Transport Canada Transports Canada

Advisory Circular

Subject: **Ice Aerodrome Development – Guidelines and Recommended Practices**

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1.0 INTRODUCTION

(1) This Advisory Circular (AC) is provided for information and guidance purposes. It may describe an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

1.1 Purpose

(1) The purpose of this document is to provide a set of guidelines or best practices for the development, operation, and on-going maintenance of ice aerodromes, including guidelines for the development and publication of an instrument procedure (IP) to an ice runway.

1.2 Applicability

(1) This document applies to ice aerodrome operators, air operators, instrument approach procedures designers, Aeronautical Information Services (AIS)/Air Navigation Services (ANS) providers, Transport Canada Civil Aviation (TCCA) personnel, and of interest to the aviation industry in general.

1.3 Description of Changes

(1) Not applicable.

2.0 REFERENCES AND REQUIREMENTS

2.1 Reference Documents

(1) It is intended that the following reference materials be used in conjunction with this document:

(a) *Aeronautics Act* (R.S., 1985, c. A-2);

(b) Part III, Subpart 01 of the *Canadian Aviation Regulations* (CARs) — *Aerodromes;*

(c) Part VIII, Subpart 03 of the CARs — *Aeronautical Information Services*;

(d) Transport Canada Publication (TP) 312 – *Aerodrome Standards and Recommended Practices*;

(e) TP 308, Change 5.2 – *Criteria for the Development of Instrument Procedures*;

(f) TP 4884 – *Water / Ice Aerodrome Standards and Recommended Practices;*

(g) International Civil Aviation Organization (ICAO) Annex 4 to the Convention on International Civil Aviation — *Aeronautical Charts*;

(h) ICAO Annex 10 to the Convention on International Civil Aviation — *Aeronautical Telecommunications*;

(i) ICAO Annex 15 to the Convention on International Civil Aviation — *Aeronautical Information Services*;

(j) Advisory Circular (AC) 300-001 — *Processing of Aerodrome Aeronautical Information;*

(k) AC 301-001 — *Procedure to be followed in order to support Instrument Approach Procedures (IAP) at a non-certified aerodrome*;

(l) AC 301-002 — *Aerodrome Registration;*

(m) AC 803-004 — *Restricted Instrument Procedures;* and

(n) NAV CANADA Aeronautic Information System (AIS) Publication – *Restricted Canada Air Pilot* (RCAP) and *Restricted Instrument Procedures* (RIPs) Manual (electronic format).

2.2 Cancelled Documents

(1) Not applicable.

2.3 Definitions and Abbreviations

(1) The following **abbreviations** are used in this document:

(a) **ICAO:** International Civil Aviation Organization

(b) **IP**: Instrument Procedure;

(c) **IMC**: Instrument Meteorological Conditions;

(d) **kN**: kilo-newton;

(e) **NOTAM**: *Notice to Airmen*;

(f) **SI**: The international system of units of measurement;

(g) **VMC**: Visual Meteorological Conditions; and

(h) **RIP**: Restricted Instrument Procedure.

(2) The following **definitions** are used in this document:

(a) **Frazil:** an accumulation of ice crystals in water that is too turbulent to freeze solid *(Oxford Dictionary, 10th edition)*;

(b) **Kilo-newton (kN):** is the SI derived unit of force;

(c) **Qualified Ice Specialist**: a person who has successfully completed training in the study of load bearing characteristics of snow and ice covers;

(d) **Qualified Instrument Procedure Designer:** as defined in Subsection 803.02(b) of the CARs "a person who has successfully completed training in the interpretation and application of the standards and criteria specified in the manual entitled *Criteria for the Development of Instrument Procedures*, which training has been accepted by the Minister"; and

(e) **Sponsor:** an individual or organization that has agreed to assume the regulatory and fiscal responsibility for an instrument procedure at an aerodrome, heliport or operational location. Sponsors may be air, private or aerodrome operators, or other organizations.

3.0 BACKGROUND

(1) Originally published in 1985, Transport Canada publication (TP) 4884 – *Water / Ice Aerodrome Standards and Recommended Practices* document included acceptable standards and recommended practices for the development and operation of both water and ice aerodromes.

(2) During development of the *Canadian Aviation Regulations* (CARs) of the 1990's, the TP 4884 standards and recommended practices were not incorporated by reference into Part III of the CARs regulations effectively becoming guidance material for development of water and ice aerodromes. In 1995, the sections of TP 4884 dealing with **ice aerodromes** was superseded by information provided in a TCCA Engineering Services Report titled *Floating Ice Thickness for Aircraft Operations*. This report resulted from a project undertaken in cooperation with the National Research Council and the Department of National Defence.

