Collaborating to address

LOSS OF CONTROL IN-FLIGHT

Upset Prevention and Recovery Training Workshop

Implementing UPRT in an airline

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AIRBUS BOEING BOMBARDIER the evolution of mobility CAE

EMBRAER FEDERAL AVIATION ADMINISTRATION IATA ICAO • OACI • ИКАО ICCAIA I·F·A·L·P·A The Global Voice of Pilots

Overview

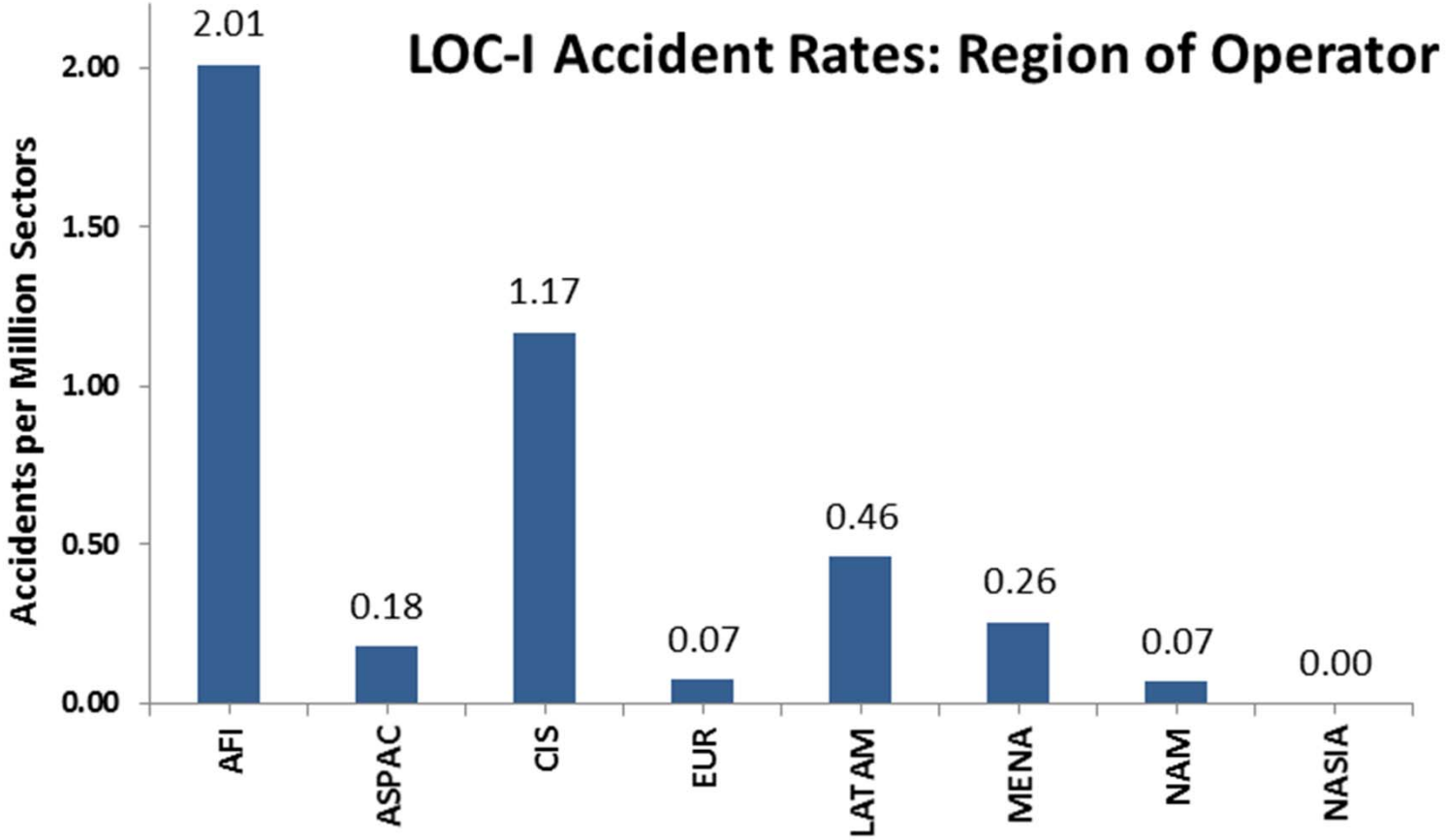
- Safety Data
- Planning Implementation
- Identifying Training Priorities
  - Academic Training Essentials
  - Practical Training for Current Pilots and Licensing
  - Integrating UPRT into Existing Training Programs
- Training Instructors
- Training Delivery
- FSTD Requirements
- Evaluation

