Docket No. SA-533

Exhibit No. 13D

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

ATR Presentation – ATR Performance Analysis of Empire Flight 8284

(17 Pages)

Flight 8284
Performance Analysis

PERFORMANCE ANALYSIS (methodology)

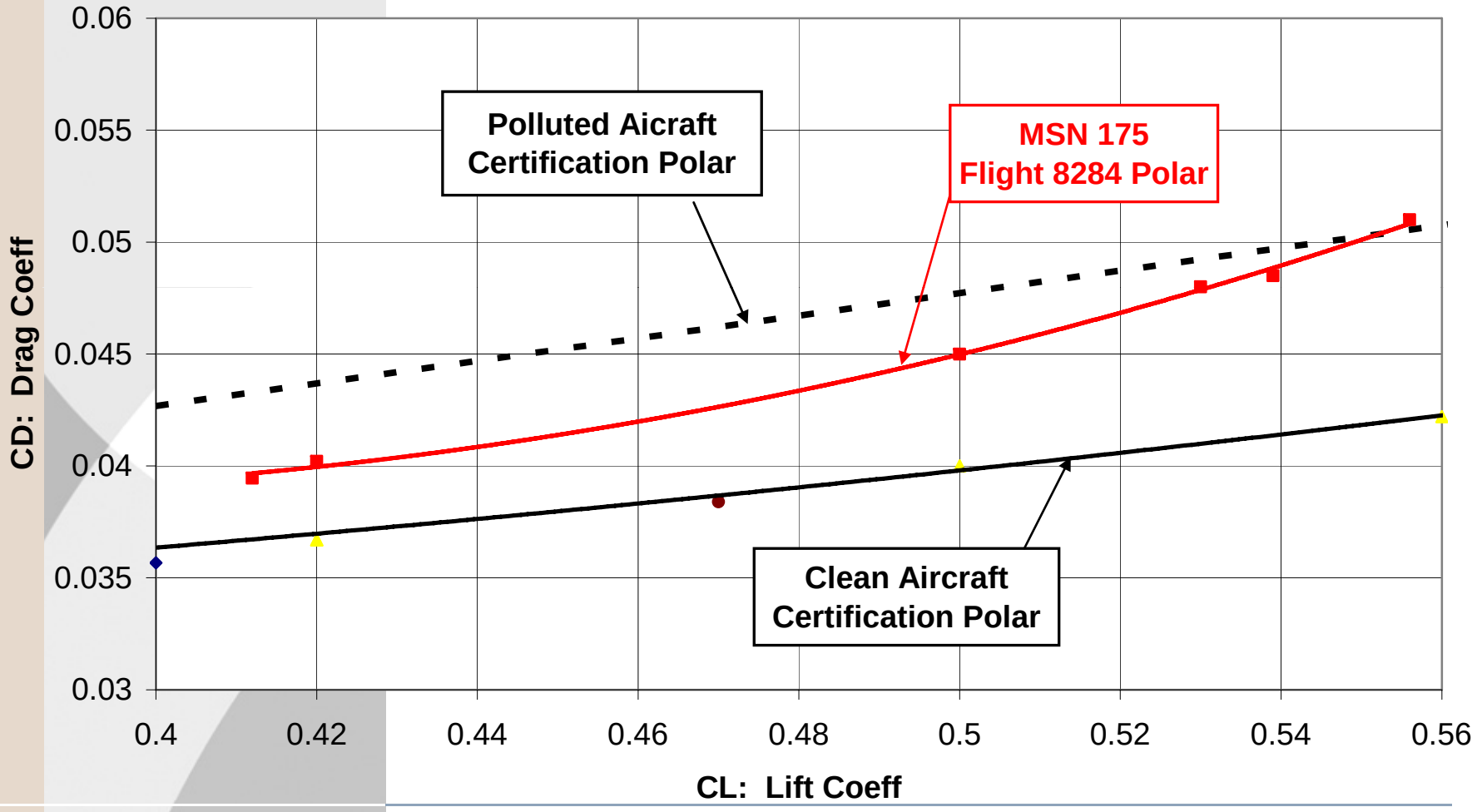
- **Factual inputs:**
  - DFDR data and load and trim sheet
- **ATR inputs:**
  - Aerodynamics data used for AFM and Flight simulator:
    - based on ATR 42-300 MSN 001 and 002,
    - Verified on MSN 175 delivery flight
- **Means:**
  - Drag analysis engineering software
  - Six Degree of Freedom engineering software
  - Hinge moments and controls forces engineering software

