BS EN 12312-6:2017

BSI Standards Publication

Aircraft ground support equipment — Specific requirements

Part 6: Deicers and de-icing/anti-icing equipment

National foreword

This British Standard is the UK implementation of EN 12312-6:2017. It supersedes BS EN 12312-6:2004+A1:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/57, Air cargo and ground support equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 86229 8

ICS 49.100

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2017.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12312-6

March 2017

ICS 49.100

Supersedes EN 12312-6:2004+A1:2009

English Version

Aircraft ground support equipment - Specific requirements - Part 6: Deicers and de-icing/anti-icing equipment

Matériel au sol pour aéronefs - Exigences particulières - Partie 6: Dégivreuses, matériels de dégivrage et d'antigivrage

Luftfahrt-Bodengeräte - Besondere Anforderungen - Teil 6: Enteiser und Enteisungs- /Vereisungsschutzgeräte

This European Standard was approved by CEN on 23 January 2017.

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Ref. No. EN 12312-6:2017 E

Contents

Page

European foreword

This document (EN 12312-6:2017) has been prepared by Technical Committee CEN/TC 274 "Aircraft ground support equipment", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2017, and conflicting national standards shall be withdrawn at the latest by September 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12312-6:2004+A1:2009.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2006/42/EC on machinery.

For relationship with EU Directive 2006/42/EC on machinery, see informative Annex ZA which is an integral part of this document.

EN 12312, *Aircraft ground support equipment — Specific requirements*, consists of the following parts:

— *Part 1: Passenger stairs*;

— *Part 2: Catering vehicles*;

— *Part 3: Conveyor belt vehicles*;

— *Part 4: Passenger boarding bridges*;

— *Part 5: Aircraft fuelling equipment*;

— *Part 6: Deicers and de-icing/anti-icing equipment* (the present document);

— *Part 7: Aircraft movement equipment*;

— *Part 8: Maintenance or service stairs and platforms*;

— *Part 9: Container/Pallet loaders*;

— *Part 10: Container/Pallet transfer transporters*;

— *Part 11: Container/Pallet dollies and loose load trailers*;

— *Part 12: Potable water service equipment*;

— *Part 13: Lavatory service equipment*;

— *Part 14: Disabled/incapacitated passenger boarding vehicles*;

— *Part 15: Baggage and equipment tractors*;

— *Part 16: Air start equipment*;

— *Part 17: Air conditioning equipment*;

— *Part 18: Nitrogen or Oxygen units*;

— *Part 19: Aircraft jacks, axle jacks and hydraulic tail stanchions*;

— *Part 20: Electrical ground power units*.

The main changes compared to the previous edition EN 12312-6:2004+A1:2009 are:

a) Amendment A1:2009 was incorporated;

b) the Introduction was updated in relation to the deviation from recommended criteria;

c) the Scope was updated to cover reasonably foreseeable misuse and an informative reference was added;

d) Clause 2, *Normative references*, was updated;

e) In Clause 3, *Terms and definitions*, the definition for the operator's cabin was clarified;

f) List of hazards was updated to exclude hazards due to traffic and repair and was moved to Annex A;

g) Subclause 5.1, *General requirements* was changed to include slip-resistance requirements and a Performance level of the speed limitation interlocking system;

h) Subclause 5.3, *Stability and strength* was changed to a minimum rated load of the basket of 205 kg and the required tests were clarified;

i) In subclause 5.4, *Safeguards and safety devices* clarification was given regarding the requirement of harness anchorage points;

j) Subclause 5.5, *Emergency systems* safety measures has been changed and a Performance Level for the control system of the overheating and overpressure safety device has been introduced;

k) Subclause 5.6, *Operator's cabin* was changed and contains a more detailed clarification of the basket/cabin door closing/folding requirements with subclause 5.6.4 being divided into three subclauses 5.6.4, 5.6.5 and 5.6.6;

l) Subclause 5.8, *Lights* was updated;

m) Subclause 5.11, *Protection against poisoning* was changed and contains new requirements and clarifications for filters;

n) Subclause 6.2.1, *Additional marking for deicers* was updated with markings for permissible jet blast, the use of a harness and the prohibited use of open baskets in combination with toxic fluids;

o) Subclause 6.3 *Instructions* was changed and now includes information about safety measures when using open basket deicers in combination with toxic de-icing fluids, maintenance of the filtration system, bystanders and the procedure of cleaning spray liquid tanks;

p) Clause 7, *Verification* was updated;

q) Normative Annex A, *List of Hazards* was updated;

r) Informative Annex B, *Fluid system* was updated and contains information about further civil aviation regulations, an increased spraying temperature, of which the operator shall know from the cabin;

s) Informative Annex C, Subclause C.3, *Effects on humans* was updated and contains a clarification about the variety and toxicity of glycols used in de-icing, Table C.1 *Acute toxicity of glycols and EU classification* was updated and Table C.2 *Some occupational exposure limits for glycol* was deleted;

t) Annex ZA referring to the Machinery directive 98/37/EC was replaced by Annex ZA referring to the new Machinery directive 2006/42/EC;

u) the Bibliography was updated.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard specifies health and safety requirements, as well as some functional and performance requirements, for deicers and equipment intended for de-icing/anti-icing of all aircraft types commonly in service in civil air transport. It contains functional and environmental aspects of de-icing in the informative Annexes B, C and D.

The minimum essential criteria are considered to be of primary importance in providing safe, serviceable, economical, and practical deicers and de-icing/anti-icing equipment. Deviations should occur only after careful consideration, extensive testing, risk assessment and thorough service evaluation have shown alternative methods or conditions to be satisfactory. Such deviations are outside the scope of this standard and a manufacturer should be able to demonstrate an equivalent level of protection.

This European Standard is a Type C standard as stated in EN ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this document.

When provisions of this Type C standard are different from those which are stated in Type A or B standards, the provisions of this Type C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of this Type C standard. Deviations from requirements do not fall within the presumption of conformity given by the standard.

1 Scope

This European Standard specifies the technical requirements to minimize the hazards listed in Clause 4 which can arise during the commissioning, the operation and the maintenance of deicers and equipment designed exclusively for de-icing and washing of aircraft with de-icing/anti-icing/washing liquids when used as intended, including misuse reasonably foreseeable by the manufacturer, when carried out in accordance with the specifications given by the manufacturer or his authorized representative. It also takes into account some requirements recognized as essential by authorities, aircraft and ground support equipment (GSE) manufacturers as well as airlines and handling agencies.

NOTE 1 Safety of aircraft in connection with de-icing/anti-icing operations is not dealt with in this European Standard. Any, even minor, aircraft de-icing or anti-icing operation directly affects flight safety on take-off. Prevention of aeronautical accidents resulting from in-flight icing principally concerns the fluids and methods used, but it may in certain cases also concern de-icing or anti-icing equipment design or operation. These aeronautical aspects are controlled by the applicable Civil Aviation regulations ICAO 9640-AN/940, *Manual of aircraft ground de-icing/anti-icing operations* and EASA EU-OPS Subpart D 1.345 and its Acceptable Means of Compliance (AMC) and covered in ISO 11076:2012 (AEA Recommendations). They are not covered in this European Standard.

This European Standard applies to:

a) self-propelled deicers with fixed or mobile platform or hinged boom;

b) towable deicers with fixed or mobile platform or hinged boom;

c) stationary de-icing/anti-icing equipment (e.g. fixed boom, gantry or tower cranes equipped with aircraft de-icing/anti-icing fluid systems).

This European Standard does not apply to:

d) fixed installations, such as separate storage tanks or heating and filling stations, which are not an integrated part of the stationary de-icing equipment;

e) hydraulic control systems;

f) pneumatic systems;

g) flow generating systems as such.

No extra requirements on noise and vibration are provided other than those in EN 1915-3 and EN 1915-4.

NOTE 2 EN 1915–3 and EN 1915–4 provide the general GSE vibration and noise requirements.

This European Standard is not dealing with hazards in respect to a standard automotive chassis and the traffic on the apron.

This part of EN 12312 is not applicable to deicers and de-icing/anti-icing equipment which are manufactured before the date of publication of this standard by CEN.

