



EASA
European Aviation Safety Agency

Flight at High altitude in Adverse conditions

CS 25 Appendix P

EASA Workshop / Flight at High Altitude in Adverse Conditions

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- Introduction & Background
- Published Material
- Ice Crystals and Mixed Phase Phenomena reminder
- Appendix P definition
- CS 25 @ Amdt 16 And CS E @ Amdt 4 Impacts
- Ice Crystals and Mixed Phase / Perspectives & Research



Introduction & Background

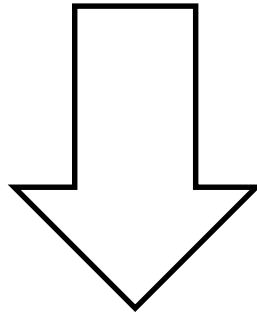
- 31 October 1994: Roselawn, USA, ATR 72 accident
 - NTSB SR A-96-54:
 - ... *Also, expand the appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions, as necessary.*
- Dec. 1997: FAA tasked ARAC > HWG's were setup to update the icing environment
- 1998-2006: Ice Protection Harmonization Working Group (IPHWG) with the support from:
 - Flight Test Harmonization Working Group (FTHWG)
 - Powerplant Installation Harmonization Working Group (PPIHWG)
 - Engine Harmonization Working Group (EHWG)
- May 2006: IPHWG Report; recommendation to update Part 25

- ARAC: Aviation Rulemaking Advisory Committee
- HWG: Harmonization Working Group



Published material

- New FAA Rule published in Nov. 2014
- New EASA Rule published in March 2015



ICING ENVIRONMENT expanded for
CS-25 @ Amdt 16 (large aeroplanes) and
CS-E @ Amdt 4 (turbine engines)



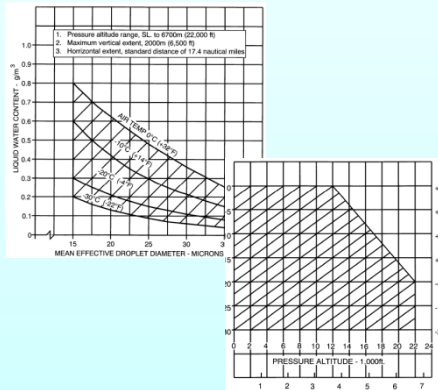
- **Icing Threats introduced in CS 25 @ Amdt 16**
 - A. SLDs: **Appendix O**
 - B. Ice Crystals & Mixed Phase: **Appendix P** (= APP.D to FAR 33 for FAA)

SLD: Supercooled large Droplet

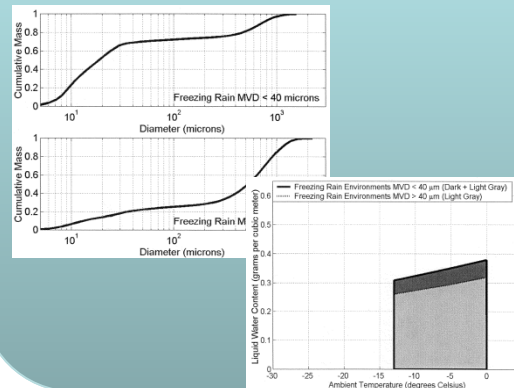


Icing environment expanded

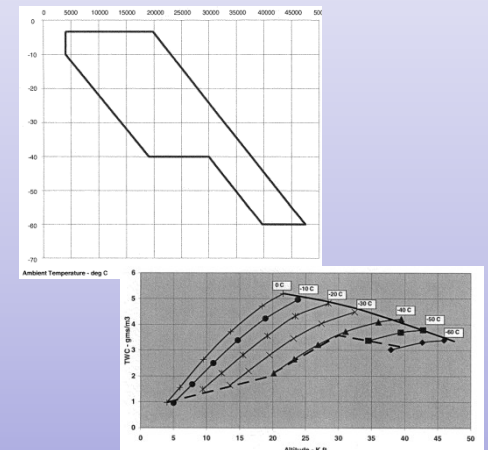
App. C



App. O (SLD)