(3) This AC primarily incorporates many of the guidelines and recommended practices presented by the report, in the areas of planning, development, management, and safe operation of aircraft on floating ice covers (both fresh water and sea ice).

(4) Additionally, this AC provides guidance for the development of IPs to be used by aircraft operators that would enhance their ability of acquiring the runway environment during periods of Instrument Meteorological Conditions (IMC) or minimal Visual Meteorological Conditions (VMC) that may otherwise preclude more frequent use of this type of facility.

4.0 SITE CONSIDERATIONS

4.1 Initial Planning

(1) All aerodromes in Canada, including those that are not listed in the *Canada Flight Supplement* (CFS) or the *Water Aerodrome Supplement* (WAS), are subject to marking, lighting, equipping and operating in accordance with the Part III of the CARs – *Aerodromes, Airports, and Heliports*.

(2) Prospective ice aerodrome operators should become informed about any local building codes and regulations respecting environmental issues, construction, occupancy, fire orders, and Workers ' Compensation, along with the provision of applicable marine regulations that may apply.

(3) Awareness of the day-to-day problems associated with sudden climatic changes and dynamic forces should be taken into account when considering the suitability of an ice aerodrome. Ice surfaces, unlike a land runway, are constantly changing.

4.2 Runway Characteristics and Considerations

(1) When deciding on the operational length of the ice runway, the operating characteristics of the most demanding aircraft type or types proposing to use the facility should be taken into consideration. The intended air operator(s) should be consulted to obtain the latest operational information or requirements for the aircraft to be used.

(2) It is recommended that the minimum width of the runway is:

(a) 125 ft (38 m) for ice runways up to 2650 ft (800 m) in length;

(b) 150 ft (46 m) for ice runways greater than 2650 ft (800 m) up to 4000 ft (1200 m) in length;

(c) 200 ft (61 m) for ice runways greater than 4000 ft (1200 m) in length.

4.3 Runway Location and Orientation

(1) When deciding on the location and orientation of the ice runway(s), consideration should be given to the following factors:

(a) surface characteristics;

(b) prevalence and nature of gusts and turbulence;

(c) provision against the loss of traffic due to unacceptable cross-wind situations;

(d) high terrain or other obstacles in the vicinity of the aerodrome site;

(e) volume and type of traffic;

(f) confliction with other aerodromes and controlled airspace; and

(g) other surface traffic.

***Note**:*

High terrain or other obstacles in the vicinity of an aerodrome may be assessed as hazardous to the navigable airspace. Such obstacles may affect the usability of the aerodrome.

4.4 Visual Aids

(1) In addition to visual aid regulatory requirements for aerodrome markers, markings, signage, wind direction indicators and runway lighting addressed by Subpart 301 of the CARs, the following guidance is provided:

(a) Markers should be used and installed to delineate the usable limits of ploughed or levelled ice runway surfaces. Surface markings could also be used to supplement the markers.

(b) Mark taxiways, when provided, where it is considered necessary to confine the taxiing of aircraft to safe movement areas.

(c) Confirm that all markers used to outline the runway and taxiways dimensions are:

(i) lightweight;

(ii) frangible;

(iii) of a contrasting colour;

(iv) clearly recognizable on the surface and from the air at a height of 300 m above ground level and at distance of one mile; and

(v) uniformly spaced at longitudinal intervals not exceeding 90 m with one or more markers at each corner of an ice runway, at 90 degrees to the centreline.

(2) Due to the nature of an ice aerodrome, closed markings and unserviceable areas are difficult to properly identify to air operators. TCCA acknowledges the challenges that face ice aerodrome operators and that different methods may be needed to properly identify any closed or unserviceable areas of the aerodrome movement surfaces around which aircraft are permitted to operate. Subsection 301.04(8) of the CARs states:

"*Where the surface of a manoeuvring area or part thereof is snow-covered or otherwise unsuitable for painting or where the closure is not permanent,* ***closed markings may be applied by means of a conspicuously coloured dye or may be constructed from a suitable coloured material or product.***"

4.5 Recommendations

(1) If an IP is planned, consultation with a qualified IP designer is recommended. Further guidance related to IPs to a registered aerodrome can be found in AC 803-004 – *Restricted Instrument Procedures* (RIPs).