This part of EN 12312 when used in conjunction with EN 1915-1, EN 1915-2, EN 1915-3 and EN 1915-4 provides the requirements for deicers and de-icing/anti-icing equipment.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 795:2012, *Personal fall protection equipment - Anchor devices*

EN 1915-1:2013, *Aircraft ground support equipment - General requirements - Part 1: Basic safety requirements*

EN 1915-2:2001+A1:2009, *Aircraft ground support equipment - General requirements - Part 2: Stability and strength requirements, calculations and test methods*

EN 1915-3, *Aircraft ground support equipment — General requirements — Part 3: Vibration measurement methods and reduction*

EN 1915-4, *Aircraft ground support equipment — General requirements — Part 4: Noise measurement methods and reduction*

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13732-1, *Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces (ISO 13732-1)*

EN ISO 13849-1:2015, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13850:2015, *Safety of machinery - Emergency stop function - Principles for design (ISO 13850:2015)*

ISO 4305, *Mobile cranes — Determination of stability*

ISO 11076:2012, *Aircraft — De-icing/anti-icing methods on the ground*

DIN 51130:2014-02, *Testing of floor coverings — Determination of the anti-slip property — Workrooms and fields of activities with slip danger — Walking method — Ramp test*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1915-1:2013, EN ISO 12100:2010 and ISO 11076:2012 and the following apply.

3.1
de-icing/anti-icing equipment
piece of equipment, mobile or stationary, used for performing de-icing/anti-icing/washing operations on aircraft on the ground

3.2
deicer
entire mobile unit, including the chassis and any structures mounted thereon

3.3
self-propelled deicer
deicer able to move by an own power source and to operate without a constant connection to external energy or fluid supply

3.4
towable deicer
deicer not able to move by an own power source

3.5
stationary de-icing/anti-icing equipment
permanently installed equipment, e.g. gantry, fixed boom or other crane types

3.6
boom
moveable hinged beam attached to the integral frame carrier to support the lifting/work platform

3.7
chassis cabin
driver's cabin mounted on the chassis of a self-propelled deicer

3.8
operator's cabin
boom mounted, enclosed lifting/work platform for the operator during spraying

3.9
basket
boom mounted, open lifting/work platform

3.10
harness anchorage point
point for attaching the operator's safety harness

3.11
de-icing pad
dedicated area on an airport specially designed for de-icing

4 List of significant hazards

The list of risks and hazards (given at Annex A) is based on EN ISO 12100:2010 and contains the hazards and hazardous situations, as far as they are dealt with in this European Standard, identified by risk assessment as significant for deicers and de-icing/anti-icing equipment and which require action to eliminate or reduce risks. Not covered are hazards due to the traffic and repair.

5 Safety requirements and/or measures

5.1 General requirements

5.1.1 Deicers and de-icing/anti-icing equipment shall conform to the requirements of this standard and relevant requirements of EN 1915-1, EN 1915-2, EN 1915-3 and EN 1915-4 unless otherwise specified in this standard. The specific requirements of this standard take precedence over those of the EN 1915 series.

5.1.2 The operating conditions shall be given by the manufacturer. Deicers shall be designed to operate safely in a continuous relative humidity of up to 95 %.

Materials and devices used shall take into account the environmental conditions intended to be encountered by de-icing equipment, e.g. with respect to temperature, sun, precipitation and freezing effects.

NOTE The operating conditions, such as temperature range to be covered and the materials chosen are depending on the airport of use (see EN 1915–1:2013, Introduction, f) — negotiation).

5.1.3 The design of deicers and de-icing/anti-icing equipment shall take into account the aircraft de-icing/anti-icing operating methods given in ISO 11076:2012 (AEA Recommendations).

5.1.4 Basket flooring, walkways and means of access outside the vehicle shall have a durable slip-resistant floor, with a minimum R13 slip-resistance classification.

Slip resistance classification shall be measured in accordance with DIN 51130:2014-02, Table 3.

5.1.5 Where speed limitation in accordance with EN 1915-1:2013, 5.23c) is ensured by interlocking, the corresponding safety device shall achieve Performance Level “b” in accordance with EN ISO 13849-1:2015.

5.2 Spray system

5.2.1 The control of hand-held spray guns shall be of the hold-to-run type.

5.2.2 Fixed spray guns of deicers shall be prevented from spraying directly towards the operator's position, e.g. by means of (a) positive stop(s).

5.2.3 In case of spray gun failure it shall be possible to stop the fluid flow by means of an additional shut-off valve.

5.3 Stability and strength

5.3.1 Calculation of stability and strength shall be carried out according to EN 1915-2. De-icing equipment shall be stable under all working conditions.

Any life limited components shall be calculated for a foreseeable lifetime of 10 000 h of operating taking into account foreseeable wear and corrosion.

5.3.2 Deviating from EN 1915-2:2001+A1:2009, 5.2.2.3 the maximum number of persons in the cabin/basket shall be two. The rated load shall not be less than 205 kg.

5.3.3 Where intended operation includes de-icing/anti-icing with aircraft engines running, the additional forces shall be taken into account.

5.3.4 Spraying forces are considered as being dynamic forces (see EN 1915-2:2001+A1:2009, 5.2.2.4).

5.3.5 Special attention shall be given to the design of telescopic boom joints.

5.3.6 The design of deicers shall not need stabilizers to ensure stability.

Where chassis spring locks or torsion bars are used, they shall automatically be engaged when the cabin/basket is moved out of its stowed position.

5.3.7 Where open baskets are used, the nozzle and hose(s) shall be considered as structural parts for calculation purposes.

5.3.8 For fatigue stress analysis, the factor for the intended load spectrum shall not be less than one and the amount of load cycles never less than 2×10^4 (see also EN 1915-2:2001+A1:2009, 5.2.6).

5.3.9 The maximum overturning and corresponding stabilizing moments shall be calculated about the most unfavourable tipping lines and with empty tanks.

Tipping lines shall be determined as shown in ISO 4305.

NOTE For solid and foam-filled tyres the tipping lines may be taken at 1/4 of the tyre ground contact width from the outside of the ground contact width.

5.3.10 In addition to the verification of stability and strength in accordance with EN 1915-2 the following tests shall be done to check the strength calculation of the structural boom components, including the lifting/work platform:

a) Vehicle driving over a test fixture at maximum allowable speed (6 km/h) in forward and reverse directions. The wheels driving over test fixture shall be the ones giving highest stresses in boom structure. The test fixture shall be a device used to simulate obstacles that may be encountered on an airport ramp (e.g. wheel chocks, storm drains, fuel pit lids, snow and ice ruts, etc.). The test fixture shall be made out of wood or any other similar material measuring 100 mm (4 in) high, 150 mm (6 in) wide and 600 mm (24 in) long. The top corners of the test fixture shall be symmetrically cut at 45° angles along its longitudinal length thereby providing a flat top surface measuring 50 mm (2 in) in width. The test fixture shall be secured in such a manner that it is prevented from sliding or overturning as the vehicle is driven over it during dynamic load testing.

b) Vehicle driving at maximum allowable speed (6 km/h) in forward and reverse directions and suddenly applying brakes to simulate emergency (panic) stops.

Both tests shall incorporate boom orientation and fluid tank level which generate maximum stress on the structural boom components. The basket/enclosed cabin shall be loaded at maximum rated capacity. In addition to these loads the windload shall be incorporated by calculation afterwards. During the tests the stress levels shall be measured using strain gauge or equivalent measurement techniques. How and where to mount the strain gauges shall be done in accordance with relevant industry practices.

NOTE Relevant recommendations for the mounting of strain gauges can be found e.g. in IIW (International Institute of weldings) publications (see Bibliography).

The design verification shall be done by comparing measured stresses (with incorporated wind loads) and yield strength of the material in question. To pass the tests the minimum acceptable safety factors are as stated in EN 1915-2:2001+A1:2009, Table 1.

5.4 Safeguards and safety devices

5.4.1 Operator's seats shall be provided with 3 point type inertial reel seat belts as used on standard automotive vehicles.

5.4.2 The risk of the operator being ejected from the basket is significant, due to rough movements of the deicer/antiicer. Therefore, harness anchorage points for each person in accordance with EN 795:2012 Type A shall be provided at baskets and instructions shall be stated (see also 6.2 and 6.3).

NOTE For safe access, see also 5.6.4.

5.5 Emergency systems

5.5.1 Deicers shall be fitted with:

a) an emergency lowering control at ground level or at an accessible position (see EN 1915-1:2013, 5.20.3 for access). The design and position of this control shall ensure visibility on the movement of the cabin/basket. This control device shall override the control devices for lifting and lowering;

b) an emergency control system in the cabin/basket to move the boom in case of primary power loss;

c) an emergency valve at the base of the lifting cylinder(s) to allow boom lowering in the event of a complete loss of all power sources. Provision shall be made for safe access if not reachable from the ground.

5.5.2 Emergency stops shall meet the requirements of EN ISO 13850:2015, 4.1.3. The emergency stop shall not de-activate the braking system. At least one emergency stop shall be provided in the cabin/basket on deicers. Additional emergency stops shall be installed on the outer contour reachable from ground level, as a minimum on each longitudinal side.

5.5.3 Emergency stops on deicers shall:

a) stop and hold all boom and cabin/basket movements;

b) shut down the fluid pump and heater;

c) apply parking brakes.

