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ASSEMBLY — 38TH SESSION

TECHNICAL COMMISSION

Agenda Item 38: Other issues to be considered by the Technical Commission

COST-BENEFIT ANALYSIS OF RNAV 2 PARALLEL ROUTES Y711 AND Y722

(Presented by the Republic of Korea)

EXECUTIVE SUMMARY

This paper presents the findings of a cost-benefit analysis conducted on newly implemented RNAV 2 parallel routes Y711 & Y722 to verify the benefit derived by implementing area navigation (RNAV) routes with 8NM lateral separation. Before conducting the cost-benefit analysis, the Republic of Korea (ROK) evaluated the level of collision risk for the routes Y711 & Y722. These routes satisfied the agreed Target Level of Safety (TLS) value of 5×10^{-9}. With the confirmation of safety level, the cost-benefit analysis of these RNAV routes was conducted with the monthly data of May and July 2012.

Strategic Objectives:	This working paper relates to all Strategic Objectives...
Financial implications:	Not applicable
References:	Doc 9613, *Performance-based Navigation (PBN) Manual*

1. INTRODUCTION

1.1 The 36th Assembly of ICAO urged its Member States to develop national performance-based navigation (PBN) implementation plans by 2009 and to implement area navigation (RNAV) and required navigation performance (RNP) air traffic services (ATS) routes and terminal/approach procedures in accordance with the ICAO PBN concept of laid down in the *Performance-based Navigation Manual* (Doc 9613).

1.2 In line with this, the Republic of Korea (ROK) established the national PBN implementation plan in December 2009 and implemented the Standard Instrument Departure (SID)/ Standard Instrument Arrival (STAR) procedures for Incheon International Airport and Gimpo International Airport in 2012. The SID/STAR procedures were implemented for Jeju International

Airport, Muan Airport, Yeosu Airport and Ulsan Airport in 2013. The PBN-based instrument flight procedures are planned to be implemented at all airports and ATS routes within the Incheon Flight Information Region (FIR) by 2016.

1.3 For the implementation of PBN on B576, which is the most congested ATS route within the Incheon FIR, two parallel routes with the lateral separation distance of 8NM were established and have been in operation since June 27th, 2012.

1.4 The collision risk of routes Y711 and Y722 was evaluated with the data of the months of June - July 2012 and July - December 2012. Papers on the results of evaluation were presented at the Seventeenth Meeting (August 28th to 31st, 2012) and the Eighteenth Meeting (April 1st to 4th, 2013) of the Regional Airspace Safety Monitoring Advisory Group (RASMAG). The estimated collision risk with traffic sample data (TSD) from both analyses met the agreed Target Level of Safety (TLS) value of 5 x 10^{-9} fatal accidents per flight hour and proved that the operation of the parallel routes shows acceptable level of safety.

1.5 With the confirmation of the safety level of the parallel, a cost-benefit analysis for these RNAV routes was conducted with the monthly data of May and July 2012. The estimated cost-benefit, based on the TSD gathered, would be USD 27.66 million by the end of year 2013, and the benefit is expected to increase every year as the traffic volume grows in number.

