



# Flight Instrument External Probes

## EASA Requirements Flight in Icing Conditions

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Flight in Icing**

**Seville, September 24-27, 2007**





# Content

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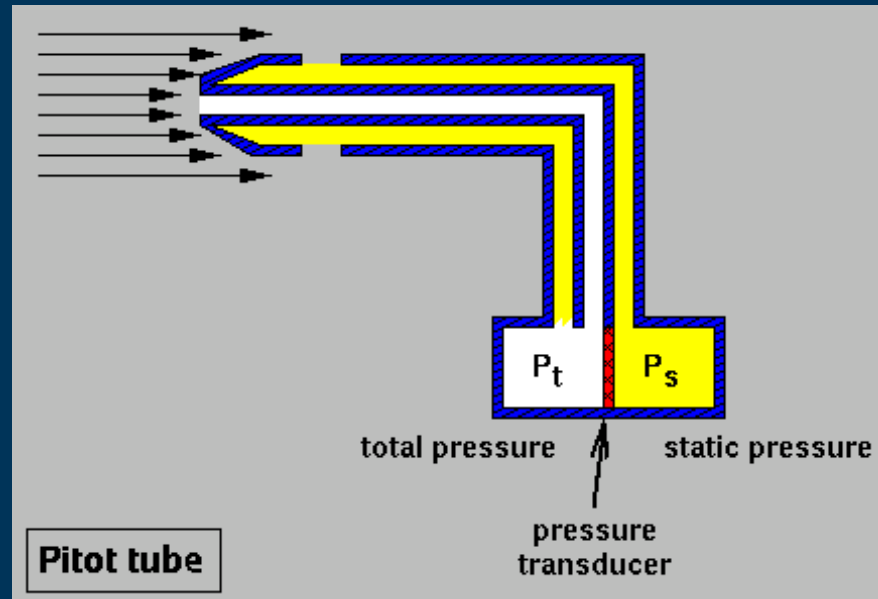
**In Service Events**  
**Underlying Safety Issue**  
**Modes of bad acquisition**  
**25.1309 approach**  
**A/C Requirements**  
**Issues**  
**EASA Conditions**



# Which Probes?

➤ Focus on

## Pitot / Static Tubes

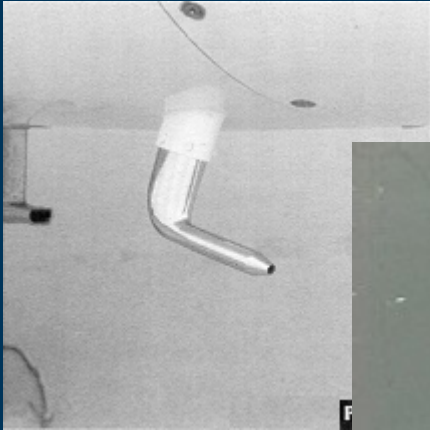




# Which Probes?

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- Usually Fuselage mounted



but....





# Which Probes?

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## ➤ Functions @ A/C level

- ★ Baro Corrected Altitude
- ★ Baro correction
- ★ Vertical Speed
- ★ Indicated Airspeed (IAS)
- ★ True Airspeed (TAS)
- ★ True Mach
- ★ VMO/MMO



# In Service Events

Underlying Safety Issue

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# In Service Events

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- A significant numbers of in-service events reported in Europe
  - ★ **icing conditions or**
  - ★ **heavy rain conditions**



# In Service Events

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Most of the incident reports:

- **airspeed fluctuation**
  - ✦ **while in severe atmospheric conditions**

But Also:

- **Temporary total loss of airspeed indications**



# In Service Events

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- **A significant incident also happened with an instrumented test aircraft during a certification test**
  - ★ **Provide more detailed data.**
  - ★ **Analysis of the atmospheric conditions**
    - ➔ Icing Conditions at an unusual high altitude and at very low Temperature
  - ★ **Conditions outside the environment of PART 25 Appendix C**



In Service Events

# Underlying Safety Issue

Modes of bad acquisition

25.1309 approach

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# Underlying Safety Issue

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Typical consequences of Pitot probes  
ice / water:

- airspeed fluctuation ( $V_c$ )

