Date Raised:	1/19/21	Status:	**Closed**
Initial Release:	9/1/23	Updated:	06/24/24
Raised By:	FAA, EASA, TCCA, ANAC		
Subject:	**Icing CWI-4 – 14 CFR 33.68/CS-E 780, Engine Air Data Probe Icing**		
Related Issue(s): (Identify Discussion Paper number, if any)	None		

Description of Issue(s):

(Give a brief description of issue(s))

The current EASA SEI list includes SEI #6 – Icing Conditions.

This SEI includes a sub-item in relation to specific guidance for Engine Air Data Probe mixed-phase and ice crystal Icing (ICI), for which no equivalent FAA guidance currently exists.

This SEI currently results in additional EASA involvement when acting as a Validating Authority.

Paragraph 3.5.10.4 (c) of the Technical Implementation Procedures revision 6 of the Bilateral Agreement between EASA and the FAA recognises that: "*the list of SEI should be frequently revised with the goal of reducing the size of the list through targeted harmonization effort*".

Background:

(Give a brief background of issue(s))

CS-E 780 requires applicant to consider the atmospheric ice crystal icing conditions defined in the turbine Engine's air intake system ice protection specifications (e.g. CS-25.1093 (b)) of the Certification Specifications applicable to the aircraft on which the Engine is to be installed.

AMC E 780 Amendment 4 introduced specific guidance for Engine Air Data Probe Icing, for which FAA does not currently have corresponding guidance.

The FAA developed a draft specific Advisory Circular (AC) aimed, amongst other things, at addressing the differences identified by EASA. A preliminary draft of the AC was reviewed by EASA (engine and aircraft teams) in 2018 and 2019 and the review resulted in certain questions and comments, which were shared with the FAA.

Those questions and comments were discussed between EASA and the FAA in 2019 during a series of conference calls and a satisfactory answer or compromise was found for each.

Subsequently, the FAA published a second draft of the AC in April 2022 (see Appendix of this CWI), intended to address previous comments, including the EASA ones. This draft has attracted a large number of comments from Industry, which will require dispositioning, and because of which publication of the final AC is not expected imminently.

EASA has reviewed this second draft AC and is in a position to confirm that, despite a small number of minor comments which may deserve additional clarifying information (see Appendix 2 of this CWI), the content aligns with the current EASA rules and guidance.

In parallel, the ARAC Ice Crystal Icing Working Group (ICIWG) includes activity likely to affect the atmospheric conditions that need to be considered for Engine Air Data Probe certification. To avoid future disharmonisation, EASA and FAA will coordinate with the objective of ensuring a consistent implementation of the ARAC ICIWG recommendations.

Proposed Prioritization:

(Per CAPP Technical Issues List Prioritization schema)

Question	Answer
1. Is there an active working group related to this issue?	There is an Ice Crystal Icing (ICI) ARAC that is ongoing to determine with higher fidelity where ICI phenomena occur and to change the Appendix D envelope, which has to be considered for the certification of Engine Air Data Probes. Much of the research is focused on mesoscale convective systems and aerosol/pollution. AIA provided recommendations that the FAA considered in drafting the AC' on air data probe icing, and issued two reports addressing Ice Crystal Icing means of compliance for probes in October 2017 and for engines in May 2019.
2. In which documents are there deviations amongst the authorities?	14 CFR 33.68 is not harmonized with CS-E 780 and with CS-25.1093(b)
3. Was this issue raised by or at the CMT?	Yes, Engine Icing is a CMT Top-3 task.
4. What is the level of impact on projects in the future (i.e. minor, major, critical)?	Major: addressing this SEI will reduce involvement of the VA in finding compliance with the VA Certification Basis and will therefore result in a significant project impact.
5. How many authorities does the issue impact?	All CAPP Authorities via certification or validation, if turbine engines are involved.
6. What is the approximate complexity of the issue (i.e. low, medium, high)?	High

Recommendation and Objectives:

(The authority or industry member that proposes a CWI provides an initial recommendation to the CAPP. The CAPP, together with CMT may refine the objectives.)

A group of Subject Matter Experts should be formed to:

Achieve Harmonisation:

1. Develop guidance to address the EASA SEI
2. Review the initially proposed draft AC (of 2018) and confirm that it addresses the EASA SEI satisfactorily and or/adjust the draft proposed AC accordingly
3. Review the latest draft of the FAA AC in relation to Engine Air Data Probes Certification, as published in April 2022
4. Ensure that all EASA comments shared with the FAA in 2018-2019 following review of the preliminary draft AC have been satisfactorily addressed in the latest draft published in April 2022.
    - Upon satisfactory completion of task 4, CAPP will publish a CWI document to inform non-EU Applicants that complying with the draft FAA AC as published in April 2022, with due consideration of the additional minor EASA comments (see Appendix 2 of this CWI) is considered acceptable to comply with the applicable EASA rules and guidance

    - Remove the corresponding EASA SEI

Maintain continued harmonisation:

5. Ensure that the final FAA AC is harmonised with the current EASA rules and guidance applicable to the Certification of Engine Air Data Probes when operating in Ice Crystal Icing Conditions.
6. Review the recommendations of the ARAC ICIWG and agree on a consistent implementation such as to avoid new SEIs related to the Certification of Engine Air Data Probes when operating in Ice Crystal Icing Conditions.

(CMT Decision (Phase 1)

Phase 1. CAPP agreement to proposition and identification of SME team.
CAPP agreed with SMEs recommendation on 1/21/22 and commits resources to complete the recommendation and objectives stated above.

This CWI is accepted into the CAPP system and the tracking number is CWI-4.

Notes:
- The CMTS approved the overall Icing Task Request Form (TRF) during their 1/19/21 meeting
- The CAPP transitioned to CATA CWI report-out format for consistency
- The overall task was separated into individual subtasks/CWIs in response to CMTS feedback
- Engine Air Data Probe Icing subtask identified as CWI-4
- Presented all CWIs, including CWI-4, to the CMTS during their 9/28/22 meeting

SME Recommendation (Phase 4 Completion)

(Recommendations from SME Working Group; may contain links and/or embedded documents)

The SMEs recommend:

- Publication of a final CWI document to inform non-EU Applicants that complying with the draft FAA AC as published in April 2022 (see Appendix of this CWI), with due consideration of the additional minor EASA comments (see Appendix 2 of this CWI), is considered acceptable to comply with the applicable EASA rules and guidance.
- Transfer of the EASA SEI#6 to the SEI ‘Part 2’ list.
- Recognition that any other Means of Compliance proposed by a non-EU Applicant, not consistent with those described in the CWI, would then trigger the TIP rev. 6 non-basic classification criteria of paragraph 3.5.3.2 (b) (5) “use of a new or different applicable method of compliance from that previously agreed by the CA and the VA”. This includes the use of the final FAA AC, if that AC is found not be equivalent to the version published as part of this CWI.
- Maintaining harmonization by:
    - Ensuring that the final FAA AC is equivalent with the latest draft published in April 2022 (see Appendix of this CWI) and harmonized with the current EASA rules and guidance applicable to the Certification of Engine Air Data Probes when operating in Ice Crystal Icing Conditions
    - EASA and FAA reviewing jointly the recommendations of the ARAC ICIWG and agree on a consistent implementation such as to avoid new SEIs related to the Certification of Engine Air Data Probes when operating in Ice Crystal Icing Conditions