IATA Safety Data 2010 - 2014

- There were a total of 415 commercial accidents during this period:
  - 409 accidents could be assigned an accident category
  - 38 of these accidents were LOC (= 9.3% of total accidents)
  - 37 of the LOC-accidents were fatal accidents
  - Resulting in 1,242 (LOC) out of 2,541(total) fatalities

LOC-I Accidents: 2010 - 2014

Region of Operator



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Planning Implementation of a UPRT Program

- Identifying the necessary steps for UPRT implementation by the stakeholders:
  - Instructional systems design (ISD) steps
  - ATOs delivering UPRT on-aircraft and in FSTDs
  - Operators delivering UPRT in FSTDs
  - OEMs (No-Technical Objection statements)

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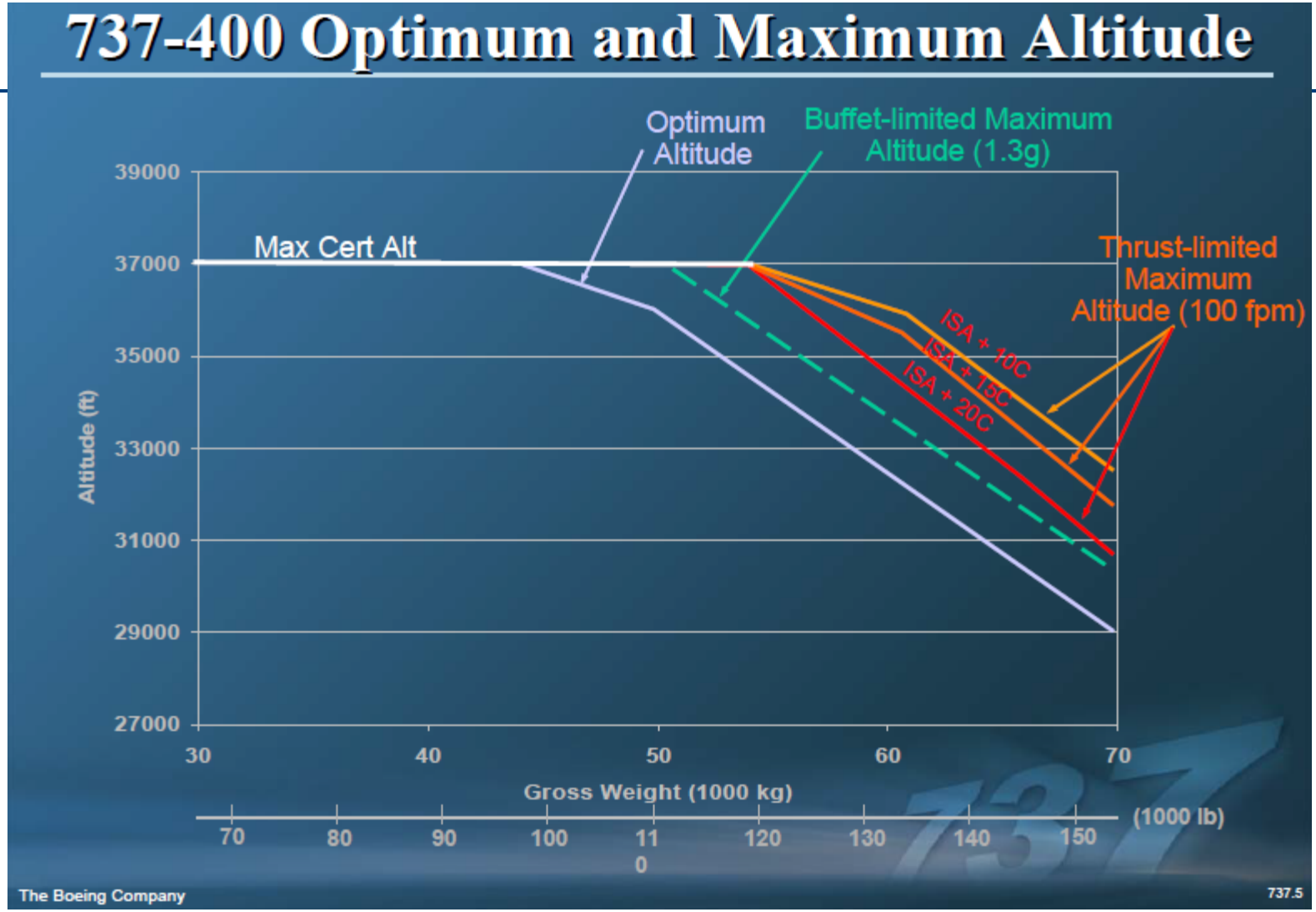
Identifying Training Priorities