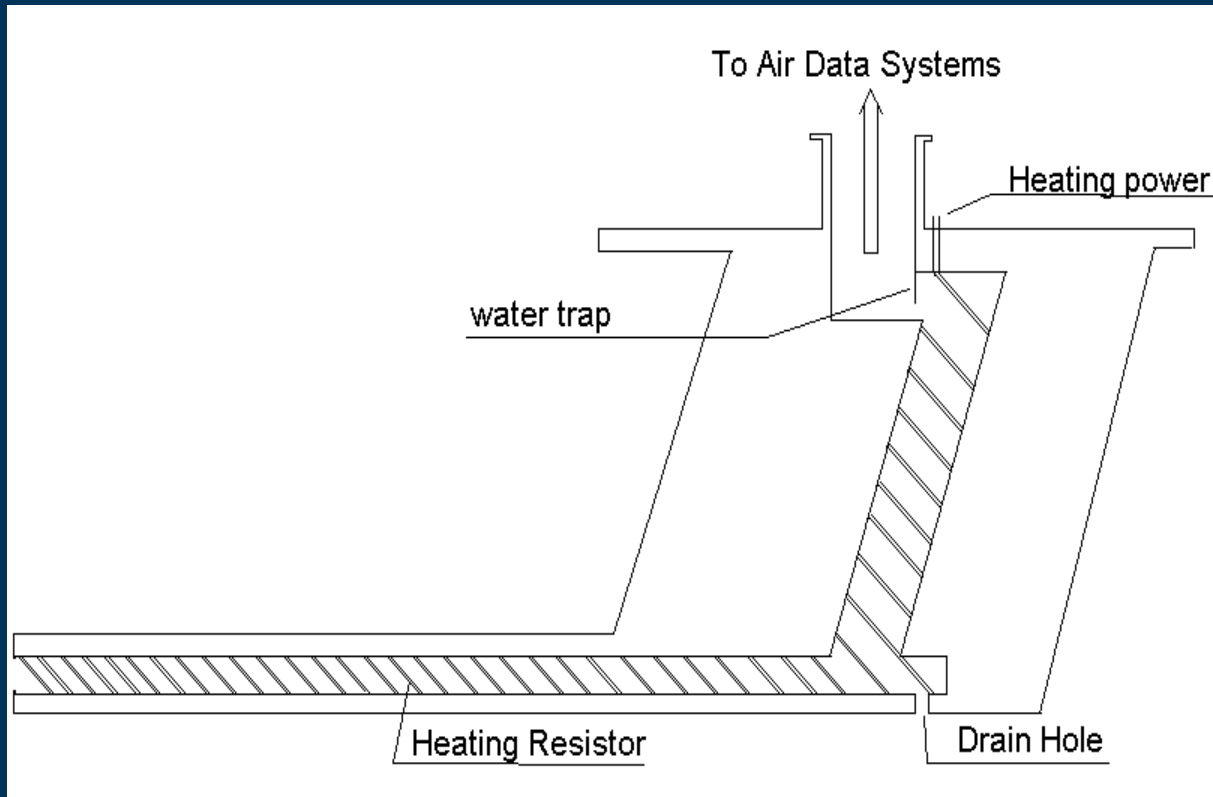
But also risk to have

- misleading airspeed indication on  
two or three airspeed indication  
systems



# Underlying Safety Issue

## ➤ Example of Conventional Design:





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In Service Events  
Underlying Safety Issue

