# Aircraft De-Icing Manual

## 2017 / 2018

<table>
<thead>
<tr>
<th>Issued by:</th>
<th>Flughafen Köln/Bonn GmbH Aviation Division Heinrich-Steinmann-Str. 12 51147 Köln</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last revised:</td>
<td>February 2018 – effective until August 2018</td>
</tr>
<tr>
<td>Version:</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Contact:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Wolfgang Lohr</strong></td>
<td><strong>Oguz Ipek</strong></td>
</tr>
<tr>
<td>Head of Operations and Winter Services</td>
<td>Head of De-Icing Training</td>
</tr>
<tr>
<td>Tel.: +49 (0) 2203 – 40 44 36</td>
<td>Tel.: +49 (0) 2203 – 40 50 62</td>
</tr>
<tr>
<td>Mobile: +49 (0) 162 – 24 38 474</td>
<td>Mobile: +49 (0) 1515 – 38 56 110</td>
</tr>
<tr>
<td>E-Mail: <a href="mailto:wolfgang.loehr@koeln-bonn-airport.de">wolfgang.loehr@koeln-bonn-airport.de</a></td>
<td>E-Mail: <a href="mailto:oguz.ipek@koeln-bonn-airport.de">oguz.ipek@koeln-bonn-airport.de</a></td>
</tr>
</tbody>
</table>
Revisions / updates

The following chapters have been revised / updated in this version:

Chapter 8.1.5.
Chapter 8.4.3.

The following chapters have been added in this version:

Chapter 8.1.5.1.
Chapter 8.1.5.2.
Chapter 10.4.
Table of Contents

Revisions / updates ........................................................................................................... 2
Table of Contents ............................................................................................................. 3
List of Figures ................................................................................................................... 4
1  Foreword.......................................................................................................................... 5
2  Responsibilities ................................................................................................................ 6
   2.1  Flight Operations and Winter Services Management ........................................... 6
   2.2  Coordination Winter Services, Aircraft De-Icing .................................................. 6
   2.3  Aircraft De-Icing Training ...................................................................................... 6
3  Applicable Documents .................................................................................................... 6
4  Background and Causes .................................................................................................. 7
5  Aircraft De-Icing Personnel .......................................................................................... 8
6  Training and Qualification in Aircraft De-Icing .......................................................... 8
   6.1  De-Icing Operator – DI-L20 + DI-L30B ............................................................... 9
   6.2  De-Icing Supervisor – DI-L30 .............................................................................. 9
   6.3  Pre/Post De-Icing/Anti-Icing Inspector – DI-L30B .............................................. 10
   6.4  De-Icing Instructor – DI-L40 ............................................................................. 10
   6.5  De-Icing Coordinator – DI-L50 ......................................................................... 10
   6.6  Fluid Quality Inspector – DI-L60 ....................................................................... 10
   6.7  Head of De-Icing Training – DI-L70 ................................................................. 10
7  Principles of Aerodynamics .......................................................................................... 11
8  Principles of Aircraft De-Icing ....................................................................................... 11
   8.1  De-Icing Fluids – ADF Fluids ........................................................................... 12
       8.1.1  ADF-Fluid Type I ..................................................................................... 12
       8.1.2  ADF-Fluid Type II ................................................................................... 12
       8.1.3  ADF-Fluid Type III and IV ..................................................................... 13
       8.1.4  Potential Hazard – Thickener ................................................................. 13
       8.1.5  Fluid checks ............................................................................................. 13
       8.1.5.1  ADF storage ....................................................................................... 13
       8.1.5.2  De-icing vehicles .............................................................................. 14
   8.2  De-Icing Methods ..................................................................................................... 14
       8.2.1  De-Icing with Fluids ................................................................................ 14
       8.2.2  De-Icing – Alternative Methods ............................................................... 14
       8.2.3  Anti-Icing – Protection against Re-Icing with Fluids .............................. 14
       8.2.4  Anti-Icing – Further Methods ................................................................. 15
8.3  De-Icing Procedures .................................................................................................... 15
8.3.1 One-Step Operation.......................................................... 16
8.3.2 Two-Step Operation ...................................................... 16
8.3.3 Pre De-Icing/Anti-Icing ................................................ 16
8.3.4 Protective Anti-Icing .................................................... 17
8.3.5 Underwing De-Icing ..................................................... 17
8.3.6 Removal of Local Area Contamination ............................ 17
8.3.7 Propeller De-Icing ....................................................... 17
8.4 Explanation of Terms in Aircraft De-Icing .......................... 18
8.4.1 LOUT ........................................................................ 18
8.4.2 Holdover Time (HOT) .................................................... 18
8.4.3 Anti-Icing Code ............................................................ 19
8.4.4 Clean Aeroplane Concept .............................................. 19
8.4.5 Special Checks ............................................................. 19
8.4.6 Obligation for Symmetric De-Icing ................................. 19
8.4.7 Cold Soak Effect ........................................................... 20
8.4.8 No Spray Areas ............................................................ 20
9 Operational Organization ...................................................... 21
9.1 Contact Person ............................................................... 21
9.2 De-Icing Order ............................................................... 21
9.3 Dispatch ....................................................................... 21
9.4 De-Icing Process ............................................................. 22
9.5 Disposal of ADF Fluids ................................................... 22
10 Infrastructure and Vehicles .................................................. 23
10.1 De-icing Locations ......................................................... 23
10.2 De-Icing Vehicles .......................................................... 23
10.3 Proximity sensor ........................................................... 24
10.4 Tank Facilities ADF Fluids ............................................. 24
11 Quality Assurance ............................................................. 24
12 Safety Management .......................................................... 24
Abbreviations ...................................................................... 25

List of Figures

Tabelle 1: Overview of De-Icing Fluids Used ........................................ 12
Tabelle 2: Overview of Aircraft-Specific Consumption Rates ............... 15
Tabelle 3: Contact Details of De-Icing Supervisor .............................. 21
Tabelle 4: De-Icing Vehicles ........................................................ 23
1 Foreword

This Aircraft De-Icing Manual describes the principles of the de-icing operation of Cologne Bonn Airport (Flughafen Köln Bonn, FKB) and gives information about different topics involved in aircraft de-icing. The contents are limited to general topics as well as applying procedures at Cologne Bonn Airport, vehicle fleet and personnel structures. This manual therefore mainly aims at employees involved in aircraft de-icing of all airlines serving Cologne Bonn Airport or using it as a diversion airport and need data for their planning. At the same time it also serves as an information basis for everyone interested in this subject.

All described procedures and measures are based on the guidelines and recommendations of the International Civil Aviation Organization (ICAO), the European Aviation Safety Agency (EASA) and the International Air Transport Association (IATA) as well as their successor organizations and sub-organizations. Furthermore, the Airport User Regulations (Flughafenbenutzungsordnung, FBO) apply as well as the deductive measures from the Aerodrome Manual (Flugplatzhandbuch), section 2.2. "Safety Management System" (SMS) of Cologne Bonn Airport. All those for whom this manual forms the basis of the de-icing operation are responsible for the implementation of and compliance with all safety regulations applicable.

