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Agenda Item 4: Review of Current ATFM Operations and Problem Areas

CASE STUDY ON THE OPERATIONAL CAPACITY GUIDELINES LINKED TO WEATHER FORECASTS

(Presented by Republic of Korea)

SUMMARY

This paper presents the operational capacity guidelines developed for proactive ATFM at Incheon International Airport during snowfall. By integrating meteorological data and Collaborative Decision-Making (CDM), the guidelines enhance predictability and foster stakeholder trust. This paper covers the development proves, methodology, application cases, outcomes, and cross-border ATFM cooperation with Asia-Pacific ANSPs.

1. INTRODUCTION

1.1 The purpose of this paper is to describe the operational capacity guidelines developed to effectively manage arrival traffic flow at Incheon International Airport. Emphasizing connectivity with weather forecasts and CDM-based decision-making, it systematically addresses the development tools, data utilization, and application cases.

2. DISCUSSION

Necessity of ATFM During Snowfall

2.1 Adverse weather conditions such as snowfall directly impact airport arrival capacity due to runway snow removal, aircraft de-icing/anti-icing operations, and increased ground congestion. For effective ATFM, measures should be issued at least two hours before the Estimated Off-Block Time (EOBT) of affected flights, requiring proactive decision-making two to three hours in advance.

2.2 Analysis of traffic patterns at Incheon Airport highlights the importance of proactive decision-making. During the morning arrival peak (06:00–09:00/Local), flights from Southeast Asia (approximately 5-hour flight duration) dominate, necessitating ATFM decisions eight hours before anticipated snowfall (around 22:00/Local the previous day). For the afternoon arrival peak (14:00–17:00/Local), flights from China and Japan (approximately 2-hour flight duration) require decisions five hours in advance (09:00–12:00/Local).

2.3 Previously, the absence of proactive capacity assessment procedures linked to weather forecasts and the lack of integration of guidelines with meteorological data limited data-driven decisions in CDM meetings.

2.4 In past snowfall events, meteorologists often faced challenges in assessing operational capacity impacts due to limited familiarity with ATFM, while air traffic controllers and flow managers lacked proficiency in utilizing meteorological data. This underscored the need for intuitive and accurate guidelines to translate weather data into capacity metrics.

2.5 Consequently, operational capacity guidelines were deemed necessary. These guidelines aim to prevent large-scale delays and disruptions, encourage stakeholder participation, and provide a transparent decision-making framework to enhance operational predictability and reliability.

Development Process of Operational Capacity Guidelines

2.6 The guidelines were developed through collaboration among the Air Traffic Management Office (ATMO), Aviation Meteorological Office (AMO), and Incheon International Airport Corporation (IIAC). ATMO handled data integration and flow management analysis, AMO provided weather forecasts and observation data, and IIAC supplied A-CDM data and snow removal and de-icing/anti-icing information.

2.7 Data integration was organized into Excel-based analysis tables. ATMO contributed runway snow removal NOTAMs and ATFM logs (recording capacity decisions and ATFM measures), AMO provided weather data (visibility, temperature, snowfall amount, wind speed, etc.), and IIAC supplied snow removal logs (runway-specific operation times) and A-CDM data (apron saturation, de-icing/anti-icing throughput, etc.).

2.8 An inductive approach analyzing past snowfall cases led to the following conclusions:

- Distinguish between “snow accumulation” (total accumulated amount) and “hourly snowfall” (additional snowfall per hour), using hourly snowfall as the decision-making criterion.

- No snowfall cases occur when ground temperatures exceed 0°C, and snow removal is highly unlikely when hourly snowfall is below 1 cm.

2.9 Initial criteria were established based on observations that snow removal is highly likely when temperatures are below freezing and hourly snowfall exceeds 1 cm. These were refined through application in CDM meetings during actual snowfall responses in January–February 2025.

Operational Capacity Guidelines Details

2.10 The guidelines classify weather and operational conditions into five levels, specifying hourly arrival capacities for each. The Table 1 below represents the currently applied guidelines:

Table 1: Incheon International Airport Operational Capacity Guidelines During Snowfall (V1.1)

Stage	Surface temp	Hourly snowfall	Runway snow removal	Ground congestion due to de-icing	Hourly arrival capacity
1	Above 0℃	Any	Very low prob (Regardless of snowfall)	Very low prob (Regardless of snowfall)	44
2	Below 0℃	0 cm	Very low prob	Smooth	40 ~ 44
3	Below 0℃	0.1 ~ 0.9 cm	Low prob	Moderate	30 ~ 35
4	Below 0℃	1 cm or more	High prob	Moderate	26

Stage	Surface temp	Hourly snowfall	Runway snow removal	Ground congestion due to de-icing	Hourly arrival capacity
5	Below 0℃	1 cm or more	High prob	Severe	20 or fewer

2.11 Detailed explanation by Stage

- **Stage 1** : when surface temperature is above 0℃, regardless of hourly snowfall, the probability of snow removal and de-icing is very low, allowing normal capacity.

