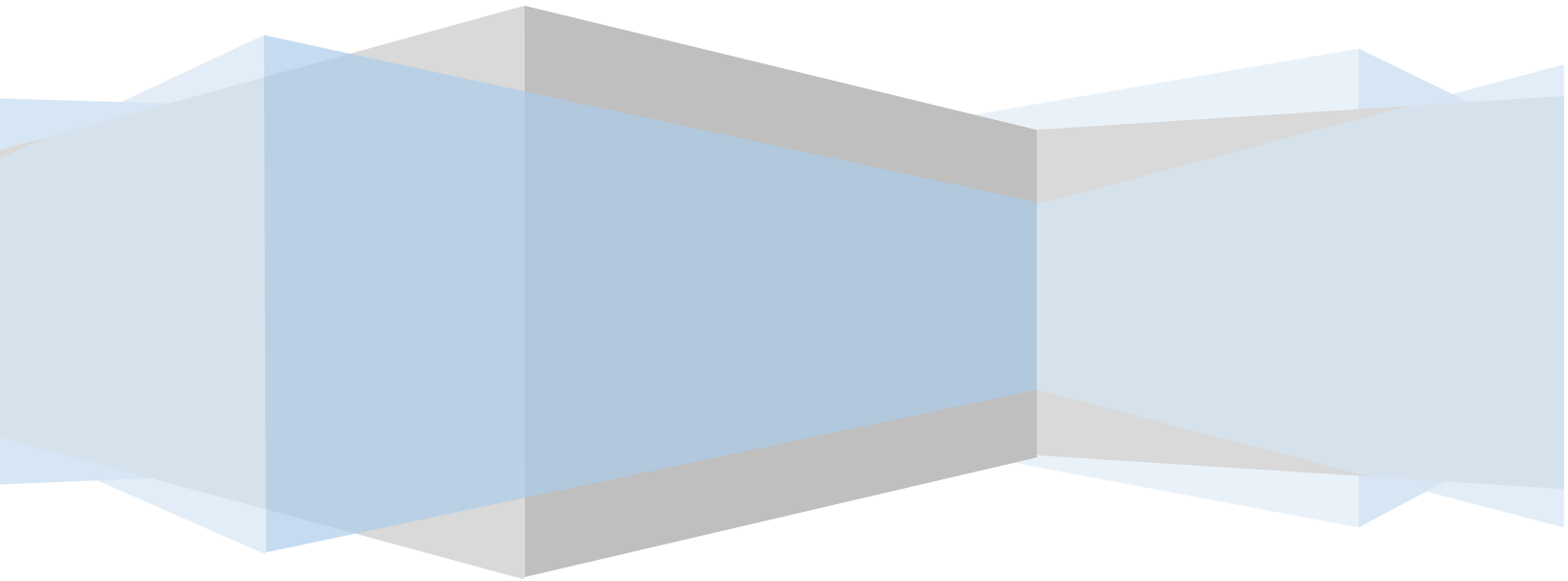


# POST OPERATIONS ANALYSIS REPORT

January, 2022

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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## A. Executive Summary

The sequential recovery in Traffic Movement at Indian Airports slumped in January 2022 with emergence of the new variant (Omicron) and related restrictions by the state governments.

The coronavirus induced suspension of scheduled commercial international passenger flights has been extended till 28<sup>th</sup> Feb’22. But special international flights have been operating under the Vande Bharat Mission since May 2020 and under bilateral "air bubble" arrangements with selected countries since July 2020. Under an air bubble pact between two countries, special international flights can be operated by their airlines between their territories.

On average, the Indian ATFCM area saw 3418 IFR flights per day. The peak day was on 2<sup>nd</sup> Jan’22 (4383 IFR flights). Thursday’s were the busiest days throughout this month with an average of 3579 flights per day. Major Airports -Delhi, Mumbai, Bengaluru, Kolkata, Chennai and Hyderabad recorded average daily movements 71%, 66%,67%, 60%,56 % and 63% of January 2019 levels.

Six(6)ATFM measures were applied in the month of January’22 due to airspace/airport closure regarding Republic Day Celebrations at Delhi.

Average ATFM ground delay to Domestic Flights was 8 minutes and the average CTOT compliance for the Month was 81%.