The references of this manual relate exclusively to general standards, directives and requirements. It includes information from requirements set by vehicle, aircraft or de-icing fluid manufacturers in the versions known to the Cologne Bonn Airport. The training content and the services offered exclusively relate to commercial aircraft. Rotorcraft and military aircraft as well as the entire private aviation are not sufficiently accounted for thereby.

The training type and its content meet the standards and quality attributes of the Society of Automotive Engineers (SAE), applicable as from this season. They include de-icing procedures, strategies and techniques, as well as operation of de-icing vehicles.

The term "de-icing" always relates to the two sub-processes of "de-icing" and "anti-icing". In principle, the de-icing season is considered to be 01.10. to 31.04. inclusive of the subsequent year.

In all measures and workflows, the safety of the persons involved, the vehicles and the aircraft always has first priority. The principles of "Safety First" and the "Clean Aeroplane Concept" apply. An aircraft is regarded as free of contamination only once all critical surfaces have been completely cleaned. A surface is only considered protected against re-icing if the required ADF minimum quantity per SAE standard has been applied specifically to the aircraft type.

Everything discussed in this manual is based on these principles. Compromises will not be made in any of these points.

Safety always takes priority over economic aspects!

Aircraft de-icing is an important safety aspect in aviation, demands high quality aspirations and requires an up-to-date training status of all involved.
All questions that may occur can be directed to the de-icing coordinator who is available at any time.
2 Responsibilities

Winter Services of Flughafen Köln/Bonn GmbH ensures that aircraft de-icing in terms of planning, organization, training and technical equipment meets all the requirements and aspirations of ICAO, IATA, SAE and manuals of airlines FKB provides services for. The structure of responsibilities is as follows:

2.1 Flight Operations and Winter Services Management

> Management, planning and organization of Winter Services and Aircraft De-Icing

2.2 Coordination Winter Services, Aircraft De-Icing

> Management, planning and organization of aircraft de-icing
> Planning of training on aircraft de-icing in theory and practice
> Preparation and review of all documents
> Archiving all documents and records for at least six years
> Review and control of the individual processes for aircraft de-icing
> Securing the functionality and operativity of the de-icing vehicles
> Development of de-icing strategies for aircraft de-icing
> Preparation of the data for billing de-icing transactions
> Support for internal and external audits
> Securing the standards based on international and local regulations
> Performing laboratory tests of the individual fluids before the season and on demand

2.3 Aircraft De-Icing Training

> Schedule planning for the training for aircraft de-icing in theory and practice
> Preparation of all training documents
> Execution of aircraft de-icing training
> Administration of written exams and practical tests
> Clearance of trained operators for de-icing operation

3 Applicable Documents

> ICAO Doc 9640 (Manual of Aircraft Ground De-Icing/Anti-Icing Operations)
> IATA SGHA (Standard Ground Handling Agreement)
> SAE AS 6285 (Aircraft Ground De-Icing/Anti-Icing Processes)
> SAE AS 6286 (Training and Qualification Program for De-Icing/Anti-Icing of Aircraft on the Ground, Slash Sheets SAE AS 6286/1 up to 6286/6)
> SAE AS 6332 (Quality Assurance Program for De-Icing/Anti-Icing of Aircraft on the Ground)
> SAE ARP 6257 (Aircraft Ground De-Icing/Anti-Icing Communication Phraseology for Flight and Ground Crews)
> SAE ARP 1971C (Aircraft De-Icing Vehicle - Self-Propelled)
> SAE AMS 1424 (De-Icing/Anti-Icing Fluid, Aircraft, SAE Type I)
> SAE AMS 1428 (Fluid, Aircraft De-Icing/Anti-Icing, Non-Newtonian SAE Types II, III, and IV)
> Process Manual Winter Services of Flughafen Köln/Bonn GmbH
> Airport User Regulations (Flughafenbenutzungsordnung, FBO) of Flughafen Köln/Bonn GmbH
> Aerodrome Manual (Flugplatzhandbuch) of the Flughafen Köln/Bonn GmbH
> General Terms and Conditions for Aircraft De-Icing (AGB – Enteisung) of Flughafen Köln Bonn GmbH
4 Background and Causes

So-called "icing-up" is the process of formation of contamination under freezing conditions. This contamination on the so-called critical aircraft components results in deterioration up to total loss of the aerodynamic flows. In addition, it can result in loss of controllability through icing of the control surfaces; all maximum weight limits can be exceeded. This issue has been the second most common cause of accidents in aviation in the last 30 years.

The process of aircraft de-icing is very cost-intensive. For airport operators or external de-icing service providers, this constitutes investments of up to double-digit millions for facilities, vehicles and personnel; operating costs of airlines quickly increase immensely by de-icing operations compared to normal aircraft ground handling. Past incidents show that economic aspects were naively prioritized over safety, which resulted in tragic accidents with many people killed and injured.

Summarized, in aircraft de-icing three main causes are mentioned that can result in damage or accidents through icing.

> Technical Faults
  → Quality defects of the fluid or de-icing equipment
  → Defect mixing systems in facilities and vehicles

> Organizational Errors
  → No timely preparation of winter services

> Human Factor
  → Deficient training of de-icing personnel
  → Deficient training of flight personnel
  → False estimation of own capabilities and performance
  → Lack of ability to accept criticism
  → Poor or confusing communication
  → Improper performance of de-icing
  → False or neglected checks
  → Misinterpretation of tables, safety provisions and instructions

This shows that most of the causes reflect the so-called human factor. Therefore, it is our constant endeavor to counteract all the above causes through qualification, organization and motivation.

Therefore, it is very important that the airport operator, respectively the de-icing service provider, as well as the airlines have both sufficient professional competence and conviction to first determine the necessity of a de-icing and then to choose and apply the appropriate de-icing procedure and de-icing fluid.

The responsibility and the decision as to whether and when de-icing is necessary is always with the pilots in command. The de-Icing operator is always responsible for performing the de-icing and the final check PDAC\(^1\). The de-icing operator therefore decides if de-icing by the FKB can be performed or not if the pilot chooses a wrong de-icing fluid or instructs a wrong de-icing method.

\(^1\) Pre/Post De-Icing/Anti-Icing Check – visual check for contamination before or after de-icing
5 Aircraft De-Icing Personnel

All personnel in aircraft de-icing is recruited from the entire workforce of Cologne Bonn Airport and perform these duties in parallel or in addition to their normal operating tasks within the company. This means that all employees have basic to highly advanced knowledge of all operations at the airport, regardless of being further trained as de-icing operators.

