

AIR TRAFFIC CONTROL COORDINATION DURING THE AIRCRAFT DE-ICING/ANTI-ICING PROCESS.

Olimova G.O, Jabborov R.B.

Tashkent State Transport University, Tashkent, Uzbekistan

olimovagozal528@gmail.com, jabborov_r@tstu.uz

Abstract

This article is devoted to one of the topical issues of improving the coordination between air traffic control (ATC), ramp/apron control and the de-icing/anti-icing service during ground treatment of aircraft in icing conditions. Methods for automating the exchange of information between the participants of the process and a method for determining the permissible time interval between the end of anti-icing treatment and the issuance of a departure clearance are proposed. Based on the method of integrating holdover time (HOT) calculation with the pre-departure clearance and departure sequencing procedures of the aerodrome control tower, the coordination of a treated aircraft's push-back, taxi and take-off is automated by determining the residual HOT reserve at each control checkpoint. The permissible minimum and maximum waiting times at the de-icing pad and in the departure queue were established, as well as calculation checkpoints were found to control compliance with holdover time limits.

Key words: Holdover time (HOT), de-icing/anti-icing fluid, clean aircraft concept, ATC clearance, ramp/apron control, de-icing pad, departure sequencing.

Methods

The proposed method determines the sequence and timing of an aircraft's entry into the de-icing pad and its subsequent release into the departure queue, calculated on the basis of the time interval between the completion of anti-icing treatment and the runway line-up point. It should be kept in mind that the de-icing/anti-icing treatment must be completed early enough for ramp control and ATC ground control to maintain sufficient intervals between successive aircraft, so that the de-icing pad, apron taxi routes and departure queue operate without conflict. However, under favourable meteorological conditions (i.e., ambient temperature above 0°C and light precipitation intensity), an aircraft treated with a Type II or

Type IV anti-icing fluid should not exceed the holdover time permitted for the prevailing precipitation type, depending on the fluid's freezing-point buffer and dilution. Thus, if the aircraft's residual holdover time at the runway line-up point does not fall below zero, the timing of the de-icing/anti-icing coordination can be considered properly organised.

In addition, the total planned interval between the end of treatment and take-off must ensure that, under the least favourable permitted conditions (i.e., the shortest applicable HOT for the observed precipitation and fluid type), the aircraft reaches the runway and receives take-off clearance before the holdover time expires. Thus, if the residual HOT reserve Δt remains positive at every control checkpoint — push-back, taxi-out and line-up — it indicates that the departure sequencing and the de-icing.

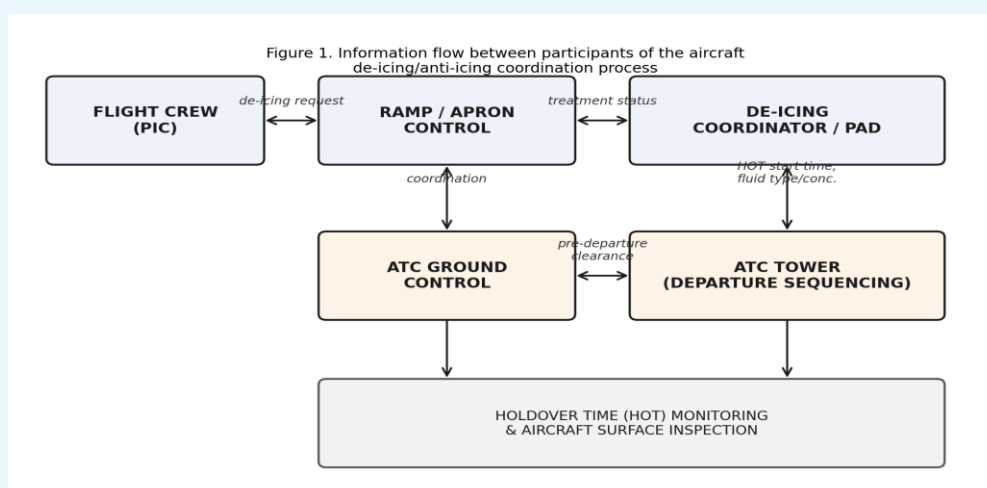


Figure 1. Information flow between participants of the aircraft de-icing/anti-icing coordination process

Based on the residual HOT reserve, a sufficient interval between the end of treatment and the runway line-up point is determined to ensure that the pre-take-off contamination check required by the clean aircraft concept can be completed without additional delay [1]. Accordingly, it becomes possible to plan the departure sequence so that aircraft treated under similar meteorological conditions are released from the de-icing pad in an order that minimises the total waiting time in the departure queue while keeping every aircraft within its holdover time [6].