Final CAPP Position (Phase 5 Completion Target: <Phase 4 + 2 Months>)

(Explain agreement, dissent or conclusion on the SME recommendation)

CAPP agrees with the SME: non-EU Applicants complying with the draft FAA AC as published in April 2022 (see Appendix of this CWI), with due consideration of the additional minor EASA comments (see Appendix 2 of this CWI), is considered acceptable to comply with the applicable EASA rules and guidance

Release of CWI:

CAPP Representative	Name	Signature	Date
ANAC	Marcelo Saito	Marcelo Batista Saito Assinado de forma digital por Marcelo Batista Saito Dados: 2024.07.05 07:59:16 -03'00'	
EASA	Javier Castillo	CASTILLO Javier Digitally signed by CASTILLO Javier Date: 2024.07.10 17:49:59 +02'00'	
FAA	Robert Ganley	ROBERT J GANLEY Digitally signed by ROBERT J GANLEY Date: 2024.07.08 07:09:24 -04'00'	
TCCA	Roop Dhaliwal	Dhaliwal, Roop Digitally signed by Dhaliwal, Roop DN: C=CA, O=GC, OU=TC-TC, OU=NCR-RCN, CN="Dhaliwal, Roop" Reason: I have reviewed this document Location: Date: 2024.07.04 09:01:28-04'00' Foxit PDF Editor Version: 13.0.1	

Appendix 1 – Draft FAA AC

as published for comments in April 2022

20-XX-X-AC.pdf

U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Turbine Engine Inlet Sensor Ice Crystal and Mixed Phase Icing Compliance

Date: MM/DD/YYYY
Initiated By: AIR-624

AC No: 20-XX-X
Change No: N/A

1. PURPOSE.

This advisory circular (AC) describes an acceptable method for demonstrating compliance with Title 14, Code of Federal Regulations (14 CFR) 33.28, 33.68, 33.89 and 33.91, regarding mixed phase and ice crystal icing (ICI) with respect to engine inlet sensors. This AC may also be useful when demonstrating compliance with 14 CFR 25.901(c), 25.1093(b), 25.1309, 25.1323, 25.1324, and 25.1325 regarding ICI with respect to engine inlet sensors on turbine-powered airplanes. This AC addresses temperature probes, combined temperature and pressure probes, and static pressure probes used by turbine engines. Manufacturers can use this method of compliance to evaluate probe behavior in mixed phase and ICI conditions and the resulting impact of engine probe performance on engines and airframe systems. In addition, this methodology is flexible enough to evaluate temperature probe, combined pressure/temperature probe, and static pressure probe behavior regardless of installation location.

2. APPLICABILITY.

2.1 The guidance in this AC applies to type certificate applicants, certificate and other design approval holders.

2.2 The contents of this guidance document do not have the force and effect of law and are not meant to bind the public in any way. This guidance document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies. This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable method, but not the only method, to show compliance to regulatory requirements regarding parameters such as air temperature and pressure. When the method of compliance in this AC is used, terms such as “should,” “may,” and "must" are used only in the sense of ensuring applicability to this particular method of compliance. The FAA will consider other methods of showing compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. If, however, the FAA becomes aware of circumstances that convince the agency that following this AC would not result in compliance with the applicable regulations, the agency will not be bound by the terms of this AC, and may require additional substantiation as a basis for finding compliance.

2.3 The material in this AC does not change or create any additional regulatory requirements, nor does it authorize changes in, or permit deviations from, existing regulatory requirements.

3. RELATED MATERIAL.

The following regulations are referenced in this AC. You can download the full text of these regulations at the U.S. Government Printing Office e-CFR website. Or you can order a paper copy by sending a request to the U.S. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-0001; by calling telephone number (202) 512-1800; or by sending a request by fax to (202) 512-2250.

3.1 Title 14, Code of Federal Regulations (CFRs).

- Section 33.28, *Engine control systems.*
- Section 33.68, *Induction system icing.*
- Section 33.89, *Operation Test.*
- Section 33.91, *Engine system and component tests.*
- Appendix D to Part 33--*Mixed Phase and Ice Crystal Icing Envelope (Deep Convective Clouds).*
- Section 25.901, *Installation.*
- Section 25.1093, *Induction system icing protection.*
- Section 25.1309, *Equipment, systems, and installations.*
- Section 25.1323, *Airspeed indicating system.*
- Section 25.1324, *Angle of attack system.*
- Section 25.1325, *Static pressure systems.*
- Appendix C to Part 25—(no title) *Part I - Atmospheric Icing Conditions.*
- Appendix O to Part 25—*Supercooled Large Drop Icing Conditions.*

- Appendix C to Part 29—*Icing Certification.*

3.2 FAA Documents.

The following FAA ACs and Technical Standard Order (TSO) are related to the guidance in this AC. The latest version of each document at the time of publication of this AC is identified below. If an AC or TSO is revised after publication of this AC, you should refer to the latest version for guidance. This guidance can be downloaded from the Internet at http://www.faa.gov/regulations_policies/advisory_circulars/ or https://www.faa.gov/aircraft/air_cert/design_approvals/tso/.

- AC 20-73A, *Aircraft Ice Protection.*
- AC 20-147A, *Turbojet, Turboprop, Turboshaft, and Turbofan Engine Induction System Icing and Ice Ingestion.*
- AC 25-28, *Compliance of Transport Category Airplanes with Certification Requirements for Flight in Icing Conditions.*
- Technical Standard Order, TSO-C16b, *ELECTRICALLY HEATED PITOT AND PITOT-STATIC TUBES.*
- FAA Report No. DOT/FAA/AR-09/13, *Technical compendium from meetings of the engine harmonization working group.*

3.3 Technical Publications.

- Aerospace Industries Association/Engine Icing Working Group, *AIA/EIWG Subcommittee on Engine Probe Icing: A Process for Evaluating the Performance of Temperature Probes, Combined Temperature and Pressure Probes, and Static Pressure Probes in Icing Conditions*, Aerospace Industries Association.
- SAE International 2011-38-0050, "An Analysis of Turbofan Inlet Water and Ice Concentration Effects in Icing Conditions," SAE Technical Paper, Liao, S., Liu, X., and Feulner, M.
- SAE International 2015-01-2086, "Studies of Cloud Characteristics Related to Jet Engine Ice Crystal Icing Utilizing Infrared Satellite Imagery," SAE Technical Paper, Grzych, M., Tritz, T., Mason, J., Bravin, M., and Sharpsten, A.
- SAE International 2015-01-2146, "Ice Crystal Ingestion In a Turbofan Engine," SAE Technical Paper, Feulner, M., Liao, S., Rose, B., and Liu, X.