(2) If geographic features or ice conditions impose operational limitations on the area declared for the runway, the site Airport Operations Manual (AOM), and/or the required aerodrome attestation (AC 301-001) should be annotated. Consideration and subsequent amendment should be made to any relevant AIS publications (i.e. CFS, WAS, Canada Air Pilot (CAP) etc,) that describe the operational area and any such limitations, otherwise the aerodrome location need only be generally specified.

(3) Aerodrome operators should consider the provision of certain on-shore items that would be needed to support both personnel and passenger safety needs when operating in cold winter weather environments, such as:

(a) personnel and passenger shelters;

(b) communications facilities;

(c) methods of passenger transport to and from shore facilities; or

(d) on-site weather information and reporting services.

(4) Operators considering aerodrome registration, have the responsibility to assure TCCA that no discernable hazards exist within either the runway approach or departure areas that would adversely impact air operator flight safety. This assurance should be provided to TCCA through either a written attestation or physically verified during any site safety inspection conducted as part of the aerodrome registration process and at the discretion of the applicable TCCA Regional Office. Further guidance is provided by TCCA AC 301-002- *Aerodrome Registration*.

(5) Operators intending to accommodate scheduled service for the transport of passengers are encouraged to contact the appropriate TCCA Regional Office for the area where the aerodrome is to be situated. Guidance can be provided on the aerodrome needs or possible certification requirements identified in Subpart 302 of the CARs – *Airports*.

4.6 Seasonal Reconstruction

(1) After every summer thaw and subsequent winter re-construction of the runway and facilities, it is the aerodrome operator's responsibility to ensure that the re-constructed runway has the same location, with the same characteristics (i.e. threshold co-ordinates, alignment, length, elevation etc) as had originally existed when first constructed, and if registered or certified, as had been originally documented, otherwise initiate an aeronautical information amendment in accordance with AC 300-001 —*Processing of Aerodrome Aeronautical Information*. If an IP exists, it is the IP Sponsor's responsibility to ensure that all reconstructed aerodrome reference points that were critical to the original IP, are maintained within IP design and publication/charting limits (see TP308/GPH209 & ICAO Annex 15 Appendix 7)

5.0 RESPONSIBILITIES

5.1 Facility Unserviceability

(1) It is the responsibility of the aerodrome operator to advise users whenever a public facility is not serviceable. In the case of both registered and certified ice aerodromes, the operator is responsible for the issuance of a NOTAM in accordance with the *Canadian NOTAM Procedures Manual*.

(2) At remote sites it is not required to report every minor interruption to aerodrome availability however, both a NOTAM and *Aircraft Movement Surface Condition Report* (AMSCR) reporting will be required pending completion of any snow clearing and removal activities associated with any of the aircraft movement areas.

5.2 Runway Incursions

(1) Where there is potential conflict between aircraft and vehicles, for example snowmobiles, the degree of confliction should be examined and addressed.

(2) Where there is a possibility of persons near an ice runway, conspicuous warning signs and markings should be installed.

6.0 FLOATING ICE THICKNESS FOR AIRCRAFT OPERATIONS

(1) The minimum ice thickness data in Appendix A provides guidelines for the safe operation of aircraft under limited operating conditions. This data is recommended for use at ice aerodromes (both freshwater and sea ice) and relate primarily to determining the safe load bearing capacity for runways by taking into account such factors as:

(a) ice thickness;

(b) ice condition;

(c) ice types; and

(d) air temperatures.

6.1 Limited Movements

(1) Subject to the restrictions and adjustments outlined in the next sections, the minimum effective thickness of ice recommended for limited aircraft movements is given in Appendix A. The use of Appendix A requires a value for ice flexural stress and that appropriate value may be selected from Appendix B. Allowable flexural stress values selected from Appendix B are generally conservative and actual measurements of ice strength conducted by an ice specialist may permit operations on thinner ice covers, or by heavier aircraft.

(2) Limited aircraft movements may involve up to three landings per day. Landing on the recommended minimum ice thickness involves the risk of breakthrough if a detailed ice survey has not been carried out. It is recommended that the following precautions to minimize this risk are conducted as follows:

(a) where practical, the aircraft is to be removed from the ice as soon as possible;

(b) if ice conditions are uncertain, moving the aircraft to another position if possible, on short notice; and

(c) the ice should be inspected at least once a day and any deflection or cracking of the ice watched closely; if cracking continues, reduce loads or cease the use of the runway if deemed necessary.