- Ramp / apron control coordination (Figure 1): the de-icing coordinator reports the treatment start time, the fluid type and its dilution to ramp control, which relays this data to ATC ground control;
- Time-budget monitoring (Figure 2):

$$\Delta t = \text{HOT} - (t_3 - t_1) \quad (1)$$

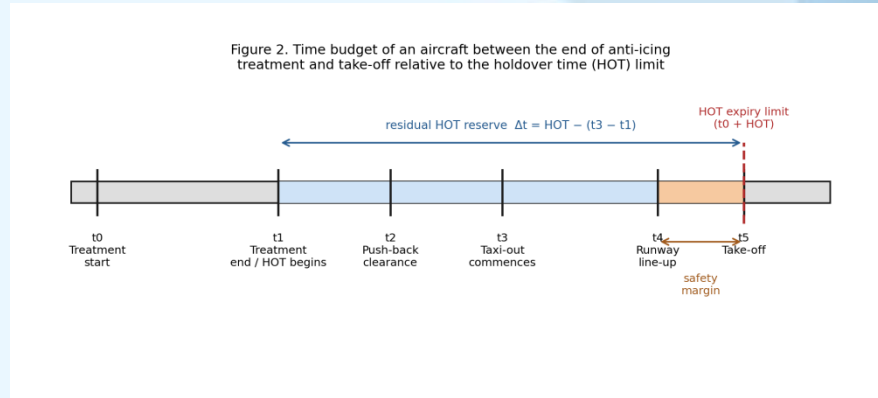


Figure 2. Time budget of an aircraft between the end of anti-icing treatment and take-off relative to the holdover time (HOT) limit

Where:

t_0 — the time the anti-icing treatment begins;

t_1 — the time the anti-icing treatment ends, marking the start of the holdover time (HOT);

t_2 — the time push-back clearance is issued;

t_3 — the time taxi-out commences;

t_4 — the time the aircraft reaches the runway line-up point;

t_5 — the take-off time;

t_{taxi} — the estimated taxi time from the de-icing pad or stand to the runway;

t_{queue} — the estimated waiting time in the departure queue;

HOT — the holdover time applicable to the fluid type, concentration and the observed precipitation conditions, taken from the applicable HOT guidance tables [2,4].

In the proposed coordination method, the residual holdover time reserve of each aircraft released from the de-icing pad is monitored continuously by the de-

icing coordinator and ATC ground control. Based on this data, the departure sequence is automatically adjusted while maintaining the required time intervals between successive aircraft. That is, the following conditions define the validity of the coordination decision:

$\Delta t \geq t_{\text{taxi}} + t_{\text{queue}}$ and the surface inspection at t_4 confirms a clean aircraft: take-off clearance is issued;

$\Delta t \geq t_{\text{taxi}} + t_{\text{queue}}$ but the inspection at t_4 is still pending: the aircraft is held at the line-up point;

$\Delta t < t_{\text{taxi}} + t_{\text{queue}}$ and precipitation has ceased: push-back clearance may be issued at reduced priority, subject to re-check at t_4 ;

$\Delta t < t_{\text{taxi}} + t_{\text{queue}}$ and precipitation is continuing: the aircraft is held at the pad or ramp for re-treatment.