3.4 Industry Standards.

- SAE AS5562, Ice and Rain Minimum Qualification Standards for Pitot and Pitot-static Probes.
- RTCA DO-160F, *Environmental Conditions and Test Procedures for Airborne Equipment.*

- ASTM F3120 / F3120M – 15, *Standard Specification for Ice Protection for General Aviation Aircraft.*

4. DEFINITIONS.

The following list of terms and definitions apply to this AC.

- **Total Water Content (TWC).** The amount of liquid contained in the icing environment. In ice crystal conditions, TWC refers to the amount of liquid water contained in the ice crystals. In mixed conditions, TWC includes the water contained in both the liquid and frozen phases.
- **Ice Water Content (IWC).** The equivalent amount of water contained in the icing environment. IWC refers to the equivalent amount of liquid water contained in the ice crystals in ice crystal conditions.
- **Liquid Water Content (LWC).** The TWC part consisting of liquid water.

5. BACKGROUND.

5.1 Background on Ice Crystal Icing.

5.1.1 The FAA is aware of more than two dozen examples of ice crystals blocking turbine engine inlet probes on turbine engine-powered airplanes. These ice blockages have resulted in serious engine power rollbacks, lack of throttle response, and out-of-range probe data flight crew warnings.

5.1.2 Some airplane manufacturers have eliminated airframe probes and, instead, use the turbine engine inlet probe data for airframe systems such as total or static air temperature. Using engine inlet probe data for different airframe systems requires applicants to put greater emphasis on ensuring that probes continue to function throughout the various icing conditions to support the airplane-level system safety analysis and overall aircraft safety. Eliminating the airframe probes also removes the ability of the electronic engine control system to use airframe probe signals to validate data from engine probes. Without the use of airframe probes, data from the engine inlet probes is substantially more critical throughout the operating envelope of the aircraft.

5.1.3 Some engine manufacturers use heated inlet probes to prevent ice from accreting on or in the probe, while others use unheated probes. Heated probes can be effective in preventing ice from accreting on the probe while in supercooled droplet icing conditions typically found at low to mid-altitudes. Heated probes, however, can be susceptible to ice accretion from ICI conditions. These conditions are typically found at high altitudes but can exist at lower altitudes. When using heated probes, manufacturers should consider airframe electrical power reliability when evaluating inlet probe-related loss of thrust control under 14 CFR 33.28(d)(1) during icing encounters. Unheated probes are less susceptible to ICI conditions but are more vulnerable to lower and mid-altitude supercooled droplet-icing conditions. Therefore, whether manufacturers use heated or unheated probes, problems with ice accretion can still occur.

5.1.4 Applicants have redesigned certain heated inlet temperature probes to reduce the potential for ice crystal blockage but not eliminate it. Engine manufacturers have incorporated Full Authority Digital Engine Control logic to detect and annunciate the obstruction and utilize an alternative temperature signal to preclude thrust anomalies.

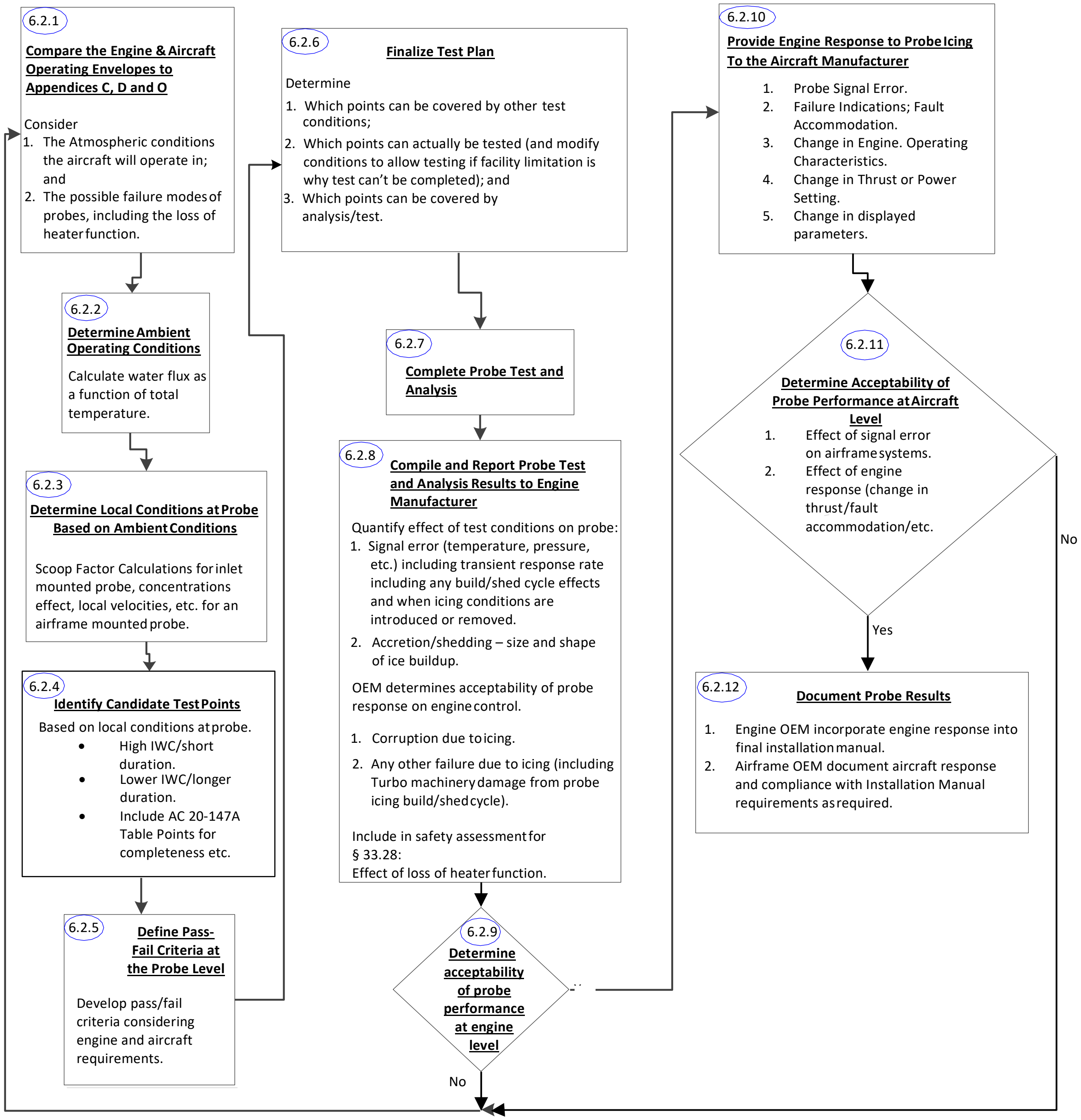
5.1.5 Although the need for reliable and accurate airspeed, temperature, and pressure data is addressed by §§ 33.28, 33.68, 33.89, 33.91, 25.901(c), 25.1093(b), 25.1303(b) and 25.1309, there is no airworthiness standard that requires applicant showings for engine probes separate from the engine control system. Historically, testing of engine inlet probes occurs during the engine's § 33.68 induction icing system compliance testing used to demonstrate continuous operation throughout the supercooled water droplet icing environment described in Appendix C to Part 25. Turbine engine inlet probes are also typically subjected to DO-160 standards and test procedures during § 33.91 testing, but DO-160F, the latest version as of this writing, does not address the effects of ice crystals on turbine engine inlet probes. FAA TSO-C16b describes the minimum performance standards for Pitot (total pressure) probes and Pitot-static (combined total and static pressure) probes. TSO-C16b and SAE AS5562 describe methods to evaluate the performance of such probes in icing conditions. This AC describes methods that assess the performance of temperature probes, combined temperature-and-pressure probes, and static pressure probes in mixed phase and ICI conditions to support design and installation requirements related to engines and airframe systems including § 33.68(e).

