Final Project Report

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Abstract

The main objective of the de-icing initiative was to contribute to the Airport Performance Monitoring Service by showing that de-icing can be seen and managed within the Airport Collaborative Decision Making (A-CDM) concept during normal operating procedures. The key is to estimate de-icing time duration for each individual flight with enhanced meteorological information and allocate de-icing resources to each flight. This information should in turn enhance the predictability of A-CDM timestamps. The project stopped at V2 maturity level due to the lack of suitable de-icing weather conditions during the planned V3 validation exercise

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Acronyms

Acronym	Definition
A-CDM	Airport Collaborative Decision Making
AOP	Airport Operations Plan
ATC	Air Traffic Control
ATM	Air Traffic Management
ATV	Airport Transit View
DIMT	De-Icing Management Tool
ECZT	Estimated Commencement of De-icing Time
EDIT	Estimated De-Icing Time
EEZT	Estimated End of De-icing Time
ICAO	International Civil Aviation Organisation
INTEROP	Interoperability Requirements
MET	Meteorological
METAR	Meteorological Aerodrome Report
ODISS	Operational De-Icing Sequence Support
OFA	Operational Focus Area
OSED	Operational Service and Environmental Description
SESAR	Single European Sky Air Traffic Management Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU
SPR	Safety and Performance Requirements
TAF	Terminal Aerodrome Forecast
TRL	Technical Readiness Level
VALP	Validation Plan
VALR	Validation Report

1 Project Overview

The SESAR project named "Integration of airport - airline/ground handlers - ATC processes (incl. turnaround) in ATM" took its starting point in the conviction that performance management is a cornerstone of the future airport concept. The existing Airport Collaborative Decision Making concept (A-CDM) aims at improving the overall efficiency of airport operations by optimising the use of resources and improving the predictability of events. A-CDM does not yet include de-icing as regular operating procedure, although de-icing activities for some airports are a reality during a substantial part of the year. Under these conditions the predictability of turn-round and pre-departure sequencing processes are affected, and this resulted in the scope of the research effort to focus on performance monitoring and the enhancement of the A-CDM concept with regard to de-icing.

The main objective has been to show that de-icing can become a predictable part in the Airport Transit View (ATV) lifecycle through accurate estimation of de-icing times and efficient allocation of de-icing resources. A second objective of the project was to contribute to the operational concept development of the 'Monitor Airport Performance' Service, which supported the overall aim of the Operational Focus Area 'Airport Operations Management' to develop a set of performance management services for airports.

1.1 Project progress and contribution to the Master Plan

The goal for the de-icing initiative was to show that de-icing operational procedures can be seen and managed within the Airport Transit View concept under nominal conditions. Despite the presence of de-icing weather conditions it is possible to accurately predict the de-icing process so that estimated or calculated take off times can be maintained and the predictability of turn-round and pre-departure sequencing processes remains high.

The project started by mapping the existing de-icing procedures at three Nordic airports (Helsinki, Oslo and Stockholm Arlanda airports) and three European airports (Paris Charles de Gaulle, Schiphol Amsterdam and Zurich airports) in order to define the nature and constraints of the current operating method. Through the use of in-depth interviews with de-icing agents the parameters affecting the de-icing process were identified. With this information as a reference, the requirements for a first prototype of a De-Icing Management Tool (DIMT) were specified.

The first validation exercise was conducted at the V2 level of maturity and consisted of two parts; a fast-time simulation experiment and a workshop experiment, carried out with a DIMT prototype. The quantitative experiment aimed at finding out if it was possible to determine estimated de-icing times at the level of each flight; and the qualitative experiment aimed at gathering the view of experienced stakeholders of the DIMT.

Building on the V2 exercise, work continued with the goal of staging a V3 live trial validation exercise with a more advanced prototype at Oslo and Stockholm Arlanda airports. The preparatory work for V3 included collaboration with P11.02.02 in order to add advanced live meteorological information for use in determining de-icing times.

The live validation trial presupposed certain weather conditions requiring aircraft de-icing during the validation execution window, that in fact did not occur over the two winter periods of 2014/15 and 2015/16 which were the potential validation dates. As a consequence the Validation Objectives could not be analysed within the context of SESAR validation methodology and the concept therefore is forced to remain at V2 at the end of SESAR 1.