- **Stage 2** : when surface temperature is below 0℃ and hourly snowfall is 0 cm, snow removal probability is very low, and the scale of de-icing requests is at a manageable level, enabling smooth processing with a capacity of 40 ~ 44 aircraft.

- **Stage 3** : when surface temperature is below 0℃ and hourly snowfall is 0.1 ~ 0.9 cm, snow removal probability is low, but increased de-icing requests require routine management, setting capacity at 30 ~ 35 aircraft.

- **Stage 4** : when surface temperature is below 0℃ and hourly snowfall is 1 cm or more, snow removal probability is high, requiring a capacity of 26 aircraft based on single-runway arrival operations (if snow removal begins, this capacity must be maintained until the final snow removal is completed, regardless of subsequent forecasts).

- **Stage 5** : with intensified snowfall, ground handler de-icing capacity decreases, de-icing wait times increase, and apron/taxiway congestion rises, necessitating a capacity of 20 aircraft or fewer based on ground congestion levels.

2.12 The figures presented above are not absolute standards and can be applied flexibly depending on the situation. They were calculated based on the operation of three runways at Incheon International Airport.

CDM Meeting Operational Procedures

2.13 CDM meetings are convened by the Republic of Korea ATFM Unit (ATMO) when operational constraints are anticipated due to snowfall forecasts. These meetings consider weather conditions, snow removal operations, and de-icing/anti-icing throughput to determine operational capacity and flow management measures, aiming to finalize decisions three hours before EOBT to prevent disruptions.

2.14 Meetings are initiated based on AMO forecasts, with ATMO’s discretion, and can also be requested by ATC Units or the Airport Operator. Participants include the ATFM Unit, AMO, ATC Units (RAMP, TWR, APP, ACC), Airport Operator, and all national Aircraft Operators.

2.15 Meetings are held eight hours before anticipated snowfall for ATFM measures targeting Southeast Asian departures and five hours before for China/Japan departures. Each meeting determines capacity for 3–4 hour periods. For example, for snowfall expected at 06:00 (KST), a meeting at 20:00 (KST) the previous day sets capacity for 05:00–09:00 (KST), with another meeting at 06:00 (KST) to determine capacity for 10:00–14:00 (KST) based on updated weather and airport information. Additional meetings are held as needed. Actual meeting outcomes are shown below:

Table 2: CDM Online Meeting Frequency (The case of January 31)

CDM Meeting Time (Local Time)	Operational Capacity Determination	ATFM Application Period (Local Time)
Jan 30, 20:00	26	Jan 31, 06:00–10:00
Jan 31, 06:00	30	Jan 31, 10:00–14:00
Jan 31, 09:00	40	Jan 31, 14:00–16:00
Jan 31, 11:00	40	Jan 31, 16:00–18:00
Jan 31, 15:00	ATFM lifted	ATFM lifted

Application Cases and Outcomes

2.16 The establishment of operational capacity guidelines has enabled swift and accurate decision-making during CDM meetings. Furthermore, setting regular CDM meeting intervals and ensuring participation from all stakeholders have institutionalized a proactive decision-making framework. This has enhanced stakeholder trust and strengthened operational predictability.

Cross-Border Impacts

2.17 Incheon Airport's proactive ATFM measures reduce the need for urgent actions like Ground Stops and facilitate efficient regional cooperation through preemptive information sharing with Asia/Pacific ANSPs.

2.18 Transparent guidelines and shared CDM meeting outcomes minimize regional disruptions and improve flow management compliance.

Ongoing Research and Future Applications

2.19 Research is underway to enhance ground congestion management, post-event analysis, and regional cooperation. Ground congestion depends on complex factors such as weather, apron saturation, and throughput, necessitating the development of a quantitative model integrating these data. Post-event analysis validates capacity decisions by comparing forecasts with actual conditions, and efforts to verify weather forecast accuracy should be strengthened.

2.20 Regional cooperation will expand through sharing CDM outcomes and guidelines with Asia/Pacific ANSPs.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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