5.1.6 This AC assumes that the engine manufacturer knows or has an intended installation in mind (a specific airplane model or manufacturer). Otherwise, the engine manufacturer should document probe assumptions, capabilities and pass/fail criteria in the engine installation manual (ref. § 33.5 (a)(4) through (6)), for later use by the airplane engine installer.

6. GUIDANCE.

6.1 Icing Probe Method of Compliance.

6.1.1 This AC provides a structured method of compliance for engine and aircraft manufacturers to show how turbine engine inlet probes perform in mixed phase and ICI conditions to support compliance with § 33.68 and other referenced regulations. This AC also describes a process applicants can use to target their analysis and develop tailored test points to show compliance with the requirements related to probe icing. Consider this method for any temperature or pressure probe that provides data to the engine control system or airframe systems, whether installed in the engine or on the airframe. Figure 1 illustrates the structured method of the compliance process. A detailed explanation of each step in the process follows. The numbered blocks in Figure 1 are consistent with the sub-paragraphs of section 6.2.



6.2.1 **Compare the Engine & Aircraft Operating Envelopes to Appendices C, D and O**

Consider
1. The Atmospheric conditions the aircraft will operate in; and
2. The possible failure modes of probes, including the loss of heater function.

6.2.2 **Determine Ambient Operating Conditions**

Calculate water flux as a function of total temperature.

6.2.3 **Determine Local Conditions at Probe Based on Ambient Conditions**

Scoop Factor Calculations for inlet mounted probe, concentrations effect, local velocities, etc. for an airframe mounted probe.

6.2.4 **Identify Candidate Test Points**

Based on local conditions at probe.
- High IWC/short duration.
- Lower IWC/longer duration.
- Include AC 20-147A Table Points for completeness etc.

6.2.5 **Define Pass-Fail Criteria at the Probe Level**

Develop pass/fail criteria considering engine and aircraft requirements.

6.2.6 **Finalize Test Plan**

Determine
1. Which points can be covered by other test conditions;
2. Which points can actually be tested (and modify conditions to allow testing if facility limitation is why test can't be completed); and
3. Which points can be covered by analysis/test.

6.2.7 **Complete Probe Test and Analysis**

6.2.8 **Compile and Report Probe Test and Analysis Results to Engine Manufacturer**

Quantify effect of test conditions on probe:
1. Signal error (temperature, pressure, etc.) including transient response rate including any build/shed cycle effects and when icing conditions are introduced or removed.
2. Accretion/shedding – size and shape of ice buildup.

OEM determines acceptability of probe response on engine control.

1. Corruption due to icing.
2. Any other failure due to icing (including Turbo machinery damage from probe icing build/shed cycle).

Include in safety assessment for § 33.28:
Effect of loss of heater function.

6.2.9 **Determine acceptability of probe performance at engine level**

6.2.10 **Provide Engine Response to Probe Icing To the Aircraft Manufacturer**

1. Probe Signal Error.
2. Failure Indications; Fault Accommodation.
3. Change in Engine. Operating Characteristics.
4. Change in Thrust or Power Setting.
5. Change in displayed parameters.

6.2.11 **Determine Acceptability of Probe Performance at Aircraft Level**

1. Effect of signal error on airframe systems.
2. Effect of engine response (change in thrust/fault accommodation/etc.

6.2.12 **Document Probe Results**

1. Engine OEM incorporate engine response into final installation manual.
2. Airframe OEM document aircraft response and compliance with Installation Manual requirements as required.

Numbers in Ovals Correspond to Paragraph Numbers in AC text

Figure 1. Process Flow Chart

6.2 **Method of Compliance.**

6.2.1 Compare engine and aircraft operating envelopes to Appendix C to Part 33 and Appendices D and O to Part 25. The initial step requires defining the engine and aircraft operating envelopes (altitude, airspeed, temperature) relative to the environmental icing conditions considered for certification. Compare Appendix C to Part 25 and Appendix D to Part 33 environmental icing envelopes with the applicable airworthiness standards for the aircraft to determine the applicability of those envelopes. As required, evaluate Appendix O to Part 25 icing envelope to support the engine and/or aircraft certification.

6.2.1.1 Appendices C and O to Part 25 and Appendix D to Part 33 apply to turbine engines except for turboshaft engines. The icing conditions depicted in Appendix O to Part 25 and Appendix D to Part 33 do not apply to turboshaft engines or their installations. Under § 33.68(b), turboshaft engines need only comply with the icing conditions depicted in Appendix C to Part 29.

6.2.1.2 At the aircraft level under 14 CFR 25.1093(b)(3), the icing conditions depicted in Appendix O to Part 25 do not apply to turbine engine induction systems on part 25 airplanes with a maximum takeoff weight equal to or greater than 60,000 pounds. Section 25.1093(b)(1) requires that turbine engine induction systems on part 25 airplanes with a maximum takeoff weight equal to or greater than 60,000 pounds comply with the icing conditions depicted in Appendix C to Part 25, Appendix D to Part 33, and in falling and blowing snow within the limitations established for the airplane for such operation. Section 23.2415(b) requires that the powerplant installation design prevent any accumulation of ice or snow that adversely affects powerplant operation in those icing conditions for which certification is requested. Guidance for part 23 airplanes is available in ASTM F3120.

6.2.1.3 The applicant should account for exposure to extended operations (ETOPS) if proposed as part of the engine or airplane certification basis. The applicant should confirm there is no impact to the probe operation during a maximum length diversion since probes tend to react to ICI in significantly less than one-hour exposures, the minimum threshold diversion time for ETOPS. If the applicant finds there is an impact to probe operation during a maximum length diversion, then the applicant should account for the effect when showing compliance to section K25.1.3(a) of Appendix K to Part 25.