Emergency stops on deicers shall not:

d) impede the emergency lowering function;

e) stop the function of communication systems;

f) switch off working lights;

g) shut down fire extinguisher systems, where applicable.

5.5.4 Emergency stops on stationary systems shall be installed at operator's position(s) as well as on the structure and reachable from ground level, e.g. on each travelling gear or fundament.

5.5.5 On stationary de-icing/anti-icing equipment emergency stops shall stop all motions, the fluid supply and the spraying system.

5.5.6 To prevent overheating and overpressure, the fluid heater shall be equipped with safety devices. The control system shall achieve Performance Level “c” in accordance with EN ISO 13849-1:2015.

5.5.7 The de-icing/anti-icing equipment shall be furthermore provided with devices to shut down automatically fluid pumping and heating systems when a hazardous condition, e.g. overheating, overpressure, arises while these systems are operating. These devices, when actuated, shall allow a deicer to be driven away from the aircraft.

5.6 Operator's cabin

5.6.1 Shape and arrangement of the operator's cabin shall not restrict the field of view for travel or operation.

5.6.2 Where the deicer is intended to be driven from the operator's cabin, the operator's cabin shall conform to the applicable requirements of EN 1915-1:2013, 5.2.1, 5.2.2 and 5.3.

5.6.3 Devices to secure cabin doors in the open position shall be provided only where a platform with guard-rails or similar contrivance prevents falling to the ground.

5.6.4 The operator's cabin or basket shall allow safe access from the ground in the stowed position, and provide for safe and easy entry and exit.

5.6.5 The cabin door or basket gate shall not fold or open outwards, and shall be constructed to either be automatically self-closing and latching or provide equivalent means to prevent the risk of falling.

5.6.6 When this is not possible, boom movements, including lifting from the stowed position, shall be prohibited unless the cabin door or basket gate is closed and fully latched. Door or gate unlatching shall be impossible from inside during normal operation while the cabin or basket is not in the stowed position.

This shall be ensured by interlocking, with door/gate locking, the related interlocking system shall achieve Performance Level “c” in accordance with EN ISO 13849-1:2015.

5.6.7 In emergency, it shall be possible to evacuate and escape.

5.7 Controls, monitoring devices and displays

5.7.1 The cabin/basket shall be equipped with a complete set of controls permitting the operator to move the boom and the cabin/basket through any of their motions.

5.7.2 Operation of the equipment and its controls shall be positive, smooth and jerk-free, e.g. by proportional control, automatic transmission.

5.7.3 Controls not situated in an enclosed cabin shall be easy to operate even with gloved hands, e.g. minimum distance between levers 60 mm, minimum diameter of push-buttons with a hoop to prevent inadvertent operation 40 mm.

5.7.4 Controls not situated in an enclosed cabin shall be protected against fluid spray and/or inadvertent snagging from lines or hoses.

5.7.5 Controls of equipment such as pumps, mixers, heaters need not be of the hold-to-run type.

5.7.6 Where de-icing/anti-icing equipment is operated by more than one person, it shall be provided with a two way communication system, e.g. radio.

5.8 Lights

In addition to the requirements of EN 1915-1, the following lighting shall be provided:

a) illumination of control panels (non-glare and non-reflecting);

b) working light(s) to illuminate the spray area (1000 lm minimum).

5.9 Fire protection

5.9.1 A deicer shall be provided with space for at least one fire extinguisher (minimum 6 kg for Class A, B and C fires).

5.9.2 Where the fluid heater is a flame type, an automatic fire extinguisher system shall be incorporated.

5.9.3 Fuel and flammable fluid lines shall be installed with a minimum of 50 mm clearance to electrical systems. Where installed close to exhaust systems, metallic piping shall be used.

5.9.4 Fuel and flammable fluid tanks shall be located for protection against collision damage.

5.9.5 Fuel and flammable fluid tanks shall be located and installed so that any overflow during filling, or any leakage from the tank, lines or fittings, will not impinge on engines, exhaust system, electrical system or other ignition sources, or enter the driver's cabin.

5.10 Protection against heat

5.10.1 Parts heated by the process fluids that are to be handled by operator(s) shall be insulated. The maximum surface temperature shall not exceed 43 °C (see also EN ISO 13732-1, 8 h contact time).

5.10.2 Filling or dumping systems for hot fluid shall be designed and positioned so that the operator is not subjected to hazards of burns.

5.11 Protection against poisoning

5.11.1 Where the exposure of the operator to toxic de-icing/anti-icing fluid, splash, vapours, aerosols, jet blast or exhaust gases is significant, enclosed operator's cabins shall be installed.

See also 6.2.1 and 6.3.

NOTE 1 For significance see applicable limits for the intended airport of use (see EN 1915–1:2013, Introduction, f) — negotiation).

NOTE 2 See Annex C for toxicological aspects of de-icing/anti-icing fluids.

NOTE 3 The environmental aspects of de-icing/anti-icing fluids are described in Annex D.

5.11.2 Enclosed cabins of de-icing/anti-icing equipment to be used with toxic fluids shall be provided with an appropriate filtration system, on the air intake, for removal of aerosols and vapours produced, consisting of a pre-filter, HEPA filter (High Efficiency Particulate Air filter), and a carbon active filter of appropriate dimensions.

NOTE 1 For mono ethylene glycol (MEG) or diethylene glycol (DEG) based fluids, the following fulfils the requirements: a pre-filter type F7 according to EN 779:2012, a HEPA filter type H13 according to EN 1822–1:2009, and a carbon-active filter type A according to EN 14387:2004+A1:2008. For other toxic fluids, the filtration system need to be determined in accordance with the fluid MSDS (material safety datasheet).

NOTE 2 For maintenance and replacement of components of the filtration filter, refer to 6.3.

In addition, with the filter system operating, ventilation shall maintain a positive pressure in the cabin.

5.11.3 Filling or dumping systems for fluid shall be designed and positioned so that the operator is not subjected to hazards of poisoning.

5.12 Special requirements for deicers

5.12.1 The requirement of EN 1915-1:2013, 5.21.3 is fulfilled for proportional controlled movement of deicers if load bearing cylinders are equipped with load control valves.

5.12.2 Tow hooks shall be installed on the chassis structure of deicers, at least one at front and one at rear.

NOTE Preferably, tow hooks as provided for appropriate standard automotive chassis will be used. Otherwise, the calculation of strength will preferably take into account the forces as calculated by the formula:

gross mass × 10 × coefficient of friction (tyres/dry clean concrete).

5.12.3 Tow hooks shall be accessible and useable irrespective of the position of the cabin/basket.

5.12.4 The wheel clearance shall be adequate for the installation and operation of tyre chains. Vulnerable components shall be protected against damage by the chains.

5.13 Operating speeds

Operating speeds of each individual movement of the cabin/basket of deicers shall not exceed the following limits:

a) 0,4 m/s in any direction for single speed on/off controlled movements;

b) 0,6 m/s in any direction for proportional controlled movements with smooth, non-jerking starting and stopping (see also EN 1915-1);

c) 0,7 m/s for proportional controlled horizontal slewing movements measured at the outer edge of the lifting/work platform.

5.14 Warning devices for stationary de-icing/anti-icing equipment

Where stationary de-icing/anti-icing equipment can move on the ground, e.g. on rails, suitable warning devices, e.g. sound and/or light signals, shall be installed. Warning devices shall be activated automatically during movement.

NOTE The type and characteristics of warning devices are depending on the airport of use (see EN 1915–1:2013, Introduction, f) — negotiation).

6 Information for use

6.1 Marking

Permanent marking of data shall consist of metal plates securely attached (e.g. riveted, welded) to the structure.

Markings shall include at least those markings required by EN 1915-1 and the additional markings in 6.2.

6.2 Additional marking

6.2.1 Additional marking for deicers

In addition to the name-plate and markings specified in EN 1915-1:2013, 6.1, the following shall be marked on the deicer and de-icing/anti-icing equipment:

a) unladen mass on each axle;

b) permissible wind and jet blast velocity;

c) cabin/basket load capacity, maximum number of persons;

d) operating instruction summary at the operator's place;

e) operating instruction summary for emergency lowering near the relevant controls;

f) pictogram for the use of harness;

g) on open basket deicers “Do not use with toxic fluids”.

6.2.2 Additional marking for stationary de-icing/anti-icing equipment

In addition to the name-plate and markings specified in EN 1915-1:2013, 6.1, the following shall be marked on stationary de-icing/anti-icing equipment:

a) clearance, e.g. height, width, span, readable from operator's place as well as from ground level;

b) wind and jet blast velocity at which the operation shall be stopped and the measures that need to be taken, readable from operator‘s place as well as from ground level;

c) operating instruction summary at the operator's place;

d) operating instruction summary for emergency lowering near the relevant controls.