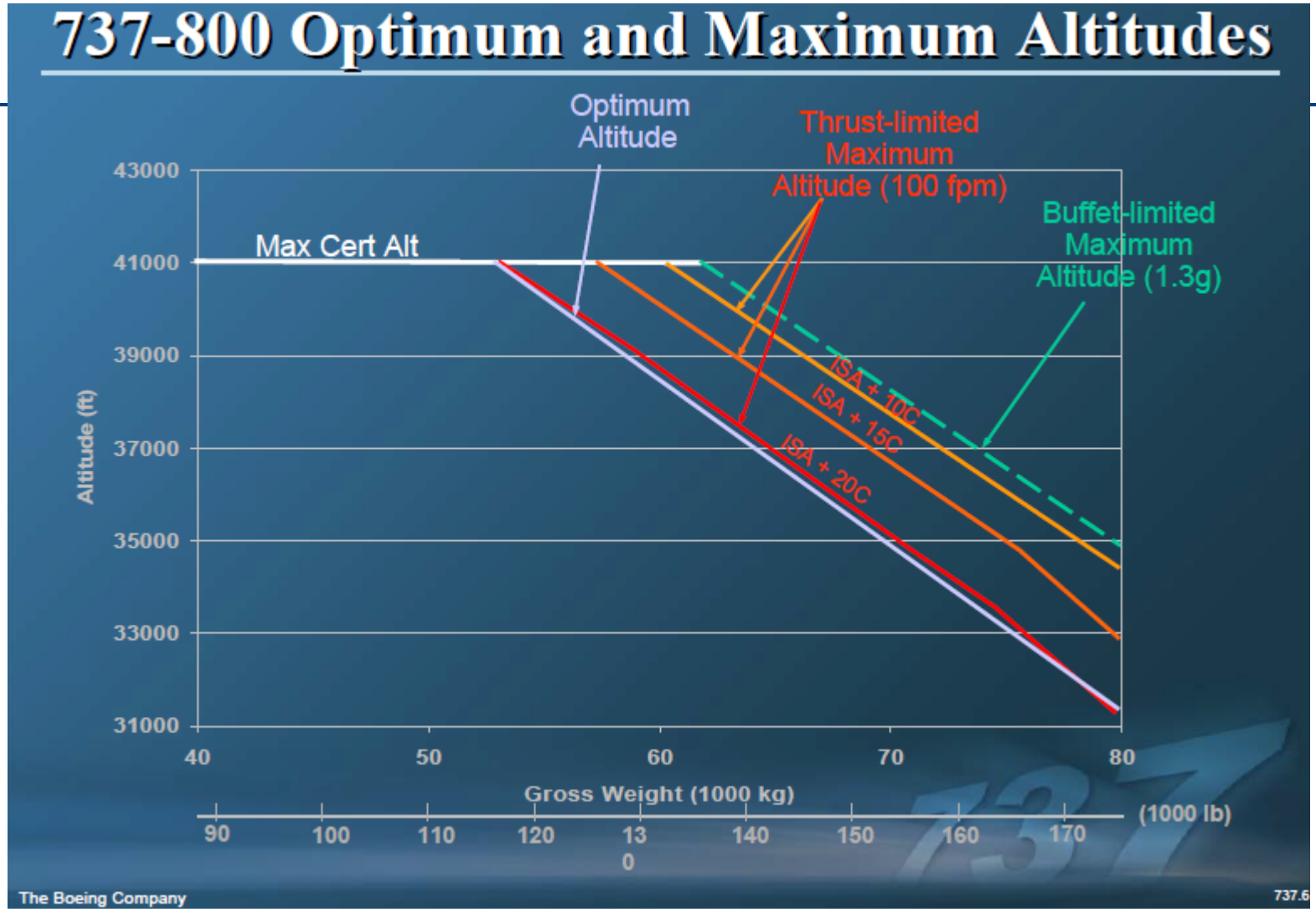
1. Academic training essentials
2. Practical training for current pilots
3. Practical training during CPL/MPL courses
4. Integrating UPRT into existing training programs