6.2.1.4 In support of engine and airframe safety analyses, identify and consider at this stage the proposed probe possible failure modes. For example, if the probe is heated, account for the failure of the heater element in the appropriate safety analysis. It is not necessary to demonstrate these failure modes as part of the test program; however, an applicant should explain the failure modes, so the installer of the probe understands the impact of probe failure.

6.2.1.5 Early in development, account for the integrity of the data provided from the probe. That way, the airframe and engine manufacturers can determine what systems the probe is acceptable for (i.e., systems with catastrophic safety effects will require a more reliable probe or multiple data sources, whereas systems with only minor safety effects may be able to utilize data from a less reliable probe).

6.2.1.6 Figure D1 in Appendix D to Part 33, entitled "*Convective Cloud Ice Crystal Envelope*," shows the temperature-altitude envelope for ICI. The envelope covers altitudes up to ~46,000 feet and temperatures down to -60°C, based on atmospheric and airline operation data available at publication. More recent data shows that ICI can occur at higher altitudes and lower temperatures than in Figure D1. For that reason, if an airplane manufacturer expects the airplane envelope to extend above the envelope shown in Figure D1, evaluate that part of the envelope for ICI vulnerability.

6.2.2 <u>Determine ambient operating conditions</u>. Appendices C and O to Part 25 and Appendix D to Part 33 icing envelopes describe ambient or free stream concentrations of liquid water and ice crystals. Use these concentrations and the aircraft operating speeds to calculate water flux as a function of total temperature. For glaciated testing, the highest water flux cases tend to be the most severe. This testing is not necessarily the case for super-cooled liquid water or mixed phase. Other parameters to account for in selecting critical points include the highest total cooling load, minimum predicted surface temperature, maximum water to air mass flux ratio, etc.

6.2.2.1 Within the mixed phase, the ice crystal envelope described in Appendix D to Part 33, TWC in g/m^3 is based upon the adiabatic lapse defined by the convective rise of 90% relative humidity air from sea level to higher altitudes. The TWC is scaled by a factor of 0.65 to a standard cloud length of 17.4 nautical miles. In-service experience shows that several temperatures and pressure probe icing events in glaciated conditions have occurred outside Appendix D to Part 33 envelope altitude and outside air temperature limits. Events have occurred in conditions outside of those considered by Appendix D to Part 33, encompassing International Standard Atmosphere (ISA) +30°C conditions and down to a minimum temperature of -70°C. Events have also happened outside Appendix D to Part 33 envelope down to ISA -5°C conditions above 25,000 ft. In that context, applicants may want to consider evaluating the icing environment within the portion of the aircraft operating envelope that is outside Appendix D to Part 33, such as that described in SAE AS5562.

6.2.2.2 In addition, data suggest that the standard cloud of 17.4 NM and the associated average TWC values described in Appendix D to Part 33 may not provide an appropriately conservative set of conditions for air data probe testing. Service data experience suggests that peak ice-crystal concentration values (not average values) are critical to probe ice freeze over or blockage. The 'max' or 'peak' TWC values occur at shorter distances than shown in Figure D3 of Appendix D to Part 33. Account for the peak TWC values with the '17.4 NM' values provided by Appendix D to Part 33. These 'max' or 'peak' adiabatic values are depicted in FAA Report No. DOT/FAA/AR-09/13 and SAE AS5562, and correspond to the '17.4 NM' values multiplied by a factor of 1.538 (1/0.65). See discussion on mixed phase values below in paragraph 6.2.4.8.

6.2.3 Determine local conditions at probe based on ambient conditions. Based on the ambient operating conditions determined in paragraph 6.2.2 above, define the local conditions at the probe. Probes are typically mounted a sufficient distance from the mounting surface (e.g., the fuselage skin or engine inlet) to accurately sense the freestream parameter of interest (total temperature, total pressure, etc.). However, when flying through particles such as supercooled water droplets, ice crystals, or rain, there can be a concentration effect near the mounting surface. This concentration effect is primarily due to inertia and drag effects, but large particles that splash or break up yet remain in proximity to the boundary layer can also affect the results. This effect is highly installation-dependent and can vary significantly depending on probe location and probe design.

6.2.3.1 The determination of local conditions involves reviewing the installed position of the probe (e.g., in the engine inlet or on the airframe) and determining local flow velocities and concentration effects for airframe mounted probes or scoop factor effects for inlet mounted probes. AC 20-73A, Appendix I presents some of the methods used to calculate drop impingement and water catch at the location of interest for supercooled liquid water cases. For ICI conditions, currently there is no standardized method for calculating ice crystal trajectories, nor the effects of ice crystals breaking up. Both of these ice crystal events have a significant effect on the local concentration levels. Preliminary research indicates the ice crystal concentration can be significantly higher than ambient conditions (reference SAE Technical Papers 2011-38-0050 and 2015-01-2146), so conservative assumptions should be made regarding local IWC for ICI conditions using state of the art analytical tools. Document the assumptions made regarding concentration factors, and provide justifications for those assumptions.

6.2.3.2 Complete a similar analysis to determine local conditions for probes installed in other places, such as behind the fan on a turbofan engine or in the core of the engine. The conditions in those locations may be significantly different from the free stream or ambient conditions, including local probe angle of attack, Mach number, pressure, temperature, etc.

6.2.4 Identify candidate test points. Based on the local conditions at the probe, identify candidate test points, including peak and cyclic conditions. Test a range of temperatures representative of the icing envelopes for the probes.

6.2.4.1 The probe design should be analyzed to determine whether the probe is more susceptible to higher TWC for short durations, to lower TWC for longer durations, or to cyclic conditions, such as those defined in Test Condition 3 of § 33.68, Table 1 (14 CFR Part 33, Amendment 34). As noted in paragraph 6.2.2 above, the maximum ambient TWC should account for peak TWC conditions corresponding to the values of Appendix D to Part 33, multiplied by 1.538.

6.2.4.2 In addition to the peak adiabatic TWC conditions discussed above, test points with reduced ambient TWC and extended duration should be included. Testing at different TWC provides evidence that the installed probe will work throughout the operating envelope and not just at the maximum level. Scale back the peak concentration to a standard (17.4 nm) cloud by dividing the peak TWC values by 1.538. Testing at a concentration of one half of the peak value is appropriate. From Appendix D to Part 33, Figure D3, the scale factor for the standard cloud is 1, and the scale factor for one half of the peak value is ½*1.538 = 0.769. Based on Appendix D to Part 33, Figure D3, this scale factor corresponds to a cloud extent of approximately 215 nm. A review of in-service engine ICI events (reference SAE paper 2015-01-2086) shows that the 99th percentile cloud length for events where engine damage occurred is 354 nm (657 km), with the majority of engine events occurring in clouds of less than 215 nm (400 km) in length. Experience has shown that, in general, probes do not take as long to respond to ICI as engines do, and therefore it is reasonable to reduce the maximum cloud length for a probe to 215 nm and use the corresponding TWC of one-half the peak value.

