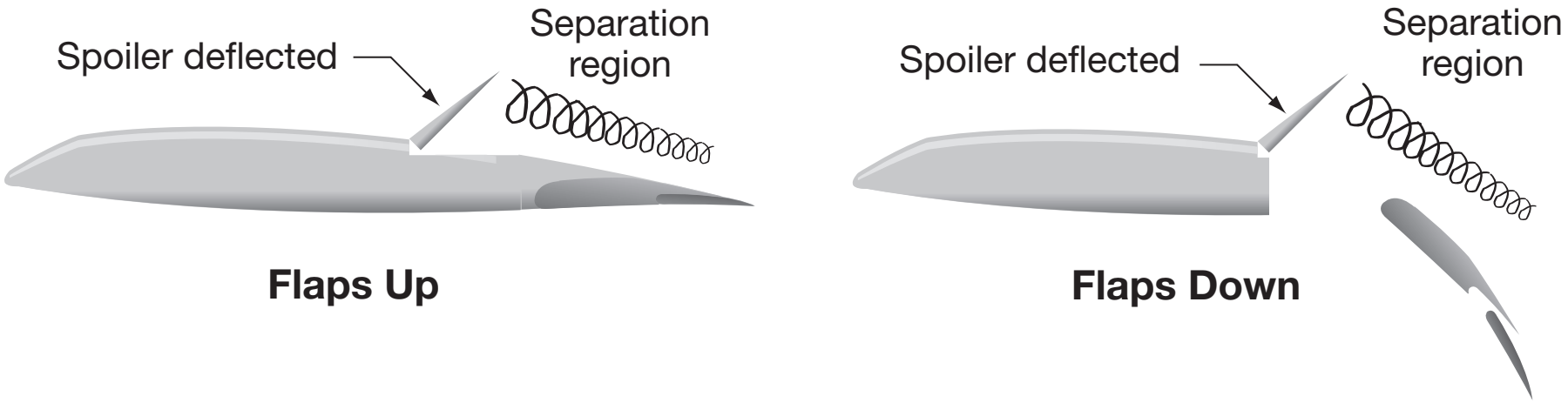


Figure 3-B.40

Trim

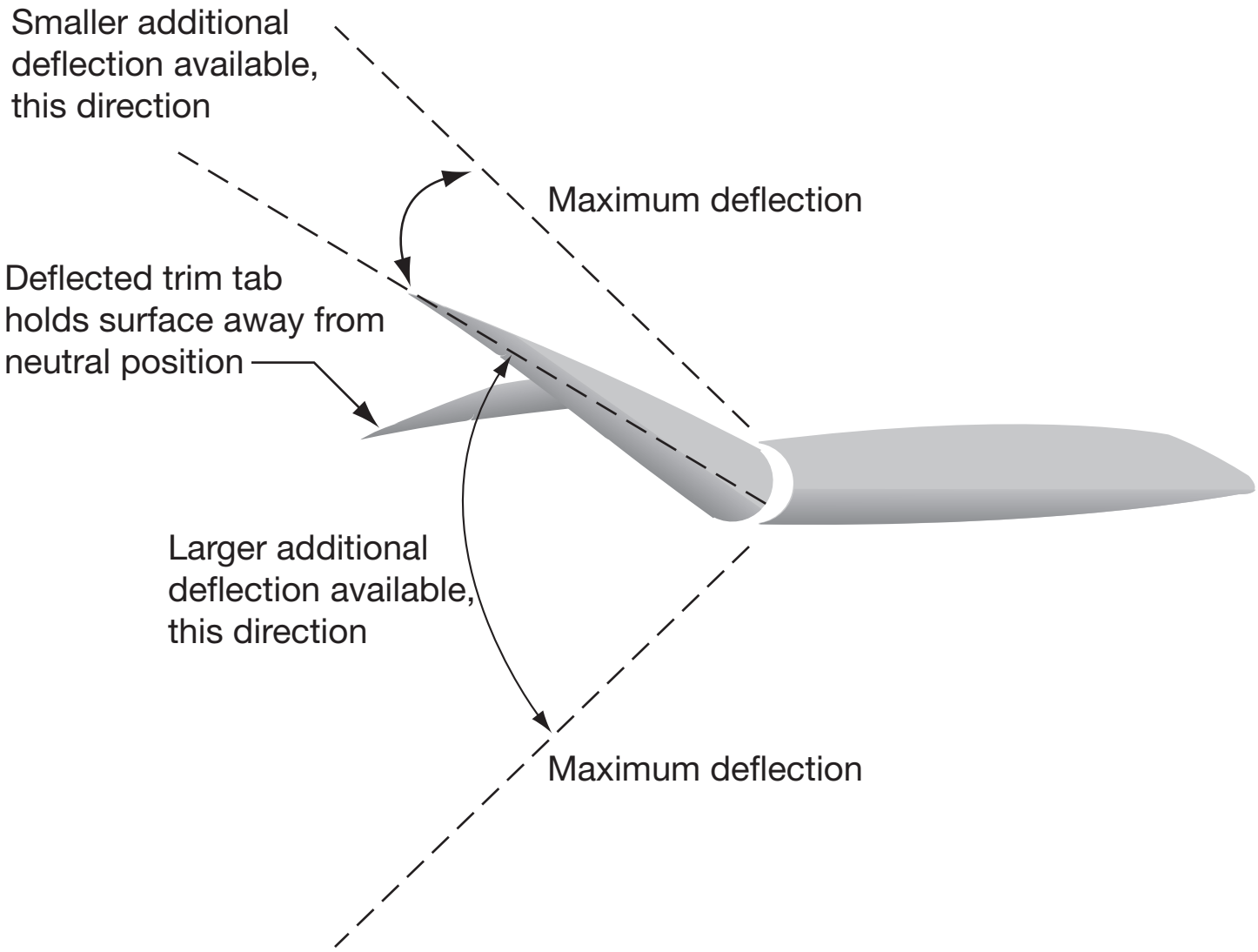


Figure 3-B.41

Lateral and Directional Aerodynamic Considerations

The magnitude of coupled roll-due-to-sideslip is determined by several factors, including

- **Wing dihedral effects**
- **Angle of sideslip**
- **Pilot-commanded sideslip**

Figure 3-B.42

Wing Dihedral Angle

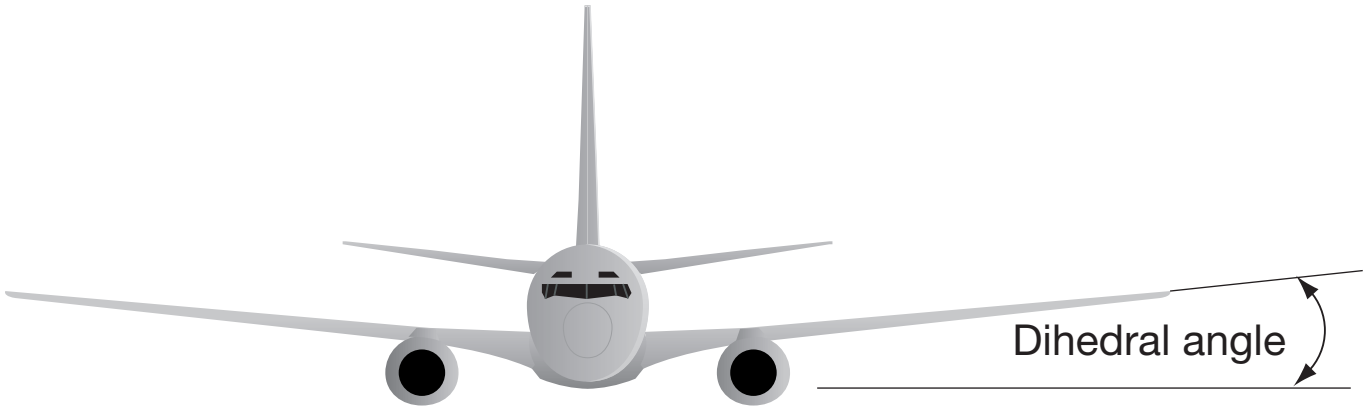


Figure 3-B.43

Angle of Slideslip

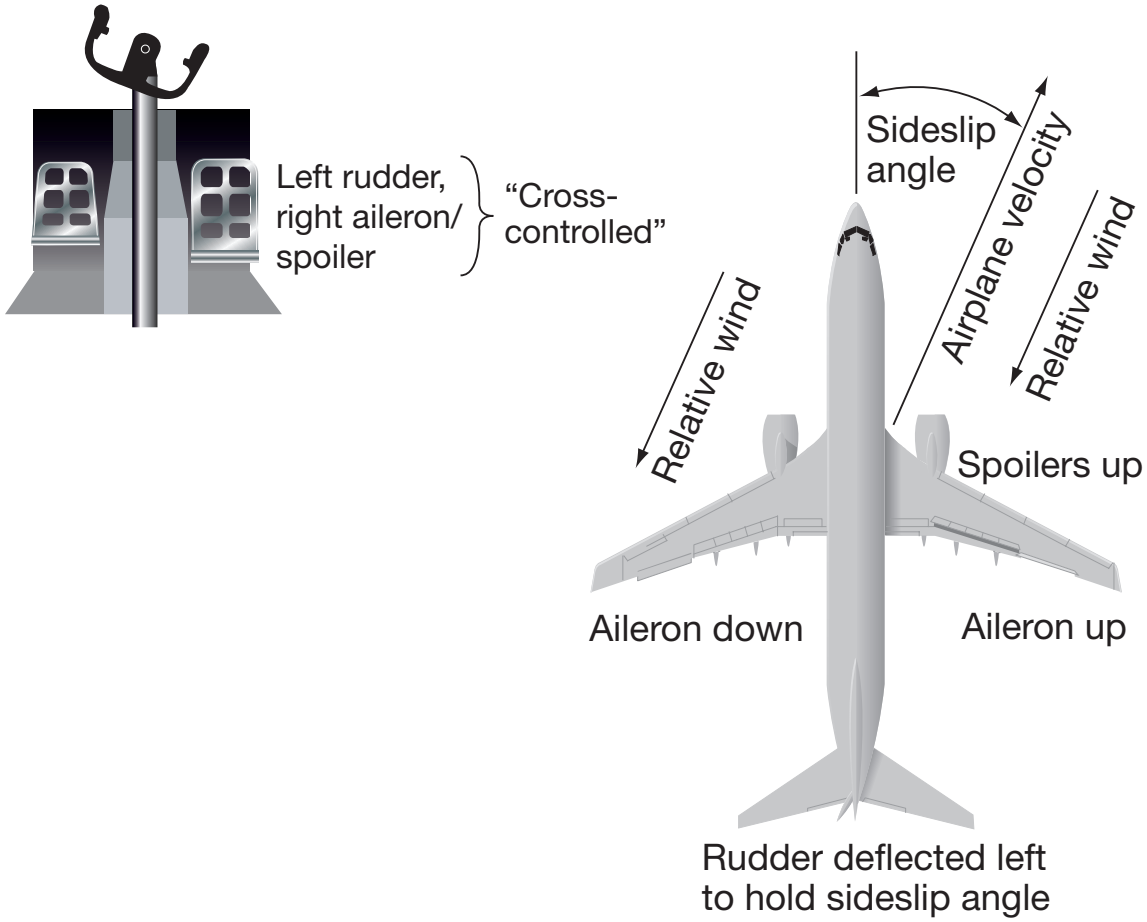
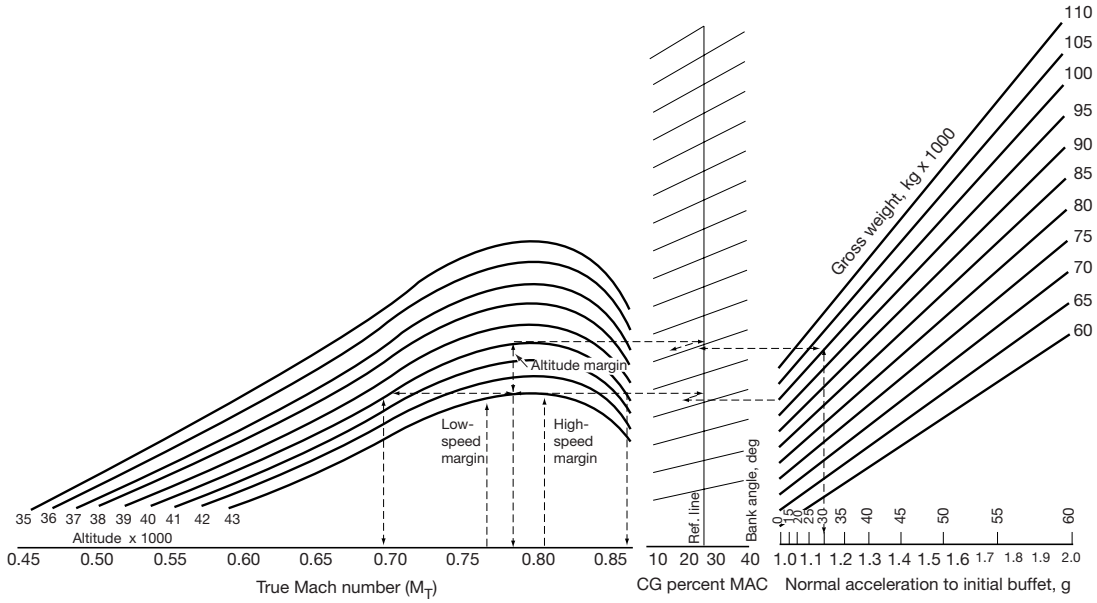