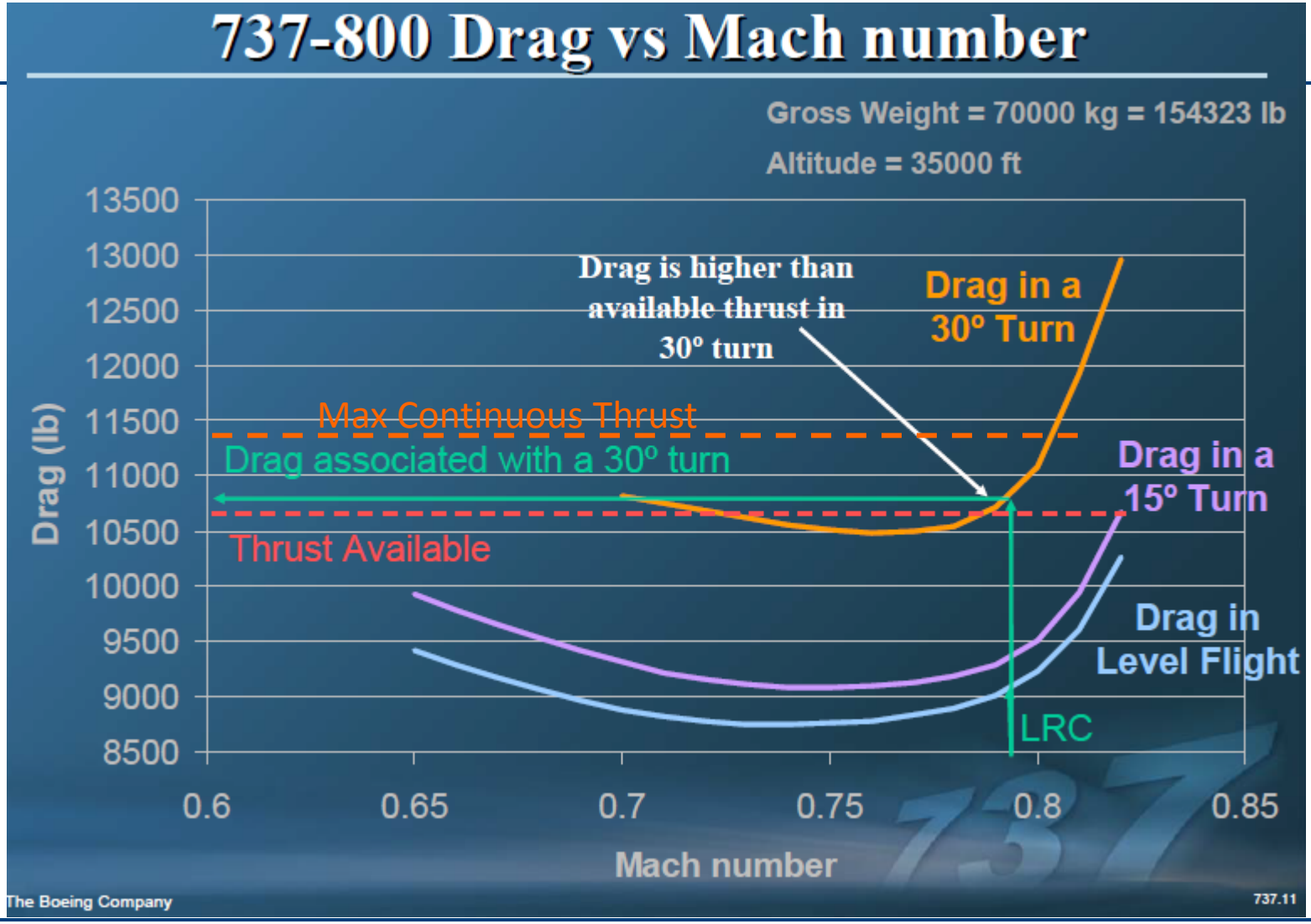
ICAO recommends that UPRT be trained to proficiency by the training organization and that no checking should be conducted by the CAA