6.2.4.3 Consider the time duration of each test point. In general, 2 minutes is a sufficient length of time to evaluate the probe's behavior when demonstrating compliance with Appendix D to Part 33. However, for cases where ice builds up on external probe surfaces, extend the test point duration as required to quantify the size of ice that may accrete and thoroughly evaluate any build/shed cycles. For the reduced concentration points, run the tests for a sufficient length of time to traverse a 17.4 nm or 215 nm cloud as appropriate to the test condition. For a typical transport airplane at cruising airspeed, traversing a 17.4 nm cloud takes about 2 to 3 minutes. For these cases, the conditions completed with the peak TWC for 2 minutes is a more severe test than 2 to 3 minutes at a reduced TWC. Therefore, you can eliminate the lower TWC case from consideration. For a typical transport airplane at cruising airspeed, a 215 nm cloud takes approximately 25 minutes to traverse. To ensure the test adequately addresses the concerns, run the half-peak TWC conditions for 30 minutes (17.4 nm / 2 minutes = 8.7 nm/minute, therefore 215/8.7 = 24.7 minutes rounded up to 30 minutes).

6.2.4.4 In regards to liquid water icing testing for engine-mounted components, test or analysis points should be identified per the conditions stated in Table 1 of § 33.68. This testing requires 10-minute duration glaze ice and rime ice tests at various power settings (airflows) as well as 45-minute glaze and rime ice holding conditions.

6.2.4.5 For airframe mounted temperature probes, identify test or analysis points per the conditions stated in Tables 1 and 2 of this AC. Table 1 requires steady-state 15-minute durations representing continuous maximum cloud concentrations and 5-minute durations representing intermittent maximum cloud concentrations. Table 2 requires either cyclical tests at the liquid water concentrations shown. For the Table 2 tests, set the LWC as follows:

6.2.4.5.1 For 28 km in the conditions of column (a) appropriate to the temperature, followed by 5 km in the conditions of column (b) appropriate to the temperature, for a duration of 30 minutes.

6.2.4.5.2 For 6 km in the conditions of column (a) appropriate to the temperature, followed by 5 km in the conditions of column (b) appropriate to the temperature, for a duration of 10 minutes.

Test number	Static Air Temperature (°C)	Altitude Range (ft)	LWC (g/M^3)	Duration (min)	MVD (µM)
SL1	-20	0-22,000	0.22 to 0.3	15	15 to 20
SL2	-30	0-22,000	0.14 to 0.2	15	15 to 20
SL3	-20	4,000-31,000	1.7 to 1.9	5	15 to 20
SL4	-30	4,000-31,000	1 to 1.1	5	15 to 20

Table 1: Stabilized Icing Conditions

Test number	Static Air Temperature (°C)	Altitude (ft)	LWC (g/M^3)		MVD (μM)
			(a)	(b)	
SL5	-10	17,000	0.6	2.2	20
SL6	-20	20,000	0.3	1.7	20
SL7	-30	25,000	0.2	1.0	20

Table 2: Cycling Icing Conditions

6.2.4.6 For both engine-mounted and airframe-mounted probes, in addition to the tests or analysis defined in 6.2.4.5 above, perform a critical point analysis based on Appendix C to Part 33 requirements to determine if there are additional critical points within the operating envelope. The critical points, which the engine is tested against to show compliance with § 33.68, may or may not be critical points for the probe. For example, high airflow conditions like maximum continuous power may be more critical for an inlet-mounted probe than for the engine as a whole. Therefore, it is important to determine the critical conditions for the probe as part of this step and not rely solely on the § 33.68 points for demonstrating the proper operation of the probe. The points defined in § 33.68 and Tables 1 and 2 represent conditions at the engine inlet for the installation. For a component (probe) test, the appropriate concentration factor needs to be determined so that the local conditions at the probe match installed conditions.

6.2.4.7 For unheated probes in liquid water environments, evaluate the impact of ice accumulation and shedding in regards to altitude. Consider analysis and testing at altitude. Heated probes may be tested in liquid water conditions in a non-pressure controlled (sea level or ambient conditions) wind tunnel, if that would be more conservative than testing at higher altitudes.

6.2.4.8 If a probe has more than one operating mode (e.g., a de-icing cycle), verify the proper operation in all operating modes.

6.2.4.9 In regards to mixed liquid and ice crystal conditions, select test/analysis points with the TWC based on a 2.6 nautical mile cloud. The TWC for a 2.6 nautical mile cloud corresponds to the '17.4 NM' values multiplied by a factor of 1.175.

6.2.4.9.1 Appendix D to Part 33 describes the liquid water portion of mixed phase conditions as ≤ 1.0 g/m^3 for clouds of less than 50 nautical mile extents for temperatures above -20°C and zero for temperatures below -20°C.

6.2.4.9.2 SAE AS5562 assumes the LWC is per the Appendix C to Part 25 intermittent maximum cloud, and the remainder of the TWC is ice crystals.

6.2.4.9.3 When performing mixed phase condition tests, use the LWC described in Appendix C to Part 25 for an intermittent maximum cloud and ice crystals for the balance of the TWC. Using these test conditions results in consistency with AS5562 and conservatively simulates mixed phase conditions in colder conditions.

6.2.4.10 Consider the time duration for mixed phase icing test points. For the maximum TWC in mixed phase conditions, test conditions lasting 2 minutes are appropriate, as this is sufficient time for an air data probe to reach a steady state and stabilized condition. In addition, flight testing in well-developed, large-diameter mesoscale convective systems completed as part of the FAA/EASA/Industry High-Altitude Ice Crystals/High Ice-Water Content (HAIC/HIWC) flight test campaigns showed a low frequency of mixed phase regions.

6.2.4.10.1 During the HAIC/HIWC flight tests, -10°C mixed phase regions amounted to less than about 5% of the total in-cloud distance traversed and maximum average distances across mixed phase zones were about eight nautical miles. The frequency of mixed phase zones decreased with decreasing temperature. Well-developed storm cells can produce large amounts of falling and recirculating ice that tend to glaciate any new updraft, thus resulting in lower LWCs and smaller regions of mixed phase conditions. For smaller or still developing cells with less glaciation and less circulation, regions of mixed phase conditions with higher LWC could exist for longer times. While traversing the storm, these areas of mixed phase conditions are still likely to exist as separate regions within the storm, resulting in alternating between mixed phase and fully glaciated conditions.