6.2 Unlimited Movements

(1) An engineering analysis, including a detailed survey and investigation of the ice cover, should be made by a qualified ice specialist to approve a runway for an unlimited number of landings per day.

(2) The bearing capacity of an ice sheet can be affected more by ice quality than by ice thickness. Safe estimates of strength values can be made by experienced ice specialists through observations of the type and quality of the ice, which may be supplemented by measurements of ice strength. These estimates can provide the basis for a decision to allow unlimited aircraft movements, or to allow loads in excess of the maximum recommended for limited use.

6.3 Parking

(1) Aircraft may normally be parked on the minimum ice thickness given in Appendix A provided that the maximum deflection of the ice sheet under the parked aircraft does not exceed 8% of the effective ice thickness.

(2) When parking on ice of minimum thickness, an aircraft should be separated by a distance of at least one load influence radius from other loads, open cracks or free ice edges. The load influence radius of an ice cover is a function of ice thickness, as given in Appendix C. The recommended minimum ice thickness should be increased by one-third for the parking of two aircraft with a separation of less than one load influence radius.

(3) Parking is **not recommended** under the following conditions:

(a) if radial or circular cracks form around the loaded area, or if continuous cracking is heard;

(b) if deflection continues at an increasing rate;

(c) if deflection exceeds 8% of the effective ice thickness; or

(d) if water appears on the surface of the ice cover.

6.4 Operations at Thawing Temperatures

(1) Recommended minimum ice thickness for limited aircraft operations must be adjusted if operations are to proceed with a daily average temperature higher than –1 °C for fresh water ice, or higher than –2 °C for sea ice. Minimum required ice thickness should be increased by 5% or aircraft weight should be decreased by 10% for each consecutive day of elevated temperature. Operations should be suspended after four days of elevated temperatures, or if the maximum air temperature exceeds 4 °C. Operations may have to be suspended before the fourth day if the condition of the ice surface deteriorates. Puddles of water should be filled with snow.

6.5 Cracks

(1) Ice covers usually have many cracks caused by thermal contractions, or by movements of the ice cover. Various types of cracks affect the bearing capacity of ice covers to varying degrees. Hair line cracks are lines in the ice not more than 2 mm in width. Wider cracks are classified as “wet” or “dry” depending on whether water can be observed. Wet cracks may re-freeze to strengths equal to the original ice sheet, but the depth of healing should be verified.

(2) The following adjustments should be made to allowable aircraft weight, or to minimum ice thickness, if cracks are present.

ADJUSTMENTS FOR CRACKED ICE

Type of Crack	Adjustment to Either	
	Aircraft Weight	Ice Thickness
Hairline Cracks	None	None
Re-frozen Cracks	None	None
Dry Cracks (≤ 2cm wide)		
Non-intersecting	Use 2/3 weight	Increase by 20%
Intersecting	Use 1/3 weight	Increase by 70%
Wet Cracks		
Non-intersecting	Use 1/2 weight	Increase by 40%
Intersecting	Use 1/4 weight	Increase by 100%

(3) Aircraft should cross single cracks at right angles and should not traverse areas where several active cracks intersect. Operations should be separated from an open or active lead by a least one load radius.

6.6 Effective Ice Thickness

(1) Effective ice thickness is the thickness of good quality dense ice. Dense freshwater ice may be taken as ice having a specific gravity of at least 0.90. If the ice is layered and if one of the layers is of poor quality (e.g. light, drained snow ice, drained frazil ice, snow or frazil slush), only the thicker section of continuous dense ice should be counted as effective ice thickness.

(2) If a water layer is present within the ice cover, effective thickness corresponds to the thickness of the upper layer of ice. An exception may occur if the water layer is thin and not continuous, or if the lower layer has sufficient thickness and strength to fully support the load at the temperature of –1 °C for fresh water ice, or –2 °C for sea ice.

(3) The effective thickness of an ice cover can vary within wide limits. Dangerously thin areas can occur in the covers of rivers, estuaries and on lakes near the inlet or outlet of rivers. Thickness should be determined by holes spaced at not more than 15 m for a river, 30 m for a lake, and 90 m for smooth sea ice. Ice thickness should be checked once a week for average daily air

temperatures between –12 °C and –5 °C. Checks can be less frequent if effective ice thickness exceeds minimum requirements.