Figure 3-B.44

High-Speed, High-Altitude Characteristics



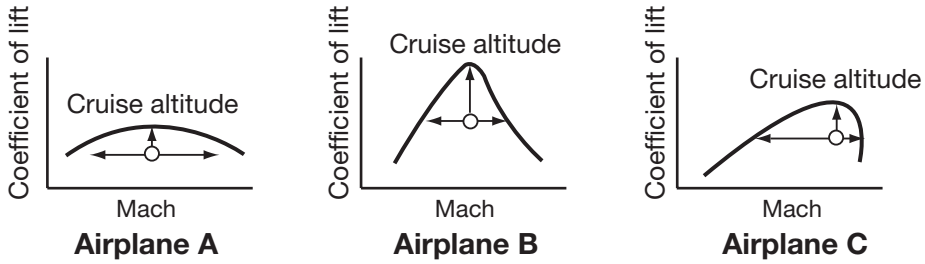
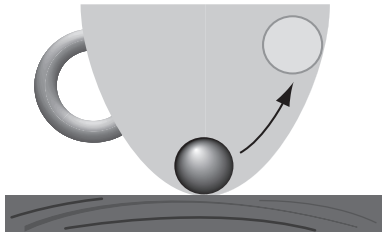


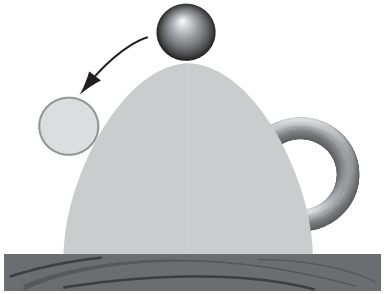
Figure 3-B.45

Static Stability



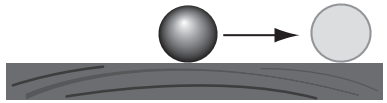
Stable

When ball is displaced, it returns to its original position.



Unstable

When ball is displaced, it accelerates from its original position.

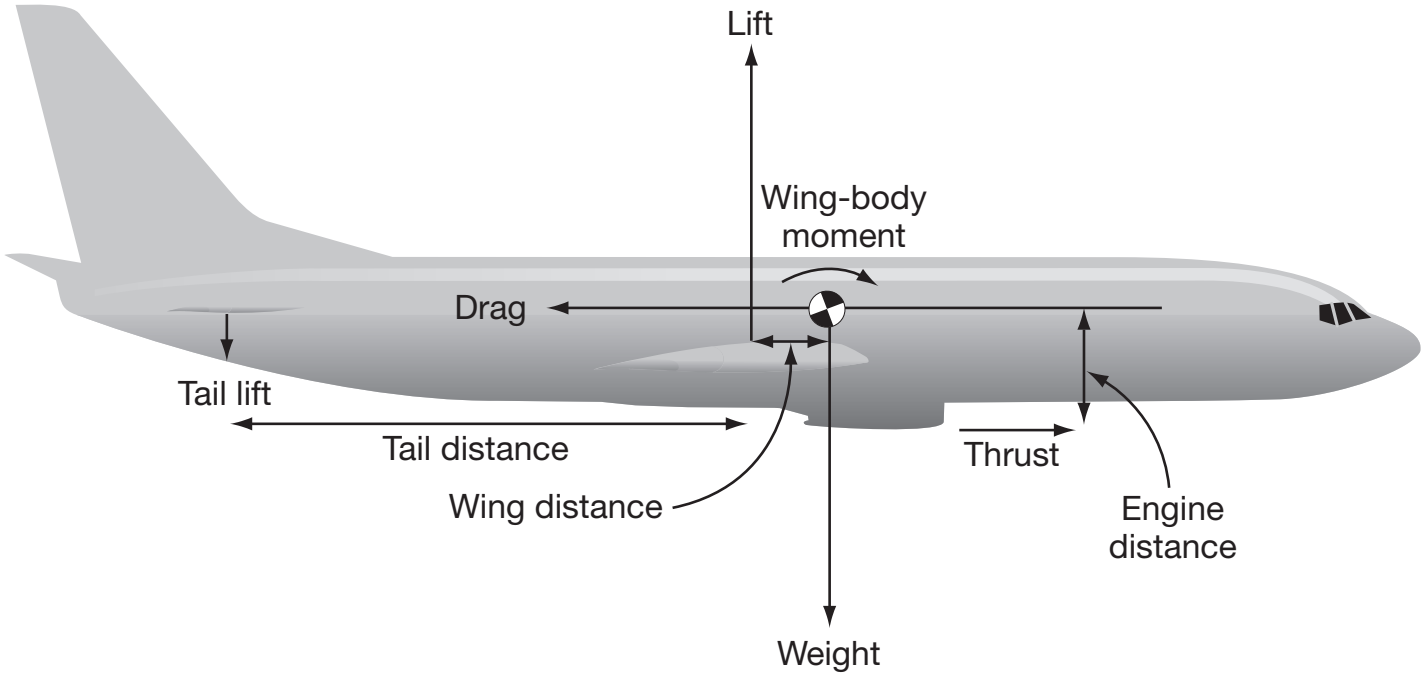


Neutral

When ball is displaced, it neither returns, nor accelerates away—it just takes up a new position.

Figure 3-B.46

Maneuvering in Pitch



$$(\text{Moment})_{\text{Tail}} + (\text{Moment})_{\text{Lift}} + (\text{Moment})_{\text{Thrust}} + (\text{Moment})_{\text{Wing-body}} = \text{Total pitching moment}$$

$$\left(\text{Tail lift} * \text{Tail distance}\right) + \left(\text{Wing lift} * \text{Wing distance}\right) + \left(\text{Thrust} * \text{Engine distance}\right) + (\text{Moment})_{\text{Wing-body}} = \text{Total pitching moment}$$