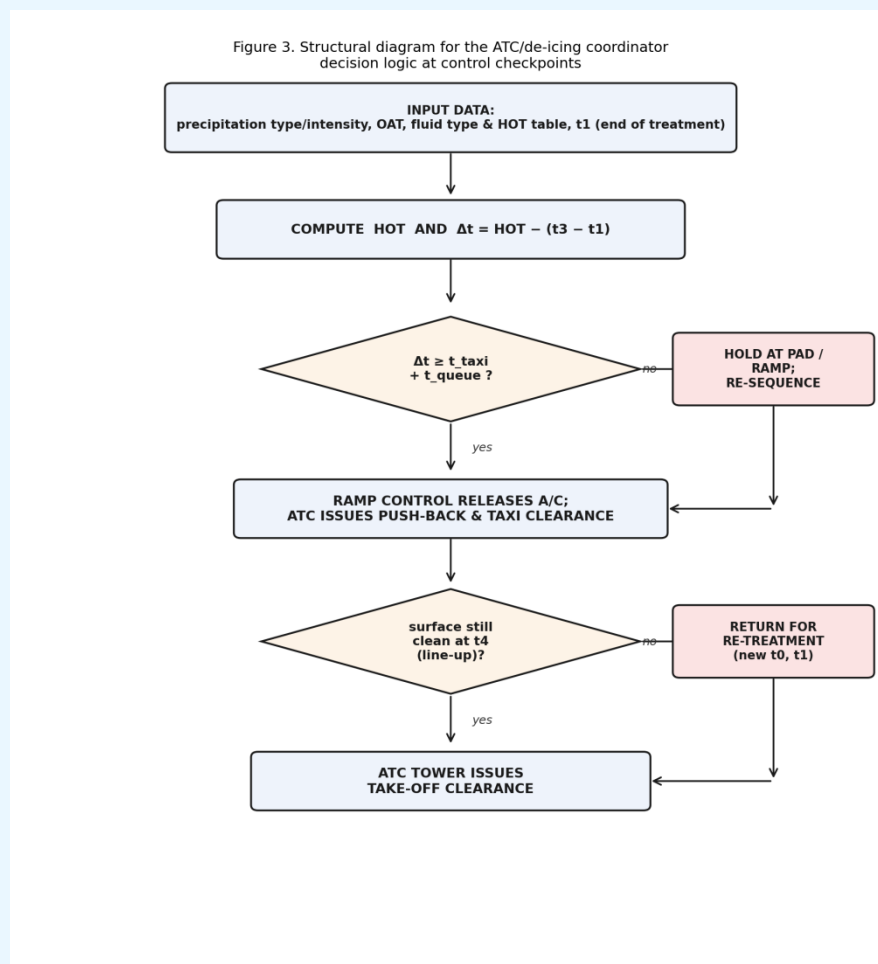


Figure 3. Structural diagram for the ATC/de-icing coordinator decision logic at control checkpoints

$$t_{\text{queue}} = n \cdot \tau \quad (2)$$

where n is the number of aircraft ahead of it in the departure sequence and τ is the average inter-departure release interval observed at the de-icing pad.

$$HOT_{eff} = HOT_{table} \times k_d \quad (3)$$

where k_d is a fluid-dilution correction factor applied when a Type II or Type IV fluid is diluted below full concentration, in accordance with SAE AS6285 guidance [4].

The results of the analysis show that by continuously monitoring the residual holdover time of aircraft released from the de-icing pad and integrating this parameter into the ATC ground control and tower departure-sequencing logic, it is possible to significantly reduce unplanned returns for re-treatment, minimise queueing delays at the pad and the runway, and reduce the influence of the human factor on the timeliness of the coordination decision. As a result, a more predictable and repeatable de-icing/anti-icing coordination procedure can be implemented at busy aerodromes experiencing winter operations.

References

1. ICAO. Doc 9640 — Manual of Aircraft Ground De-icing/Anti-icing Operations, 3rd edition (unedited). Montreal: ICAO, 2018.
2. SAE International. AS6285 — Aircraft Ground Deicing/Anti-icing Processes. Warrendale, PA: SAE International.
3. ICAO. Annex 6 to the Convention on International Civil Aviation — Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes, § 4.3.5.4.
4. ISO 11076:2012 — Aircraft — De-icing/anti-icing methods on the ground. Geneva: International Organization for Standardization, 2012.
5. ICAO. Doc 4444 — Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM).
6. ICAO. Annex 11 to the Convention on International Civil Aviation — Air Traffic Services.

7. Ashford N.J., Mumayiz S.A., Wright P.H. Airport Engineering: Planning, Design and Development of 21st Century Airports. 4th ed. Hoboken, NJ: John Wiley & Sons, 2011.
8. Ashford N.J., Coutu P., Beasley J.R. Airport Operations. 3rd ed. New York: McGraw-Hill, 2013.
9. ICAO. Annex 3 to the Convention on International Civil Aviation — Meteorological Service for International Air Navigation.
10. ICAO. Doc 9137 — Airport Services Manual, Part 2 — Pavement Surface Conditions.