DRAG ANALYSIS

- **Period**:
  - End of climb to flap extension or gear extension.
- **Principle**:
  - The drag analysis principle is to compare the aircraft theoretical drag with an “in-flight drag” computed with measured parameters available in the FDAU (Flight Data Acquisition Unit), and on ASCB bus.
- **Results**:
  - The results are compared to certification polars, clean and polluted (3” + Intercycle ice shapes) aircraft.

DRAG ANALYSIS RESULTS (Flaps 0°)

First icing encounter Level 180 and 140



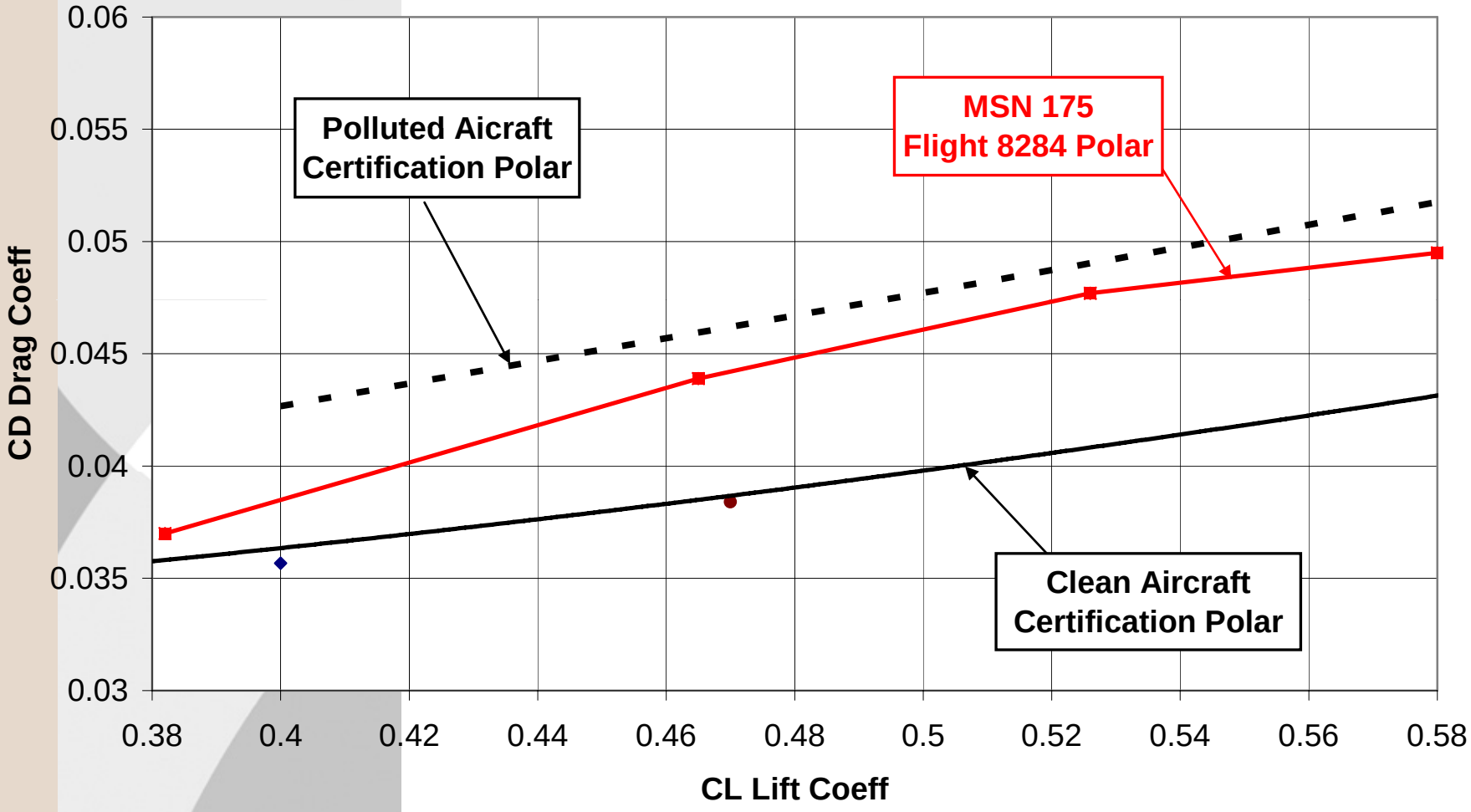
Polluted aircraft = 3”+ intercycle ice shapes