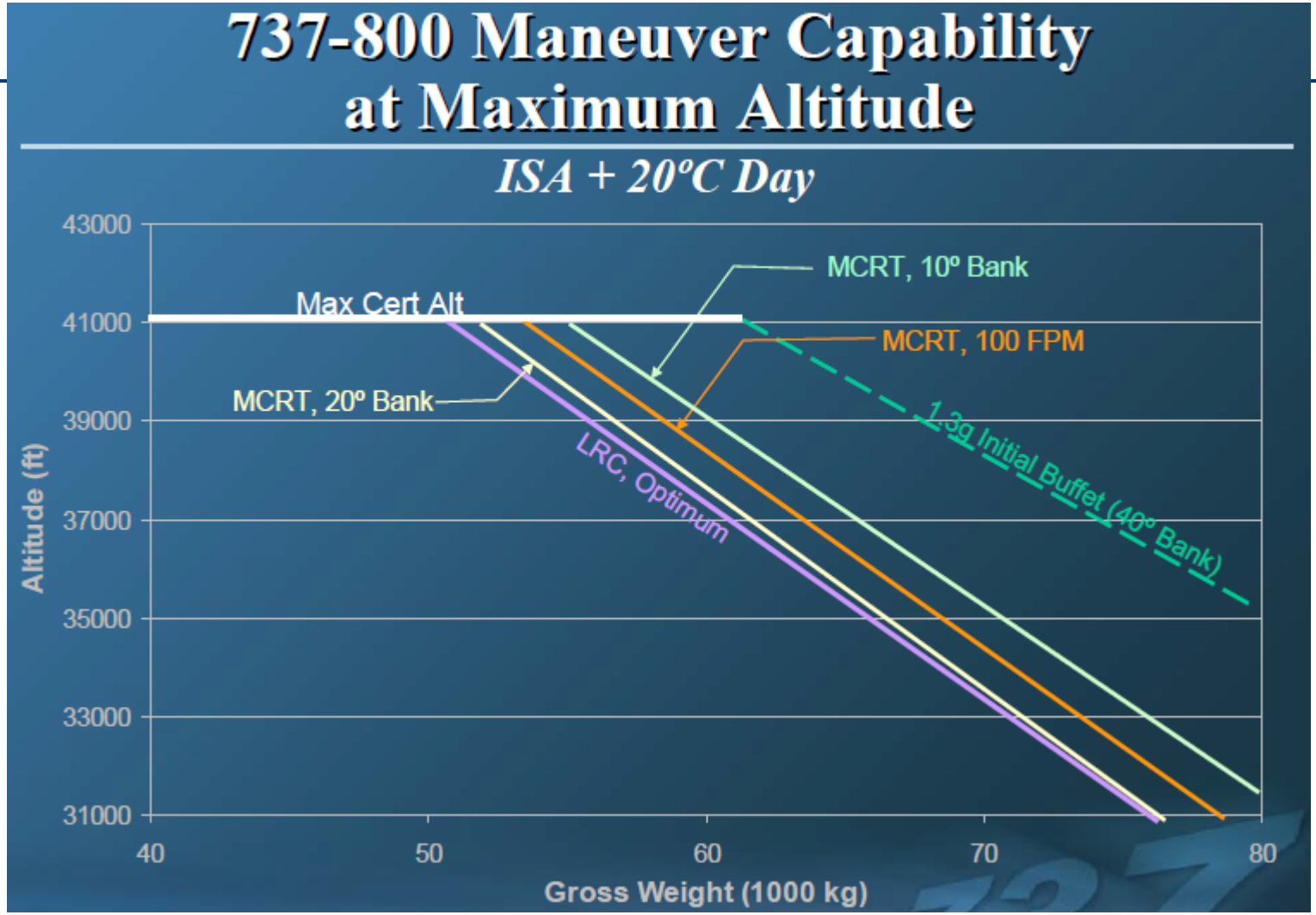
1. Academic Training Essentials

- Energy Management
- Threat and Error Management (TEM) and causes of upsets
- Understanding AoA
- Understanding stall-speed; Vs is variable and depends on g-load
  - Understanding the Stall Recovery SOP
  - Use of flight controls/thrust
- Understanding the OEM-Recommendations
- Aircraft performance at high altitude


737-400 Optimum and Maximum Altitude
Optimum Altitude
Buffet-limited Maximum Altitude (1.3g)
Max Cert Alt
Thrust-limited Maximum Altitude (100 fpm)
ISA + 10C
ISA + 15C
ISA + 20C
39000
37000
35000
33000
31000
29000
27000
Altitude (ft)
30
40
50
60
70
Gross Weight (1000 kg)
70
80
90
100
110
120
130
140
150
(1000 lb)
The Boeing Company
737.5


737-800 Optimum and Maximum Altitudes
Optimum Altitude
Thrust-limited Maximum Altitude (100 fpm)
Buffet-limited Maximum Altitude (1.3g)
Max Cert Alt
ISA + 10C
ISA + 15C
ISA + 20C
43000
41000
39000
37000
35000
33000
31000
Altitude (ft)
40
50
60
70
80
Gross Weight (1000 kg)
90
100
110
120
130
140
150
160
170
(1000 lb)
The Boeing Company
737.6


737-800 Drag vs Mach number
Gross Weight = 70000 kg = 154323 lb
Altitude = 35000 ft
Drag (lb)
13500
13000
12500
12000
11500
11000
10500
10000
9500
9000
8500
Drag is higher than available thrust in 30° turn
Drag in a 30° Turn
Max Continuous Thrust
Drag associated with a 30° turn
Drag in a 15° Turn
Thrust Available
Drag in Level Flight
LRC
0.6
0.65
0.7
0.75
0.8
0.85
Mach number
737
The Boeing Company
737.11


737-800 Maneuver Capability
at Maximum Altitude
ISA + 20°C Day
43000
41000
39000
37000
35000
33000
31000
Altitude (ft)
40
50
60
70
80
Gross Weight (1000 kg)
Max Cert Alt
MCRT, 10° Bank
MCRT, 100 FPM
MCRT, 20° Bank
LRC, Optimum
1.3g Initial Buffet (40° Bank)