Figure 3-B.47

Mechanics of Turning Flight

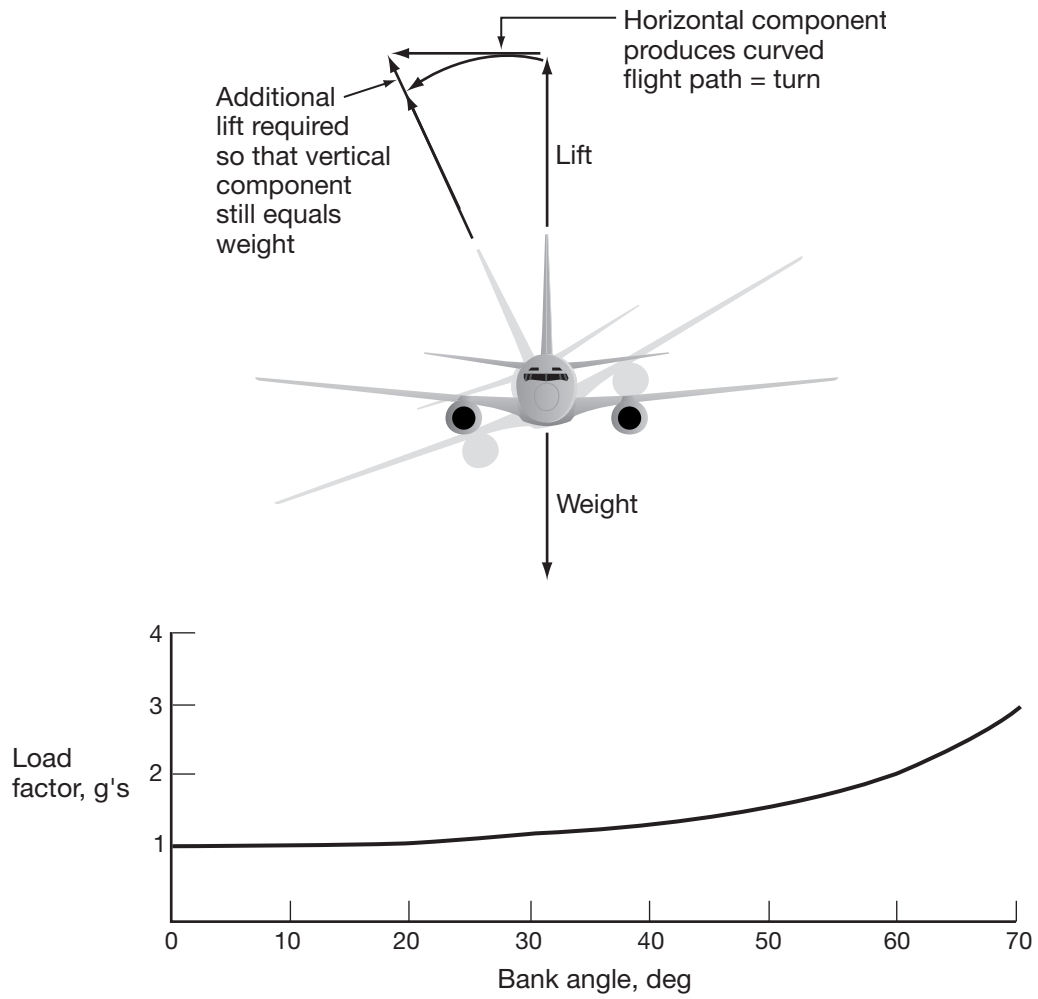


Figure 3-B.48

Lateral Maneuvering—Roll Axis

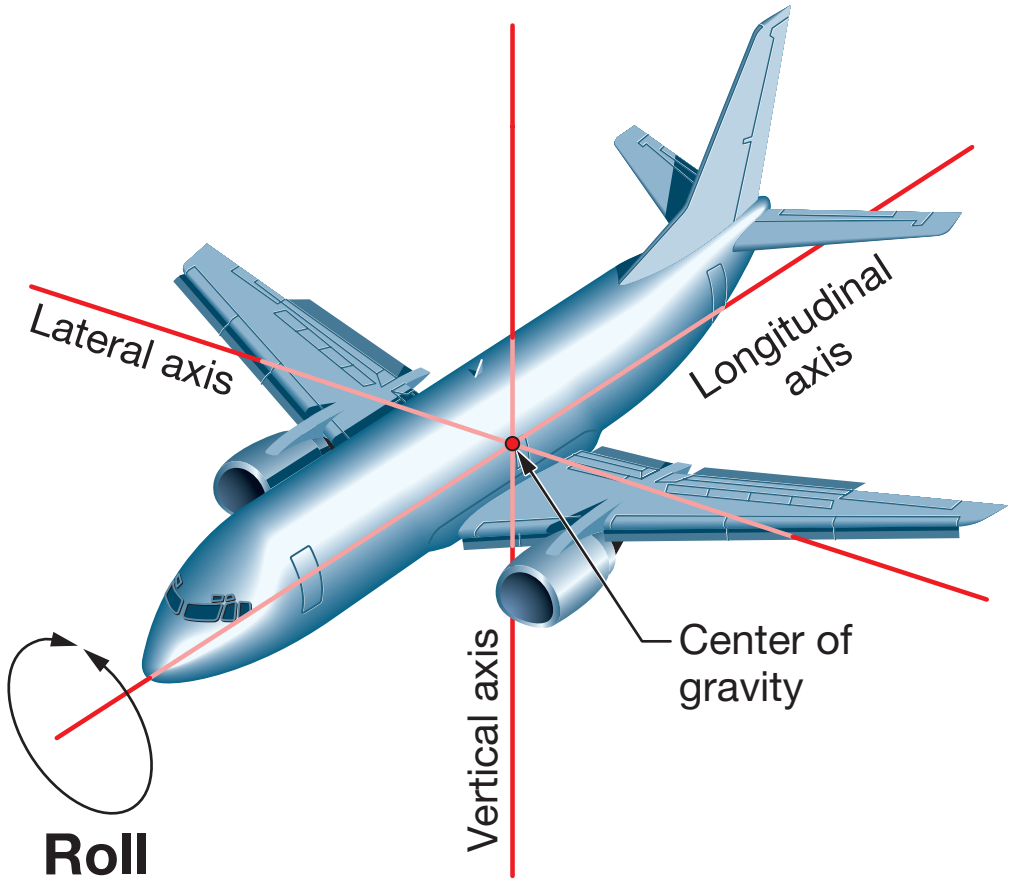


Figure 3-B.49

Lateral Maneuvering—Flight Dynamics

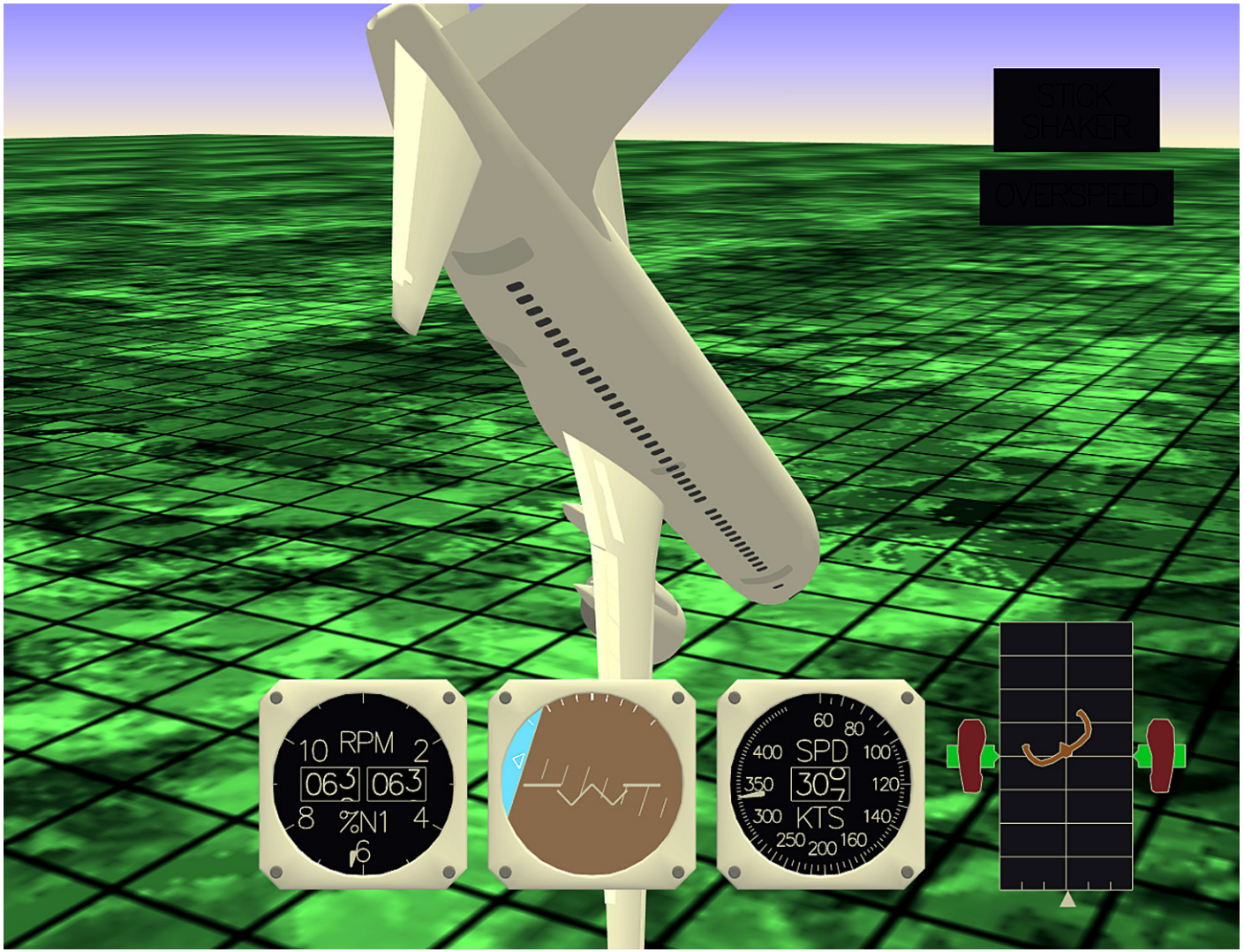


Figure 3-B.50

Directional Maneuvering—Yaw Axis

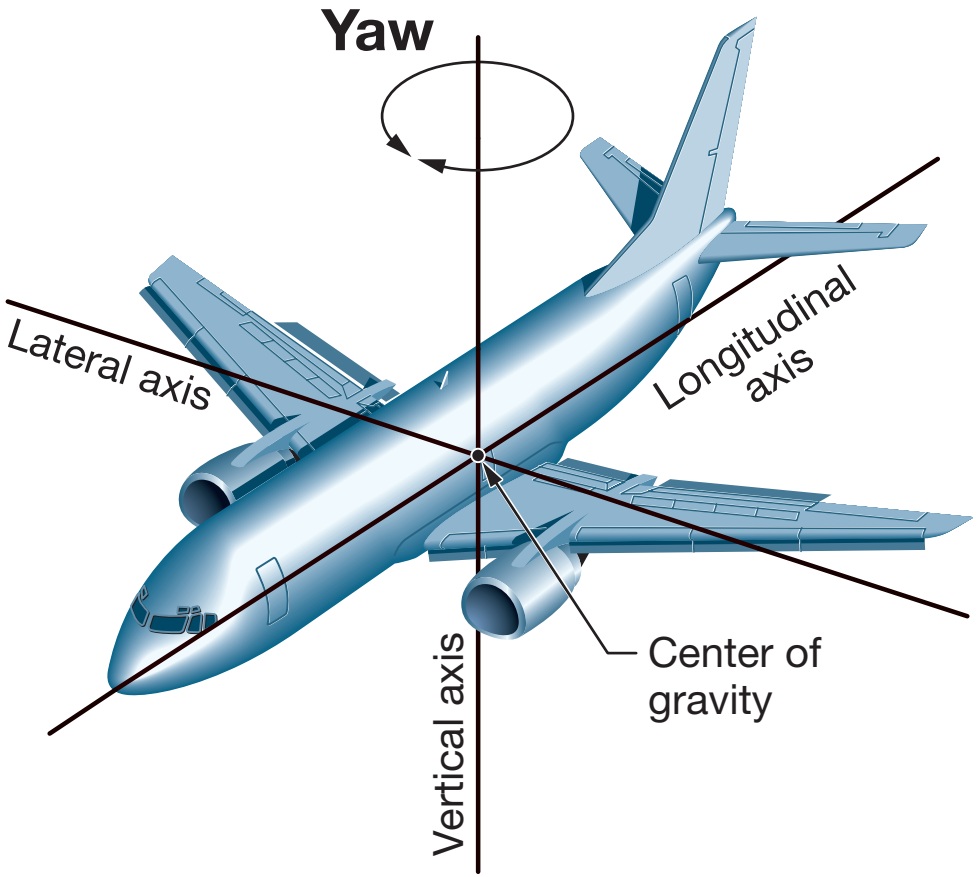


Figure 3-B.51

Flight at Extremely Low Airspeeds

Figure 3-B.52

Flight at Low Airspeeds and Thrust Effects

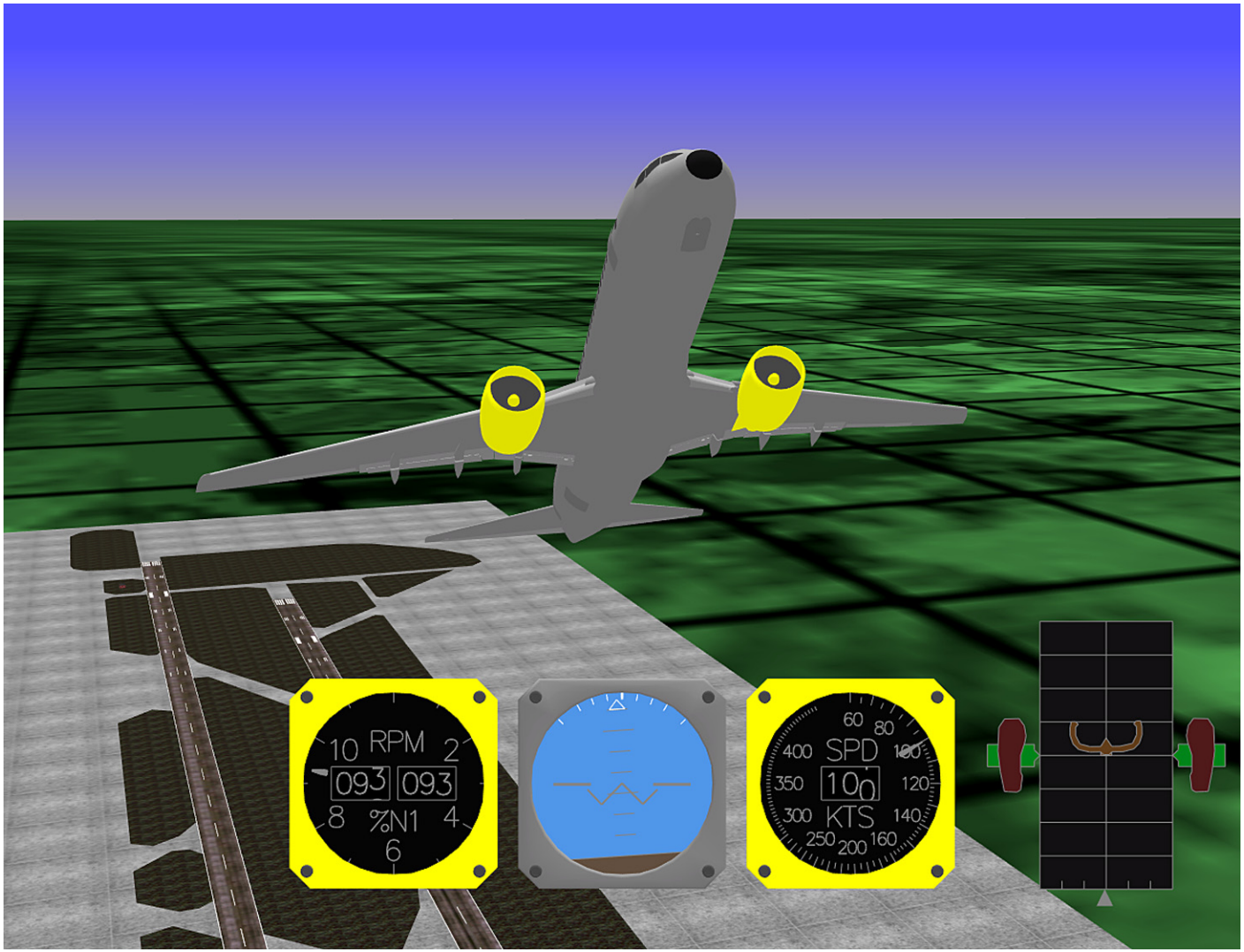


Figure 3-B.53

Flight at Extremely High Speeds

Figure 3-B.54

Summary of Swept-Wing Fundamentals

- Flight dynamics: Newton's laws
- Energy states: kinetic, potential, and chemical
- Load factors: longitudinal, lateral, and vertical
- Aerodynamic flight envelope: operating and demonstrated speeds
- Aerodynamics: the relationship of angle of attack and stall