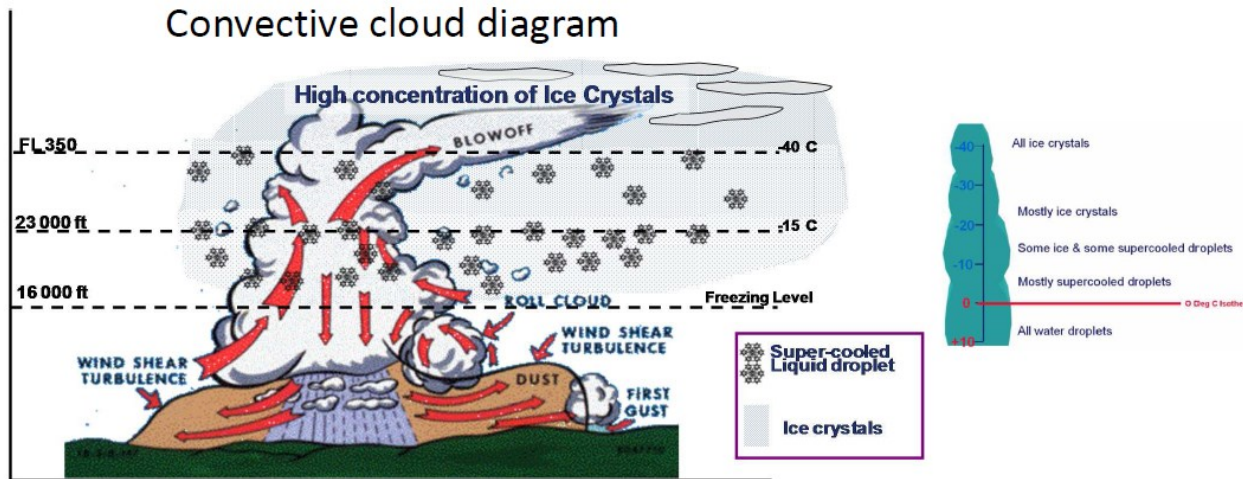


App. P (Ice Crystals)