2. Practical Training for Current Pilots

- The biggest challenge for airlines is to conduct bridge training for the thousands of current pilots, aiming to bring them up to the necessary competence in upset prevention and recovery
- UPRT for new pilots during type rating/conversion training can then maintain the competence of the airline's pilots

2. Practical Training for Current Pilots

- Human Factors affecting flight crew resilience
- TEM
  - Prevention! Managing causes of upsets
- Manual flying skills
- Crew coordination
- Monitoring skills and Autoflight Mode Awareness
- Use of, and interaction with, automated systems

2. Practical Training for Current Pilots

- Human Factors affecting flight crew resilience
  - Flight crew discipline
  - Confidence
  - Surprise
  - Startle

- Data shows that pilots do not always comply with SOPs, although safety and operational benefits of compliance with published SOPs has been increasingly emphasized – why?

2. Practical Training for Current Pilots

- TEM
  - Upsets are a defined subset of Undesired Aircraft State
  - Prevention! Managing threats and errors causing upsets
    - Environmental
    - Mechanical
    - Crew-error induced
  - Countermeasures to prevent upsets
  - Timely switching from TEM to handling a developing or developed undesired aircraft state

2. Practical Training for Current Pilots

- Manual flying skills
  - Adequate energy management using manual control
  - Appropriate manual control after transition from automated flight
  - Appropriate control inputs for the situation
  - Manual flying skills to recover from upset conditions
  - Crew coordination when faced with unexpected conditions and upset recovery
  - Practice of manual flying skills in both training and line operations.