Figure 3-B.55

Airplane Upset Recovery

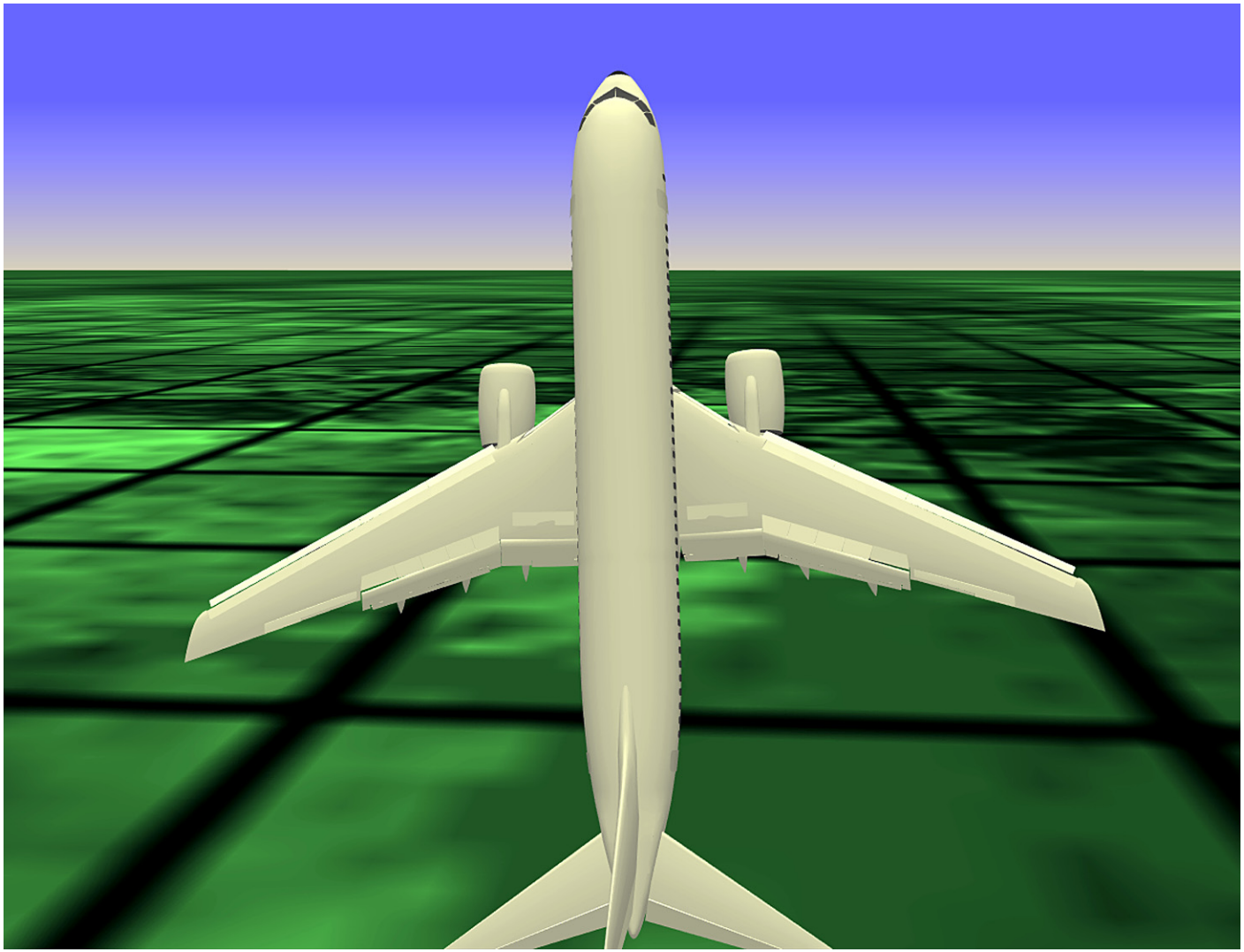


Figure 3-B.56

Situational Awareness During an Airplane Upset

"Recognize and confirm the situation" by the following key steps:

- **Communicate with crew members**
- **Locate the bank indicator**
- **Determine pitch attitude**
- **Confirm attitude by reference to other indicators**

Figure 3-B.57

The Miscellaneous Issues Associated With Upset Recovery Have Been Identified by

- Pilots who have experienced an airplane upset
- Pilot observations in a simulator-training environment

And they are associated with

- The startle factor
- Negative g force
- Full control inputs
- Counter-intuitive factors