During its lifecycle the project contributed to the maturity of the following Operational Improvement Steps and Enablers referenced in the roadmap version Data Set 16 [4] (table below).

Code	Name	Project contribution	Maturity at project start	Maturity at project end
AO-0803	Integration of Airport into ATM through Monitoring of Airport Transit View	In the current A-CDM concept de-icing is seen as an adverse condition. By analysing the prevailing conditions at the time de-icing is needed, the project has developed a concept for automatic determination of estimated de-icing times at the level of each flight and planning for the flight's need of de-icing into the departure sequence. By doing so de-icing will be a predictable ATV process and will contribute to an operational improvement through the possibility of monitoring the progress of de-icing activities.	V1	V2
MET-0101	Enhanced MET observations, nowcasts and forecasts provided by ATM-MET for Step 1	Enhanced winter weather observation and nowcast methods were used to enhance the quality of the observed and forecasted weather parameters needed for determination of de-icing weather categories. De-icing weather categories are an important parameter for determining the need of de-icing for each individual flight. Precise predictions of the weather parameters contribute to the creation of a reliable planning phase for de-icing operations and thus may avoid that the airport experiencing an adverse condition.	V2	V3
AIRPORT-04	De-icing support tool in a A-CDM environment	The project developed a De-icing Management Tool (DIMT) prototype intended for use by de-icing agents and operators. The tool includes, but is not limited to, the following functionalities: * Estimation of de-icing times for individual flights; * Inserting the planning of de-icing into the departure sequence with respect to A-CDM timestamps; and * Allocation of de-icing resources to flights. The tool subscribes to the necessary A-CDM information for planning and allocation; and returns de-icing information in the form of timestamps EDIT, ECZT and EEZT which can be published to the Airport	TRL3	TRL6

		Operations Plan (AOP).		
METEO-03	Provision and monitoring of real-time airport weather information, Step 1	METAR observation and weather radar information are collected and used in the process of determining the current de-icing weather category.	TRL4	TRL6
METEO-04b	Generate and provide MET information services relevant for Airport and final approach related operations, Step 1	MET information, in the form of de-icing weather categories, was defined as one of three important parameters for automatically determining and predicting the estimated de-icing time for each flight. De-icing weather categories were created on the experiences of de-icing agents at three Scandinavian airports. The categories consist of weather parameters that are known to affect the needs of de-icing operations. By combining relevant weather parameters and thresholds within each weather parameter, the de-icing weather categories can be forecasted with satisfactory result approximately 120 minutes in advance. Observation and forecasts are generated automatically and delivered in real time to the DIMT.	TRL4	TRL6
PRO-073a	Procedures to optimize the de-icing process within the constraints of the operational schedule, the optimal runway use and the local de-icing capacity.	Procedures were developed to integrate the DIMT into the normal operating procedures of the de-icing agents in order to be able to evaluate the functionalities of the DIMT. This makes up part of the contribution to the OI step AO-0803.	TRL3	TRL6

1.2 Project achievements

With the closure of project the SESAR de-icing operational concept remains at V2 level of maturity. The project has shown that:

1) It is possible to automatically determine estimated de-icing times at the level of each flight with a precision of three minute intervals, first demonstrated in the V2 validation exercise and later in the V3 exercise. This is a key finding as automatically estimated de-icing times for each individual flight is at the core of the operational concept and the functionalities of the DIMT build upon this.

2) The most important parameters to use when determining the estimated de-icing times are meteorological (in the form of de-icing weather categories), aircraft type and number of de-icing rigs used for de-icing activities.

3) The forecasts of de-icing weather can be ameliorated by the use of the 'Enhanced Winter Weather Prototype' instead of using the ICAO products Meteorological Aerodrome Report (METAR) and Terminal Aerodrome Forecast (TAF) when determining de-icing weather categories.

The concept did not reach V3 maturity due to the lack of suitable de-icing weather conditions for testing it; therefore there were fewer occasions than needed to complete the planned validation activities. The foreseen contribution to the Key Performance Area 'Predictability' in the form of accurate de-icing time stamps being part of the turn-round and pre-departure sequence processes was also not possible to prove and/or quantify due to this.

The DIMT prototype achieved TRL6 which was a prerequisite for being able to stage the intended V3 live trial. Important recommendations for further development of the DIMT as well as further refinement of the operational concept were collected during the validation occasions that did take place.. The qualitative feedback from the validation exercises was very positive, and the continuation and eventual deployment of a fully developed DIMT are expected to be implemented at Stockholm Arlanda Airport.