2. DISCUSSION

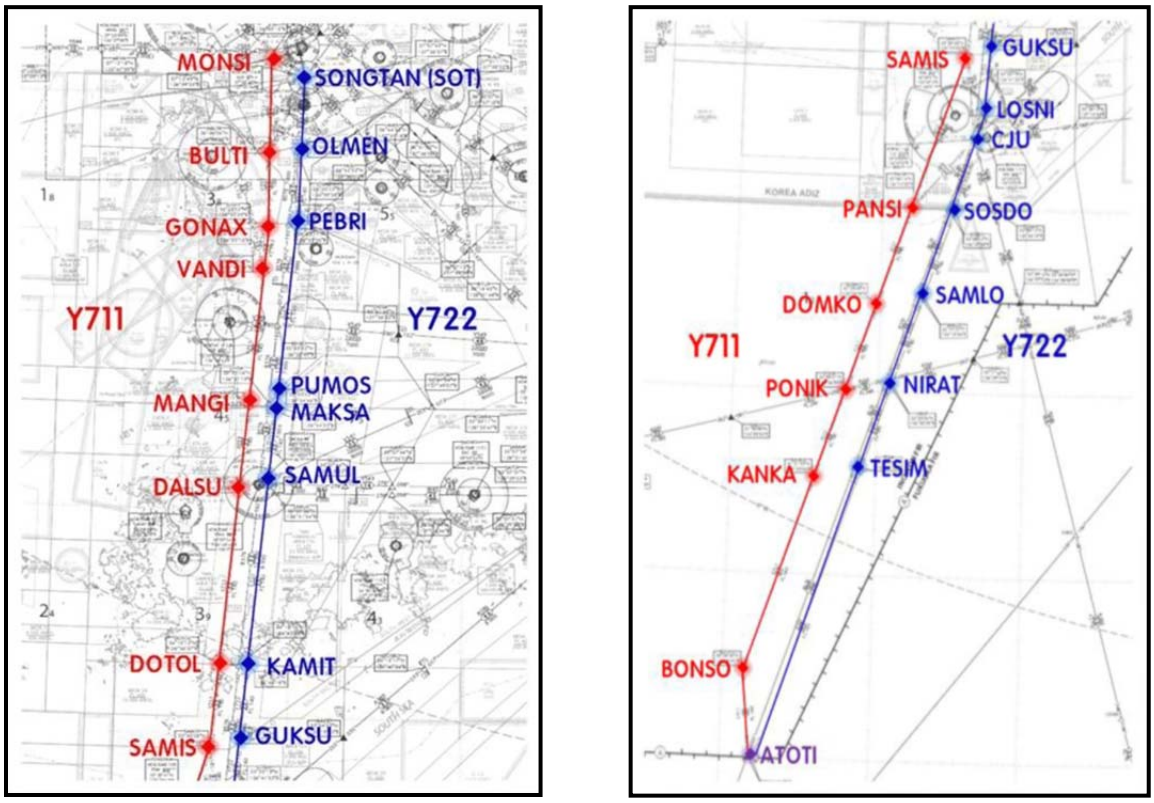
Airspace Description

2.1 The newly implemented RNAV routes Y711 and Y722 are the only parallel PBN routes within the Incheon FIR (refer to Figure 1). The Y711 is for the traffic from Incheon/Gimpo International Airport to South-East bound, and Y722 is for inbound traffic to Incheon/Gimpo International Airport. These ATS routes are operated above FL140, but the conventional route B576 is still being used for aircraft operating below 13,000 feet.

2.2 The Y711 and Y722 are divided into two segments, which are upper and lower. The upper segments, between MONSI and PANSI on Y711 and between SONGTAN VORTAC (SOT) and SOSDO on Y722, have been applied as RNAV 2. The lower segments, between PANSI and BONSO on Y711 and between SOSDO and ATOTI on Y722, have been applied as RNAV 5.

Table 1. Application of Y711 and Y722

Portions of Routes	MONSI~PANSI(Y711) SOT~SOSDO(Y722)	PANSI~BONSO(Y711) SOSDO~ATOTI(Y722)
Navigation Requirement	RNAV 2	RNAV 5
Separation Distance Between Y711 and Y722	8NM	12NM
Required Equipment	DME/DME/IRU, GNSS	INS or IRS, GNSS



< Upper Segment > < Lower Segment >

Figure 1. Parallel ATS Routes Y711 & Y722 in Incheon FIR

Traffic Sample Data (TSD

2.3 Since the safety level for the lateral separation distance of 8 NM on RNAV 2 routes was already evaluated as acceptable, this analysis focused on the RNAV 2 segment to confirm the economic benefit of parallel routes.

2.4 As shown in Table 2, TSD from the month of May to July 2012 was used to conduct a cost-benefit analysis of parallel routes.

Table 2. Traffic Sample Data of ATS Routes

Status	Pre-Implementation	Post-Implementation
Period of TSD	May 1st to 31st, 2012	July 1st to 31st, 2012
Altitude	Above FL 140 (total 725 flights)	Above FL 140 (total 864 flights)
Segment of ATS Route	SOT ~ JeJu (B576)	MONSI ~ YONGDAM (Y711) SOT ~ Jeju (Y722)

Outcome of Simulation

2.5 The MATLAB of MathWorks was used for constructing the database of massive aircraft trajectory files. Track miles and flight time of each aircraft in the segments were calculated with the basic aircraft trajectory in database, i.e. time, longitudinal, latitudinal coordinate and altitude.

2.6 The BADA (Base of Aircraft Data) of Eurocontrol was used for predicting fuel consumption of different types of aircraft and different altitude-velocity per time.

2.7 The outcome presents that the flight speed increased by 17 knots whereas the flight time decreased about 1.2 min. Above all, fuel consumption was saved by 228.4 kg per each aircraft.

Table 3. Outcome of Simulation

Status	Pre-Implementation	Post-Implementation
Segment of ATS Route	SOT ~ JeJu (B576)	MONSI ~ YONGDAM (Y711) SOT ~ Jeju (Y722)
Flight Distance	229NM	230NM
Flight Speed	408 knots	425 knots
Flight Time	33.8 min	32.6 min
Fuel Consumption	4,173.7 kg/flight	3,945.3 kg/flight

Results of Cost-Benefit Analysis of RNAV 2 Parallel Routes

2.8 The estimated benefit by the end of 2013 is as follows:

- Airlines direct operating cost savings – USD 19.13 million
- Environmental benefit from reduced aircraft emission (CO_2 only) – USD 0.37 million
- Passenger value of time – USD 8.16 million
- **Total estimated cost-benefit – USD 27.66 million**