6.3 Instructions

Operating and maintenance instructions shall be supplied with each deicer and each de-icing/anti-icing equipment. They shall generally meet the requirements in EN 1915-1. In addition, the operating and maintenance instructions shall contain, depending on type and design of the deicer and de-icing/anti-icing equipment, information about:

a) complete operation of the de-icing/anti-icing equipment;

b) use of deicers with aircraft engines running or not;

c) personal protective equipment;

d) possible severe operating conditions, e.g. wind, jet blast, unevenness of the ground due to ice and snow;

e) danger zones during aircraft de-icing, e.g. suck in, jet blast;

f) types of aircraft the equipment is intended to service;

g) types of de-icing/anti-icing fluids and washing fluids, e.g. water-based fluids, the equipment is intended for;

   1) Instructions not to use open basket deicers with toxic fluids such as products containing mono ethylene glycol (MEG) or diethylene glycol (DEG) with open basket deicers (see EU Directive 2004/37 EC).

   2) Where unavoidable, appropriate personal protection equipment shall be used (see Material Safety Data Sheets, MSDS).

h) controls;

i) simultaneous use of controls;

j) spray procedure and use of movement controls;

k) emergency and rescue procedures;

l) routine checks and regular test procedures to be carried out;

m) minimum training programme for the operators;

n) type of hoses used in the fluid system;

o) safety requirements for maintenance;

p) lashing points and transportation facilities;

q) maintenance of the filtration system, including periodic checks and replacements of components;

r) bystanders should be kept out of the spray zone;

s) procedure for the safe cleaning of spray liquid tanks;

t) noise declaration established in accordance with EN 1915-4.

7 Verification of requirements

The verification of requirements shall be carried out generally in accordance with EN 1915-1:2013, Clause 7 and EN 1915-2:2001+A1:2009. See also details for verification in EN 1915-3 as relevant and EN 1915-4.

The following shall be verified by functional tests, and measurement (as appropriate):

a) spray system (see 5.2);

b) emergency systems (see 5.5 and EN 1915-1);

c) visibility during operation (see 5.6.1, 5.6.2 and EN 1915-1);

d) controls, monitoring devices and displays (see 5.7);

e) lights (see 5.8 and EN 1915-1);

f) stability and strength (see 5.3 and EN 1915-2);

g) speeds (see 5.13 and EN 1915-1);

h) warning devices (see 5.14 and EN 1915-1);

i) brakes and steering (see EN 1915-1).

In addition, each harness anchorage point shall be tested according to EN 795:2012 Type A.

Annex A
(normative)

List of hazards

Table A.1 — List of hazards

No	Hazards identified in EN ISO 12100:2010, Annex B and Table B.1	Hazardous situations	Relevant clauses in this part of EN 12312
1	**Mechanical hazards**		
	General mechanical hazards	Structural failure due to insufficient mechanical strength	5.3
		Unbalance due to energy of moving elements or additional forces (dynamic forces)	5.3.1, 5.3.3, 5.3.4, 5.3.5
		Vehicle tilting or overturn and instability due to inadequate dimensioning	5.3.1, 5.3.6, 5.3.9
		Vehicle tilting or overturn and instability due to wind	5.3.1
		Structural failure due to snow load	5.3.1
	Being run over due to machinery mobility	Collision or person run-over due to insufficient visibility	5.6.1, 5.6.2
		Collision or person run-over due to missing or inappropriate warnings	5.14
	Being thrown	Operator (Driver) thrown or injured due to inadequate restraint	5.4.1, 5.4.2
	Crushing or shearing	Crushing by cabin door	5.6.2, 5.6.3, 5.6.4
	Impact	Hitting due to the inadequate surfaces and or corners	5.6.2
		Hit by the spray gun or parts of it due to inadequate design	5.2
		Hit by the spray gun or parts of it due to missing or inadequate safety system	5.5.3, 5.5.5
	Cutting	Cutting or severing due to splintering material	5.6.2
		Cutting or scratches due to sharp corners or edges	5.6.2
	High pressure fluid impact	Hit by high pressure fluid jet due to inadequate design of the spray system	5.2.2, 5.2.3
	Slipping or tripping	Slipping due to slippery walkway or standing position surface	5.1.1, 5.1.4
		Tripping due to jerks in movements	5.7.2, 5.13 b)

No	Hazards identified in EN ISO 12100:2010, Annex B and Table B.1	Hazardous situations	Relevant clauses in this part of EN 12312
	Falling from height	Falling from height due to missing or insufficient means for fixing a safety harness	5.4.2, 5.5.1 c)
		Falling from height due to inappropriate means of access	5.1.4, 5.5.1 c)
		Falling from height due to inappropriate dimensions and/or location of walkways, working areas and platforms	5.6.3, 5.6.4
		Falling from height due to cabin door or basket gate opening in the elevated position	5.6.5, 5.6.6
2	**Electrical hazards**		
	Burn, electrocution from arc or live parts	Contact of persons with live parts (direct or indirect contact)	5.1.1
3	**Thermal hazards**		
	Objects or materials with high temperature	Burning by hot parts due to inadequate or insufficient cover	5.10
		Burning by a hot medium due to inadequate or insufficient safety system	5.2.2, 5.2.3, 5.5.3, 5.5.6, 5.5.7
	Burn due to fire	Hazards to persons due to missing or inadequate fire extinguisher	5.9.1
		Hazards to persons from equipment fire due to missing or inadequate fire protection	5.9.3, 5.9.4, 5.9.5
		Hazards to persons from fire hazard due to fluid heater burner malfunction	5.9.2
4	**Hazards generated by noise**		
	Loss of hearing, loss of awareness, accidents	Deafness, physiological disorders (e.g. loss of balance, loss of awareness), accidents due to interference with communication and to non-perception of auditory warning signals	5.1.1, 5.7.6
5	**Hazards generated by vibration**		
	Neurological or osteo- articular disorder	Whole body vibration, particularly when combined with poor postures	5.1.1, 5.6.2

No	**Hazards identified in** EN ISO 12100:2010, Annex B and Table B.1	**Hazardous situations**	**Relevant clauses in this part of** EN 12312
6	**Hazards generated by radiation**		
7	**Hazards generated by materials or substances**		
	Poisonous substances	Hazards to persons from contact with or inhalation of harmful substances due to missing or inadequate protection	5.2.2, 5.11.1, 5.11.2
		Contact with harmful fluids due to inadequate filling or dumping systems	5.11.3
8	**Ergonomic hazards**		
	Discomfort, musculo- skeletal disorder	Unhealthy postures or excessive effort	5.5.1 a), 5.6.2, 5.6.4
		Discomfort due to insufficient atmospheric environment in the driver cabin	5.6.2, 5.11.2, 5.11.3
	Consequences of human error	Insufficient visibility from driving or operating position	5.6.1
		Inadequate design, location or identification of manual controls	5.5.1 a); c), 5.5.2, 5.5.4, 5.7
		Misunderstanding of safety signs or markings	6.1, 6.2
		Misunderstanding of manufacturer's instructions	5.5.3, 6.2.1 d); e), 6.2.2 b); c); d), 6.3
	Visual fatigue	Inadequate local lighting	5.6.2, 5.8
9	**Hazards associated with the operating environment**		
	Structural damage, fatigue, failure and/or dysfunction of the relevant controls, control system and/or safety systems	Miscellaneous hazards to Persons due to inadequate design of the equipment	5.1.2, 5.3.1, 5.5
	Collision	Collision with other objects due to excessive speed of lifting device	5.13
		Collision with other objects or person due to insufficient visibility	5.6.1, 5.6.2
		Collision with other objects due to inappropriate illumination of the working area	5.8 b)
		Collision with other objects due to missing or inappropriate warnings	5.14

No	**Hazards identified in** EN ISO 12100:2010, Annex B and Table B.1	**Hazardous situations**	**Relevant clauses in this part of** EN 12312
		Collision with other objects due to vehicle uncontrollable sliding on ice or snow	5.12.4
10	**Combination of hazards**		
	Injuries or other physical harm from inappropriate controls and/or control systems	Simultaneous hazardous situation due to failure and/or dysfunction of the relevant control or control system	5.7.1, 5.7.2, 5.7.3, 5.7.4, 5.7.5
	Injuries, distressing situations or physical harms	Loss of balance due to unexpected movement and/or speed of lifting device	5.13
		Loss of balance due to unexpected movements of the lifting device	5.12.1
		Persons stuck up on the raised cabin/basket in an emergency situation due to lifting system failure	5.5.1, 5.6.7, 5.12.1
		Person stuck in a enclosed area/cabin due to missing means to escape	5.6.2, 5.6.7
		Miscellaneous hazards to Persons due to inadequate consideration of matching between operational conditions and the design of the equipment	5.1.3
		Hazardous situations not identified due to lack of communication between operators	5.7.6

Annex B
(informative)

Fluid system

B.1 General

This annex describes recommendations for performance and capacity of fluid systems for de-icing equipment as well as methods for verification of fluid systems, important for the reliability of the de-icing operation.