(4) When a build-up of ice thickness is necessary, care must be taken to ensure that the built-up ice is of good quality. Snow cover should be removed prior to flooding. Alternately, if the snow cover is uniform, good quality ice can be constructed by slow, careful flooding of the snow cover from the bottom upward. Flooding should occur outward from runway centreline and should be limited to a depth that will freeze within 12 hours. A water depth of 50 mm will freeze overnight with an average air temperature of –18 °C, and a depth of 90 mm will freeze overnight at –30 °C. Complete freezing should be ensured before adding subsequent lifts.

6.7 Resonance

(1) Under certain conditions, a taxiing aircraft will induce resonance waves under an ice cover which can place considerable stress on the ice. When operating on ice which is at or close to recommended minimum thickness, safety can be increased and resonance avoided, by observing the following precautions:

(a) avoid taxiing at the speeds indicated in Appendix D;

(b) avoid taxiing parallel to a shoreline at a distance of one load influence radius or less;

(c) cross the shoreline at an angle of about 45 degrees when taxiing between an ice runway and land; and

(d) locate manoeuvring surfaces on an ice runway more than 2 influence radii, or less than one-half an influence radius from the shore. If this positioning is not practical, then the runway should be oriented at an angle of approximately 45 degrees to the shore.

7.0 BEST PRACTICES

7.1 General

(1) When conducting planning, development, and operational activities, the following information is provided to assist the aerodrome operator in dealing with various issues such as:

(a) The size and zoning of ice aerodromes should meet the aviation standards given in TP 312 – *Aerodrome Standards and Recommended Practices*.

(b) Centreline and threshold markings can be made with blue or purple dye for ease of identification.

(c) The thickness of an ice cover should be determined with sufficient accuracy to allow a recommended maximum load to be established. The runway should be closely inspected for ridges and depressions, which can be corrected by bulldozing and flooding respectively.

(d) A runway used for the first time should be inspected after the first landing and after subsequent landings of heavier aircraft, in addition to the inspection frequencies previously recommended.

(e) An aircraft may land on ice without incident, but may produce many cracks in the ice cover. The aircraft may then break through the ice when moving at a low speed during a subsequent take-off. Crack inspection should be a serious undertaking for ice aerodrome operators.

(f) Wheeled aircraft should not land on un-compacted snow deeper than one-third of the wheel diameter or in accordance with the Aircraft Operations Manual (AFM).

(g) Snow should be removed except for a 50 to 75 mm layer. Greater ice thickness is required when the ice is covered with deep snow, and when the ice is used less than two

days after the removal of deep snow. Snow banks should not be allowed at the ends of runways. The height of snow banks at the sides of runways should not exceed one-half of the ice thickness.

(h) Weight of stored materials, stationary loads and snow should not exceed the aircraft loading allowed for the condition and thickness of the ice cover.

(i) Allowable weight for aircraft on skis is determined in the same manner as for wheeled aircraft.

7.2 Aerodrome Log

(1) Aerodrome operators should maintain a log on the construction, maintenance and operation of their aerodromes. Following is an example of the type of information that the log is intended to record, such as:

(a) location of the aerodrome;

(b) name of the operator;

(c) length of runway (ft);

(d) width of runway (ft);

(e) description of the construction of aircraft parking/unloading area;

(f) runway threshold (and end) coordinates; and

(g) threshold elevations (Mean Sea Level), if the runway has an IP.

(2) Information regarding maintenance activities should also be recorded (log can be divided into periods of one week intervals) indicating a brief description of:

(a) work done on the ice such as snow compacting or ploughing, flooding, reinforcing, any precautions taken to prevent snow drifting, etc;

(b) observed ice thickness at the end of each period for built-up ice and surrounding undisturbed ice cover; and

(c) annotation, if available, for the characteristics of the ice cover such as ice types, density, salinity, temperature, and strength, to mention a few.

8.0 INSTRUMENT PROCEDURES

8.1 General

(1) Aerodrome operators and/or IP sponsors intending to provide IP at a non-certified ice aerodrome should refer to AC 301-001 and AC 301-002 for further guidance.

8.2 Requirements for an Instrument Procedure

(1) At a minimum, the aerodrome should:

(a) be registered with TCCA as an aerodrome (Part III, Subpart 01 of the CARs) and as such should have a four character ICAO aerodrome location indicator and a NOTAM file provided by NAV CANADA; and

(b) if operated as a private aerodrome, the aerodrome operator should if necessary annotate their published aeronautical information (CFS, WAS, CAP etc) as Prior Permission Required (PPR) to limit the number of air operators intending to use the aerodrome.