6.2.4.10.2 A conservative approach to represent these smaller or fresh convective cells is to perform a cyclic test alternating between mixed phase and fully glaciated conditions. In addition to the test conditions for maximum TWC conditions for two minutes, test points should include cycling between mixed phase and fully glaciated conditions. For these cyclic conditions, set the TWC to one-half of the 2.6 nautical miles scaled TWC. This lower TWC is justifiable as the HAIC/HIWC flight test results indicate that extended regions of liquid water seem less likely in high IWC conditions. Therefore, lower IWC and the resulting lower TWC values are necessary to sustain mixed phase conditions without transitioning to fully glaciated conditions. Because the HAIC/HIWC flight tests did not evaluate mixed phase conditions in developing storm cells, a conservative estimate of LWC should be used. To define a conservative test, assume LWC equal to the Appendix C to Part 25 Intermittent Maximum value for the test conditions. As discussed below, other engine or airframe level mitigation may be necessary to ensure acceptable aircraft operation, depending on the test results in these conservative conditions. Each cycle should alternate between 2 minutes in mixed phase conditions and 2 minutes in fully glaciated conditions. To simulate an engine flying through a developing storm system or holding in such conditions, continue cycles until the probe experiences repetitive stabilized operation, or operation for a maximum of 30 minutes.

6.2.4.10.3 For heated probes, account for test conditions with the heater turned off. The purpose is to address an inadvertent icing encounter where the heater is not turned on immediately or a transient power interruption. For example, some engine anti-ice systems link to nacelle anti-ice, requiring the pilot to activate the system. Such normal, non-failure interruptions to probe heat should not result in erroneous probe signals. The timing should be coordinated with the engine and airframe manufacturers to define appropriate conditions. Paragraph 6.2.1.4, above, discusses evaluation of failure modes.

6.2.5 Define test pass-fail criteria at the probe level. Considering engine and aircraft-level requirements, define the pass/fail criteria for the candidate test points determined in paragraph 6.2.4 above. Pass/fail criteria should consider a system level analysis developed by the probe, engine, and airframe manufacturers.

6.2.5.1 Ice buildup on a probe should not adversely influence probe function. The probe remaining free of ice is not necessarily the only pass criteria. Applicants should develop acceptance criteria upon consideration of the criticality of the probe and the air data it provides to the engine and the airframe. One simplified acceptance criterion is for the engine and airframe systems that utilize the data from the probe to continue to operate within an acceptable range in icing conditions. In all expected operating conditions, the probe should perform its original intended function; for example, measuring air temperature within some reasonable accuracy, rather than measuring probe heater temperature. The probe manufacturer can typically only quantify the effect at the probe level (e.g., the probe output/accuracy is ±x° when exposed to a specific condition). The engine manufacturer should translate that probe effect into the resulting system impact at the engine level (e.g., ±x° of measured temperature error equates to ±y thrust or some impact on engine operability). The airframe manufacturer needs to know the probe level effect (e.g., ±x° measured temperature error) and the installation level effect on airframe systems that use data from the probe along with the engine effect and the impact the engine effect has at the aircraft level.

6.2.5.2 The applicant should evaluate potential ice shedding from the probe as part of the pass/fail criteria to ensure no damage to downstream components occurs from ice shedding.

6.2.5.3 Applicants should also account for different atmospheric conditions and the possible failure modes of the probe when developing acceptance criteria. Some failure modes include:

- In ICI conditions, a probe may clog with partially melted crystals driving the probe to read 0°C (the temperature of the slush) continuously.
- Smaller errors for some short periods.
- Fluctuations in the probe output with ice build and shed cycles. Pressure probes may clog with ice, resulting in a fixed or unchanging signal without normal signal noise.

6.2.6 Finalize test plan. Applicants should complete an analysis of the test points identified in paragraph 6.2.4. Evaluate the points to determine which points are covered by other conditions or covered by analysis supported by other test conditions. Also, evaluate the points to determine if the proposed test facility can perform the specific test conditions. When a test facility limitation precludes a particular test condition, an applicant may use the scaling methods of AS5562, sections 3.3.2 through 3.3.4, to vary temperature, airspeed, and water flux to achieve defined equivalent test conditions. If a significant number of test points require modification in this manner, consider an alternate test facility capable of testing more of the proposed envelope to minimize the number of candidate points not directly tested.

6.2.6.1 As noted in AS5562 section 3.3.1, there is no acceptable method to scale the altitude for ICI conditions at this time. Therefore, test ICI conditions at the altitude determined in paragraph 6.2.5. Test facilities capable of testing probes in ICI conditions at altitude are available. It may be possible to change the probe design such that any untested points are no longer critical. Alternatively, it may be possible to impose limitations on the probe's operating envelope. However, this may require engine or aircraft level design changes or limitations. Identify and communicate any limitations on the probe installation to the engine and aircraft manufacturers so those manufacturers can adhere to the limitations as installed.

6.2.6.2 As stated in paragraph 6.2.4.9.3, you should account for the engine and aircraft level effects of loss of the heater function as appropriate. Address the loss of the heater function either in a test matrix or by analysis. This activity documents the effect on the probe with the heater inoperative in the worst case icing conditions.

6.2.7 Complete probe test and analysis. Complete testing of all conditions identified in paragraph 6.2.6 above in a facility capable of meeting the test conditions. The configuration of the test article should match the intended installation, including orientation, as closely as possible, and the probe itself should match the type design configuration, except as necessary to install instrumentation or other test equipment. Meet the following criteria for each test condition.

6.2.7.1 SAE AS5562 test criteria. The following test characteristics should be consistent with the requirements defined by SAE AS5562:

- Probe Mounting Location.
- Probe Mount Heating Requirements.
- Installation Heat Sink Effects.
- Probe Power for Electrically Heated Probes.
- Tunnel Blockage.
- Data Collection Sample Rate.
- Electrically Heated Probe Test Unit Selection.

6.2.7.2 Non-electrically heated probes. For heated probes using some method other than an electrical heater, set the heat source to the minimum allowable value expected for the installation. For example, test a probe that is heated using bleed air with the bleed air supply at the minimum expected regulation pressure and temperature. Provide the specific air supply conditions tested to the installer to support installation approval. It is essential to characterize this air supply fully, including in-line pressure drop, piping clearances, local heat transfer characteristics, and any control orifices in the supply line or sensor.

6.2.7.3 Non-electrically heated probe test unit selection. Perform probe qualification tests on a unit having the lowest performance acceptable on a production article as defined by the acceptance test procedure. If necessary, adjust the inputs to simulate the lowest performing probe (e.g., a bleed air heated probe may have the air pressure or air temperature adjusted to simulate the lowest performing probe heater).

6.2.7.4 Angle of attack (AOA). Account for the effect of AOA in the intended installation. Coordinate the AOA of the tested probe location with the engine/aircraft manufacturer to cover all operational scenarios. If determined that the AOA will have no significant impact, run all test conditions at a single AOA. If the AOA could have an impact, test the probe at AOAs of -15°, 0° and +15° for each icing test condition, or if nominal AOA is known, nominal -15°, nominal, and nominal + 15° for each icing condition.