It is not the intention of this annex to specify a comprehensive set of technical design criteria for de-icing equipment for aircraft, but only those relating to function, safety and performance.

The annex is divided into the following three subdivisions:

a) B.2 Functional information;

b) B.3 Recommendations for fluid system performance and capacity;

c) B.4 Verification of fluid system functions.

The general functional requirements of a deicer can be found in ISO 11077:2014.

The content of B.2, B.3 and B.4 is agreed as internationally mandatory by industry, civil aviation authorities and airlines. These requirements have been developed over a number of years and they play an important role in designing de-icing/anti-icing equipment.

The applicable Civil Aviation Regulations are:

a) IC AO 9640-AN/940 (see Bibliography);

b) EASA EU-OPS Subpart D, 1.345 (see Bibliography).

B.2 Functional information

B.2.1 General

To optimize the snow and ice removal effect, the fluid system of the de-icing equipment should be designed for spraying fluid up to a temperature of 95 °C (the maximum allowed temperature of the surface of the aircraft is 70 °C at skin level).

B.2.2 Size/design of de-icing equipment

The size and design of the de-icing equipment should be agreed upon between manufacturer and user, as the operational conditions can vary considerably from one airport to another. The requirements can be very different concerning reach of aerial device, tank capacity, means of heating, etc.

In airports where the operators are de-icing for longer periods or are de-icing aircraft with running engines, a deicer with enclosed cabin offers a much better working environment concerning exposure to noise, weather, glycol, aerosols, etc.

As training of the operator is of major importance in order to perform a fast, technically and environmentally safe de-icing operation, it is important that the basket/operator's cabin has the capability to carry a second person.

Certain conditions in the different airports (e.g. narrow gates, low tunnels, passenger boarding bridges, etc.) can give rise to special requirements for the maximum width and height of the deicer with the aerial device in base position. This has to be stipulated between the manufacturer and the user.

B.3 Recommendations for fluid systems

B.3.1 General

Agreement on size and configuration of the fluid tanks should be made between manufacturer and user to suit the conditions on the airport concerned.

Of paramount importance in the design of the de-icing equipment is that the fluid system should be able to withstand, and to spray, fluid at temperatures from - 20 °C [cold Newtonian fluid (see ISO 11075:2007) or Non-Newtonian (pseudoplastic) fluid (see ISO 11078:2007)] to 95 °C (hot water or water/glycol mix). It should, likewise be able to handle all types of commercially available de-icing/anti-icing fluids, approved to aerospace specifications.

B.3.2 Fluid tanks

When designing fluid tanks, the mobile use of deicers should be remembered. The tanks need to be well stiffened to deal with the dynamic forces occurring during manoeuvring. Likewise, the tanks should be adequately baffled to prevent starving pumps and to minimize the fluid motion.

A tank made of a non-corrosive material will prevent discolouring of the fluid in the tank, and is a prerequisite if the de-icing equipment is supposed to handle Non-Newtonian (pseudoplastic) fluid.

As fluid in tanks is often heated or filled from filling pumps via valves in the bottom of the tank, suitable vents, overflows and drains should always be provided.

Each tank should, where necessary, be provided with a manhole, big enough to allow a person wearing personal protective equipment to enter the tank for cleaning and inspection.

Where fluid tanks are heated there is normally a request for insulation, as the heat loss from a full tank should not exceed 1 °C per hour when the difference between fluid in tank and ambient temperature (ΔT) is 100 °C. This insulation should be of a non-absorbing and, preferably, flame retardant material.

Isolation shut-off valves mounted at relevant locations on each tank will make it possible to reduce spillage if fluid lines are opened (e.g. if a hose bursts).

Where the tanks are provided with filling couplings, it is recommended that the dimensions of these from one tank to another are varied. This will prevent erroneous connection of filling equipment.

B.3.3 Pipe and pump system

Non-corrosive materials (e.g. stainless steel) are most suitable for the pipe system of de-icing equipment, and a necessity if the equipment is designed for spraying Non-Newtonian (pseudoplastic) fluid.

Flow demand for the various de-icing/anti-icing operations will vary with the amount of precipitation on the aircraft, wind conditions, temperature of fluid, spraying distance, etc., but if the deicer can deliver a flow rate from 50 l/min to 275 l/min at a pre-nozzle discharge pressure of 650 kPa with the boom fully elevated, it will be suitable for any de-icing task.

A 100 % Non-Newtonian (pseudoplastic) fluid system should be designed to spray 20 l/min to 100 l/min, when the boom is fully elevated.

The general demand for a Non-Newtonian (pseudoplastic) fluid concerning degradation, is a maximum of 20 % viscosity loss when pumping the fluid through the whole system from tank to nozzle output (monitored with a Brookfield Viscometer) when fluid in the tank has a viscosity within the fluid manufacturer's specification.

To conform to this requirement it is necessary to select components for the fluid system (e.g. pumps, spraying nozzles, pipes etc.) that do not degrade the thickened fluid by excessive agitation or molecular shearing.

As pumping fluid through relief valves or using by-pass valves to maintain pressure will degrade the fluid, it is necessary that the pumps “work on demand”.

B.3.4 Nozzle, spraying equipment

To perform an effective de-icing operation, the operator should have full control over the movement of the nozzle. It is necessary for the nozzle to be able to vary the pattern between fan shaped and solid beam, and the flow rate from minimum to maximum. It shall be possible to know from the cabin the fluid temperature at the nozzle.

For Non-Newtonian (pseudoplastic) fluid systems, a nozzle type permitting a spray pattern with a minimum of degradation should be used.

For underwing de-icing, a ground level hose reel with minimum 15 m hose length and a spraying nozzle may be provided.

In many cases it is most useful to be able to select and to spray more than one type of fluid or fluid mixes (e.g. to perform environmentally and operationally safe de-icing, to perform two-step de-icing, etc.). In such cases there should, for safety reasons, be a means of informing the operator which fluid system is engaged.

B.3.5 Heating

Many deicers are equipped with various means of fluid heating, e.g. Diesel fuel heaters, heat exchanger, electrical heating, etc.

Diesel fuel heaters should be able to operate while the deicer is in motion during the de-icing/anti-icing operation, as the heating time after refilling could be critical under severe weather conditions.

Where the Non-Newtonian (pseudoplastic) fluid is heated, it should be done by means of a heating system that will not degrade the fluid. Special attention should be paid to the fact that surface temperature of the heating surface is critical for Non-Newtonian (pseudoplastic) fluid.

Over the longer term (30 days at 70 °C, according to ISO 11078:2007), the degradation of Non-Newtonian (pseudoplastic) fluid should not exceed 10 % (monitored with a Brookfield Viscometer) when the original fluid was within the fluid manufacturer's specifications.

B.3.6 Mixing systems

It can be very useful to provide de-icing equipment with a mixing system for spraying a mixture of water and Newtonian fluid or Non-Newtonian (pseudoplastic) fluid.

Where de-icing equipment is equipped with a mixing system, the accuracy of this system should be stated in the operator's manual. This will be useful information for the operator when determining the safety margin of the de-icing operation and when examining whether the mixing system is working properly.

The safety of the system will be improved if there is a means of easy detection if accuracy of fluid mix is not within the stated tolerance. However, no matter how sophisticated the means of automatically verifying the accuracy of mixing system the de-icing equipment has, the operator should still periodically check the accuracy of the fluid mix at the nozzle, at least daily during de-icing operations.

A step-by-step method of how to test the accuracy and reliability of the mixing system, prescribed in the operator's manual, will be helpful for operators and maintenance personnel.

For the safety of the aircraft, efforts should be made in order to make the mixing system fail safe, i.e. the fluid mix should become stronger (contain more glycol) if something fails.

The design should likewise ensure that the mixing system produces a homogeneous fluid mix, and that the fluid mix is never weaker than the specified concentration (except for insignificant peak values). Where a mixing system cannot fulfil these criteria, the danger of covering large areas with an incorrect mixture exists.

B.4 Verification of fluid system functions

B.4.1 General

Verification of fluid metering systems, fluid mixing system and degradation of Non-Newtonian (pseudoplastic) fluid is necessary on any de-icing equipment.

The following step-by-step method is established to ensure that tests are performed under the same conditions and thus comparable and reproducible.