Ice Crystals & Mixed Phase phenomena



➤ Ice crystals/mixed phase icing

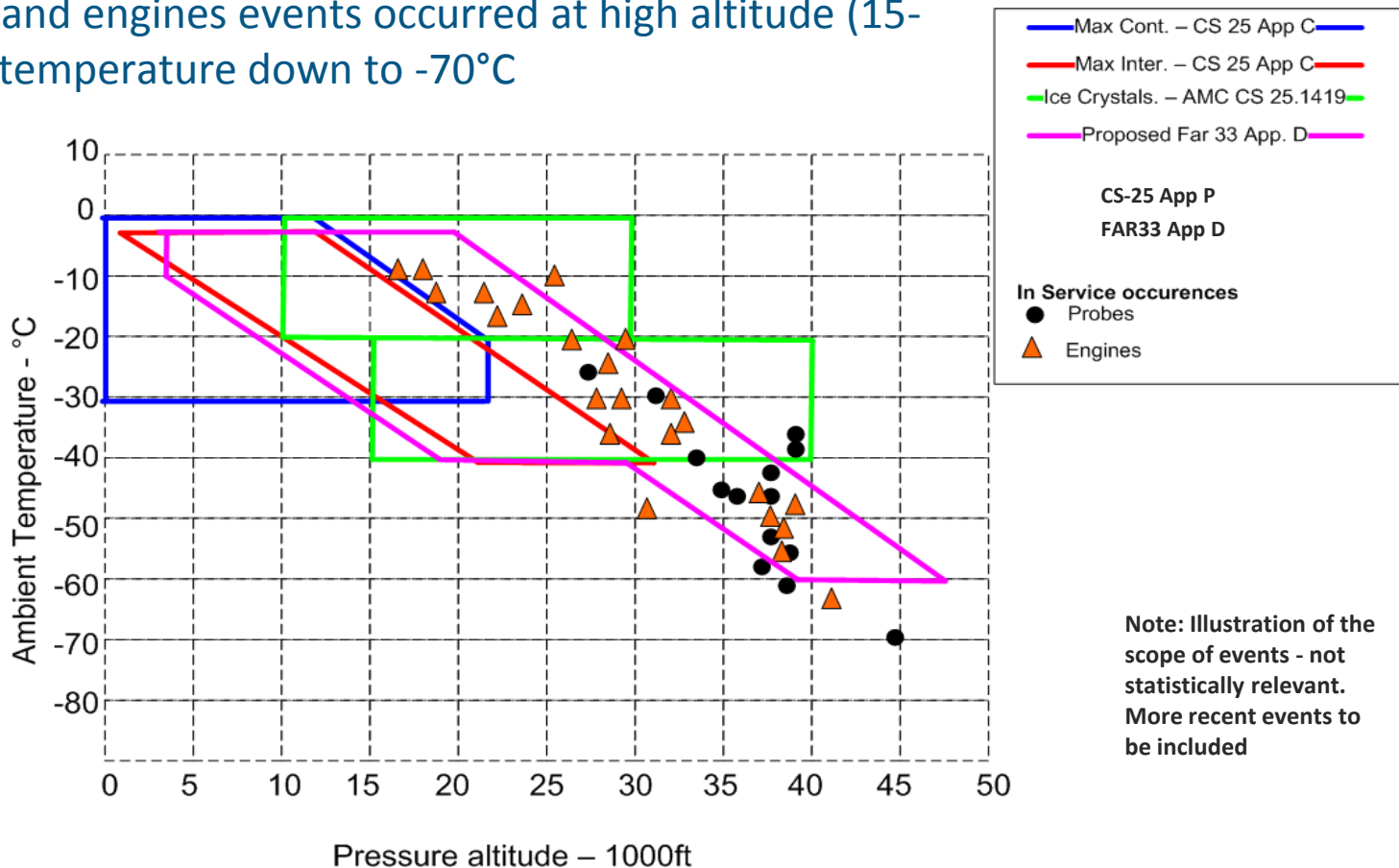
- Cells of deep convection developing into storms – high altitude with ice crystal in high concentrations
- Mixed Phase: Crystals and supercooled droplets with SAT > -40°C
- No more liquid water with SAT < -40°C; only glaciated conditions
- Threat for surfaces with high collection coeff. and/or warm parts: external flight probes, engines and APUs



Appendix P definition

► An envelope derived from Service events:

Probes and engines events occurred at high altitude (15-45Kft), temperature down to -70°C





Appendix P definition

- Ice crystal conditions associated with convective storm cloud formations can exist within the CS-25 Appendix C, Intermittent Maximum Icing envelope: Mixed Conditions
- concentration factor according to App.P, fig.3