# Modes of bad acquisition

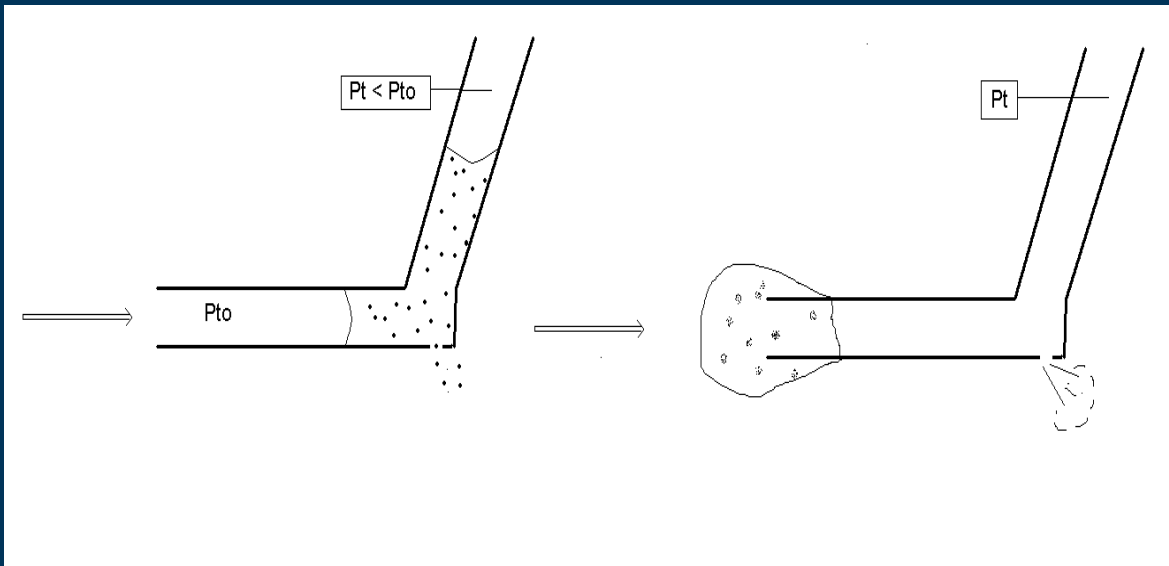
25.1309 approach  
A/C Requirements  
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# 2 modes of bad acquisition

## MODE 1:

- the Pitot tube is filled up with water.
- Pitot head obstructed by ice, the drain holes is free of ice or

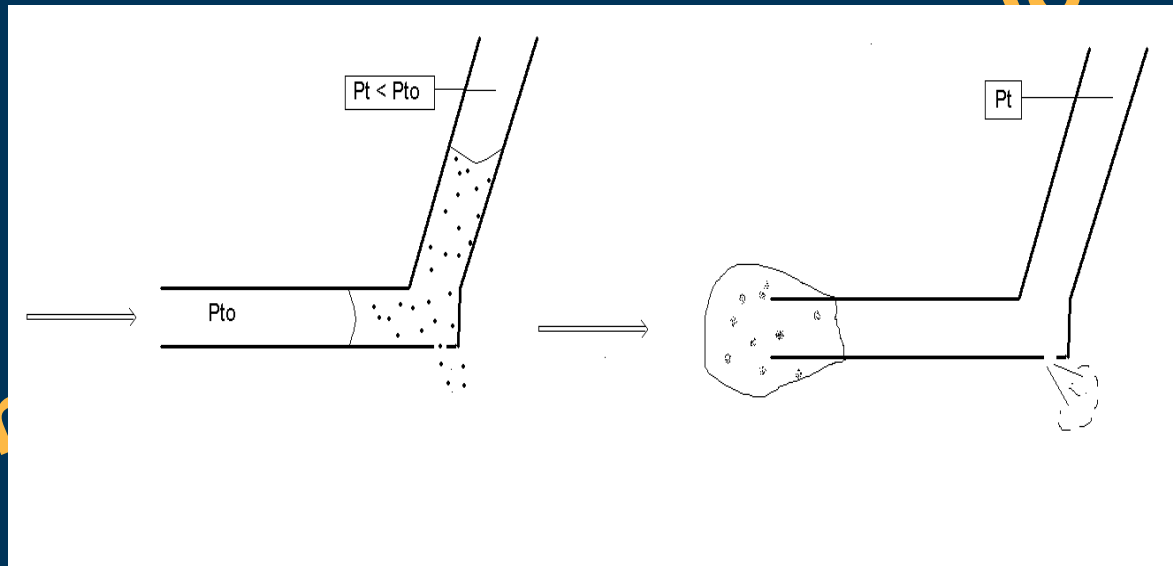




# 2 modes of bad acquisition

## MODE 1:

- the Pitot tube is fill up with water.
- Pitot head obstructed by ice, the drain holes is free of ice or