B.4.2 Verification of accuracy of a fluid mixing system

The verification of accuracy of a fluid mixing system should be done as follows:

a) fill the two tanks in question with sufficient fluid volume (water and Newtonian or Non-Newtonian (pseudoplastic);

b) start up the mixing system and select the fluid mix;

c) purge the system until the selected fluid mix positively comes out of the nozzle;

d) spray into a barrel or a bucket lined with a plastic bag or sack of appropriate size and strength, until sufficient amount of fluid volume is in the bag/sack;

e) remove the bag from the barrel and compare the refractive index of this fluid mix with the refractive index of a manually mixed sample.

The accuracy shall be within the specified limit.

If more than one fluid mix ratio is to be tested, the above-mentioned method should be repeated from b).

B.4.3 Verification of fluid system concerning degradation of Non-Newtonian (pseudoplastic) fluid

The verification of a fluid system concerning degradation of Non-Newtonian (pseudoplastic) fluid should be done as follows:

a) make sure that the Non-Newtonian (pseudoplastic) fluid tank is completely clean and free from water;

b) fill the tank with a sufficient volume of Non-Newtonian (pseudoplastic) fluid;

c) take 2 reference samples of the fluid from the tank;

d) select 100 % Non-Newtonian (pseudoplastic), and purge the fluid system until this fluid positively comes out of the nozzle;

e) spray into a barrel or a bucket lined with a plastic bag or sack of appropriate size and strength, until sufficient amount of fluid volume is in the bag/sack. Be sure to make exact notes about parameters concerning:

1) fluid temperature;

2) fluid flow rate;

3) shape of spray jet;

f) the test shall as a minimum be carried out with maximum flow rate and maximum angle on spray jet;

g) compare the samples from the bag/sack with the reference samples concerning Brookfield viscosity and hold-over-time.

B.4.4 Verification of accuracy of a fluid metering system

Where the de-icing equipment is equipped with a fluid metering system, this should be verified by spraying with a compact stream into a bucket or into a barrel, lined with a plastic bag or sack of sufficient size and strength (make sure that no fluid splashes out of the bag/sack).

Remove the bag and monitor the contents. Compare with the figures indicated on the fluid meter display. Accuracy shall be within the stated tolerance.

Annex C
(informative)

Toxicological aspects of using de-icing/anti-icing equipment

C.1 General

The aim of this annex is to highlight toxicological problems, arising from the use of fluids for de-icing/anti-icing aircraft. The annex concentrates on the use of glycol itself and not on the effect of any additives for increasing viscosity, reducing flammability and preventing corrosion.

C.1 covers the general aspect of using glycol for de-icing/anti-icing, C.2 describes how to minimize and overcome these problems. C.3 contains a description of the effects on humans and finally, recommendations for minimizing these effects are given in C.4

The Association of European Airlines (AEA) and ISO have specified two types of de-icing/anti-icing fluids. Among other things the specification states the minimum glycol content of the fluids as follows:

Newtonian fluid (de-icing) shall contain at least 80 percent by weight of glycols;

Non-Newtonian (pseudoplastic) fluid (anti-icing) shall contain at least 50 percent by weight of glycols.

There is no requirement for the type of glycol used. The commonly used glycols in Europe are **mono propylene glycol** and **diethylene glycol**. In other parts of the world, e.g. North America **mono ethylene glycol** is also used.

The main constituents of de-icing/anti-icing fluids are one or more glycols and water. Furthermore the fluids contain minor amounts of proprietary additives, neutralizers, inhibitors, and thickeners (in anti-icing fluids).

The use of de-icing/anti-icing fluids results in environmental exposure (water and soil) as well as exposure of personnel. The degree of environmental exposure depends on the environmental protection measures taken. Personnel exposure depends on the way of application and the personal protection measures taken.

C.2 Systems and training of operators

C.2.1 General

In order to ensure personnel and environmental protection, various aspects of the de-icing procedure should be carefully considered. The involved components/structures should then be designed or adapted with the goal of: Minimizing the consumption of de-icing and anti-icing fluids whilst having flight safety in mind. The goal can be achieved through emphasis on the following:

a) dedicated low fluid consuming spraying equipment;

b) well trained de-icing staff.

C.2.2 Design of the spraying equipment

C.2.2.1 Short spraying distance

For the most effective environmental protection, the de-icing equipment should provide a short spraying distance. This is important for the following reasons:

a) temperature loss caused by long spray distances is minimized;

b) the physical effect of the spray jet is optimized;

c) loss of fluid through wind effects is minimized.

A short spraying distance makes it possible to minimize the fluid consumption and by that, the exposure of glycol to the environment.

C.2.2.2 Mixing systems

The fluid system of the de-icing equipment should give the operator the possibility of selecting a glycol/water mix precisely suited to the prevailing weather conditions and which includes the necessary temperature buffer. This means glycol concentration can be optimized within the limits of safety. The nozzle should be able to provide a concentrated spray stream for de-icing (removal of frozen precipitation) and a flared spray stream for anti-icing (applying a film to protect against new ice build-up). Dedicated fluid lines to the nozzle, e.g. for 100 % Non-Newtonian (pseudoplastic) fluid, will limit fluid loss when switching between the fluid selections. A print out containing data similar to that mentioned in C.2.3.4 could be helpful for documentation and statistics.

C.2.3 Training of operators

C.2.3.1 Theoretical training

Theoretical training, mandatory for aeronautical purposes (see EU-OPS 1.345 and associated material) should include a basic understanding of the reasons for de-icing and recommendations for de-icing procedures. Operators should be aware of the crucial de-icing points in order to give them an understanding of how and where to apply de-icing fluid. This ensures that sufficient fluid is used on critical areas and that fluid is economized on non-critical areas.

C.2.3.2 Practical training

Practical training should be of such a duration that the operator feels “as one” with the de-icing equipment. Total familiarization enables the operator to understand the concept of the equipment and optimally exploit the benefits of its design, thereby minimizing fluid consumption.

C.2.3.3 Composition of the de-icing staff

Optimizing the number of de-icing staff means finding a balance that keeps it small enough to ensure that each operator performs a large number of de-icing operations thereby maximizing experience, whilst at the same time ensuring that the staff numbers are large enough to cope with absences. It is recommended that the specialized personnel are permanent, thereby maintaining the accumulated skills year after year.

C.2.3.4 Recording operation data (statistics)

To enable useful evaluation and follow-up of operator training/performance, a system for recording and controlling operations should be established. The details fed into the system — e.g. flight no., aircraft type, duration of operation, volume and type of fluid used, weather conditions etc. — will depend on the level of detail desired from the analysis. Data such as the above could provide a basis for comparing actual performance with ideal figures.

C.3 Effects on humans

C.3.1 Toxicity of glycols

C.3.1.1 General

Glycols are hygroscopic. In prolonged contact with glycols, skin and mucosae may dry up resulting in irritation of skin, eyes and mucosae in the respiratory tract. Mono ethylene glycol and mono propylene glycol are readily taken up through the skin whereas diethylene glycol is only taken up upon prolonged skin contact.

C.3.1.2 Mono propylene glycol (MPG) – CAS number 57-55-6

Mono propylene glycol is metabolized in the body to lactic acid and pyruvic acid, which are normal constituents of the glycolysis, normal metabolic pathways in the body. Mono propylene glycol is practically non-toxic. It is allowed in cosmetics and in medicine for cutaneous application. Prolonged skin contact has resulted in a few rare cases of allergic eczema.

C.3.1.3 Mono ethylene glycol (MEG) – CAS number 107-21-1

In the body, mono ethylene glycol is metabolized to oxalic acid, which binds calcium ions. Calcium oxalate crystals ("stones") may form in the kidney and in the bladder, possibly giving rise to bladder cancer in the case of many years exposure to relatively high concentrations. Prolonged skin contact has resulted in a few rare cases of allergic eczema. Large doses of mono ethylene glycol may be toxic to the kidneys and to the central nervous system. An oral dose of approximately 100 g may cause death in man.

MEG is classified as Acute Tox* (4) – hazard statement code H302.

C.3.1.4 Diethylene glycol (DEG) – CAS number 111-46-6

Diethylene glycol is metabolized in the body to 2-hydroxyethoxyacetic acid, which is eliminated via the urine. Large doses may be toxic to the kidneys and the central nervous system. An oral dose of approximately 75 g may cause death in man.

The three glycols are rather harmless to experimental animals having LD_{50}-values ranging from 6 g/kg body weight to 33 g/kg body weight depending on glycol and species. However, mono ethylene glycol and diethylene glycol appear to be toxic to humans and to the same degree, but only mono ethylene glycol is classified in the EU as a dangerous substance. Mono propylene glycol is regarded as non-toxic.

DEG is classified as Acute Tox* (4) – hazard statement code H302.