2. Practical Training for Current Pilots

- Monitoring skills
  - Ineffective cross-verification and monitoring procedures are commonly cited causal factors in flight-path-management-related incidents and accidents
  - Autoflight Mode Awareness is critical to ensure proper monitoring of the flight path
  - There is general industry consensus that monitoring, cross verification, and error management are important and should explicitly be trained

2. Practical Training for Current Pilots

- Use of, and interaction with, automated systems – some vulnerability areas:
  - Pilots sometimes rely too much on automated systems and may be reluctant to intervene
  - Autoflight mode confusion errors continue to occur
  - The amount of information increases and the reliance on automation is increasing, which can lead to errors and confusion, when systems show conflicting info
  - Errors in FMS programming and usage
  - Comprehensive systems knowledge of autoflight/FMS modes is essential to safe operations

3. Integrating UPRT into Existing Training Programs

- CPL/MPL courses
  - Prevention training
  - Recovery training
- Type rating courses
- Operator conversion courses
- Operator recurrent training
  - Initial UPRT
  - Recurrent UPRT
- Command Upgrading training

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Training Instructors

- Instructors are key!
- Advanced instructor training for UPRT is required
- Selection of an initial core-group of instructors is advisable
- On-aeroplane UPRT for the core-group is advisable
  - First hand experience of the critical human factors during upset conditions

Training Instructors

- Challenges for the instructors
  - Understanding the FTSD valid training envelope (VTE) and the limitations of simulator motion cueing
  - Instructor Operating Station (IOS) displays
  - On-aeroplane risk and safety management
  - Delivery of human factor aspects in FSTDs, where psycho-physiological effects may be absent
  - Avoidance of negative transfer of training (CPL/MPL)
  - Avoidance of negative training
  - Assessing crew performance

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Training Delivery

- Maneuvers-based training
  - Video from Airbus on stall training

Training Delivery

- Maneuvers-based training
  - Manual control skills
  - Recovery training should be only maneuvers-based
  - Exercises can be taken from AURTA
  - OEM SOPs for Stall Recovery
  - OEM recommendations for Nose-high and Nose-low upset recovery techniques

Training Delivery

- Scenario-based training
  - Prevention Training can be embedded in scenarios
  - Scenarios should be realistic and valid
  - Training objective is effective prevention of upsets
  - Scenarios could consider
    - Environmental threats
    - Mechanical threats
    - Crew induced errors

Training Delivery

- Exercises contained in AURTA are approved by Boeing and Airbus
- For other maneuvers / scenarios / solutions **N**o-**T**echnical **O**bjection statements from the OEM are recommended

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FSTD Requirements

See Doc 9625, 4th edition

- Valid training envelope
  - All maneuvers delivered in an FSTD must be designed to remain in the device's VTE of the flight envelope data provided by the OEM and used for the FSTD qualification. Excursions beyond the VTE may not be representative of the aircraft and must be briefed if planned/ debriefed if detected during the training to the student.
- The IOS
  - Instructors should be provided additional IOS displays when delivering UPRT to aid in identification of incorrect flight control usage by the student
- FSTD Enhancements (Stall boxes)
  - Any enhancements made to simulator data should involve flight test experts and be evaluated by a competent authority before training is delivered
- FSTD Motion
  - FSTD Motion limitations should be understood by the instructors and explained to student as the device cannot replicate extreme or sustained g forces, or may be limited in buffet intensity/frequency

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Evaluation of training course efficiency

- Data from FOQA
- Data from crew performance during UPRT
- Post training course evaluation

Remember:
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Take-Home Messages

- Significant research and preparation is required prior to training program development
- Targeted UPRT Instructor training is essential to ensure thoughtful delivery
- ATOs or operators should evaluate training and operational data in the development of scenarios
- Each UPRT course should foster an environment of encouragement and thorough instructor discussion/explanation
- No checking by the CAA – **UPRT to proficiency**