6 Training and Qualification in Aircraft De-Icing

All employees involved in aircraft de-icing have to attend a training for de-icing operators including all required tests in terms of exams or practical tests. In addition, skilled and experienced de-icing operators can qualify for the position of the de-icing supervisor. By start of this season, these trainings are based on the guidelines and recommendations of the SAE AS 6286 "Training and Qualification Program for De-Icing/Anti-Icing of Aircraft on the Ground" and are adapted to the local conditions. With regard to the environment and the clients, one aim in this context is the independent planning and performance of de-icing by the trained de-icing operators and de-icing supervisors in order to bring aircraft types and weather situations with the number of vehicles and fluid required into an acceptable form.

However, the most important rule in this context is: Safety first!

The SAE defines the qualifications in aircraft de-icing and recommends the following terms:

- DI-L10 - De-Icing Vehicle Driver
- DI-L20 - De-Icing Operator
- DI-L30 - Supervision of De-Icing/Anti-Icing
- DI-L30B - Pre-/Post De-Icing/Anti-Icing Inspector
- DI-L40 - De-Icing Instructor
- DI-L50 - De-Icing Coordinator (Remote De-Icing)
- DI-L60 - Fluid Quality Inspector (Laboratory Staff)
- DI-L70 - Head of De-Icing Training
- DI-L80 - Flight Crew - Winter Operations (Basics of De-Icing/Anti-Icing)
- DI-L80B - Cabin Crew (Icing Awareness)

As Cologne Bonn Airport has completed its vehicle fleet with de-icing vehicles approved for one-person operation\(^2\) since de-icing season 2016/2017, there will be no separate driver training according to qualification DI-L10 anymore. All participants undergo the training for the de-icing operator and acquire in addition the ability to independently perform the PDAC. Thus, all participants who successfully completed the training are qualified according to qualifications DI-L20 and DI-L30B.

All training records and examination results will be archived for six years.

---

\(^2\) Technically, the vehicles can also be used in a two-person operation
6.1 De-Icing Operator – DI-L20 + DI-L30B

Those who apply for aircraft de-icing, and also the de-icing operators who did not perform de-icing operations in the previous season/seasons, have to attend a training of five days minimum. De-Icing operators who successfully performed in de-icing in the previous season have to attend a three-day refresher training. All trainings take place in classes with on-site attendance. All theoretical training parts are provided equally to all course participants and are completed with a compulsory exam on the second day at the latest. The test is successfully passed when at least 80% of 32 questions have been answered correctly and is a precondition for participation in the practical training. Regardless of that, the content of questions that have been answered incorrectly will be trained again in a refresher training until there is a positive result of 100%.

The theoretical part of the training focusses on the legal basis, familiarity with aircraft types, aerodynamics, causes of de-icing, de-icing methods and procedures, de-icing fluids, capabilities and potential uses of de-icing fluids, HOT (holdover time) tables, weather influences, organization of de-icing, de-icing strategies, communication on de-icing, checks and documentation, competent and appropriate handling of vehicles and equipment, safety regulations and Safety Management (SMS).

The practical training starts with exercises on de-icing simulators, which are exactly modelled on the operator cabins of our de-icing vehicles. Here, the participant is already trained how to approach the aircraft with the de-icing vehicle as well as how to operate the necessary units of the cabin control and the spraying arm. The simulation software especially enables the practice of the sensitive controlling of the spraying arm, which in reality has to be moved very closely to the aircraft wings and fuselage to obtain efficient de-icing. Subsequently, the instruction for the de-icing vehicles is carried out which comprises all necessary vehicle checks, handling of all operational units including emergency operation as well as fuelling processes with water and ADF fluids.

The exams are carried out based on the requirements of the EASA. It requires at least 30 questions with three possible answers each, whereby only one answer may ever be correct. No multiple mentions are allowed. A time limit of 45 seconds is available for each question, whereby, however, only the total duration of the test is defined (e.g. 30 questions à 45 seconds makes 23 minutes and 15 seconds). No documents may be used for the test except those addressed directly by a question (e.g. tables). With this exam Cologne Bonn Airport even exceeds the requirements. The exam may not be anonymous. Each participant must be clearly identifiable. Upon failing, the exam may be repeated at the earliest after 90 days, or after 30 days if the course is also repeated completely.

The qualification only applies for the current season and has to be updated with a refresher training after a maximum of twelve months. If this is not done, a complete training of five days is mandatory.

6.2 De-Icing Supervisor – DI-L30

Only experienced de-icing operators can qualify for the position of a de-icing supervisor, thus always being qualified as DI-L10, L20 and L30B, too. The de-icing supervisor also has to do the refresher trainings for de-icing operators every year with a positive result of the exam and a successful participation in the practical training. New prospective de-Icing supervisors accompany an experienced de-icing supervisor during one season in order to obtain sufficient knowledge on practical work.

The de-icing supervisor plans the distribution of the de-icing orders and is the contact person in these matters for the crews. He/she can be contacted via radio or phone at any time. The de-icing supervisor is also the link between the crew and the de-icing operator if they cannot communicate directly due to operational reasons.
He/she carries out contamination checks and decides upon the result if a pre de-icing is necessary and can also support the de-icing operators with the PDAC or other tasks at any time.

6.3 Pre/Post De-Icing/Anti-Icing Inspector – DI-L30B

see 6.1.

6.4 De-Icing Instructor – DI-L40

The trainings are only conducted by trainers with qualification level DI-L4 DI-L40, who themselves obtained their license from internationally recognized and qualified trainers according to ICAO/IATA Global Standard. Here also, a several-day refresher training takes place once a year to obtain a new license. As a rule, these are external trainings. Qualification DI-L40 also always includes the qualifications of DI-L10, L20, L30 and L30B.

6.5 De-Icing Coordinator – DI-L50

The de-icing coordinator controls the processes at so-called remote de-icing positions. Remote de-icing is currently not practised at Cologne Bonn Airport, thus the position of the de-icing coordinator is not filled at the moment.

6.6 Fluid Quality Inspector – DI-L60

Due to local conditions, the quality checks of ADF fluids are distributed between various persons responsible and are carried out independently of one another. Regular checks are primarily carried out upon delivery of the fluids by the ADF coordinators who also supervise the tank facilities. In addition, the ADF coordinators are responsible for the annual ADF fluid checks from the tank facilities. The laboratory samples are tested externally. The ADF coordinators receive an annual refresher training from an external trainer and are thereby certified.

Furthermore, every time a de-icing vehicle is put into operation samples of the ADF fluids are taken and the refractive index is measured with a refractometer, which is part of the training for de-icing operators.

6.7 Head of De-Icing Training – DI-L70

The head of de-icing training is responsible for the entire planning, controlling and carrying out of trainings and de-icing. He/she provides updated information and ensures that all employees involved in de-icing are always kept up to date regarding directives, requirements and legal provisions. Qualification DI-L70 also includes all lower qualifications. Head of De-Icing Training at Cologne Bonn Airport is the coordinator of the aircraft de-icing.