Table C.1 — Acute toxicity of glycols and EU classification

	MPG	MEG	DEG
LD_{50} (animals)	10–33 (g/kg bw [a])	6–19 (g/kg bw [a])	9–26 (g/kg bw [a])
(humans)	b	1,5 (g/kg bw [a])	1,0 (g/kg bw [a])
EU-classification	—	H302	H302

[a] bw means body weight

[b] no values found

C.3.2 Work environment considerations

Due to the glycol content the de-icing/anti-icing fluids are irritating to skin, eyes and mucosae. Furthermore, mono ethylene glycol and diethylene glycol are toxic to humans. During the de-icing/anti-icing process aerosols (fog, mist) and vapours are produced in high concentrations. Inhalation of these aerosols and vapours may cause adverse effects in the lungs.

Personnel exposure to de-icing/anti-icing fluids should be minimized as much as possible. In the case of exposure, personnel should wear a protective suit with hood, gloves, face shield and respirator. The respirator shall protect against wet aerosols and vapours, as recommended by the fluid supplier in the Material Safety Data Sheet (MSDS), such as filters of class P2, P3, and A of EN 143:2000.

C.3.3 Aircraft internal environment considerations

Persons inside the aircraft may be exposed to de-icing/anti-icing fluids and their pyrolysis products formed in the engines/auxiliary power unit (APU) entering the aircraft via the ventilation system. To avoid adverse health effects, the aircraft ventilation system shall be shut off during the de-icing/anti-icing process, (see ISO 11076:2012).

C.4 Recommendations

Summarizing this chapter, the following recommendations are given:

a) The de-icing/anti-icing process should be mechanized to minimize personnel exposure;

b) Personnel working manually with de-icing/anti-icing procedures should be suitably protected;

c) Aircraft air conditioning systems shall be shut off during de-icing.

Annex D
(informative)

Environmental aspects of de-icing/anti-icing at airports

D.1 General

The aim of this annex is to highlight environmental problems, arising from the use of fluids for de-icing/anti-icing aircraft, inflicted on airport surroundings. The purpose is to point out ways in which users can overcome these problems. The annex concentrates on the use of glycol itself and not on the effect of any additives for increasing viscosity, reducing flammability and preventing corrosion.

Glycols may be utilized by microorganisms as a source of carbon and energy, whereby the glycols ultimately are transformed into water and carbon dioxide. This process requires oxygen which is absorbed from the environment, possibly resulting in oxygen deficiency.

IMPORTANT — This oxygen consumption is considered the biggest environmental problem in connection with de-icing of aircraft today.

Theoretically the glycols require the following amounts of oxygen for complete transformation:

Table D.1 — Oxygen demand for transformation of glycol

Glycol	oxygen demand	kg oxygen/kg glycol
Mono ethylene glycol	5 atoms oxygen per molecule	1,3
Mono propylene glycol	8 atoms oxygen per molecule	1,7
Diethylene glycol	10 atoms oxygen per molecule	1,5

Table D.1 shows that a diethylene glycol molecule needs the highest number of oxygen atoms to degrade to water and carbon dioxide; but due to the difference in mol weight, mono propylene glycol, however, requires more oxygen if calculated by weight.

The oxygen content in normal sea water is dependent on many factors (e.g. temperature, daily or seasonal variations etc.), but a theoretical value of 10 mg/kg may realistically be used for the sake of this calculation. This necessitates the oxygen from approximately 170 m^3 of water to degrade 1 kg mono propylene glycol.

For additional information about different types of glycol see also C.3.1.

D.2 Environmental protection

D.2.1 General

De-icing on dedicated pads close to the runway allows for a reduction in the amount of glycol consumed, because less hold-over time is needed. Therefore it is possible to either use a weaker Newtonian solution or eliminate the need for Non-Newtonian (pseudoplastic) fluid.

No matter how efficient the de-icing system (i.e. de-icing equipment, de-icing pads, operators) is, glycol residue is unavoidable. This residue means that two tasks should be performed:

a) collection of used glycol (see D.2.2);

b) treatment of the collected glycol (see D.2.3).

D.2.2 Collection of glycol

D.2.2.1 General

When collecting used glycol, two different methods are most common:

a) mobile collection;

b) central collection.

The goal should be to collect glycol in an as concentrated form as possible. This means that the following treatment is as simple as possible and that the required capacity of collection tanks is reduced.

D.2.2.2 Mobile collection

The used glycol can be collected by special vehicles, by means of suction or absorption. This is a time consuming process which closes the area for a period, thereby reducing de-icing capacity, whilst collection takes place. The suction vehicles are normally redesigned mobile vacuum street cleaners.

The absorption vehicle is a mobile roller sponge fluid collector. This vehicle will usually have the greatest application in airports where de-icing is performed at the gate, and where the glycol cannot be isolated in the draining system.

It is strongly recommended that removal of the glycol is performed immediately after aircraft de-icing is completed. In this way most of the glycol will be captured before it is diffused and diluted.

D.2.2.3 Central collection

At airports where de-icing can be performed in dedicated areas (central or remote de-icing) the used glycol can be guided from collecting pads into a drainage system in the ground. There are various points to be considered when designing both elements of the dedicated area:

a) Collecting pad

The surface of the pad should be designed in such a way that fluid is not blown away when the aircraft uses break-away power. A grooved surface will for example prevent fluid from being blown away. The grooves shall be perpendicular to the aircraft. The surface material, which can be concrete or rubber mats, should prevent fluid seeping away. Even when exposed to Non-Newtonian (pseudoplastic) fluid, the material shall retain the necessary friction for aircraft and vehicles. It is vital that the grooved surface is resistant to the environment and treatments to which it is exposed. Break down of the surface reduces friction and increases the risk of foreign object damage (FOD) to aircraft engines.

b) Drainage system

It is very important that the system has a by-pass facility in order that non-contaminated water may be diverted back to the usual waste water system. This means avoiding unnecessarily large tanks in the system. Retention time of fluid in the collection system should be short, meaning that fluid should pass quickly from the collecting pad to the storage tank or waste water system respectively.

D.2.3 Treatment of glycol

D.2.3.1 General

The collected glycol can be treated in 3 different ways:

a) recycling;

b) destruction;

c) decomposition.

D.2.3.2 Recycling

In order to decide whether recycling is the optimal way to treat glycol, many conditions should be considered. These conditions are variable as no two airports operate precisely under the same circumstances. The sum of the variables will provide a basis on which to conclude whether recycling is cost-effective from an environmental and economical point of view. Some of the variables are as follows:

a) average and total glycol consumption at the airport;

b) average and total precipitation at the airport, and estimated volume of collected fluid;

c) average, minimum and maximum glycol concentration in collected fluid;

d) quality of collected glycol: matters in the surrounding environment that affect the size of the cleaning step in the recycling process (e.g. metal ions, runway de-icing fluid, spillage of oil and lubricants from aircraft and vehicles, etc.);

e) total energy demand for recycling of glycol:

f) energy for the distillation process and for other necessary additional equipment;

g) realistic utilization of excess heat from distillation process;

h) necessary capacity of buffer tanks, both collecting and ready tanks;

i) recycled glycol shall have the same quality as new glycol;

j) total costs for recycled glycol (including investments in facilities, cost of operations and maintenance, etc.) compared with the costs of using new glycol (including the cost of "used glycol treatment");

k) environmental consequences of the recycling process, compared to treating used glycol in other ways;

l) treatment of the collected fluid with a low glycol content which has by-passed the recycling system.

The design of the system should pay attention to the required size of the buffer tank. A distillation unit will have a certain capacity, but the amount of fluid used in any given period will vary in accordance with factors such as weather conditions and flight activity. In certain circumstances much glycol will have to be stored in the buffer tank and allowances should be made for this.

D.2.3.3 Destruction

Burning glycol is very energy consuming due to the content of water, despite the burning value of the glycol itself. The environmental consequences of burning should also be investigated.

D.2.3.4 Decomposition

The last method mentioned here is decomposition of glycol, by means of aerobic microorganisms. By leading the glycol to a public sewage plant the process can be controlled and thus the oxygen consumption regulated. This means avoiding the problems created through disturbing the oxygen content of natural recipients.

The microorganisms for decomposition cannot live from glycol and oxygen alone, but need to "eat" other essential matters in order to sustain their vital life functions. All these matters are normally present at a public sewage plant, which makes glycol decomposition possible there.

The decomposition rate of glycol varies greatly with the ambient temperature. The inlet of glycol should therefore be regulated in accordance herewith.

The sewage plant will have a fixed capacity, but its work load will differ due to daily peaks and seasonal variations. The inlet of glycol should therefore also be regulated with regard to these variations. This means that the considerations when determining adequate buffer tank size are the same as those in connection with recycling of glycol. Furthermore, it is important that the capacity of an available sewage plant is compatible with the size of the airport in question.