DRAG ANALYSIS

- **When the aircraft crossed 10,000ft the static temperature was above freezing and the crew deselected the airframe de-icing.**
- **At this time the aircraft was nominal in terms of performance.**

DRAG ANALYSIS RESULTS (Flaps 0°)

Second icing encounter at 4800ft



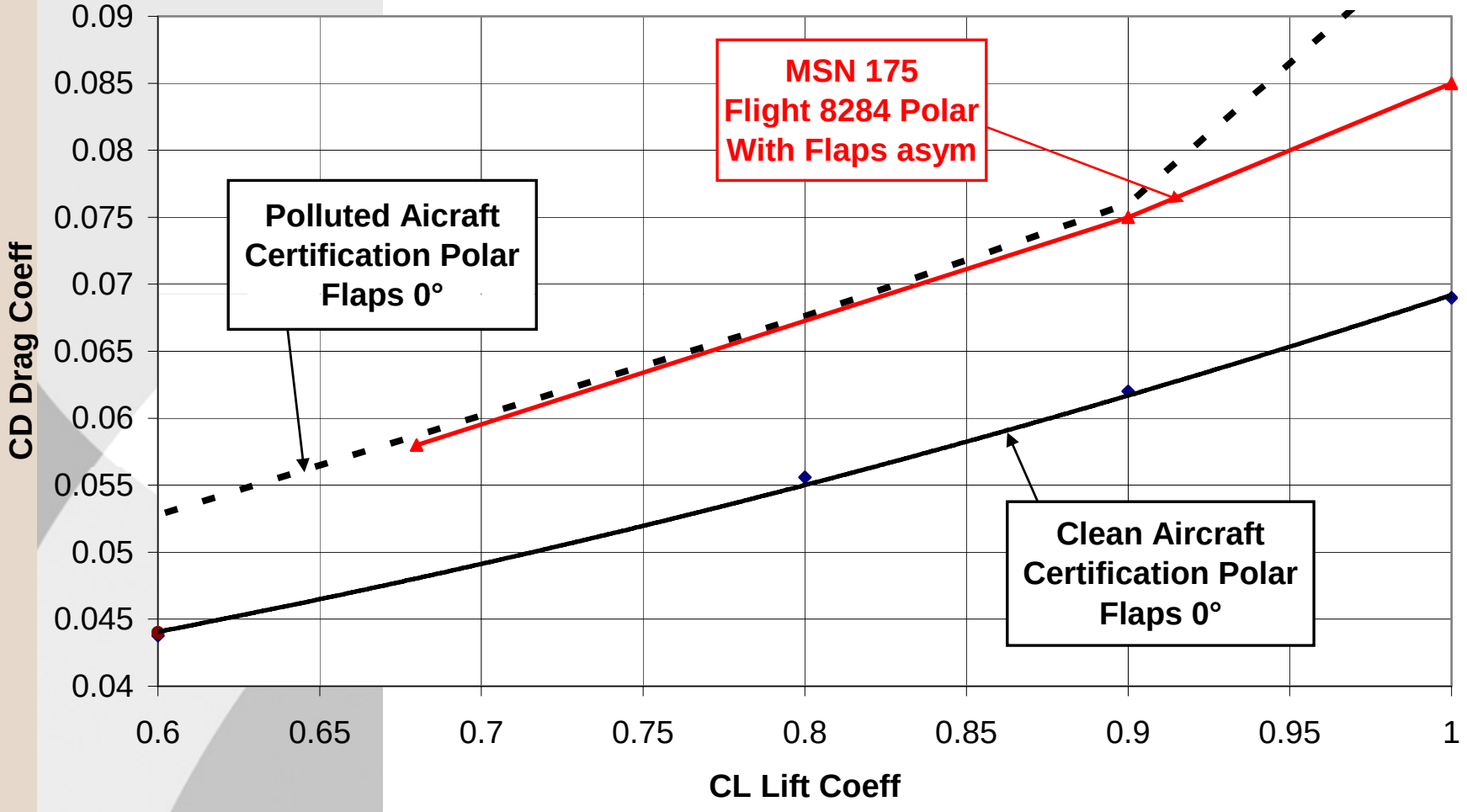
Polluted aircraft = 3"+ intercycle ice shapes