The qualifications DI-L80 and L80B relate to crew members of the airlines and are not taken into consideration in this manual. However, it shows that also crew members, especially cockpit crews, have to acquire basic knowledge in aircraft de-icing.

---

1 Is carried out on request by the airline and varies according to the season.
7 Principles of Aerodynamics

All calculations of flight characteristics of the various aircraft types are based on the assumption that the aerodynamic surfaces are free of contamination and that airflows are unhindered. One must therefore ensure that the airflow is not interrupted or disturbed by contamination of ice or snow, which significantly impacts the flight characteristics.

Four forces are exerted on the aircraft during take-off, flight and landing: lift, resistance, thrust and weight. Any disturbance or interruption of the airflow has a negative effect on flight characteristics and these four forces. The greatest risk occurs during take-off, when the form of the wings is changed through contamination in a way that the necessary lifting forces cannot be reached. In an extreme case, this can result in a so-called "stall".

In addition, contamination can result in exceeded weight limits of the aircraft. This means that the MTOW, MTW or the MRW may be higher than the permitted weight limits. On a B 737-800, a thin cover of snow on the aircraft can result in additional weight of more than half a ton. Thicker covers of snow thus can result in additional weight of several tons. Furthermore, icing of the moving control surfaces such as flaps, spoilers or the rudder can result in the aircraft becoming partially or completely uncontrollable. For that reason, the so-called "Clean-Aeroplane-Concept" forms the basis as a binding, mandatory ruling for all involved in aviation. Simplified, this means:

"No aircraft departs with contamination on the aerodynamically critical surfaces."

More precise regulations and permitted exceptions can be looked up in the manuals of the respective aircraft types. Upon request by crews, we gladly perform a PDAC, in this case the pre-de-icing/anti-icing check and inform the crews if the aerodynamically critical surfaces are contaminated with ice, snow etc.

8 Principles of Aircraft De-Icing

What is aircraft de-icing actually? First of all, aircraft de-icing means that an aircraft contaminated with snow, ice, frost or hoar frost has to be cleaned from these contaminations, thus preventing all possible negative impact on the flight characteristics of the aircraft. Furthermore, an aircraft can be protected against re-icing during the de-icing process. Thus, aircraft de-icing consists of two major components, the de-icing and the anti-icing. Both methods\(^4\) are mentioned below.

It always depends on the weather conditions and the traffic volume which method when and how is to be applied. These two factors determine if the chosen method provides an effective protection for the aircraft and thus for the passengers and the crew until take-off.

In order to guarantee this, time coordination is a further and often the more important factor besides the choice of method. Therefore, a well-functioning and cross-company team work between the de-icing team, cockpit crew, ground handling and air traffic control is absolutely necessary.

\(^4\) According to the requirements of the SAE AS 6285 (Aircraft Ground De-Icing/Anti-Icing Processes)
There are different methods in aircraft de-icing. FKB only offers de-icing with liquid de-icing agents (ADF fluid). Protection against re-icing (anti-icing) can only be guaranteed by applying suitable fluids. The following section describes the fluids used by FKB, operating methods and procedures as well as several explanations of terms.

8.1 De-Icing Fluids – ADF Fluids

Aircraft de-icing fluids are specified by the SAE and are produced in four different types. The main component of these fluids is propylene glycol and additives for the corrosion protection as well as food colouring for identification. This is important to make clearly visible, which ADF fluid is used.

The following section describes the fluids used by FKB, operating methods and procedures as well as several explanations of terms.

8.1.1 ADF-Fluid Type I

Type I\(^5\) is a so-called Newtonian liquid and behaves physically like water. It runs off proportionally. Type I is always used diluted. An undiluted use has no better effect as the physical property of the fluid already decreases at a concentration at 70 %, meaning that the freezing point increases. According to the manufacturer the use at full concentration of 100 % is not permitted.

The mixing ratio water/ADF fluid Type I depends on the OAT, respectively ATT\(^6\). A further factor for calculating the mixing ratio is the LOUT\(^7\).

8.1.2 ADF-Fluid Type II

Type II\(^8\) is a non-Newtonian liquid, which contains a thickener\(^9\) and therefore develops a pseudo-plastic property. It behaves like solid material at low shear forces and only shows liquid behaviour at higher shear forces. Above a take-off velocity of approximately 85 kn (158 km/h), also called shear rate, a shear force is reached where the Type II runs off the aircraft surfaces.

---

\(^5\) According to SAE AMS 1424 standards (De-Icing/Anti-Icing Fluid, Aircraft SAE Type I Glycol (Conventional and Non-Conventional) Based)
\(^6\) See also cold soak effect
\(^7\) Lowest Operational Use Temperature – see explanation of terms
\(^8\) According to SAE AMS 1428 standards (Fluid, Aircraft De-Icing/Anti-Icing, Non-Newtonian (Pseudoplastic), SAE Types II, III, and IV)
\(^9\) See also 8.1.4. – Potential Hazard Thickener
Type II is primarily used for anti-Icing and forms a thin protective layer on the sprayed parts of the aircraft. Because its structure is long-lasting and solid on the surfaces of both the aircraft and the wings, even if in this case limited until the starting process, it prevents snow or other contamination from getting onto and freezing on these surfaces.

FKB always uses Type II undiluted, which means at a concentration of 100 %.

8.1.3 ADF-Fluid Type III and IV

Type III and Type IV have similar properties as Type II. However, they are not used at Cologne Bonn Airport at the moment.

8.1.4 Potential Hazard – Thickener

When the water and later on the glycol have separated out from the ADF fluid Type II (also Type III and IV) after a certain time, thickener residues\(^\text{10}\) in the form of a grey powder remain. These residues still have the ability of binding fluids up to 150 times their original volume. However, as there is no glycol left, the freezing point of this mass is at zero degrees. If these residues get stuck in gaps of the control elements and even only start to bind air humidity, there is a risk of ice chunks forming which can result in a negative impact on the controllability of the aircraft.

The de-icing teams are trained in dealing with this problem and avoid active spraying on relevant parts during anti-icing.

The responsibility for the checks for residues remains with the airlines. These residues may only be removed mechanically, with hot water or ADF Type I.

8.1.5 Fluid checks

Before ADF are used, they are regularly tested in accordance with the requirements of SAE AS 6285. Different procedures as follow.

8.1.5.1 ADF storage

From the de-icing fluids samples are taken on delivery by the ADF coordinator and the refractometer value, viscosity and acidity are measured and documented in the internal laboratory. The results are checked with the values specified by the manufacturer. If the values are within the permitted limits, the ADF may be filled into the storage tanks. If the values are outside the limits the delivery will be rejected. A new delivery must be made.