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low or

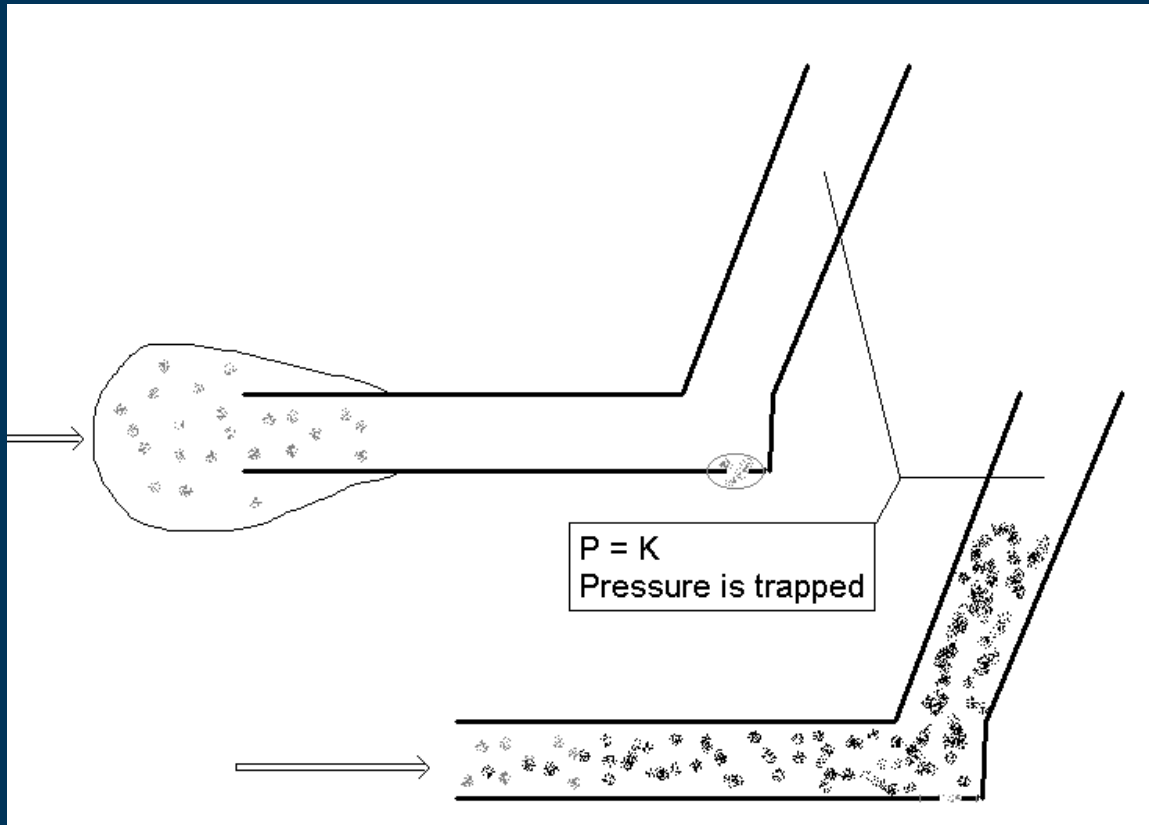


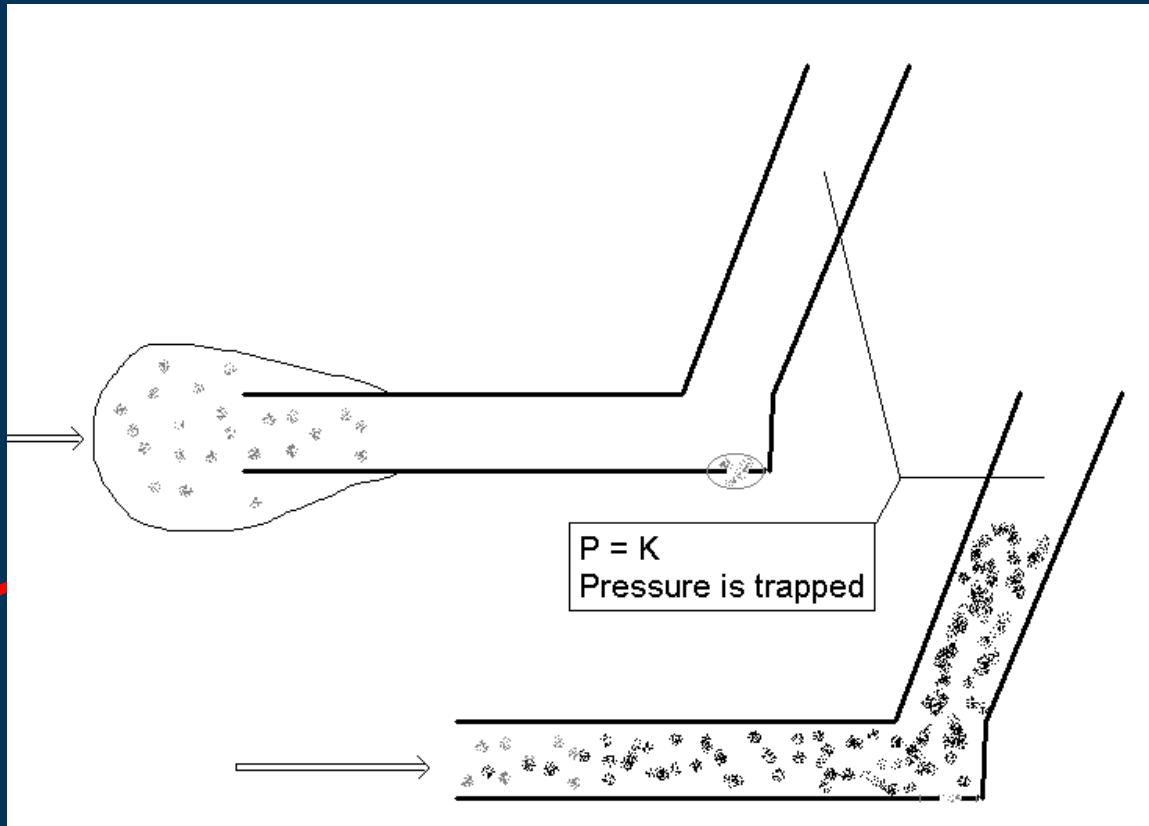
## 2 modes of bad acquisition

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### MODE 2:

- The Pitot head and the drain holes are obstructed by ice.
- The Total pressure is trapped in the probe.
- The airspeed indication do not follow the barometric altitude







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In Service Events  
Underlying Safety Issue  
Modes of bad acquisition

# 25.1309 approach

A/C Requirements  
Issues  
EASA Conditions



# 25.1309

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- Several factors, affect the consequences of the failure
  - ★ aircraft design,
  - ★ failure conditions,
  - ★ flight phases,
  - ★ specific crew procedure and training



# 25.1309

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  - ★ aircraft design,
  - ★ failure conditions,
  - ★ flight phases,
  - ★ specific crew procedures and training

**Misleading Information  
should be considered at least  
Hazardous  
per CS 25.1309**



In Service Events  
Underlying Safety Issue  
Modes of bad acquisition  
25.1309 approach

# A/C Requirements

Issues

EASA Conditions



# A/C Requirements

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*QUALIFICATION  
CERTIFICATION*



# A/C Requirements

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## ■ *QUALIFICATION*

- ★ FAA TSO C16a / EASA ETSO C16

- ★ AS 393

- ★ AS 8006



# A/C Requirements

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## ■ *CERTIFICATION (Large A/C)*

- CS 25.1323 (e)
  - + AMC 1323 (e)
  - + cross ref AMC 25.1093 (b)
- CS 25.1325 (b)
- CS 25.1326
- CS 25.1419 + AMC 25.1419



**In Service Events**  
**Underlying Safety Issue**  
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**25.1309 approach**  
**A/C Requirements**