Figure 3-B.58

Startle Factor

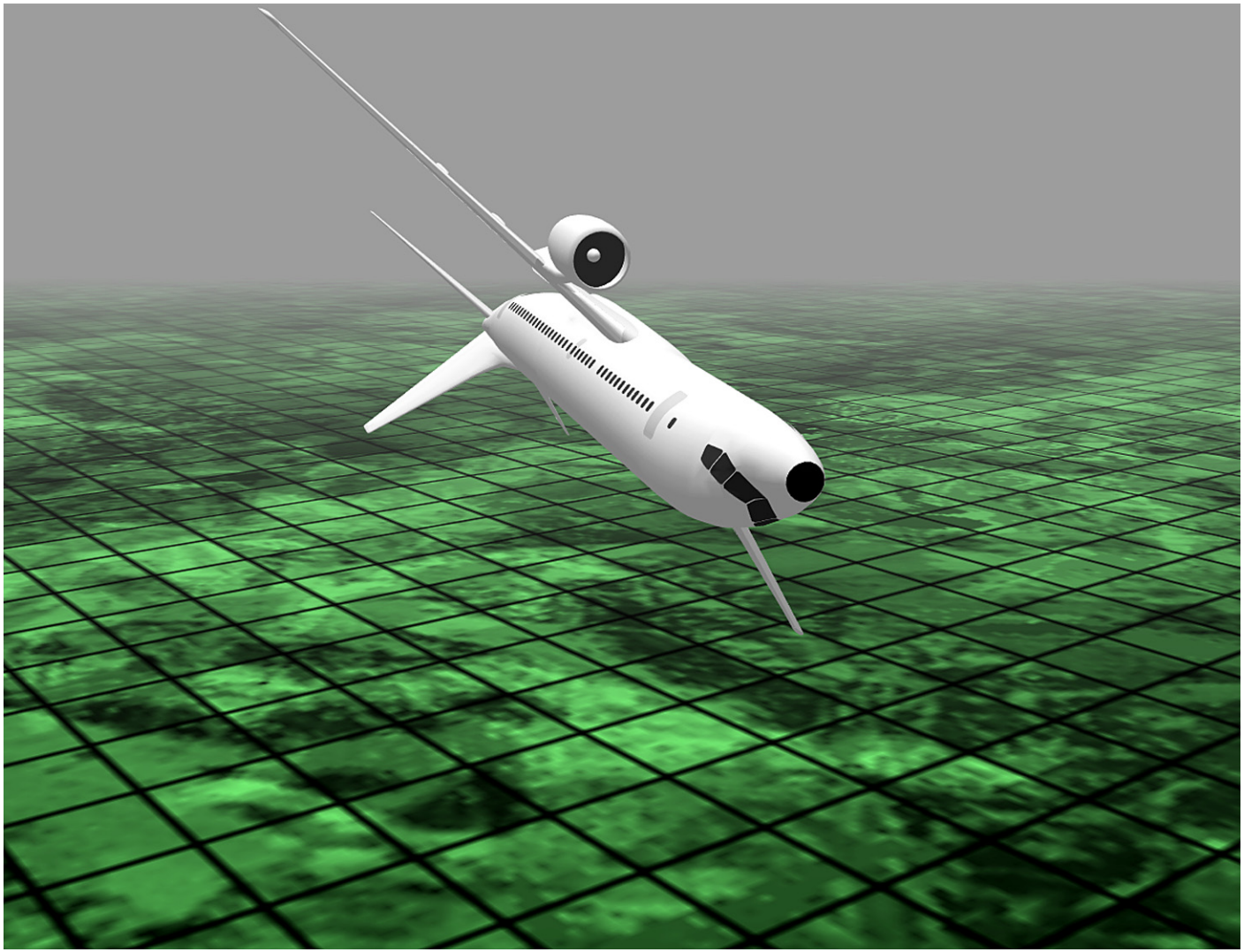


Figure 3-B.59

Negative G Force

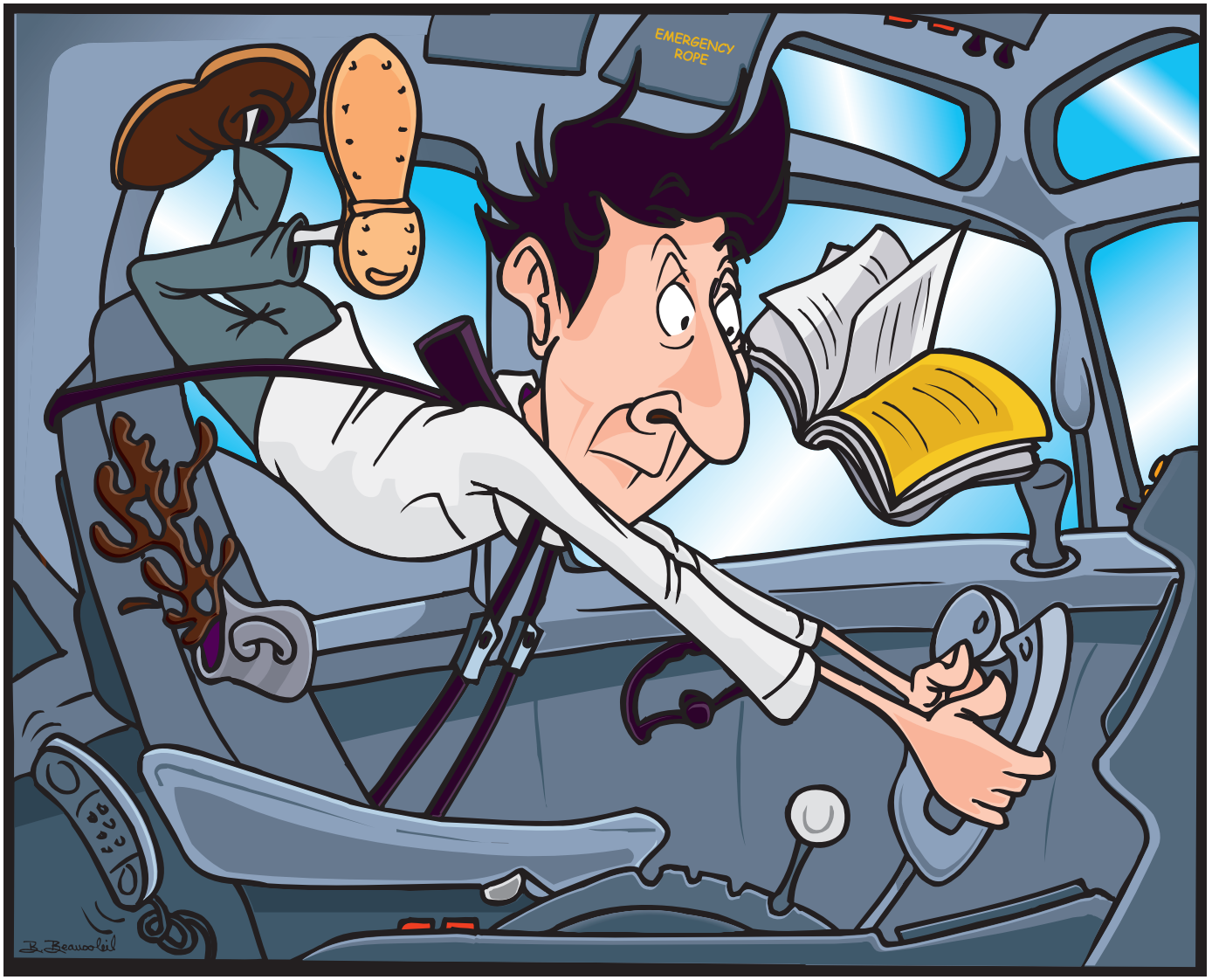


Figure 3-B.60

Use of Full Control Inputs

Figure 3-B.61

Nonintuitive Factors

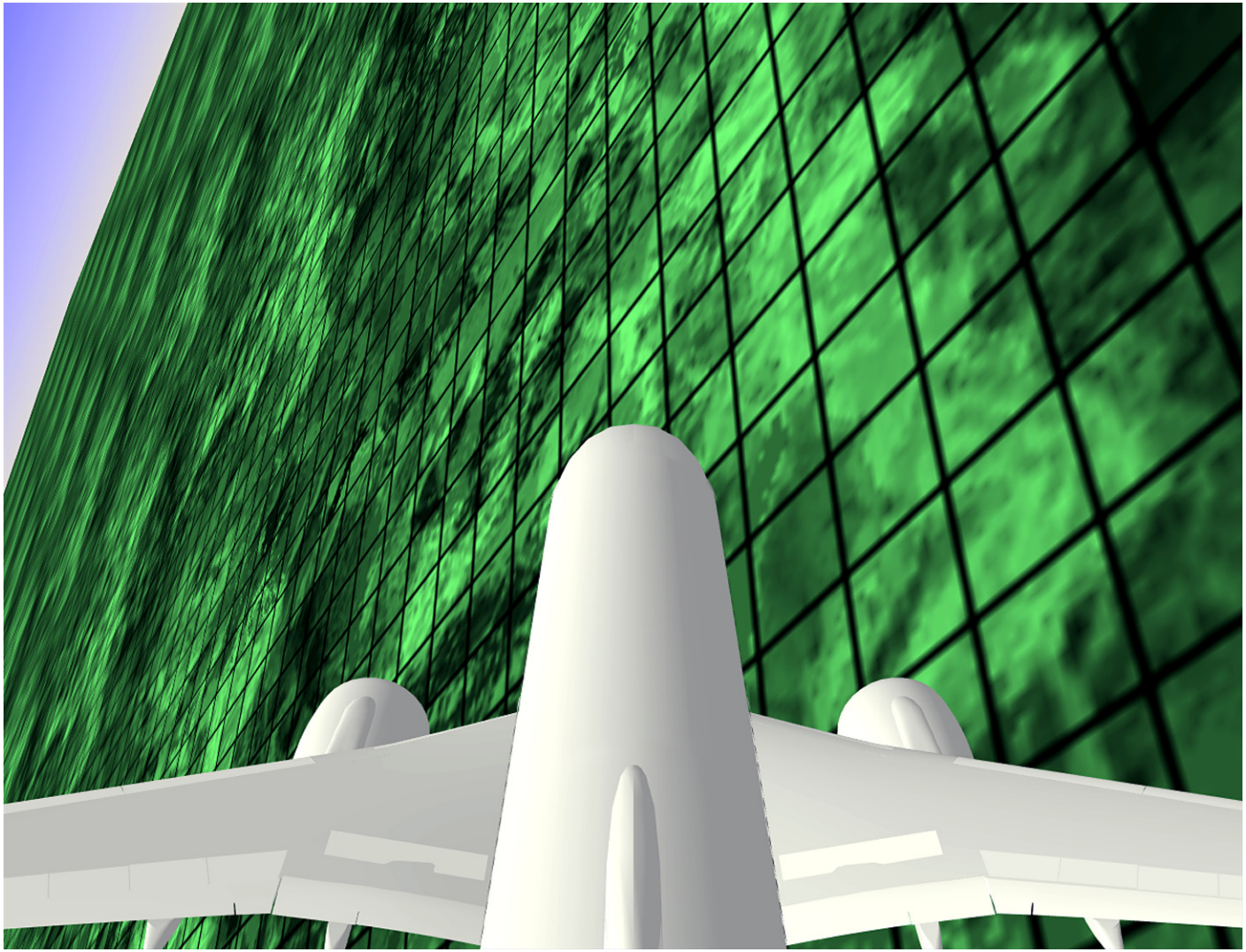


Figure 3-B.62

Airplane Upset Recovery Techniques Will Include a Review of the Following Airplane Upset Situations:

- Nose high, wings level
- Nose low, wings level
- High bank angles:
  - Nose high
  - Nose low
- And a review of recommended upset recovery techniques based on two basic airplane upset situations:
  - Nose high
  - Nose low

Figure 3-B.63

Airplane Upset Recovery Techniques

- **Stall characteristics**
  - **Buffeting**
  - **Lack of pitch authority**
  - **Lack of roll control**
  - **Inability to arrest descent rate**

Nose-High, Wings-Level Recovery Techniques

Figure 3-B.65

Nose-High, Wings-Level Recovery Techniques

Figure 3-B.66

Nose-High, Wings-Level Recovery Techniques

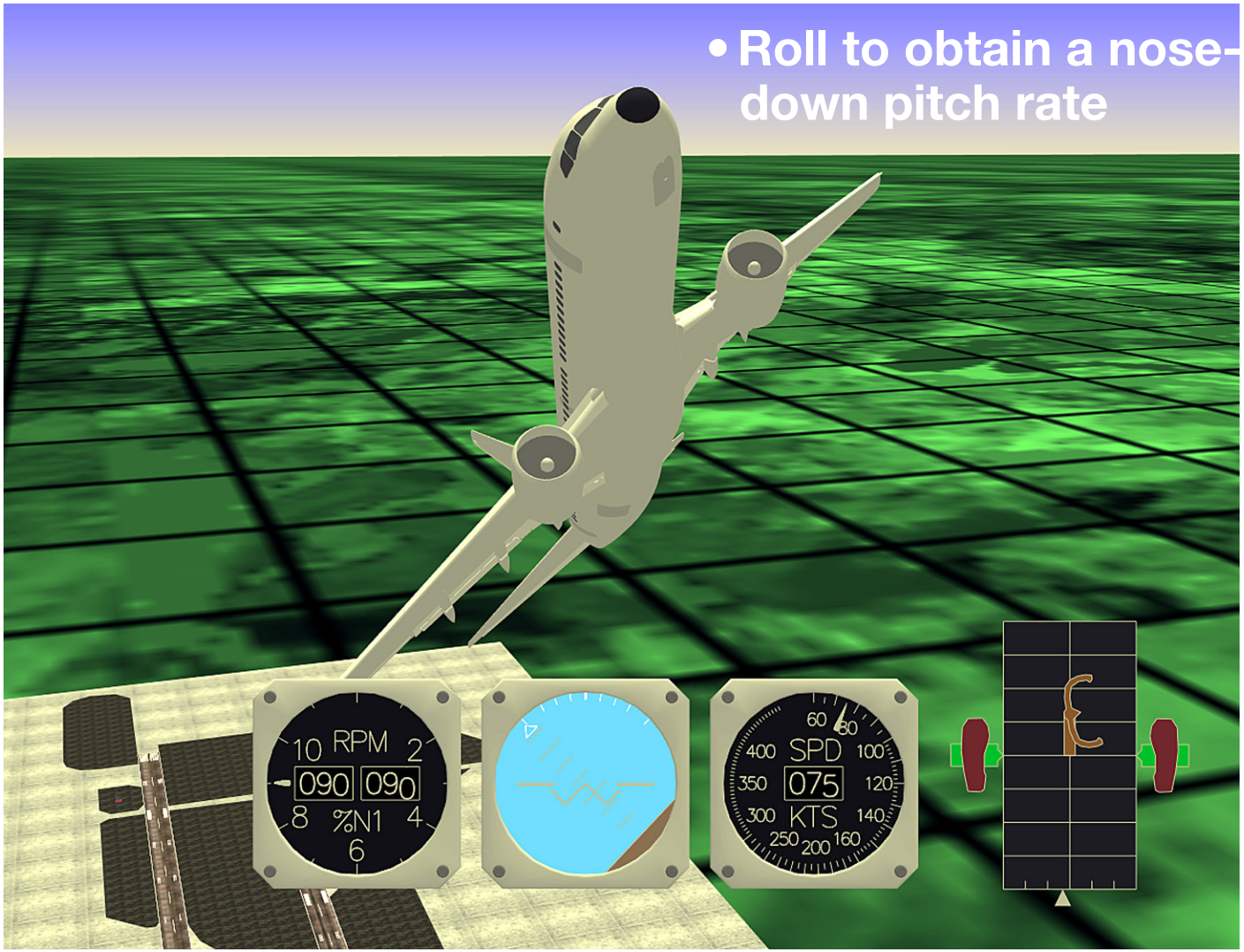


Figure 3-B.67

Nose-High, Wings-Level Recovery Techniques

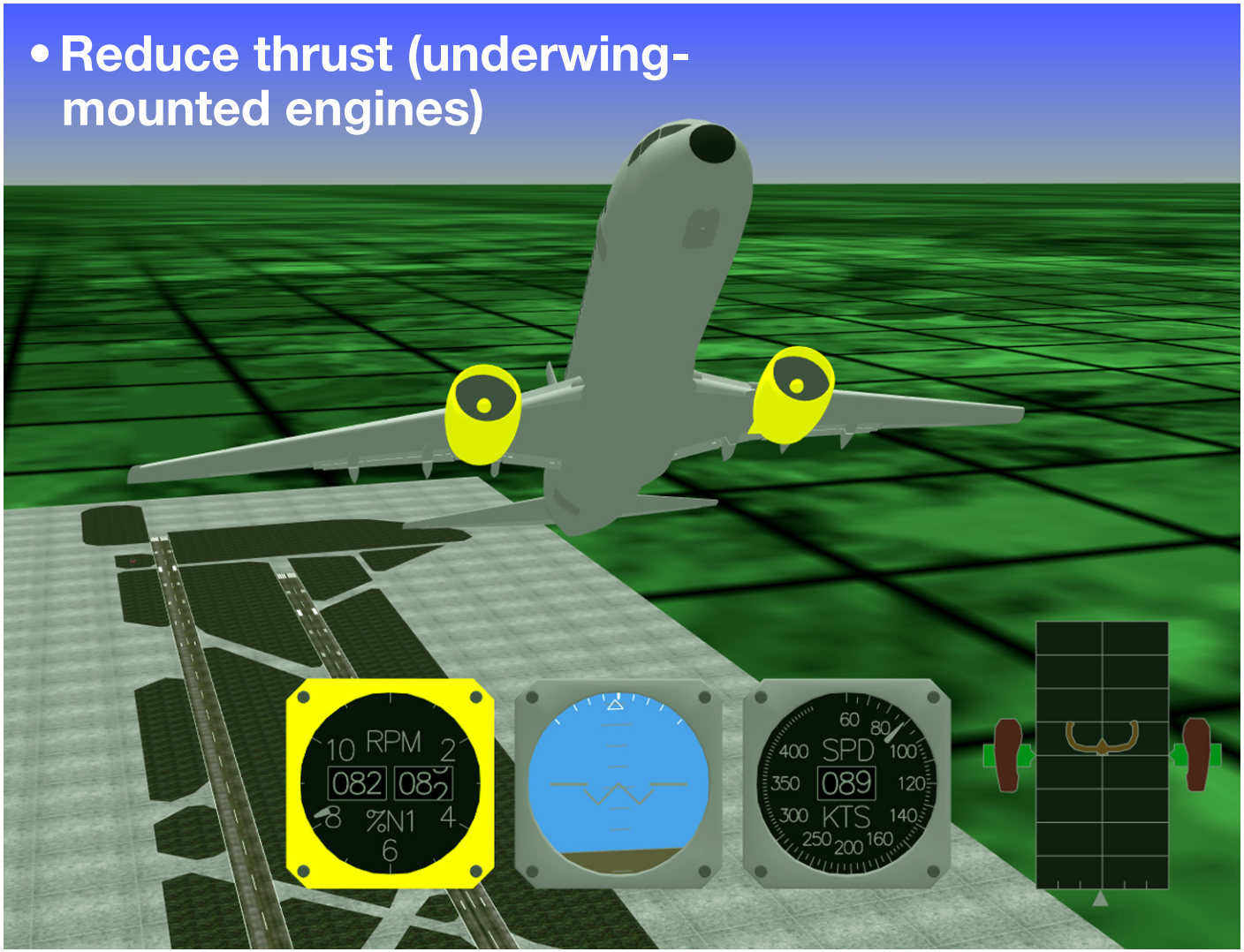
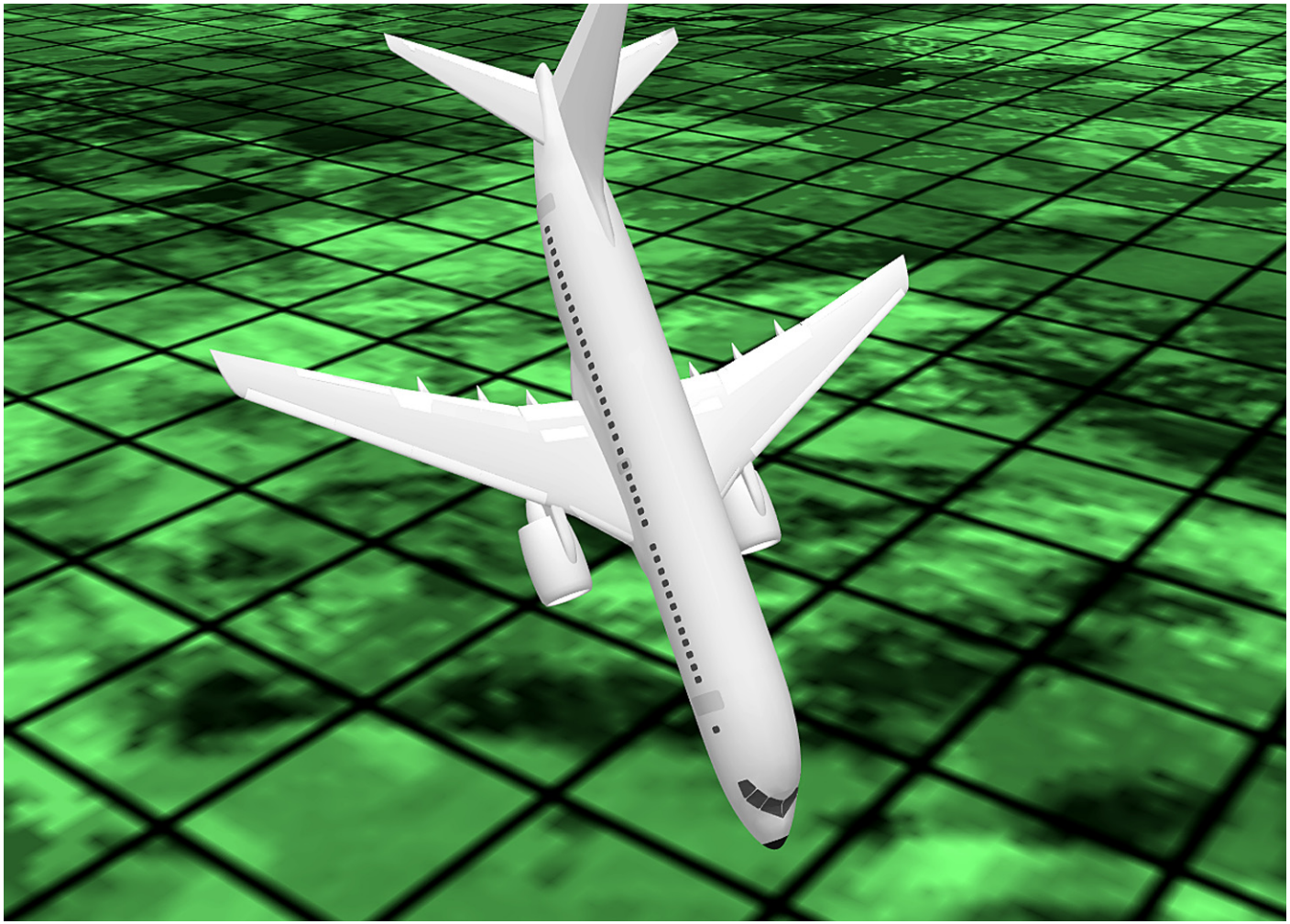