Before the season, samples are taken by the ADF coordinator and sent to the manufacturer. The manufacturer checks the samples in his laboratory and informs us in writing if the tests were positive or negative. If the result is negative, a second sample is taken and returned for re-examination. If this test is also negative, the ADF must be disposed.

The de-icing vehicles may only be filled from the storage tanks before of the season, if the positive test results are available from the manufacturer.

---

\(^{10}\) See also 8.3.3. – Pre De-Icing/Anti-Icing
8.1.5.2 De-icing vehicles

Prior to the start of the season, ADF samples are taken from all tanks and spray nozzles by the Head of de-icing trainer and sent to the manufacturer. The manufacturer checks the samples in his laboratory and informs us in writing if the tests were positive or negative. If the result is negative, a second sample is drawn and returned for re-examination. If this test is also negative, the ADF must be disposed of from the de-icing vehicle.

Daily checks of the deicing fluids are performed when using the deicing vehicles. In this case, a sufficient amount of deicing liquid is sprayed and collected with a bottle and its refractometer value is measured by the de-icing supervisor using a digital refractometer. The result is compared with the information provided by the manufacturer and checked. If the values are within the permitted limits, the vehicle is used for de-icing. If the values are outside the limits allowed by the manufacturer, a second sampling and testing takes place. If this test is also negative, the vehicle shall not be used. In this case, the tank contents are disposed of, cleaned if necessary and refueled. The examination procedure must then be completely repeated.

8.2 De-Icing Methods

It depends on the weather conditions if only the removal of contamination is sufficient or if the aircraft needs additional protection against re-icing. The different de-icing methods are described below.

8.2.1 De-Icing with Fluids

A mixture of water and ADF fluid Type I is sprayed on the aircraft surfaces at high pressure and at a temperature of at least 60 °C until all contaminations are removed from the aerodynamically critical areas. The quantity required depends on the aircraft type, the type and level of contamination and the concentration.

De-Icing conducted by FKB is performed as described in this manual. The choice of methods and fluids used by other service providers may be different.

8.2.2 De-Icing – Alternative Methods

Various other methods exist besides de-icing with fluids. This can be the removal of snow with a broom and a brush, with hot air or cold compressed air (forced air). Also, the use of infrared techniques is applied. These methods are not offered and applied by FKB. However, for de-icing of landing gears and engines FKB may provide a hot air blower if needed.

8.2.3 Anti-Icing – Protection against Re-Icing with Fluids

ADF Type II is sprayed cold and without pressure on the aircraft surfaces, or at least on the aerodynamically critical surfaces. It forms a protective film with a smooth surface and protects these areas against re-icing for a time frame depending on the weather conditions.

The following principle applies: **Only a clean aircraft may be protected against re-icing!**

This means that an aircraft may only be protected against re-icing after completion of de-icing. It has to be kept in mind that any existing ice layer must not be oversprayed with ADF Type II, thus unnoticedly
endangering the aerodynamics on wings, for example. If an aircraft is released clean and free of any contamination (coming from the hangar, for example), no de-icing is necessary.

If weather conditions are favourable with no precipitation expected, protection with ADF Type II can last up to eight hours according to several measuring studies. In adverse weather conditions, like freezing rain, for example, the holdover time can be less than 15 minutes\(^{11}\). The protection is guaranteed as long as the ADF fluid can absorb precipitation.

In very favourable weather conditions and taking the LOUT into account, the use of Type I guarantees a sufficient protection against re-icing up to 30 minutes. In this case, the de-icing would also have the effect of an anti-icing.

A certain minimum fluid quantity is required for the applied protective layer to bring out an effect. A minimum quantity of 1 l/m² was determined by the SAE. The table below shows exemplarily the aircraft specific consumption rates in liters:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Aircraft Type</th>
<th>Wings</th>
<th>Tail</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus</td>
<td>A300 (-600R)</td>
<td>282</td>
<td>81</td>
<td>363</td>
</tr>
<tr>
<td>Airbus</td>
<td>A310</td>
<td>300</td>
<td>70</td>
<td>370</td>
</tr>
<tr>
<td>Airbus</td>
<td>A319</td>
<td>180</td>
<td>50</td>
<td>230</td>
</tr>
<tr>
<td>Airbus</td>
<td>A320</td>
<td>180</td>
<td>50</td>
<td>230</td>
</tr>
<tr>
<td>Airbus</td>
<td>A321</td>
<td>180</td>
<td>50</td>
<td>230</td>
</tr>
<tr>
<td>Boeing 737</td>
<td>-300/ -400/ -500</td>
<td>150</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Boeing 737</td>
<td>-600/ -700/ -800/ -900</td>
<td>180</td>
<td>50</td>
<td>230</td>
</tr>
</tbody>
</table>

Table 2: Overview of aircraft specific consumption rates

This table is not exhaustive and only shows recommended values. The actual ADF fluid consumption depends on further factors. The key factor here is the wind which can strongly influence the direct and loss-free application of the fluid.

### 8.2.4 Anti-Icing – Further Methods

Several aircraft types dispose of an own protective system against re-icing, where, for example, warm air produced by the engines is conducted through the fronts of the wings. Other types have bellows which regularly inflate and deflate, thus breaking ice formations. All aircraft in commercial aviation have heating systems for measuring equipments like the pitot-static system. Aircraft operators are responsible for their functionality.

### 8.3 De-Icing Procedures

In aircraft anti-icing, one differentiates between two procedures, the One-Step and the Two-Step procedure. As the terms imply, anti-Icing is carried out in one or in two different steps. It depends on the current overall situation which of these two procedures is chosen. In addition, there are several procedures that are based on strategic decisions.

\[^{11}\text{See also holdover time (HOT)}\]
Regardless of which of these procedures described in detail below was applied, a complete PDAC\textsuperscript{12} is performed. The result is communicated to the crew, if required, with the additional information if hold-over times are applicable.

### 8.3.1 One-Step Operation

Here, de-icing and anti-icing are carried out in one operation. This procedure is recommended when there is only low contamination, no precipitation and if the time interval between the beginning of the de-icing/anti-icing and take-off is 35 minutes at the most. During the one-step operation a water/Type I mix heated to 60 °C at least (temperature at the nozzle) is usually used. It is very important to observe the correct concentration specified by the manufacturer. As the anti-icing takes place in the same operation, it is mandatory to always calculate the fluid concentration according to the LOUT. The aircraft is only considered to be sufficiently protected when at least 1 l/m² of Type I is applied on the aerodynamically critical surfaces. This amount only refers to the protection. Therefore, an additional quantity has to be calculated according to needs for the removal of contamination, which takes place at the same time.

### 8.3.2 Two-Step Operation

Anti-icing takes places in two steps if the aircraft is severely contaminated and there is precipitation and/or take-off is not possible within a short period of time due to slot, traffic, etc., and/or precipitation until take-off is expected so that a thorough cleaning and longer protection until take-off is necessary.