DRAG ANALYSIS (With 6 DOF)

- **Period:**
  - After gear and flap extension until the last stall warning
- **Principle:**
  - To try and match the DFDR parameters (IAS, altitude, AOA, Pitch ...) with clean aircraft data, drag and lift are added if necessary.
- **Results:**
  - The results are compared to certification polars clean and polluted (3” + intercycle ice shapes) aircraft.

DRAG ANALYSIS RESULTS (6 DOF)

Second icing encounter during final approach

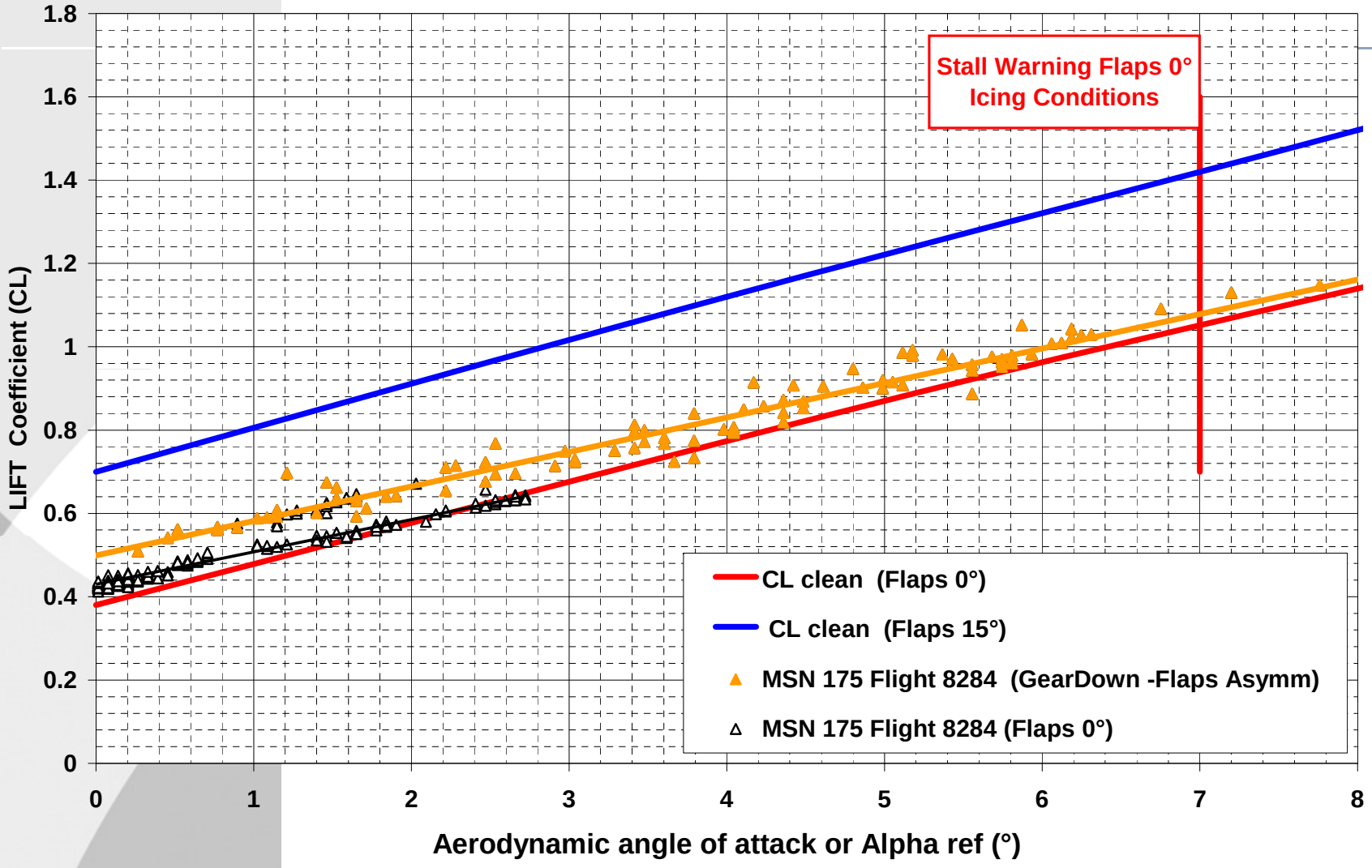


Polluted aircraft = 3"+ intercycle ice shapes

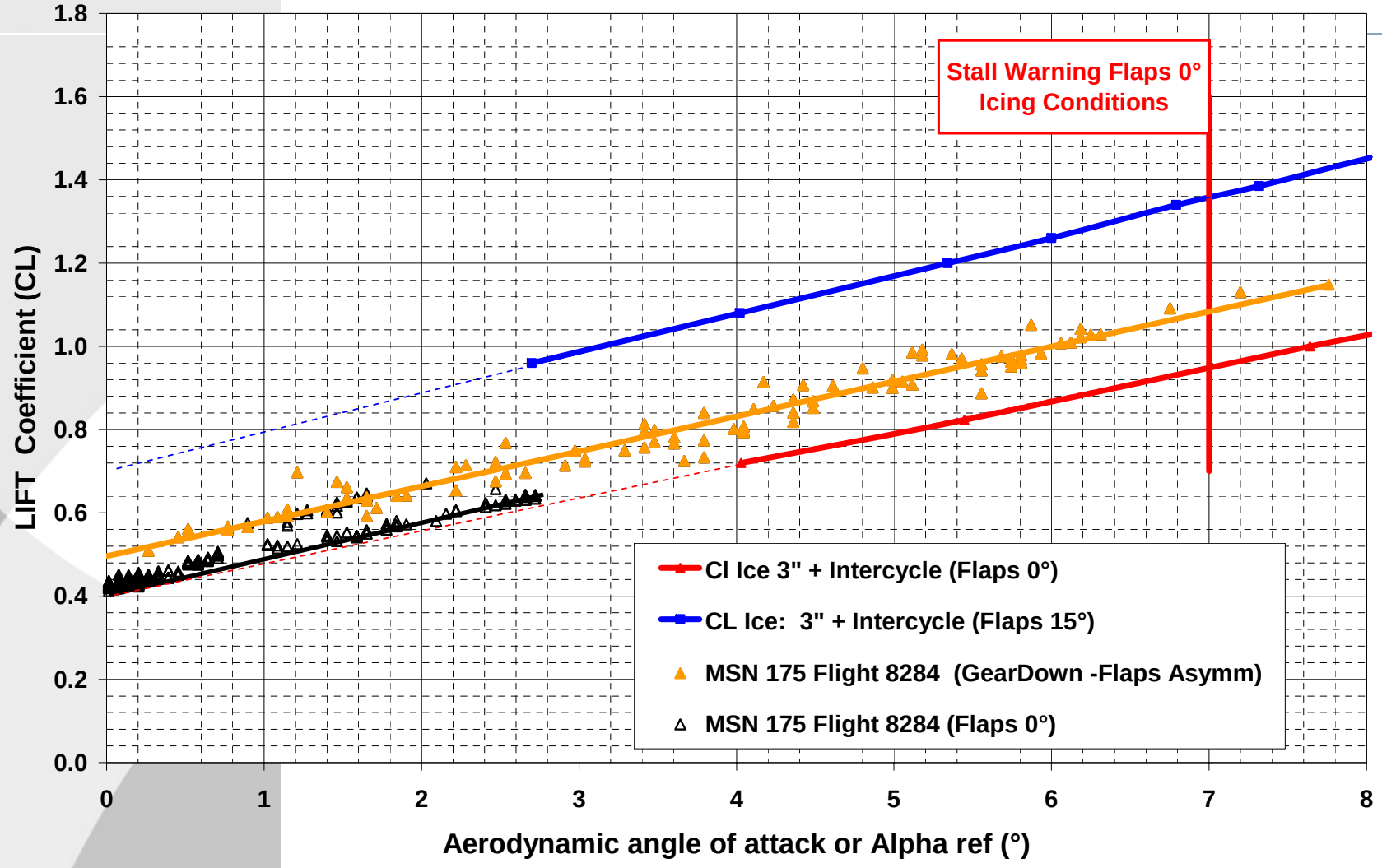
DRAG VS POWER

- **80 Drag counts is equivalent at:**
  - 14% of torques to maintain the cruise speed at 201 Kt at level 180.
  - 9% of torques to maintain the cruise speed at 213 Kt at 14,000 ft.
  - 10% of torques to maintain the cruise speed at 190 Kt at 5,000 ft.
- **130 Drag counts is equivalent at 8% of torques to maintain the cruise speed at 156 Kt at 5,000 ft.**

LIFT: Flight 8284 compared with clean aircraft



LIFT : Flight 8284 compared with Icing Certification



LIFT ANALYSIS RESULTS (6 DOF)

- **There is no significant loss of lift during the final approach until 8° of aerodynamic angle of attack corresponding to 12.2° of AOA vane.**