Figure 3-B.68

Nose-High, Wings-Level Recovery Techniques

Figure 3-B.69

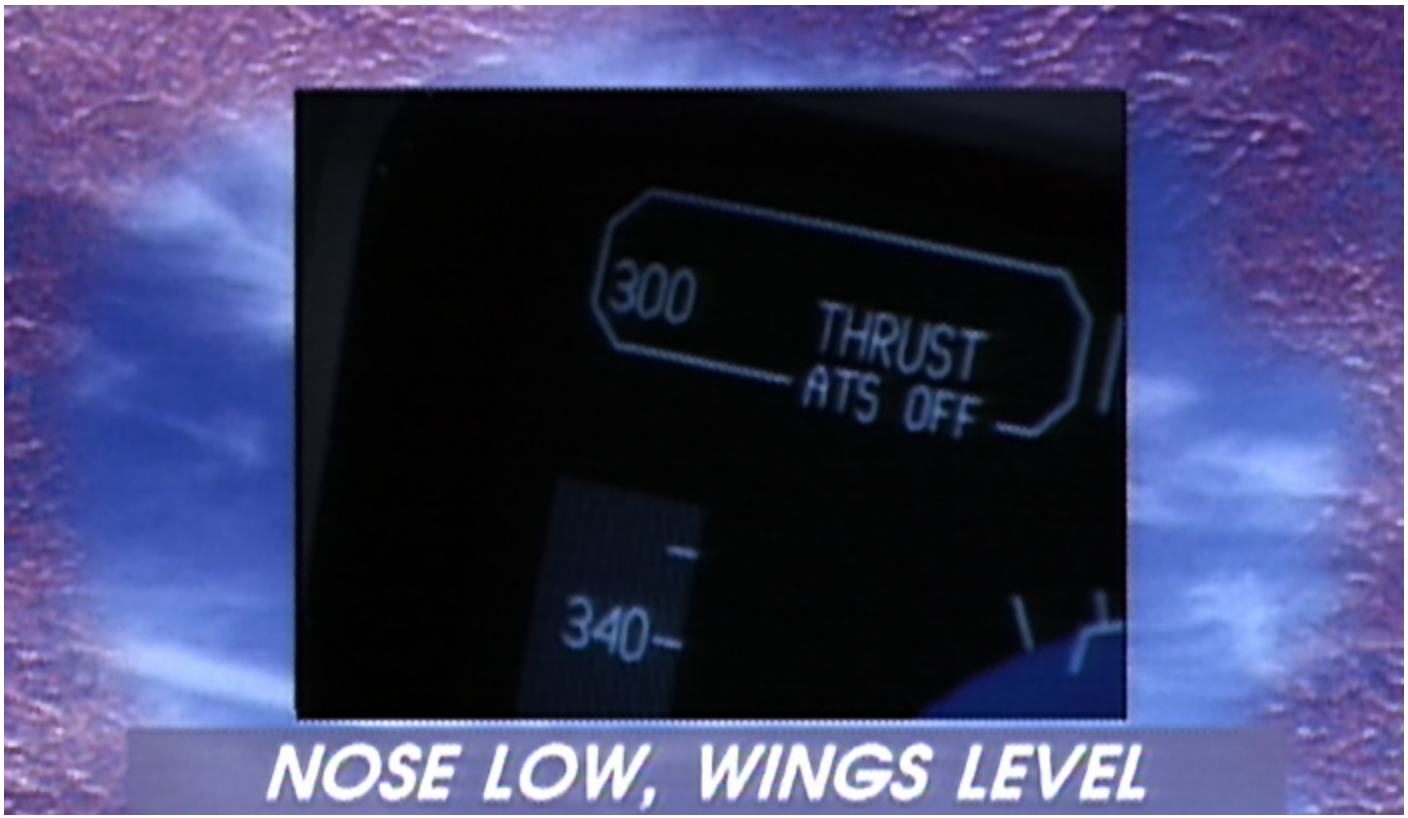
Nose-Low, Wings-Level Recovery Techniques