# Issues

**EASA Conditions**



# Issues

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## ➤ *ETSO C16*

- ★ *obsolete (based on TSO C16: 1951!) and need to be updated*

## ➤ *Past certification practices*

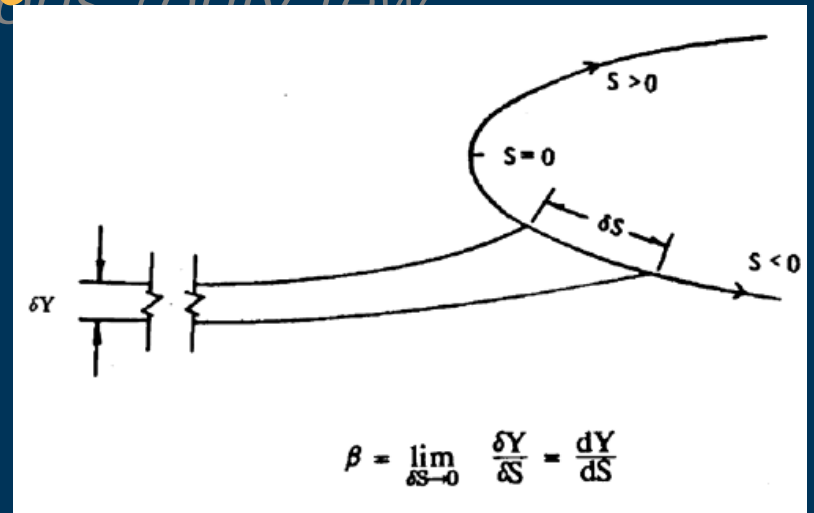
- ★ *use of qualified piece of equipment and*
- ★ *flight in Natural Conditions (only few conditions of AppC)*



# Issues

- ETSO C16 is obsolete and need to be updated
- Past certification practices use of qualified pieces of equipment and flight in Natural Conditions (only few conditions for AppC)

This does not address the installation correctly (local vs upstream)





# Issues

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- *Existing A/C requirements do not address:*
  - ★ *heavy rain conditions*
  - ★ *Ice crystals*
    - *Mentioned only in AMC*
  - ★ *Specific installation issues*
    - *local LWC*



# Issues

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- No requirements for AoA Probes
  - ★ Current vs. IPHWG
- Multifunction Probes
  - ★ AoA + Pitot + Static
  - ★ Total failure / miss functioning is Catastrophic



# Issues

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- EASA address these issues with a “Generic” Certification Review Item
  - ★ **Advisory Material**



# Issues

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- EASA address these issues with a Generic Certification Review Item

- ★ Advisory Material

**Need for Research  
to support  
New Certification &  
Qualification  
Requirements**



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# **EASA Conditions**



# EASA Conditions

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## 3 Phases:

**Liquid Icing**

**Supercooled droplets**

**Mixed & Solid Icing**

**Crystals & supercooled droplets**

**Rain**

**Droplets**



# EASA Conditions

## ■ Liquid

Test #	SAT (°C)	LWC (g/m <sup>3</sup> )	MVD (µm)	Time duration (min)
L1	-30	0,2	20	15
L2	-30	1.1	20	5
L3	-20	1,85	20	5
L4	-10	2.5	20	5



# EASA Conditions

## ■ Mixed & Solid

Test #	SAT (°C)	Droplet LWC (g/m <sup>3</sup> )	Crystal LWC (g/m <sup>3</sup> )	Droplet MVD (µm)	Crystal MVD (µm)	Time duration (min)
M1	-10	1	4	20	1000	5
S1	-35	0	2	0	1000	15
S2	-35	0	5	0	1000	5



# EASA Conditions

## ■ Rain

Test #	SAT (°C)	LWC (g/m <sup>3</sup> )	MVD (µm)	Time duration (min)
R1	-2 to 0	2	1000	15
R2	-2 to 0	6	2000	1.5
R3	-2 to 0	15	2000	0.33



# EASA Conditions

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## Various Modes of Operation to be tested:

- **Anti-Icing:**

- ★ **"on" prior to reaching freezing temperatures**

- **De-Icing:**

- ★ **"off" until 0.5 inch of ice has accumulated**
- ★ **May not be tested if always in power "on"**



# EASA Conditions

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## PASS / FAIL :

- **Function: NO ACCRETION**
- **Acceptable deviations**
  - ✦ **primary parameter (pressures) vs secondary (Speed, altitude, etc)**
  - ✦ **need to understand what deviation are acceptable for primary parameters in relation with design objective for secondary parameters**



# ■ Questions ?



■ Questions

**Thank You**