In order to remove contamination, heat and pressure are always necessary. This takes places in the first step with only heated water and Type I. As the mixing ratio depends on the temperature, the amount of Type I can be kept as low as possible by thinning the ratio (no LOUT calculation necessary), thus saving costs for the airline. The actual protection against re-icing takes place in the second step when Type II is applied. The FKB always applies Type II cold.

In the event of active precipitation the protective effect of Type I is very low. Depending on the weather conditions and concentration, it can freeze even within a couple of minutes and form an unintended ice layer on the aircraft surfaces. To avoid this, Type II has to be applied very soon for aircraft protection. This can also mean that a single wing has to be de-iced in several sections with Type I and then immediately be protected with Type II as there would not be enough time for a complete treatment of only one wing first with Type I and then with Type II.

The de-icing operator ensures that the second liquid is applied before the liquid applied in the first step can freeze. Here too, the rule is that an aircraft is only considered to be sufficiently protected if at least 1 l/m² of Type II has been applied on the aerodynamically critical surfaces.

### 8.3.3 Pre De-Icing/Anti-Icing

FKB offers pre de-icing/anti-icing, which is only carried out in agreement with the customer. Aircraft from the night/day stop are pre de-iced/anti-iced up to eight hours prior to the scheduled time of departure (STD) in the same way and under the same conditions as in the Two-Step operation. Here, the final check is based on the Clean Aeroplane Concept.
the advantage for the airline is that after handling processes are finished no time is lost for de-icing.

The de-icing supervisor decides if a pre de-icing /anti-icing is necessary and if it can be performed with respect to the conditions. For example, pre de-icing/anti-icing makes no sense in case of precipitation or if precipitation is expected or if the aircraft has not been preconfigured correctly by the crew or the technical personnel. This includes especially open doors, flaps etc. or the position of the control elements. If a control element is incorrectly set, there is the risk of fluid accumulating in the wrinkles and the thickener builds up residuals.

8.3.4 Protective Anti-Icing

If an aircraft is completely clean and free of any contamination, thus making a de-icing dispensable, it can be protected against icing by applying Type II up to eight hours depending on the weather conditions. This is done as a strategic decision and on request of the airline in order to avoid further delays caused by a possible necessary de-icing at the scheduled departure time. Protective anti-icing always takes places in the One-Step procedure as well. However, only cold Type II is applied.

8.3.5 Underwing De-Icing

In principle, underwing surfaces are not considered critical. According to different aircraft manufacturers, even a frost formation up to 3 mm is uncritical. The reason for frost or ice formations on underwing surfaces is generally cold kerosene. Here, the de-icing/anti-icing is only carried out on demand of the crew.

Important: Holdover times do not apply!

8.3.6 Removal of Local Area Contamination

If only single parts or parts of the aerodynamically critical areas are contaminated, a local treatment of only those parts is permissible. Especially here, it is important that the cold-soak effect is considered.

Important: Holdover times do not apply!

8.3.7 Propeller De-Icing

On demand and if permitted by the airline, FKB also carries out propeller de-icing, whereby always the bottom blade of the propeller is de-iced with ADF Type I with a broadly fanned out jet. For turning the propeller, the support of a crew member or technician ordered by the airline is needed.

A de-icing of jet engines is not offered by the FKB. In general, jet engines are defrosted with hot air. If needed and on request, FKB provides a hot air blower.

---

13 See also 8.1.4. – Potential Hazard – Thickener
14 See also Cold Soak Effect
8.4 Explanation of Terms in Aircraft De-Icing

In aircraft de-icing, there are several terms related to methods and procedures that have to be understood.

8.4.1 LOUT

Lowest Operational Use Temperature

Every de-icing fluid or antifreeze has an own freezing point, meaning the temperature at which the fluid freezes. When this temperature is reached, of course, any protection against re-icing is no longer guaranteed as the fluid alone would freeze on the aircraft surfaces. To avoid this, a so-called safety buffer is taken into consideration when using de-icing fluids. The calculation formula for the LOUT is as follows:

\[
\begin{align*}
\text{Type I – unthickened fluid} &= \text{freezing point of the fluid minus } 10^\circ \text{C} \\
\text{Type II/III/IV – thickened fluid} &= \text{freezing point of the fluid minus } 7^\circ \text{C}
\end{align*}
\]

This means, for example, if according to the manufacturer’s specifications Type I freezes with a certain mixture (Type I/water) at -15 ° C, it is only to be used up to -5 ° C OAT or ATT. For example, if the OAT or the ATT is at -8 degrees, the LOUT is exceeded and the concentration must be adjusted accordingly.

A binding principle and rule is: If the LOUT is exceeded, there are no holdover times, meaning that the protective effect of the fluid is NOT ensured.

8.4.2 Holdover Time (HOT)

The holdover time (HOT) describes the so-called protection time against re-icing, which is the time period from the first spraying of the aircraft surfaces in the anti-icing process until take-off of the aircraft. Within this time frame no ice-forming contamination may accumulate on the aerodynamically critical areas.

In their documents SAE AMR 1424 and SAE AMR 1428, the SAE specifies standards for measurement methods, properties and approval of the de-icing fluids. Among other things, the maximum holdover times against re-icing in different weather conditions are calculated.

The results are currently published by the FAA\(^5\) or the TC\(^6\) (different measurement methods) in so-called HOT tables. These tables are structured according to different criteria (material, setting of the control elements) and are very difficult to evaluate depending on the weather conditions. For calculating the HOT, one needs comprehensive knowledge of the aircraft, airline guidelines, evaluation of weather conditions and most of all current information about the take-off time/departure time. As the de-icing team is not informed about this and the parameters of their evaluation are unknown, too, neither the de-icing operator nor the de-icing supervisor will name a HOT.

*Holdover times are calculated only by the pilot in command (PIC).*

\(^5\) Federal Aviation Administration – aviation authority USA
\(^6\) Transport Canada – aviation authority Canada
While communicating the anti-icing code, the de-icing team also informs the crew if a holdover time is not applicable.

**8.4.3 Anti-Icing Code**

After completion of the de-icing/anti-icing, the de-icing team communicates the so-called anti-icing code to the crew. This code contains at least five points of information: 1. ADF Type, 2. Concentration, 3. name of manufacturer/brand name, 4. timestamp, giving information on when the first application of the anti-icing fluid was carried out and 5. confirmation that PDAC has been carried out.

Example: "TYPE II, 100 %, Clariant MP2 Flight, 14:25 pm, post de-icing/anti-icing completed"

With this information given, the crew can determine the holdover times with the tables to be used and by evaluating further influencing conditions and factors.

Under certain conditions, the anti-icing code is transmitted with the additional information "no holdover time applicable". This is the case with asymmetrical de-icing, local frost removal, partial de-icing or only underwing de-icing.