- Recognize and confirm the situation

Figure 3-B.70

Nose-Low, Wings-Level Recovery Techniques



- Disengage autopilot and autothrot-

Figure 3-B.71

Nose-Low, Wings-Level Recovery Techniques

- Recover from stall, if necessary

Figure 3-B.72

Nose-Low, Wings-Level Recovery Techniques

Recover to Level Flight

- Apply noseup elevator

- Apply stabilizer trim, if necessary

Figure 3-B.73

Nose-Low, Wings-Level Recovery Techniques

- Adjust thrust and drag, as necessary

Figure 3-B.74

High-Bank-Angle Recovery Techniques

Figure 3-B.75

High-Bank-Angle Recovery Techniques

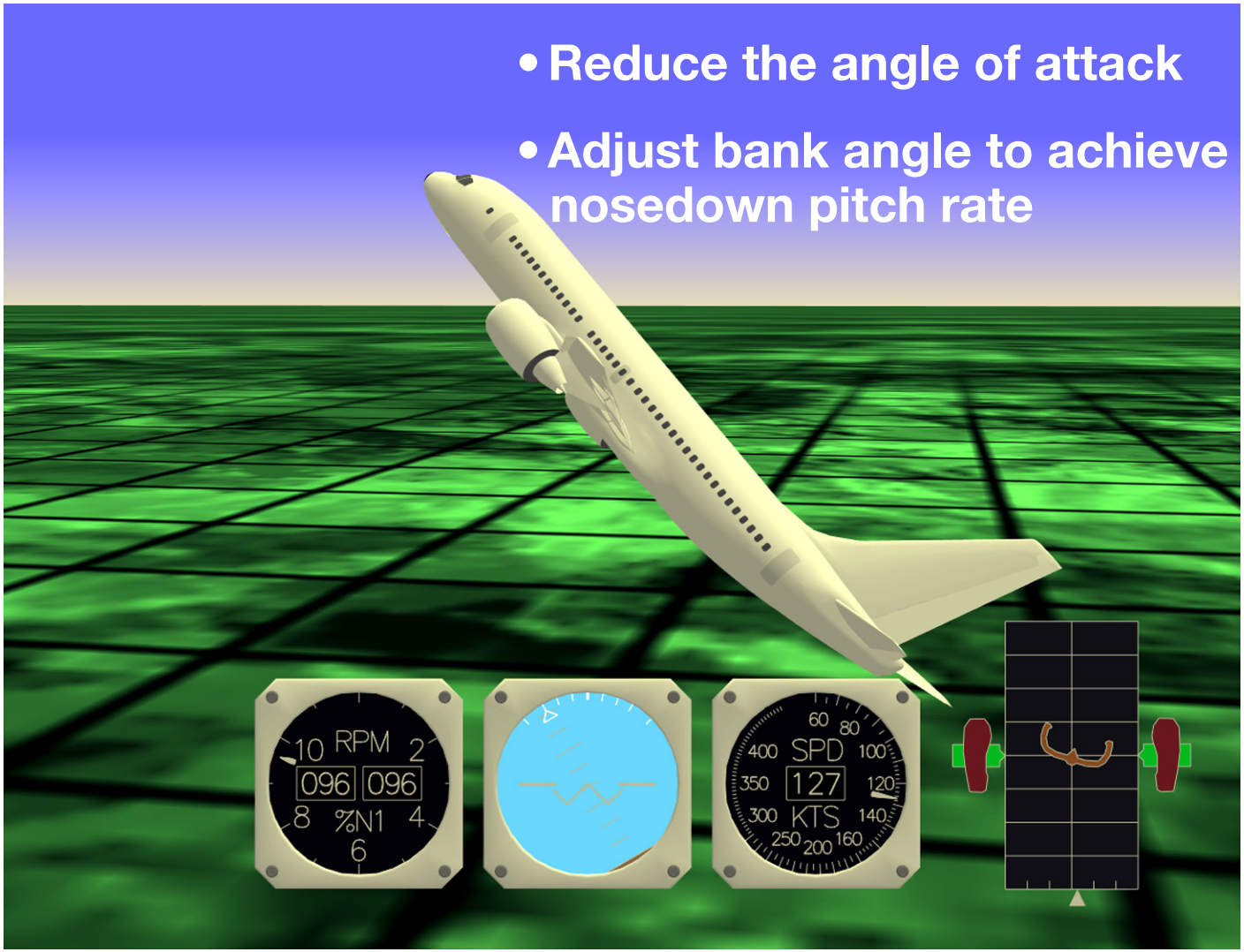


Figure 3-B.76

High-Bank-Angle Recovery Techniques

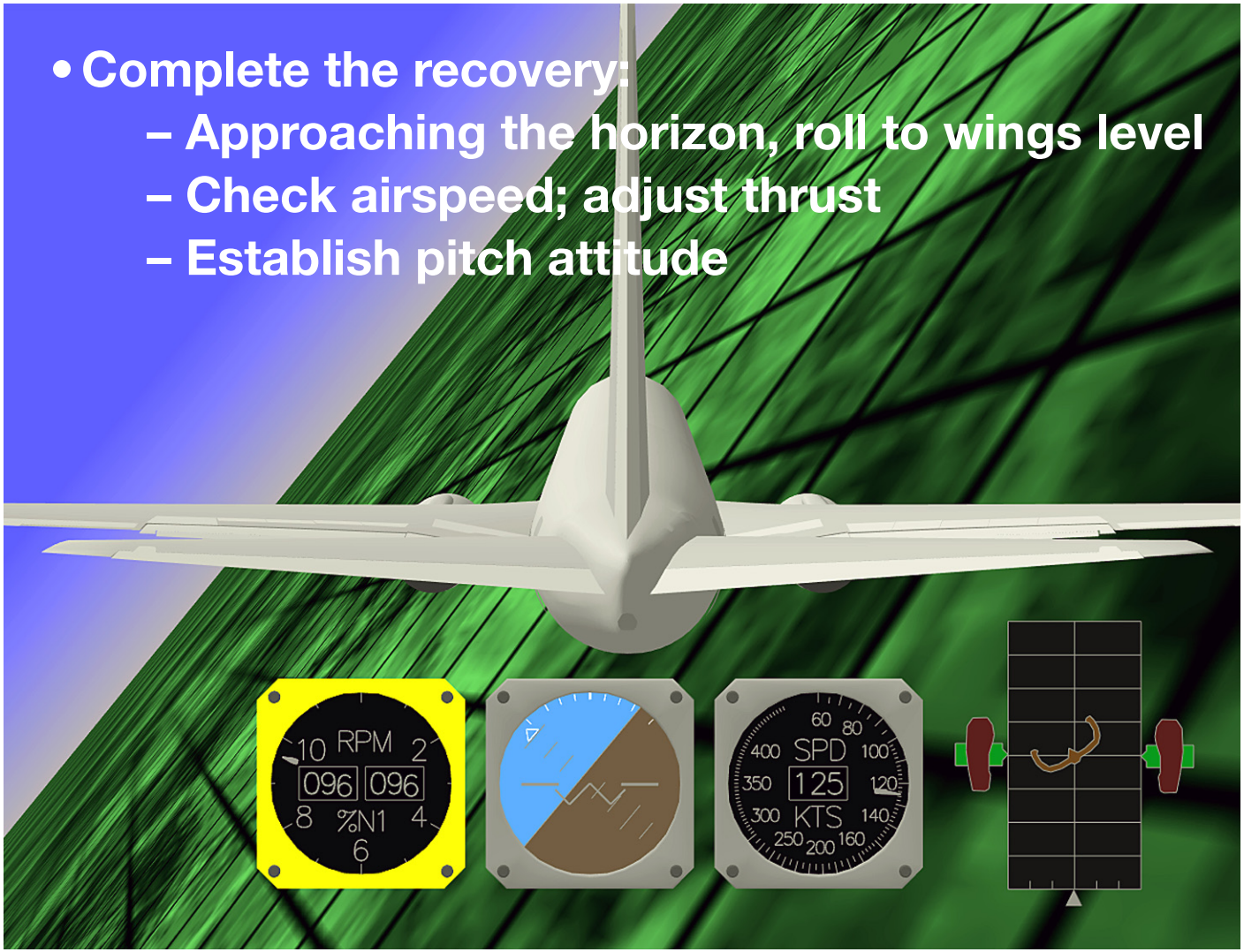


Figure 3-B.77

High-Bank-Angle Recovery Techniques

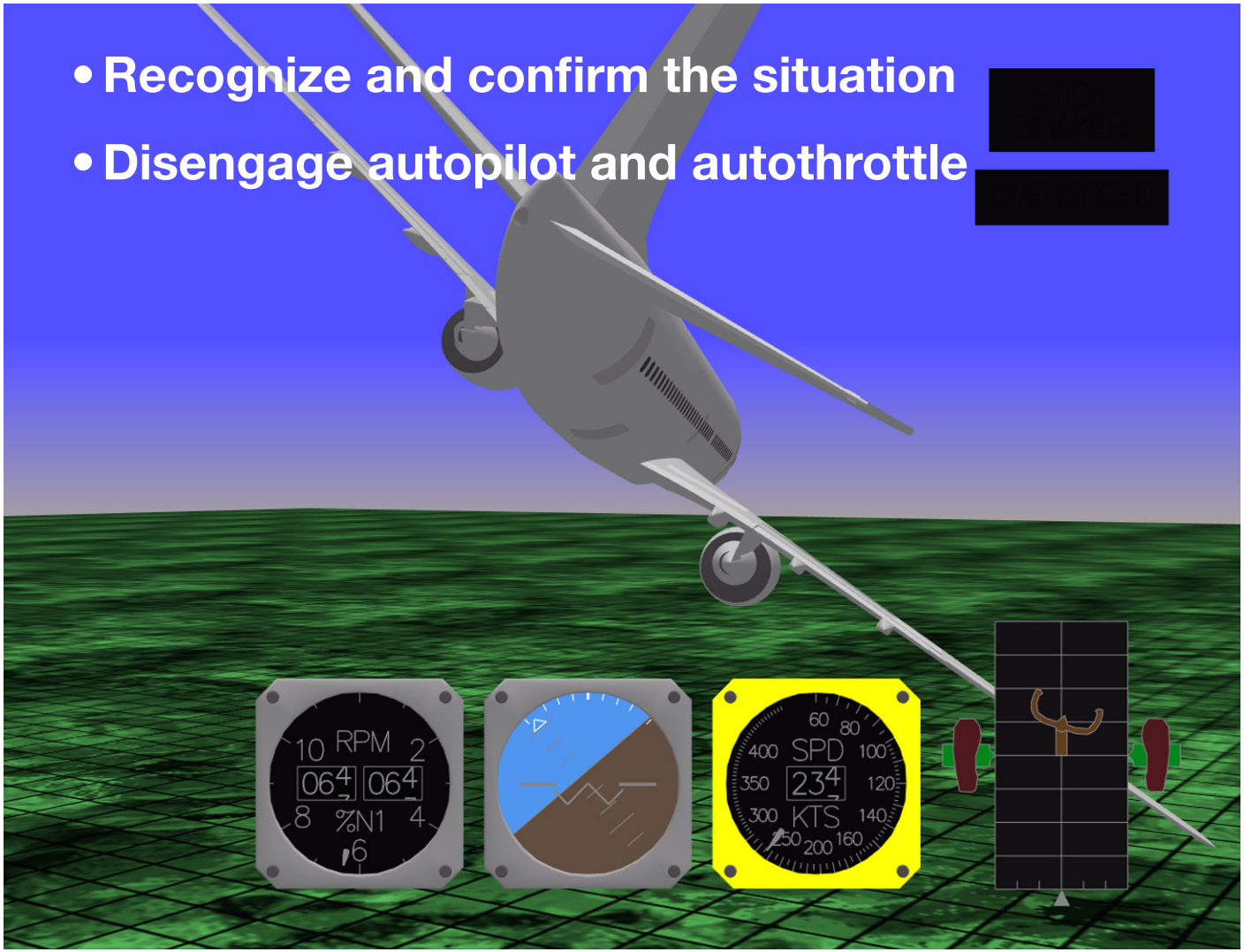
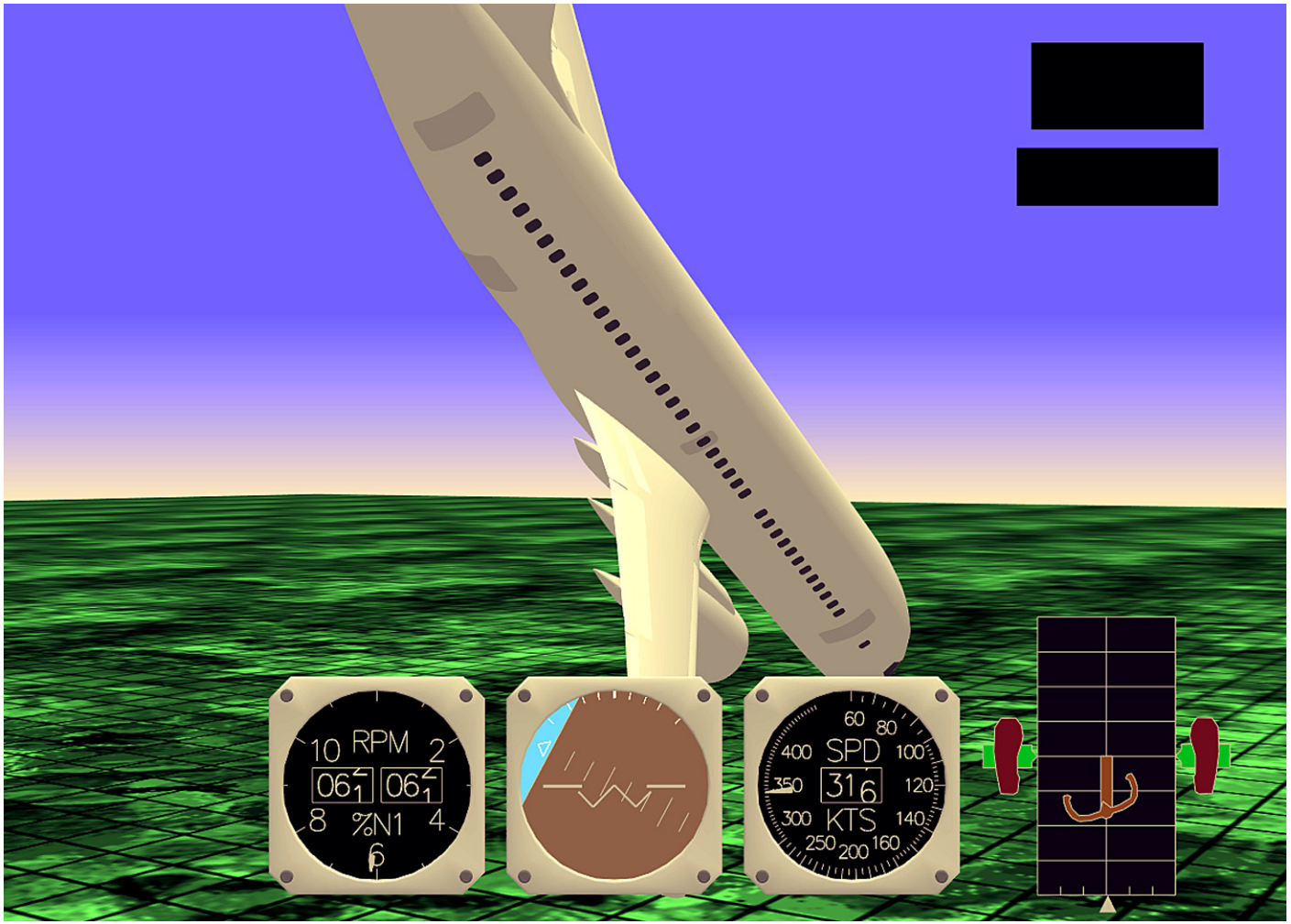