Figure D1 - Convective Cloud Ice Crystal Envelope

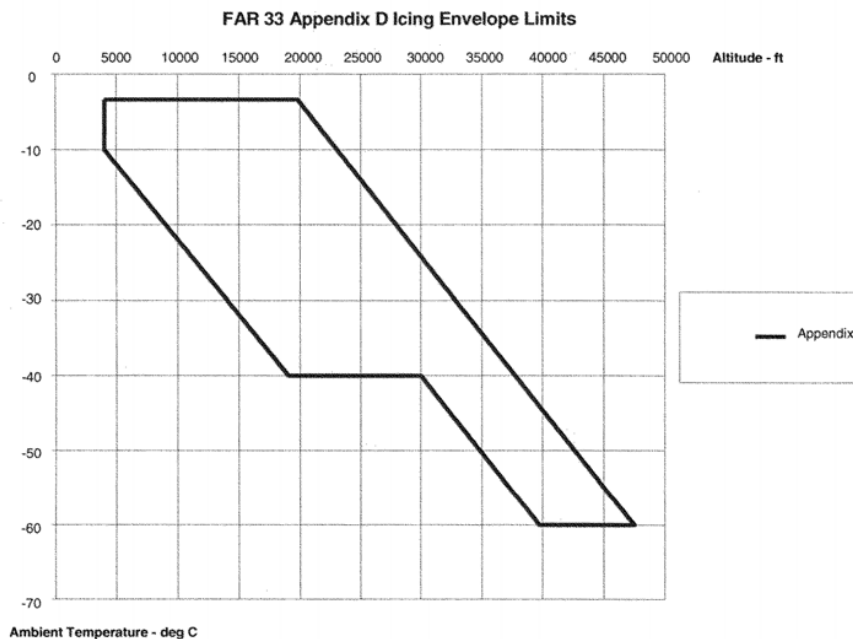
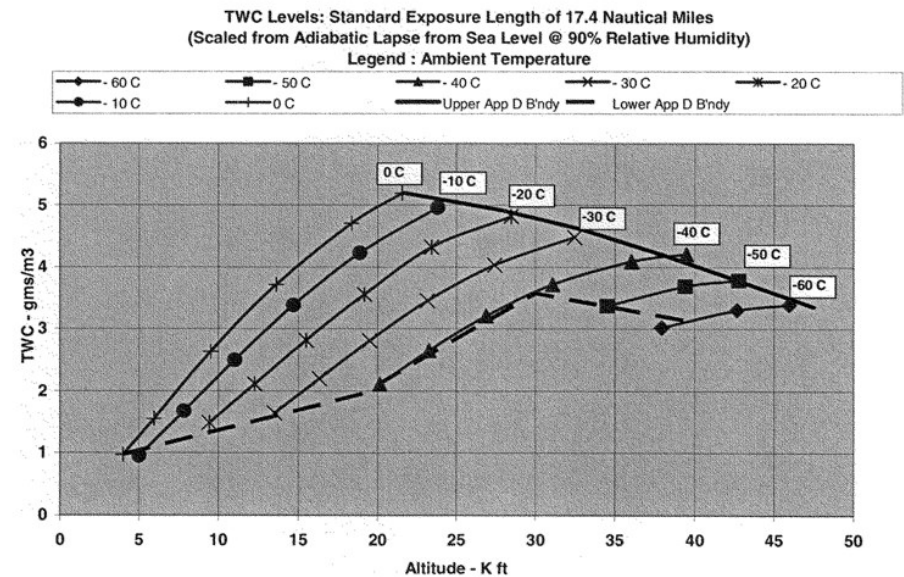


FIGURE D2 - Total Water Content





Appendix P definition

- Ice crystal size median mass dimension (MMD) range is 50–200 microns (equivalent spherical size)
- The TWC can be treated as completely glaciated (ice crystal) except as noted in the Table 1 for Mixed conditions.

Table 1 – Supercooled Liquid Portion of TWC

Temperature range – deg C	Horizontal cloud length	LWC – g/m ³
0 to -20	≤92.6 km (50 nautical miles)	≤1.0
0 to -20	Indefinite	≤0.5
< -20		0



CS 25 & CS E Impacts

Handling & Performance

25.21(g)

C

O

Windshield

25.773

C

O

Engines & Air Intakes & ess. APU AI

E.780 & 25.1093 & 25.J.1093

C

O

P

Propellers

25.929

C

O

Flight Instruments Probes

25.1324

C

O

P

Airframe

25.1419, 25.1420

C

O



► Research

- On-going: International cooperation through HAIC-HIWC-EASA High IWC (Ice water content of clouds at high altitude):
 - 1st Flight test campaign in Darwin (early 2014)
 - 2nd Flight test campaign in Cayenne (May 2015)
 - Goal is to characterize the properties of ice crystal/mixed phase in convective areas



Ice Crystals / Perspectives & Research

➤ Research

- On-going: International cooperation through HAIC-HIWC-EASA High IWC (Ice water content of clouds at high altitude):
 - Complete HAIC and HIWC in 2016
 - Results will be used to validate, or identify needs for update, of the new CS-25 Appendix P environment and AMC for flight probes ice crystal conditions
 - Opportunity for new probes and detectors to be tested in Ice crystals conditions



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**Thank you for your
attention**

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