1.3 Project Deliverables

The following table presents the relevant deliverables that have been produced by the project.

Reference	Title	Description
D21	De-icing Step 1 V3 Validation Report [19]	This document summarises the results of the V3 validation exercise, EXE-06.06.02-VP-513. This exercise aimed to validate the de-icing concept by applying the V3 DIMT prototype in a live environment - Oslo airport for remote de-icing and Stockholm Arlanda airport for on-stand and after push de-icing. The lack of suitable de-icing weather conditions limited the scope of the validation considerably and therefore the concept remains in V2. The accuracy of the DIMT tool in estimating de-icing times (EDIT) proved to be in line with the earlier V2 predecessor exercise, EXE-06.06.02-VP-512.
D32	DIMT Technical Specification [20]	This document contains the system-level technical requirements (functional and non-functional requirements) regarding a De-icing Management Tool (DIMT). It guides the development and implementation of a prototype for the DIMT. The requirements are derived from the OFA05.01.01 documents – OSED Edition 3 and SPR Edition 2 - and are aligned with VP-513.

1.4 Contribution to Standardisation

If V3 maturity had been reached the contribution to standardisation from the de-icing initiative would have been a re-definition of Estimated De-Icing Time, EDIT.

EDIT is currently defined as a metric in the A-CDM manual; the difference between Estimated End of De-icing Time (EEZT) and Estimated Commencement of De-icing Time (ECZT). The result of the de-

icing validation exercises imply that EDIT can be a constituent component in itself and work as input for the calculation of ECZT and EEZT. Therefore the proposed alteration to the definition of EDIT is "Estimated time duration for the de-icing/anti-icing of an aircraft".

1.5 Project Conclusion and Recommendations

The future European Air Traffic Management system relies on the full integration of airports as nodes into the network, as well as enhanced airport operations, ensuring a seamless process through Airport Collaborative Decision Making (A-CDM). Today the A-CDM concept defines the occurrence of de-icing weather conditions as 'adverse conditions', and the project aimed to show that there are de-icing weather conditions that can be handled as regular operational procedures, i.e. conditions under which airport operations can continue without the need for collaborative recovery procedures. The key to doing so is to be able to estimate the accurate duration for the operational procedure of applying the required de-icing fluids to a specific aircraft. The project has concluded that this timespan is mainly dependent on three parameters; the prevailing weather at the airport during the visit of the aircraft to that airport, the aircraft type and the number of de-icing rigs that are used for the application of fluid.

The project showed that it is possible to estimate the required de-icing time with a precision of three minutes intervals. This estimated de-icing time can be used for many purposes, e.g. planning of a de-icing sequence, allocation of de-icing resources for each individual flight and increasing situational awareness at the airport amongst stakeholders with regard to expected de-icing procedures. There is also potential to further enhance the quality of the weather parameters which in turn will enhance the quality of estimated de-icing times. This can be done through the use of probabilistic instead of deterministic weather forecasts, which is an area of development identified by the contributing meteorological team.

Due to the lack of suitable de-icing weather conditions during the V3 validation exercise, the concept could not reach V3 maturity. The prototype achieved TRL6 which was a prerequisite to be able to carry through the V3 validation exercise, and the exercise itself gave rise to a number of recommendations for further development of the De-icing Management Tool and its associated operational concept.

Although the de-icing concept is not included in the scope of SESAR 2020, it is likely that the concept will be further developed outside of SESAR as an implementation project at Stockholm Arlanda airport in order to enhance the predictability during winter operations as well as the current A-CDM concept.

2 References

[1] SESAR Programme Management Plan, Edition 03.00.01

[2] European ATM Master Plan

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[18] P06.06.02, De-icing Step 1 V3 - Validation Plan (VALP), D19, 00.01.01, February 11th 2015

[19] P06.06.02, De-icing Step 1 V3 - Validation Report (VALR), D21, 00.01.01, August 29th 2016

[20] P06.06.02, De-icing V3 DIMT Technical Specification, D32, 00.01.01, July 22nd 2015

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[23] P06.06.02, De-icing V3 DIMT Verification Report, D35, 00.01.00, April 16th 2015

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