Figure 3-B.78

High-Bank-Angle Recovery Techniques



- Reduce the angle of attack, if necessary

Figure 3-B.79

High-Bank-Angle Recovery Techniques

Figure 3-B.80

High-Bank-Angle Recovery Techniques

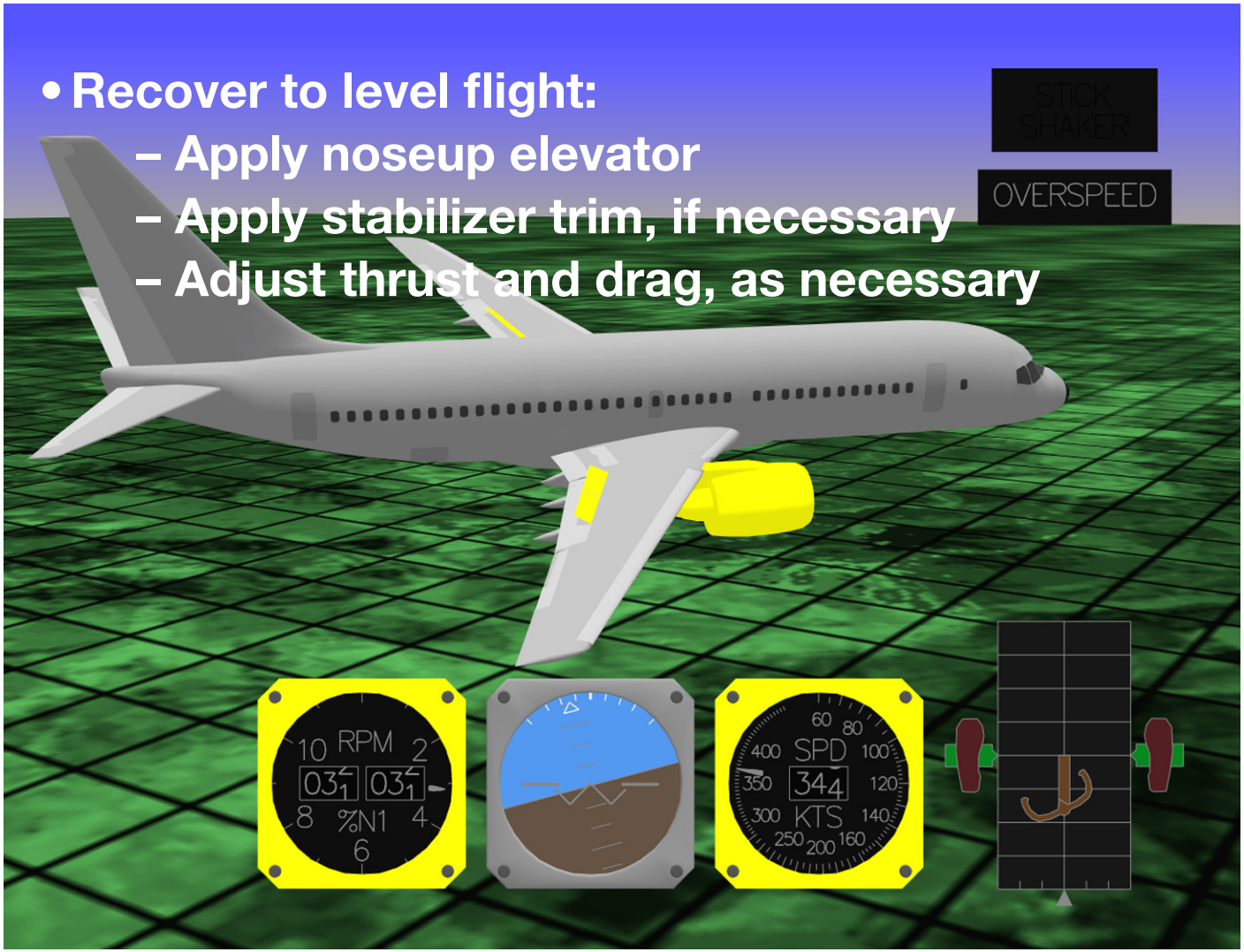


Figure 3-B.81

Summary of Airplane Recovery Techniques

Nose-High Recovery

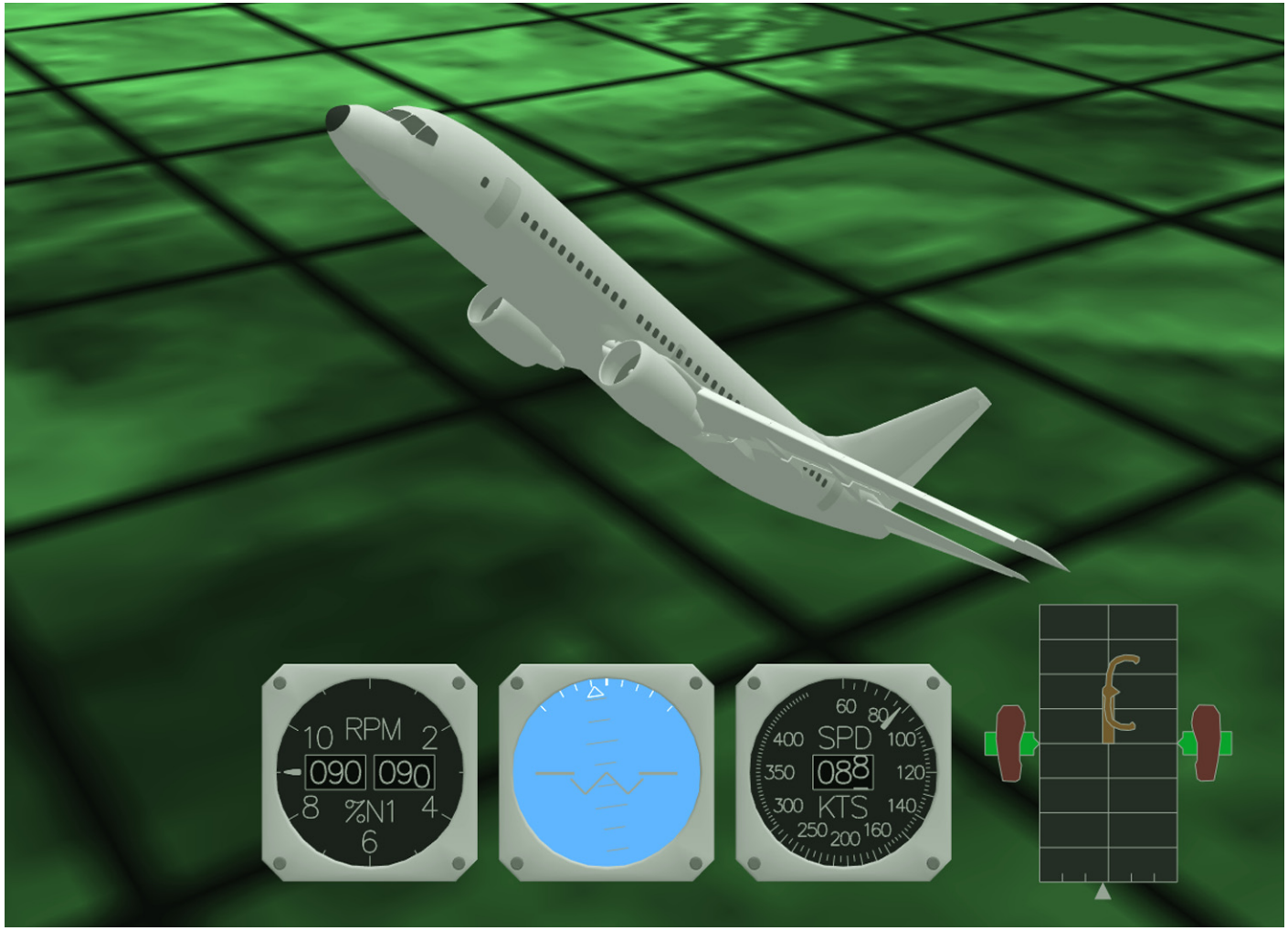


Figure 3-B.82

Summary of Airplane Recovery Techniques

Nose-High Recovery

- **Recognize and confirm the situation**
- **Disengage autopilot and autothrottle**
- **Apply as much as full nosedown elevator**

Figure 3-B.83

Summary of Airplane Recovery Techniques

Nose-High Recovery

- **Use appropriate techniques:**
  - **Roll (adjust bank angle) to obtain a nosedown pitch rate**
  - **Reduce thrust (underwing-mounted engines)**

Figure 3-B.84

Summary of Airplane Recovery Techniques

Nose-High Recovery

- **Complete the recovery:**
  - **Approaching the horizon, roll to wings level**
  - **Check airspeed; adjust thrust**
  - **Establish pitch attitude**

Figure 3-B.85

Summary of Airplane Recovery Techniques

Nose-Low Recovery

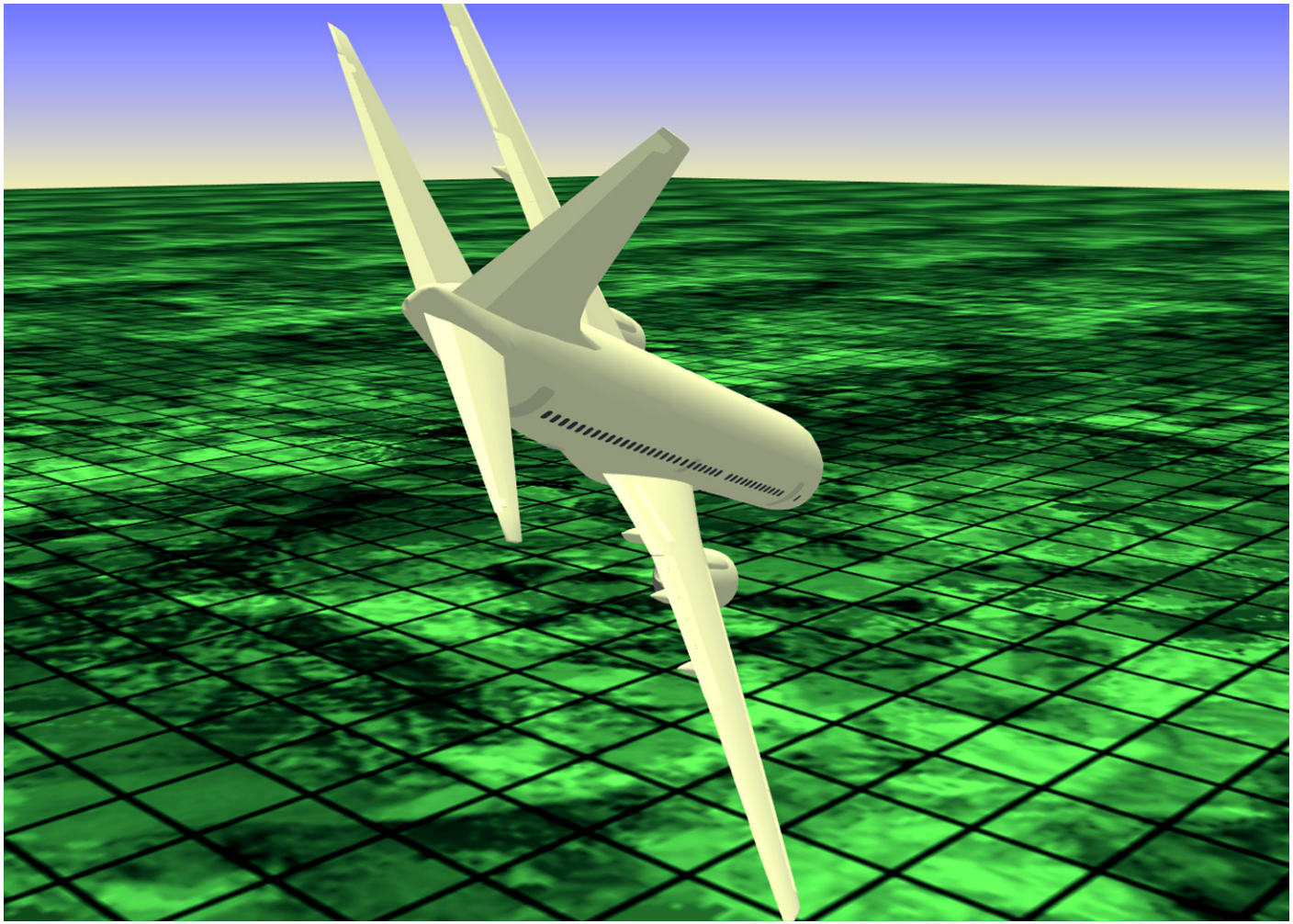


Figure 3-B.86

Summary of Airplane Recovery Techniques

Nose-Low Recovery

- **Recognize and confirm the situation**
- **Disengage autopilot and autothrottle**
- **Recover from stall, if necessary**

Figure 3-B.87

Summary of Airplane Recovery Techniques

Nose-Low Recovery

- **Roll in the shortest direction to wings level:**
  - **Bank angle to more than 90 deg; unload and roll**

Figure 3-B.88

Summary of Airplane Recovery Techniques

Nose-Low Recovery

- **Recover to level flight**
  - **– Apply noseup elevator**
  - **– Apply stabilizer trim, if necessary**
  - **– Adjust thrust and drag, as necessary**

Figure 3-B.89