6.2.7.5 Test particle size distribution. The particle size median mass dimension for the test conditions must match that defined by Appendix D to Part 33 (50-200 microns equivalent spherical size) unless justified that a different size will not significantly affect the test.

6.2.7.6 Test duration. Run steady-state ice crystal conditions tests completed at the peak TWC values for 2 minutes and run tests completed at one-half of the peak TWC value run for 30 minutes.

6.2.7.6.1 For mixed phase condition tests, run tests conducted at the maximum TWC values for 2 minutes. Run the tests conducted at the reduced TWC values as cyclic tests. Each cycle should alternate between 2 minutes in mixed phase conditions and 2 minutes in fully glaciated conditions. Continue the cycles until the repetitive, stabilized operation has been shown, or for a maximum of 30 minutes.

6.2.7.6.2 For liquid water icing conditions, identify test/analysis points per the conditions stated in Tables 1 and 2. This testing requires 15-minute durations per continuous maximum cloud concentrations, 5-minute duration per intermittent maximum cloud concentrations, and either 30-minute or 10-minute duration cyclical liquid water concentrations.

6.2.8 Compile and report probe test and analysis results to engine manufacturer. Produce the test report. The test and analysis results should quantify the effect of the conditions on the probe including:

- Signal error (temperature, pressure, etc.), including transient response rate, any build/shed cycle effects, and when icing conditions are introduced or removed.
- Measurement accuracy and any changes upon introduction or removal of icing conditions, and any changes when a probe heater is turned on or off.
- Accretion/shedding - size and shape of ice buildup.

- The frequency of build/shed cycles, impact on signal error, and probe transient response to shedding.

Provide the results of the testing and analysis to the engine manufacturer so that the acceptability of the probe response can be determined. The engine manufacturer should evaluate the effect on the engine of variations in the probe output signal due to icing and any other failure modes observed during the testing.

6.2.9 Determine acceptability of probe performance at engine level. Based on the testing and analysis results, the engine manufacturer should determine whether the effect of the probe response to the icing conditions meets the requirements of § 33.68. If the response is not acceptable, review the pass/fail criteria to ensure an acceptable defined engine response and repeat the process from paragraph 6.2.1. The reason for reviewing all of the steps is that the revised system analysis may require a review of the candidate test points or design changes to the probe or installation (for example engine control system changes).

6.2.9.1 It is important to note, do not change the pass/fail criteria to match the results. Instead, repeat the system analysis step to ensure correctness and ensure the design is reviewed or changed as necessary.

6.2.9.2 The engine manufacturer should account for uncertainty regarding probe-level test data validity: for an engine inlet probe, static testing outside of the engine inlet system may not exhibit the same build and shed behavior due to variations in airflow and vibration levels. Results from an integrated inlet/engine test could be quite different due to changes in vibration and local airflow and may result in differences in shedding behavior than an isolated probe in an icing tunnel.

6.2.10 Provide engine response to probe icing to the aircraft manufacturer. The engine manufacturer should document the response of the engine based on the probe response to the icing conditions tested and provide that response to the airframe manufacturer. The engine response evaluation should address:

- Probe Signal error.
- Failure indications/Fault accommodation.
- Changes in engine operating characteristics (surge/stall, flameout, etc.) due to signal error.
- Change in thrust or power setting.
- Change in displayed parameters.

6.2.11 Determine acceptability of probe performance at aircraft level. As part of the aircraft certification and compliance demonstration activities, the aircraft manufacturer should review the data provided by the engine manufacturer in paragraph 6.2.10 above to determine the impact on the aircraft. The aircraft manufacturer may need information on the probe location in the engine, etc., from paragraph 6.2.7.1, above, to complete this review.

Based on the testing and analysis results, the aircraft manufacturer should determine whether the effect of the probe response to the icing conditions is acceptable at an aircraft level, as part of the aircraft certification and compliance demonstration activities. If the probe response is not acceptable at the aircraft level, the aircraft manufacturer should review the pass/fail criteria to ensure aircraft-level requirements are clearly defined, and repeat the process from paragraph 6.2.1. The revised system analysis may necessitate a review of the candidate test points and/or design changes to the probe or installation, and/or re-evaluation of the aircraft response.

6.2.11.1 Engine probes usually are part of the engine type design and therefore, the engine manufacturer is primarily responsible for evaluating the probe. When the engine utilizes an aircraft probe, the aircraft manufacturer is primarily responsible for assessing whether the probe meets aircraft-level requirements (such as 14 CFR 25.1323 or 25.1324). Regardless of primary responsibility, however, it is vital that both the aircraft and engine manufacturer communicate requirements and capabilities early and throughout the certification process.

6.2.11.2 When the engine probe is part of the engine type design, the engine manufacturer will still need information on the engine installation. The aircraft manufacturer should coordinate with the engine manufacturer to determine what installation information is required under 14 CFR 33.5. The aircraft manufacturer should provide the engine manufacturer with appropriate information to support the engine manufacturer’s design and compliance demonstration.

6.2.11.3 The aircraft manufacturer should also ensure that the engine manufacturer provides the necessary information about the engine probe and engine type design to facilitate demonstrating compliance to relevant aircraft certification requirements, such as 14 CFR §§ 25.901(c), 25.1093(b), 25.1309, 25.1324, and 25.1325.

6.2.11.4 When the aircraft probe is part of the aircraft type design and utilized by the engine manufacturer, the aircraft manufacturer should coordinate with the probe manufacturer and engine manufacturer as necessary. The aircraft manufacturer should refer to AC 25-28 for additional information on certification requirements for flight in icing conditions for aircraft probes.

6.2.12 Document probe results. Complete the final documentation of the probe, engine, and aircraft response to the icing environments, to show compliance with relevant engine and aircraft requirements (e.g., §§ 33.68 and 25.1394). The final documentation should include the engine manufacturer incorporating information about the engine response into the engine installation instructions provided under 14 CFR § 33.5. This information should consist of the data provided to the airframe manufacturer in paragraph 6.2.10 above, a description of the icing environments evaluated, and any other pertinent data from the safety assessments required by §§ 33.28(e) and 33.75(a), describing the probe and engine response. As part of the aircraft certification and compliance demonstration activities, the airframe manufacturer should document the response and compliance with any requirements included in the engine installation instructions as required. Aircraft-level documents that might be affected include the Airplane Flight Manual, the system safety documentation for the aircraft, compliance documents, etc.

7. SUGGESTIONS FOR IMPROVING THIS AC.

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback Form at the end of this AC.

End

Appendix 2 – Additional EASA comments

in relation to draft FAA AC published in April 2022 (see Appendix 1)

EASA comment #1:

Regarding paragraph 6.2.4.5 of the draft AC and its Table 2, the LWC conditions should be set in accordance with 6.2.4.5.1 OR 6.2.4.5.2

EASA comment #2:

It should be clear to Applicants that TWC (Total Water Content) = IWC (Ice Crystal Water Content) + LWC (Liquid Phase Water Content)

End of EASA comments