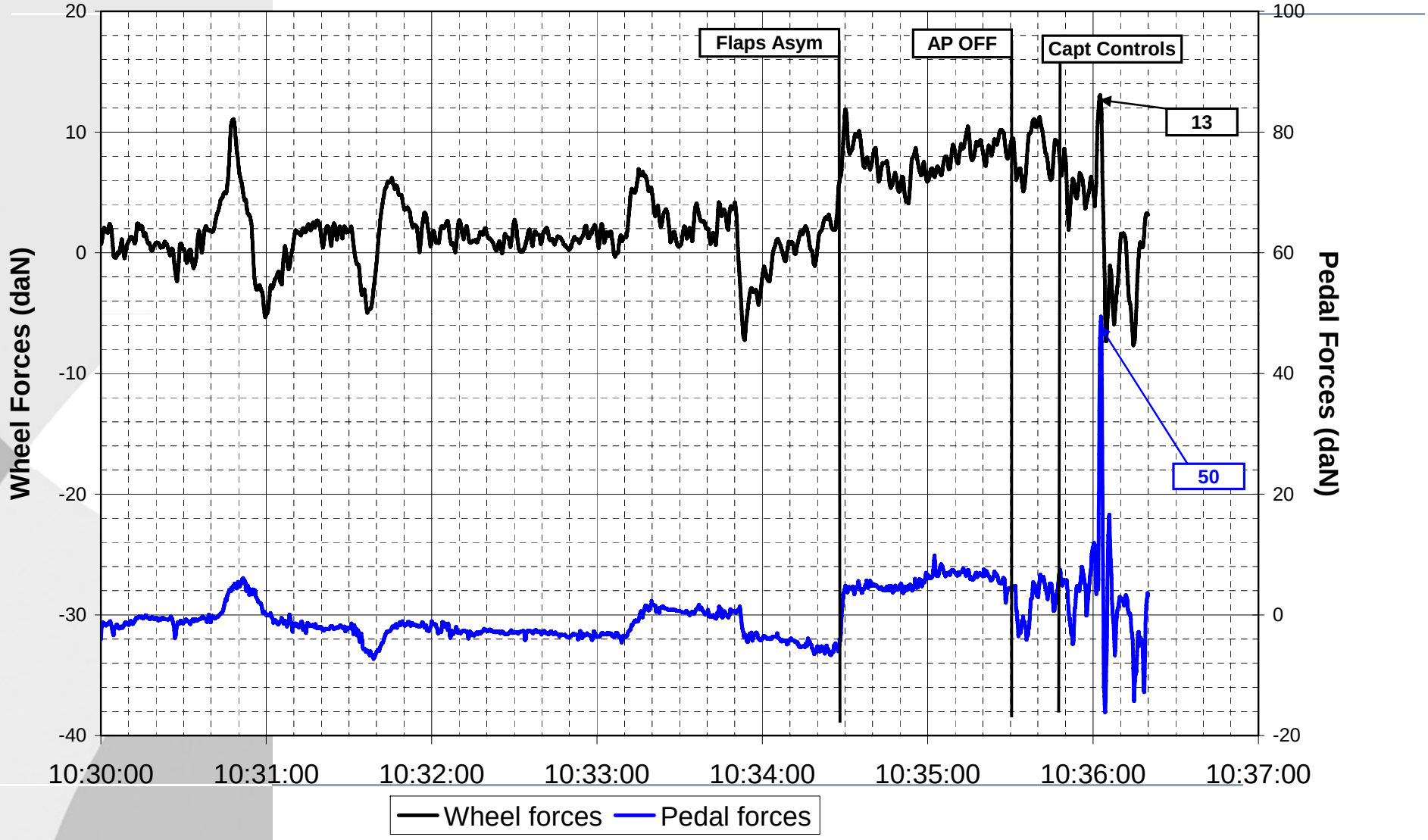
PERFORMANCE ANALYSIS RESULTS

- **The icing conditions encountered during flight 8284 degraded the aircraft performances (drag and lift).**
- **These degradations stayed within the certificated envelope.**