D.2.3.5 Summary

It should be pointed out that there is not one single way to optimally remove glycol. Each airport is a unique case and many factors will have influence when choosing the best method, for example:

a) economy;

b) amount of glycol;

c) topography and urbanization of the surroundings;

d) local health, safety and environmental regulations;

e) meteorological conditions;

f) special environmental and ecological conditions.

D.3 Environmental effects of de-icing/anti-icing fluids

D.3.1 General

The following describes the environmental effects, including the toxical aspects, on surrounding environment:

a) effects on aquatic environment (see D.3.2);

b) effects on soil environment (see D.3.3);

c) effects on humans (see C.3).

Additional safety information can be found in material safety data sheets in accordance with 91/155/EEC.

D.3.2 Effects on aquatic environment

D.3.2.1 Biodegradation

The glycols are readily biodegraded in aquatic environment including waste water and sludge. The biodegradability depends on the temperature — the lower the temperature, the slower the biodegradation rates. Mono ethylene glycol and mono propylene glycol are fully degraded — mono propylene glycol at the fastest rate, whereas diethylene glycol is degraded to a lesser extent, possibly due to the ether-bond.

D.3.2.2 Toxicity

The toxicity of glycols to water organisms is low or absent, diethylene glycol being the most toxic and mono propylene glycol being the least toxic to bacteria, fish and mammals.

D.3.3 Effects on soil environment

D.3.3.1 Biodegradation

In soil all three glycols are readily biodegraded. As in water, biodegradation in soil depends of the temperature, as may be seen from Table D.2.

Table D.2 — Mean biodegradation rates of glycol in soil

Mean biodegradation rates in soil [mg glycol/(kg soil x day)]			
	− 2 °C	8 °C	20 °C
Mono ethylene glycol	3,0	19,7	66,3
Mono propylene glycol	2,3	22,7	83,5
Diethylene glycol	4,5	27,0	93,3

Source, see [1].

D.3.3.2 Toxicity

The degradation takes place over a wide range of concentrations indicating that glycols do not inhibit the growth of soil microorganisms, i.e. they are probably not toxic to these.

D.4 Recommendations

Summarizing this chapter, the following recommendation are given:

a) de-icing/anti-icing procedures should be organized so that as little as possible de-icing/anti-icing fluids are used within the limits of safe de-icing;

b) de-icing/anti-icing procedures should be carried out in locations constructed for reception of residual de-icing/anti-icing fluid in order to avoid environmental pollution. The collected fluids should subsequently be treated by e.g. recycling, controlled feeding to a biological purifying plant or proper destruction.

Annex E
(informative)

Loading control

The Machinery Safety Directive 2006/42/EC, Annex I calls for loading control according to the following quotations:

4.2.2 Loading control

Machinery with a maximum working load of not less than 1 000 kg or an overturning moment of not less than 40 000 Nm must be fitted with devices to warn the driver and prevent dangerous movements in the event:

— *of overloading, either as a result of the maximum working load or the maximum working moment due to the load being exceeded; or*

— *of the overturning moment being exceeded.*

6.1.2 Loading control for machinery moved by power other than human strength

The requirements of section 4.2.2 apply regardless of the maximum working load and overturning moment, unless the manufacturer can demonstrate that there is no risk of overloading or overturning.

The risk of overloading as mentioned in 6.1.2 of Machinery Directive 2006/42/EC, Annex I does not exist for the machinery covered by this standard.

The reasons are:

— the machinery is exclusively designed for de-icing/washing, not for e.g. maintenance purposes, and contain no facilities for other purposes than de-icing/washing;

— no load in the cabin/basket other than the operators;

— no external overload to be expected when used as intended;

— the risks due to incorrect use, such as excessive slope or use on unprepared supporting surfaces, do not exist in de-icing/washing areas of airports;

— stability is automatically ensured for all configurations;

— the operation instructions delivered with each deicer include information for intended and unintended use.

Annex ZA
(informative)

Relationship between this European Standard and the essential requirements of EU Directive 2006/42/EC aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/396" to provide one voluntary means of conforming to essential requirements of EU Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).

Once this standard is cited in the Official Journal of the European Union under that *Directive*, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding *essential* requirements of that *Directive*, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and EU Directive 2006/42/EC

Essential Requirements of EU Directive 2006/42/EC	Clause(s) / subclause(s) of this EN	Remarks / Notes
all requirements covered	**all clauses**	

WARNING 1: Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2: Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

This bibliography contains additional references for deicers and de-icing/anti-icing equipment from regulations, publications, standards or draft standards.

— **European Standards:**

EN 143:2000, *Respiratory protective devices - Particle filters - Requirements, testing, marking*

EN 149:2001+A1:2009, *Respiratory protective devices - Filtering half masks to protect against particles - Requirements, testing, marking*

EN 280:2013+A1:2013, *Mobile elevating work platforms — Design calculations — Stability criteria — Construction — Safety — Examinations and tests*

EN 779:2012, *Particulate air filters for general ventilation — Determination of the filtration performance*

EN 1777, *Hydraulic platforms (HPs) for fire fighting and rescue services - Safety requirements and testing*

EN 1822-1:2009, *High efficiency air filters (EPA, HEPA and ULPA) - Part 1: Classification, performance testing, marking*

EN 13034:2005+A1:2009, *Protective clothing against liquid chemicals - Performance requirements for chemical protective clothing offering limited protective performance against liquid chemicals (Type 6 and Type PB [6] equipment)*

EN 14387:2004+A1:2008, *Respiratory protective devices - Gas filter(s) and combined filter(s) - Requirements, testing, marking*

EN ISO 13688:2013, *Protective clothing - General requirements (ISO 13688:2013)*

EN ISO 13732-1, *Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces (ISO 13732-1)*

EN ISO 17491-3:2008, *Protective clothing - Test methods for clothing providing protection against chemicals - Part 3: Determination of resistance to penetration by a jet of liquid (jet test) (ISO 17491-3:2008)*

NOTE EN 280 and EN 1777 do not apply to aircraft ground support equipment. However, in view of design similarity with elevating nacelle equipment for general use, deicer manufacturers may wish to consult them in parallel with this European Standard.

— **International Standards:**

ISO 6966-2:2014, *Aircraft ground equipment — Basic requirements — Part 2: Safety requirements*

ISO 11075:2007, *Aircraft — De-icing/anti-icing fluids — ISO type I*

ISO 11077:2014, *Aircraft ground equipment — De-icers — Functional requirements*

ISO 11078:2007, *Aircraft — De-icing/anti-icing fluids — ISO types II, III and IV*

— **International Air Transport Association (IATA), Airport Handling Manual (AHM), Section:**[1)]

AHM 975, *Functional specification for aircraft self-propelled de-icing/anti-icing unit*

AHM 977, *Functional specification for a towed de-icing/anti-icing unit*

— **International Civil Aviation Organization (ICAO):**[2)]

IC AO 9640-AN/940, *Manual of aircraft ground de-icing/anti-icing operations*

— **European Aviation Safety Agency (EASA):**[3)]

EU-OPS Subpart D Operational procedures 1.345, *Ice and other contaminants*

Acceptable Means of Compliance (AMC) OPS 1.345, *Ice and other contaminants — Procedures*.

— **Society of Automotive engineers (SAE) recommended practice:**[4)]

SAE/ARP 1971C, *Aircraft de-icing vehicles — Self Propelled*

SAE/ARP 5058, *Enclosed operator's cabin for aircraft ground support equipment*

SAE AMS 1424, *De-icing/anti-icing fluid, aircraft, SAE type I*

SAE AMS 1428, *Fluid, aircraft de-icing/anti-icing, non-Newtonian, pseudoplastic, SAE types II, III and IV*

— **Association of European Airlines (AEA):**[5)]

Recommendations for de-icing/anti-icing of aircraft on the ground

— **International Institute of Welding (IIW):**[6)]

Recommendations for the mounting of strain gauges

[1] Klecka GM, Carpenter CL, Landenberger BD. *Biodegradation of aircraft de-icing fluids in soil at low temperatures*

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1) Publications Assistant, International Air Transport Association, 800 Place Victoria, P.O. Box 113, Montreal, Quebec, Canada, H4Z 1M1

2) International Civil Aviation Organization (ICAO), 999 Robert-Bourassa Boulevard, Montréal, Quebec H3C 5H7, Canada, www.icao.int

3) European Aviation Safety Agency (EASA), https://www.easa.europa.eu

4) Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA, 15096-0001, USA

5) Association of European Airlines (AEA), Avenue Louise 350, Bte 4, B 1050 Brussels, Belgium, www.aea.be

6) Secretariat of the International Institute of Welding, ZI Paris Nord 2, BP: 50362, F 95942 ROISSY CDG Cedex, France

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