2.9 The benefit is expected to increase every year, as the traffic volume and the number of passengers are expected to increase by 3.44% and 4.33%[1] every year, respectively. Based on this assumption, the estimated benefit from 2013 through 2022 is as follows:

- Airlines direct operating cost savings – USD 223.77 million
- Environmental benefit from reduced aircraft emission – USD 4.31 million
- Passenger value of time – USD 99.33 million

[1] The figures are from the 4th Korean Long-Term Master Plan for the Airport development (2011)

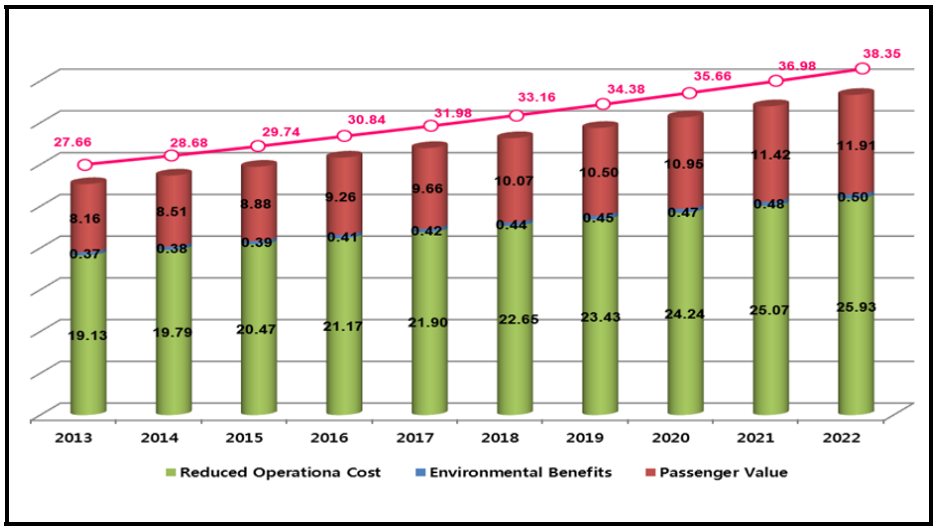


Figure 2. Estimated benefit from 2013 through 2022

Table 4. Expected Growth of Traffic Volume and the Number of Passengers

Year	No. of Flight	Fuel Saving (ton)	CO_2 Reduction (ton)	No. of Passenger	Total Time Saving (min)
2013	485,480	25,503	80,514	72,277,311	332,476
2014	502,181	26,381	83,283	75,378,007	346,739
2015	519,456	27,288	86,148	78,611,724	361,614
2016	537,325	28,227	89,112	81,984,167	377,127
2017	555,809	29,198	92,177	85,501,287	393,306
2018	574,929	30,202	95,348	89,169,293	410,179
2019	594,706	31,241	98,628	92,994,655	427,775
2020	615,164	32,316	102,021	96,984,126	446,127
2021	636,326	33,427	105,531	101,144,745	465,266
2022	658,215	34,577	109,161	105,483,855	485,226

* Of the number of flight, the fleet of aircraft using the routes Y711 and Y722 account for 23%.

Table 5. Estimated Benefit (2013~2022, USD million)

Year	Airline Direct Operating Cost	Environmental Benefit	Passenger Value of Time	Total Benefit
2013	19.13	0.37	8.16	27.66
2014	19.79	0.38	8.51	28.68
2015	20.47	0.39	8.88	29.74
2016	21.17	0.41	9.26	30.84
2017	21.90	0.42	9.66	31.98
2018	22.65	0.44	10.07	33.16
2019	23.43	0.45	10.50	34.38
2020	24.24	0.47	10.95	35.66
2021	25.07	0.48	11.42	36.98
2022	25.93	0.50	11.91	38.35

Summary and Future Plan

2.10 This paper analyzes the cost-benefit for the newly implemented routes, Y711 and Y722 with RNAV 2. The outcome, which was simulated with TSD comparing to the pre- and post-implementation, is shown in Table 3.

2.11 The results in Tables 4 and 5 were derived from the outcome of flight speed, flight time and fuel consumption in Table 3. This indicates that the implementation and operation of RNAV parallel routes will improve operational efficiency and airspace capacity and will offer operational benefit.

3. CONCLUSION

3.1 The estimated benefit of implementation would be USD 27.66 million by the end of 2013. PBN implementation increases efficiency and capacity in limited airspace, enhances aviation safety and minimizes the environmental effects.

3.2 The ROK will continue to assess safety, conduct cost-benefit analyses on RNAV 2 parallel routes and amend PBN implementation plans in accordance with the results.

3.3 The Assembly is invited to:

a) note the estimated benefit from the analysis conducted on RNAV 2 parallel routes within the Incheon Flight Information Region (FIR);
b) encourage States to implement RNAV 2 parallel routes to improve operational efficiency, airspace capacity and operational benefit; and
c) discuss any relevant matters as appropriate.

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