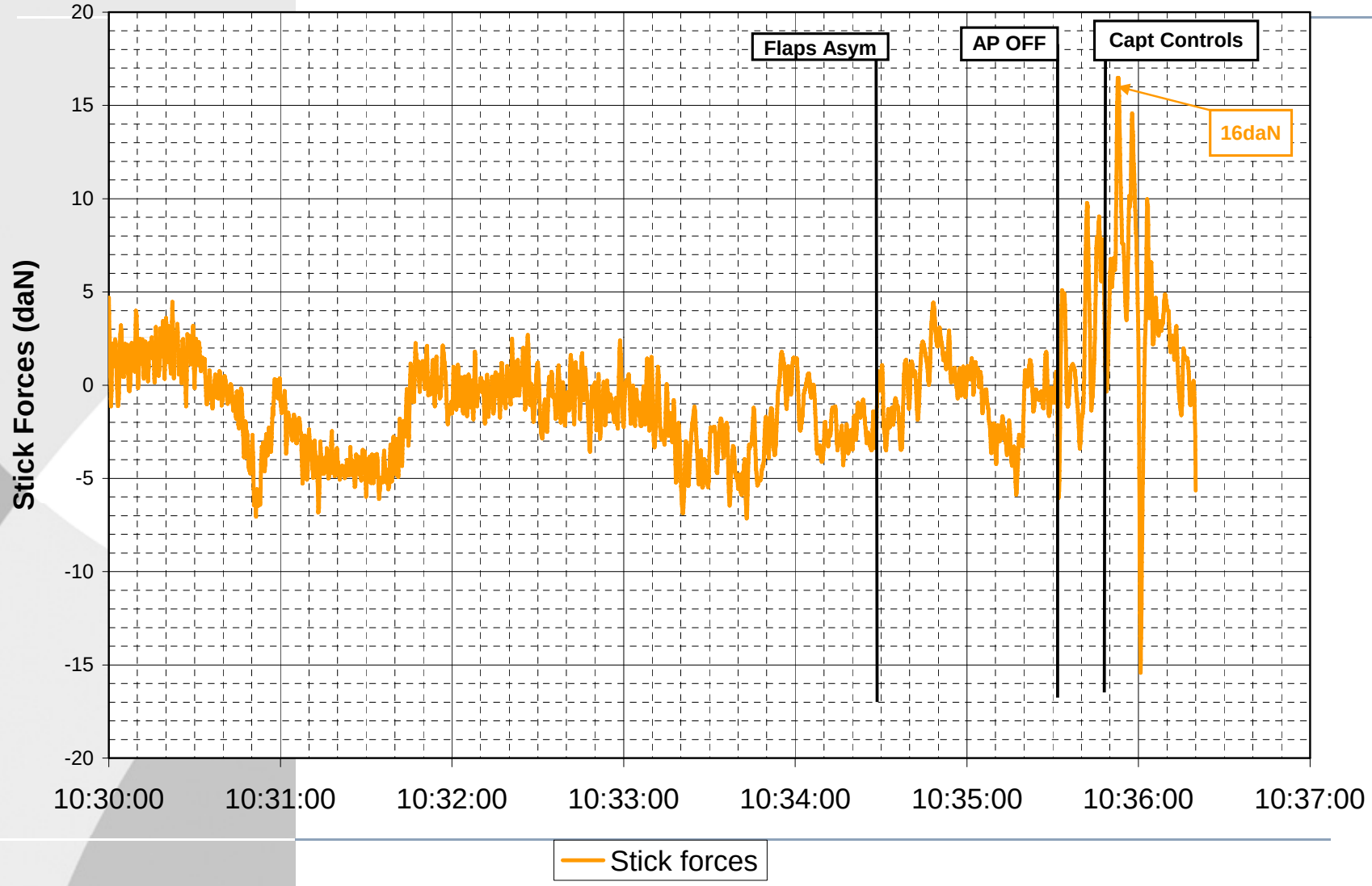
CONTROL FORCE ANALYSIS

- **The hinge moments have been computed in the three axes using DFDR parameters.**
- **The control forces on the cockpit have been determined using the previous hinge moments and ATR 42-320 kinematics.**
- **After the AP disconnection the max control force peak computed using DFDR data are:**
  - In roll axis: 13daN (29lb)
  - In yaw axis: 50daN (110lb)
  - In pitch axis: 16daN (35lb)

Flight 8284 : CONTROL FORCES



Flight 8284: CONTROL FORCES



Flight 8284 : PERFORMANCE

- **The A/C behaviour and performance during Empire flight 8284 were always within the control envelope in terms of drag, lift and control forces.**