(2) The runway should be landlocked or relatively immobile thereby limiting movement of reference points critical to the IP. The runway should also be assessed for ice shift on a routine basis (daily or more frequently if ambient conditions dictate) so that all horizontal and vertical movements are

maintained within IP design criteria and publication/charting limits (see TP 308/GPH209 & ICAO Annex 15, Appendix 7). If limits are exceeded, NOTAM action is required.

(3) The IP should:

(a) be TP 308/GPH 209 criteria compliant (see Sections 803.01 and 803.02 of the CARs) despite ice shift (i.e. runway alignment, threshold coordinates, threshold elevation, etc);

(b) maintain "Publication Resolution" regarding all aeronautical data as found in ICAO Annex 15, Appendix 7 – *Aeronautical Data Quality Requirements*.

(4) See paragraph 4.5(1) 'Recommendations' and paragraph 4.6(1) 'Seasonal Reconstruction' of this AC regarding IPs.

9.0 INFORMATION MANAGEMENT

(1) Not applicable.

10.0 DOCUMENT HISTORY

(1) Not applicable.

11.0 CONTACT OFFICE

For more information, please contact the appropriate Regional Transport Canada Civil Aviation Office – Aerodromes and Air Navigation at the following address:

http://www.tc.gc.ca/eng/aboutus-offices.htm

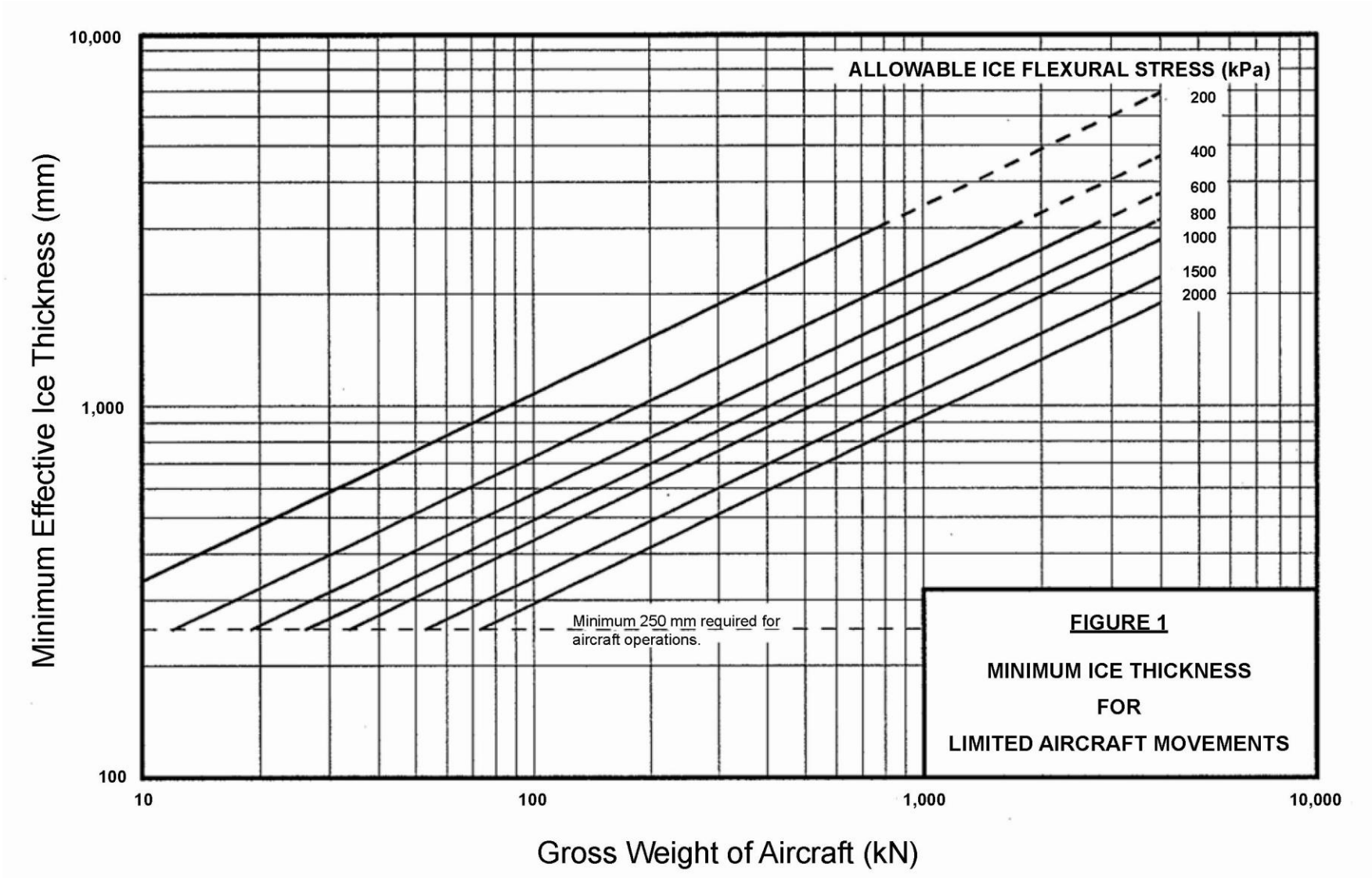
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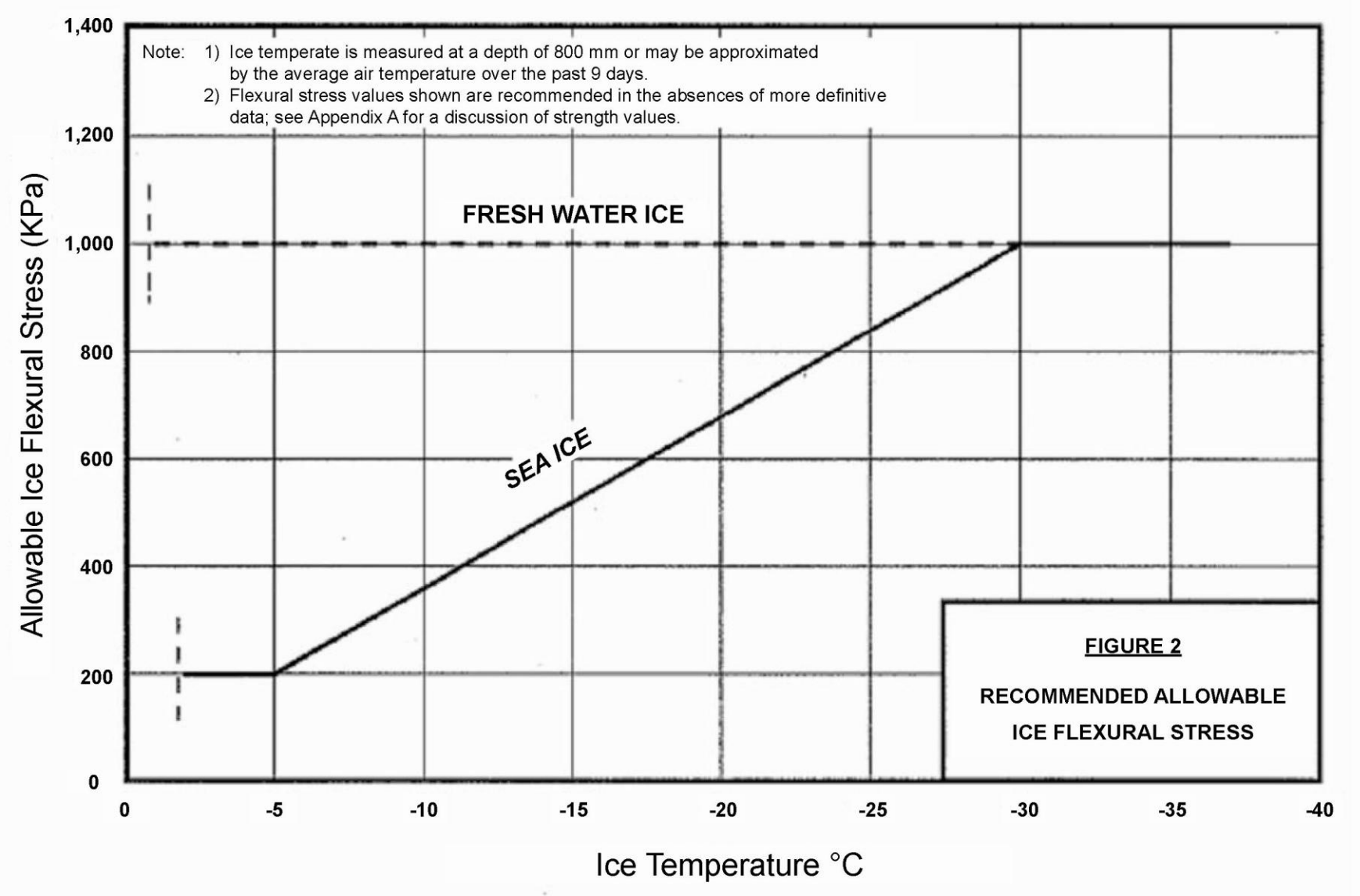
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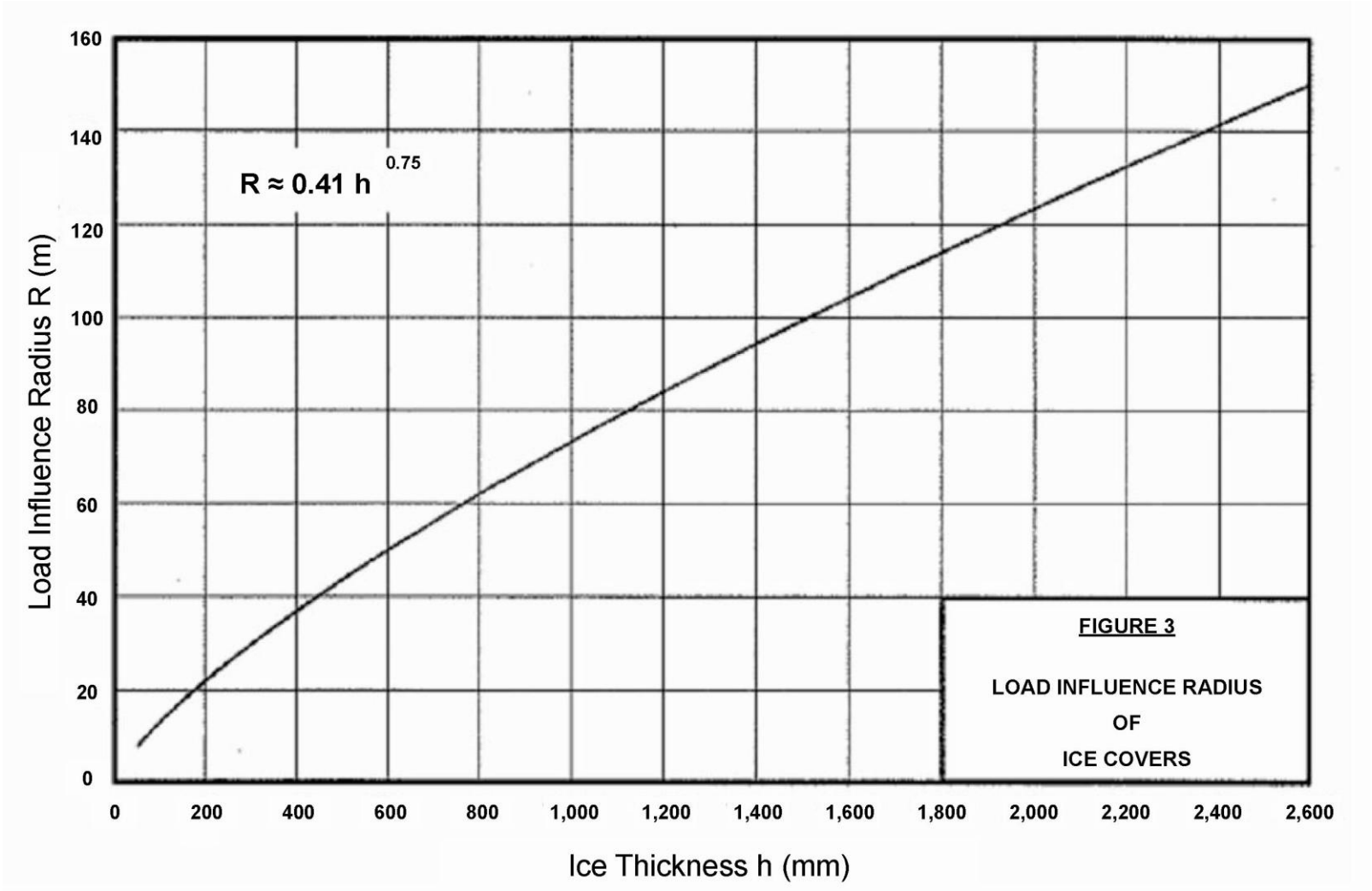
APPENDIX A— MINIMUM ICE THICKNESS FOR LIMITED AIRCRAFT MOVEMENTS



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