**8.4.4 Clean Aeroplane Concept**

After every de-icing, the de-icing operator must compulsively carry out visual checks (PDAC) of the entire aircraft for contamination. Here, it is irrelevant if only a partial de-icing or a complete de-icing has been carried out. The result of the check will be immediately transmitted to the crew. On request of the crew, the maintenance department or the airline, the de-icing team carries out this check even without a de-icing order.

**8.4.5 Special Checks**

Special checks for contamination have to be carried out with few certain aircraft types\(^1\). These checks are called Hands On Check, Clear Ice Check, Clean Wing Check or Tactile Check. Depending on the aircraft type, different parts of the wings are checked for ice formations with the bare hand. The use of a ladder is usually necessary.

These checks cannot be carried out by our de-icing team due to a lack of practical experience. If required and upon request, a ladder can be provided to the crew or the technical personnel by the FKB.

**8.4.6 Obligation for Symmetric De-Icing**

Every aviation organization requires that all work in aircraft de-icing must be carried out symmetrically: "Whatever happens on the left-hand side of the aircraft also happens on the right-hand side". Symmetrical de-icing has to be carried out even when only one side or one wing is contaminated. This primarily prevents negative effects on aerodynamics.

Important: If the crew emphatically rejects a symmetrical de-icing, holdover times are not applicable!

\(^{1}\) e. g. F70/100 or MD80
8.4.7 Cold Soak Effect

Cold Soaked Wing essentially describes a wing that is soaked with cold. The cold soak effect occurs if the temperature on the wing surfaces is lower than the outside air temperature. This means that the reason for the icing is not the cold outside air temperature (OAT) but the temperature of the much colder wings surfaces which were cooled down by a very low tank or kerosene temperature.

Every liquid has a freezing point. For example, water freezes at 0°C. The aircraft kerosene Jet A1 freezes at -47°C. Naturally, kerosene adapts to the ambient temperature, thus being very rarely in the minus range, particularly because it is protected in the tanks of the fuel depots, the vehicles or the aircraft. However, if an aircraft is exposed to surrounding air temperatures of ca. -50°C and colder during a flight of several hours, even the kerosene will cool down extremely to temperatures far below the freezing point of water. The kerosene in turn needs a very long time to absorb heat. The cold temperature is transmitted to the surrounding material and also cools the wings, whereby temperatures of below 0°C often occur on the wings, which facilitates the freezing of surrounding humidity, rain or snow. This effect can even lead to ice formation on the wings at ground temperatures of up to 15°C.

The ICAO/IATA state: "Is the aircraft fuel tank temperature (ATT\textsuperscript{18}) lower than the outside air temperature (OAT\textsuperscript{19}), the fluid concentration in anti-icing must be higher than at OAT. The use of an only 50 % thickened de-icing fluid is not permitted.

If icing is identified at temperatures between -2 and 15 degrees, the tank temperature has to be checked".

To determine the correct concentration, the wings temperature would be the reference here. However, as FKB lacks of the technical possibilities to determine the wing surface temperature, the current tank temperature (ATT) is always queried from the crew and used as a reference.

8.4.8 No Spray Areas

The entire de-icing team is well trained and aware of the fact that several areas of the aircraft may never be sprayed directly with fluid for safety reasons. Amongst others, these areas are the engine and APU inlets, landing gears and all measuring sensors. Furthermore, all windows, especially cockpit windows, door frames, door seals and the radom also belong to these areas.

\textsuperscript{18} Actual Tank Temperature
\textsuperscript{19} Outside Air Temperature
9 **Operational Organization**

FKB and the entire de-icing team constantly strive to serve all of their clients on time and to their satisfaction. However, winter operations rarely allow for a reliable planning. Furthermore, other factors influence operating procedures caused by extreme weather conditions, which cannot be controlled by the de-icing team. Airlines have to take this into consideration for every planning.

### 9.1 Contact Person

The de-icing supervisor is the contact person for active de-icing deployments and dispatch.

<table>
<thead>
<tr>
<th>Telephone</th>
<th>+49 (0) 2203 40-5072</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>+49 (0) 162 243 83 77</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:deicing-supervisor@koeln-bonn-airport.de">deicing-supervisor@koeln-bonn-airport.de</a></td>
</tr>
<tr>
<td>VHF frequency</td>
<td>130,005 Mhz</td>
</tr>
</tbody>
</table>

Table 3: Contact details of the de-icing supervisor

### 9.2 De-Icing Order

The airline or the handling agent must request the de-icing for each aircraft separately. The order must be placed at least 60 minutes prior to STD/ETD, otherwise a timely provision of personnel and vehicle cannot be guaranteed. If the weather forecast predicts lowest temperatures of +4 degrees and warmer, the order must be placed at least 120 minutes prior to STD/ETD, otherwise a timely provision of the de-icing team cannot be guaranteed.

In urgent or extraordinary cases, the de-icing supervisor can be contacted via the Resource Planning Department by telephone +49 (0) 2203 / 40-2500.

The order must be placed via the electronic system of FKB (currently FARMS). The order is only binding for the FKB if it is electronically confirmed (via FKB FARMS) by the de-icing supervisor. Every airline or handling agent will be provided with access to FARMS on request.

An order cancellation by the ordering party may also be made via FARMS. A cancellation fee may be charged in accordance with the current FKB schedule of fees.

The currently published Terms and Conditions of Aircraft De-Icing of FKB (AGB – Enteisung) apply to all de-icing orders (published on the FKB website http://www.koeln-bonn-airport.de/b2b/vertragsbedingungen-entgelte.html).

### 9.3 Dispatch

All de-icing orders are always processed in chronological order of receipt. The de-icing supervisor distributes the de-icing order to one or to several de-icing operators/vehicles, which have to be at the handling position ten minutes prior to STD/ETD at the latest. The de-icing supervisor shall be promptly informed about possible delays in order to optimally plan following de-icing orders. If within these ten minutes...

---

20 This does not apply to contractual agreements for pre de-icing/anti-icing.

21 Flight and Resource Management System
minutes the starting time of the de-icing cannot be determined, FKB reserves the right to adjust the chronological de-icing orders and to bring forward an order scheduled for a later time due to operational reasons.

9.4 De-Icing Process

The de-icing supervisor or the de-icing operator determines the scope of the de-icing together with the cockpit crew. This can be done personally or via VHF frequency. The de-icing supervisor can always be contacted via the VHF frequency 130,005 Mhz; the de-icing operator can be contacted via the vehicle-specific VHF frequency which is clearly visible on both sides of the de-icing vehicle. If several de-icing vehicles are in use, the de-icing operator left or front left in the vehicle is the team leader and thus the contact person.

De-icing can only be started after the aircraft has been readily configured for this purpose and has been subsequently released by the pilot in command (PIC). If the ramp agent is the contact person, then he/she will release the aircraft on behalf of the pilot. If the aircraft is released but not readily configured for de-icing, FKB shall not assume any liability for possible damage.

After de-icing and PDAC, the de-icing supervisor or the de-icing operator/team leader communicates the anti-icing code to the cockpit crew.

9.5 Disposal of ADF Fluids

After every de-icing, the handling positions are cleaned with a sweeping vehicle specialized for ingesting ADF fluid Type II, which is then brought to the treatment plant. Currently, there is no recycling.
10 Infrastructure and Vehicles

10.1 De-icing Locations

At Cologne Bonn Airport, de-icing takes place at the handling positions (Gate De-Icing). Remote de-icing (central position) is currently not carried out. FKB reserves the right to assign a new handling position if a safe and appropriate de-icing at the initial handling position is not possible.

10.2 De-Icing Vehicles

The Cologne Bonn Airport vehicle fleet currently includes seven modern de-icing vehicles from the Elephant model series of Vestergaard company (Roskilde, Denmark). The de-icing supervisors use a Toyota RAV4 with high recognition value. These vehicles are also equipped with a mobile office and offer all necessary communication options such as telephone, email, internet access and diverse radio equipment.

<table>
<thead>
<tr>
<th>Vehicle:</th>
<th>Elephant Beta</th>
<th>Elephant Beta 15</th>
<th>Beta</th>
<th>Toyota RAV4 De-Icing Supervisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number:</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Tank Configuration:</td>
<td>one tank with 4000 liters of water, heatable</td>
<td>one tank with 2000 liters of ADF Type I, heatable</td>
<td>one tank with 2000 liters of ADF Type II, cold</td>
<td>./.</td>
</tr>
<tr>
<td>Mixing System:</td>
<td>proportional mixing system in steps of 1 %</td>
<td>20 %/40 %/55 %</td>
<td>./.</td>
<td></td>
</tr>
<tr>
<td>Sensors:</td>
<td>temperature sensor at the spray nozzle to check the 60(^\circ) C for the water/Type I mix</td>
<td>./.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation:</td>
<td>one-person and two-person operation possible</td>
<td>./.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication:</td>
<td>any time between cockpit and operator via a vehicle-specific VHF frequency, clearly visible on both sides of the vehicle</td>
<td>VHF 130,005 Mhz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Height:</td>
<td>up to 21 meters</td>
<td>up to 25 meters</td>
<td>up to 15 meters</td>
<td>./.</td>
</tr>
<tr>
<td>Cabin Height:</td>
<td>up to 12 meters</td>
<td>up to 16 meters</td>
<td>up to 15 meters</td>
<td>./.</td>
</tr>
<tr>
<td>Readiness for Use:</td>
<td>active</td>
<td>active</td>
<td>in reserve</td>
<td>active</td>
</tr>
</tbody>
</table>

Table 4: De-Icing vehicles

These vehicles can be used for all aircraft types of any size.

It has to be taken into account that de-icing vehicles may not be operated at wind speeds of 40 kn (74 km/h) and above due to safety reasons. Furthermore, the spraying of the ADF fluids at these wind speeds is not feasible anymore due to drifts.

Year-round vehicle maintenance is conducted by FKB maintenance. Once a year, water and ADF tanks are checked and cleaned by the manufacturer.
10.3 Proximity sensor

All deicing vehicles of Cologne Bonn Airport are equipped with proximity sensors which trigger an immediate stop of all further movements of the vehicle and the spray arm during a de-icing process on contact with the aircraft. In this case the de-icing supervisor shall inform the cockpit crew immediately and the de-icing vehicle shall remain the position. If no visible damage is observed, the de/anti-icing process may continue at the discretion of the pilot in command. If damage is visible or suspected, de-icing should be discontinued and further investigation will be required.

Communication with the crew takes place in accordance with the requirements of SAE AS-6285

10.4 Tank Facilities ADF Fluids

Cologne Bonn Airport has two separate tank facilities for ADF fluids with a total capacity of 360,000 liters ADF Type I and Type II as well as additional water tanks. Thus, the availability of ADF fluids is guaranteed at any time.

11 Quality Assurance

Cologne Bonn Airport has a separate department inside the business division where internal audits are regularly conducted in order to assure and improve quality, whereby all procedures and training measures in aircraft de-icing are evaluated, too. The evaluations of the neutral observers assure and further develop existing processes.

Further questions and suggestions can be directed to the quality assurance team via email: verteileralq@cgn.de.

12 Safety Management

Flughafen Köln/Bonn GmbH operates a proactive Safety Management System (SMS) with the objective to monitor and continuously improve the safety standards at Cologne Bonn Airport. The principle of “Safety First” applies to all operational processes at all times.

Therefore, it is mandatory to report accidents, near accidents and uncertain incidents. These can be reported to the Safety Management as follows:

- via E-Mail: safety@cgn.de
- in a letter: Safety postboxes can be found at control points of P5, Terminal 1A, Terminal 2 and at the entrance of the VR building
- on the internet: safety.cgn.de

All reports are always treated as strictly confidential. Further information about the Safety Management System can be obtained from the Aerodrome Manual of Flughafen Köln/Bonn GmbH.
# Abbreviations

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| Aircraft de-icing fluid | ADF | Aircraft de-icing fluid | AMS | Aerospace Materials Specifications | ARP | Aerospace recommended practice | AS | Aerospace standard | ATT | Aircraft fuel tank temperature | E | European Aviation Safety Agency | EASA | Estimated time of departure | ETD | Estimated time of departure | F | Federal Aviation Administration | FAA | Flight and Resource Management System | FARMS | Flight and Resource Management System | FBO | Flughafenbenutzungsordnung | FBO | Flughafenbenutzungsordnung | FKB | Cologne Bonn Airport | FKB | Cologne Bonn Airport | G | H | Holdover time | HOT | Holdover time | I | IATA | International Air Transport Association | IATA | International Air Transport Association | ICAO | International Civil Aviation Organization | ICAO | International Civil Aviation Organization | J | K | Km/h | Kilometer per hour | Km/h | Kilometer per hour | Kn | Knot (nautical) | Kn | Knot (nautical) | L | LOUT | Lowest operational use temperature | LOUT | Lowest operational use temperature | M | Mhz | Megahertz | Mhz | Megahertz | MRW | Maximum ramp weight | MRW | Maximum ramp weight | MTOW | Maximum take off weight | MTOW | Maximum take off weight | MTW | Maximum taxi weight | MTW | Maximum taxi weight | O | OAT | Outside air temperature | OAT | Outside air temperature | P | PDAC | Post de-icing/anti-icing check | PDAC | Post de-icing/anti-icing check | PIC | Pilot in command | PIC | Pilot in command | S | SAE | Society of Automotive Engineers | SAE | Society of Automotive Engineers | STD | Scheduled time of departure | STD | Scheduled time of departure | T | TC | Transport Canada | TC | Transport Canada | V | VHF | Very high frequency - Ultra Shortwave | VHF | Very high frequency - Ultra Shortwave |