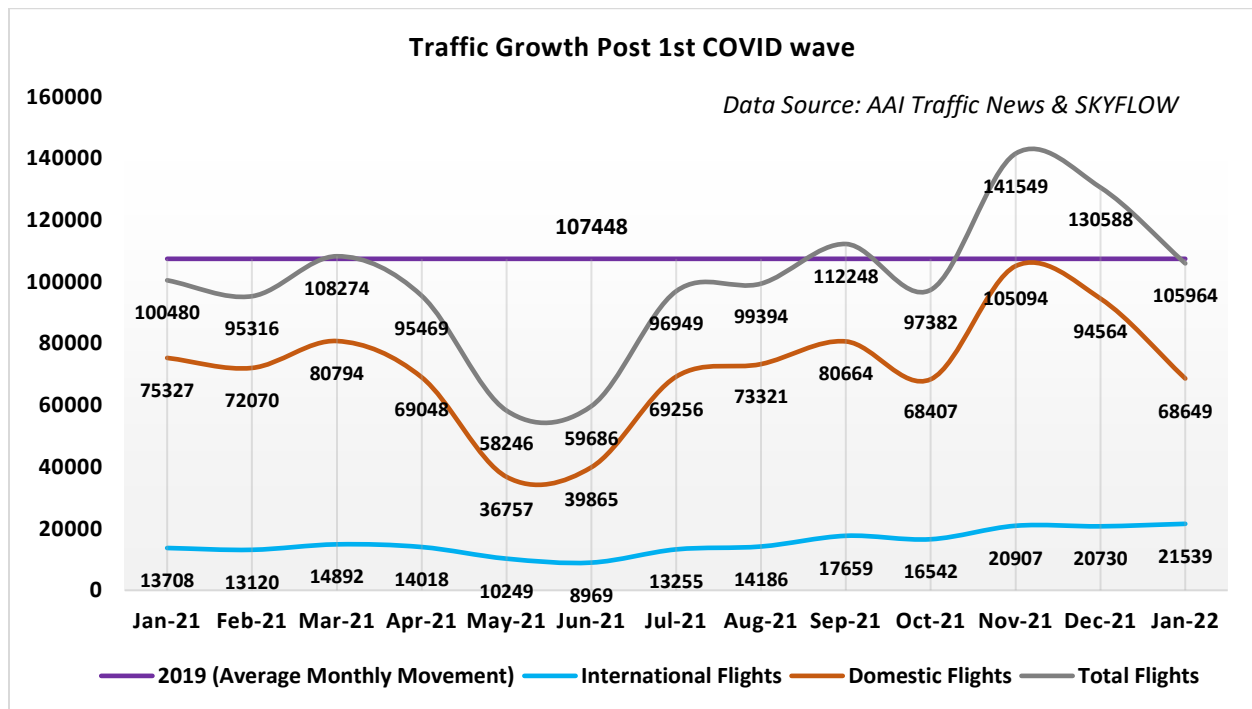


Figure 1: Traffic Growth Post 1<sup>st</sup> COVID wave



The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last year (Jan’ 2021 to Jan’2022). The traffic demand is visibly impacted by the Covid-19 infections through out the period.

## B. Traffic Analysis

### I. Comparison of total ATMs (YoY) and Monthwise

The total Air traffic movement including Passenger and Combination of other flights i.e. All-Cargo flights, International scheduled, International non-scheduled, Domestic scheduled, Domestic non-scheduled, Air taxi & commercial business flights at six major Indian Airports namely Delhi, Mumbai, Bengaluru, Hyderabad, Kolkata and Chennai is plotted for the month of January for two consecutive years. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

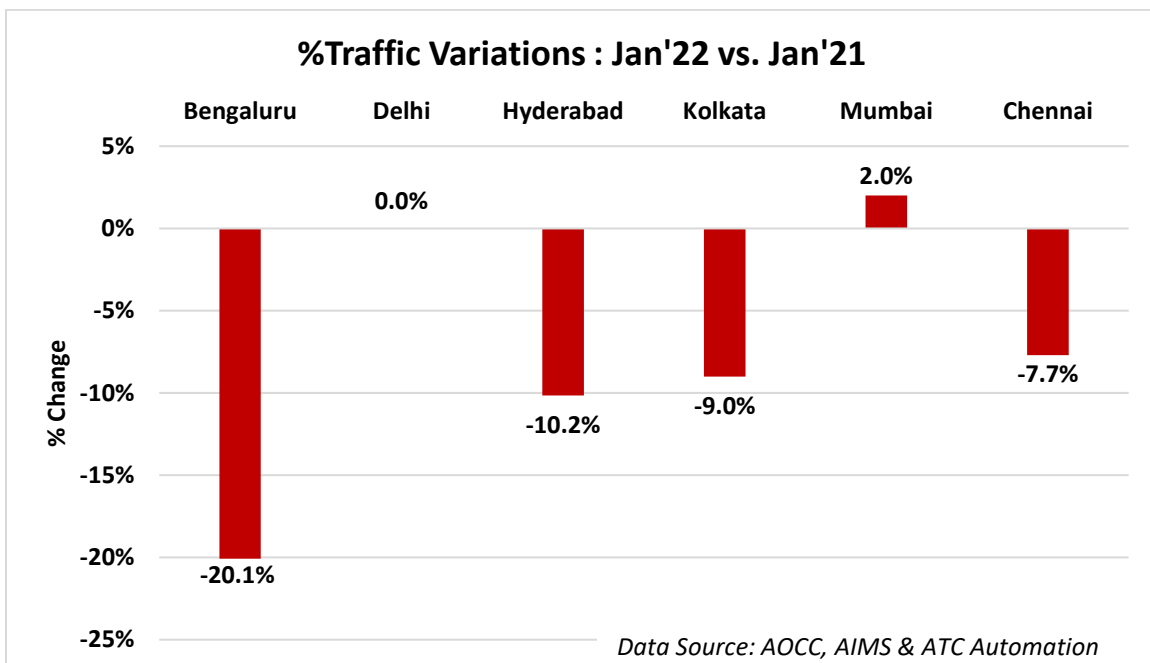


Figure 2: Percentage Traffic Variation (YoY)

Airports\Year	Total ATMs (YoY) for six major airports	
	Jan'22	Jan'21
Bengaluru	12223	15294
Delhi	28559	28552
Hyderabad	10139	11285
Kolkata	8870	9775
Mumbai	17649	17300
Chennai	8623	9343

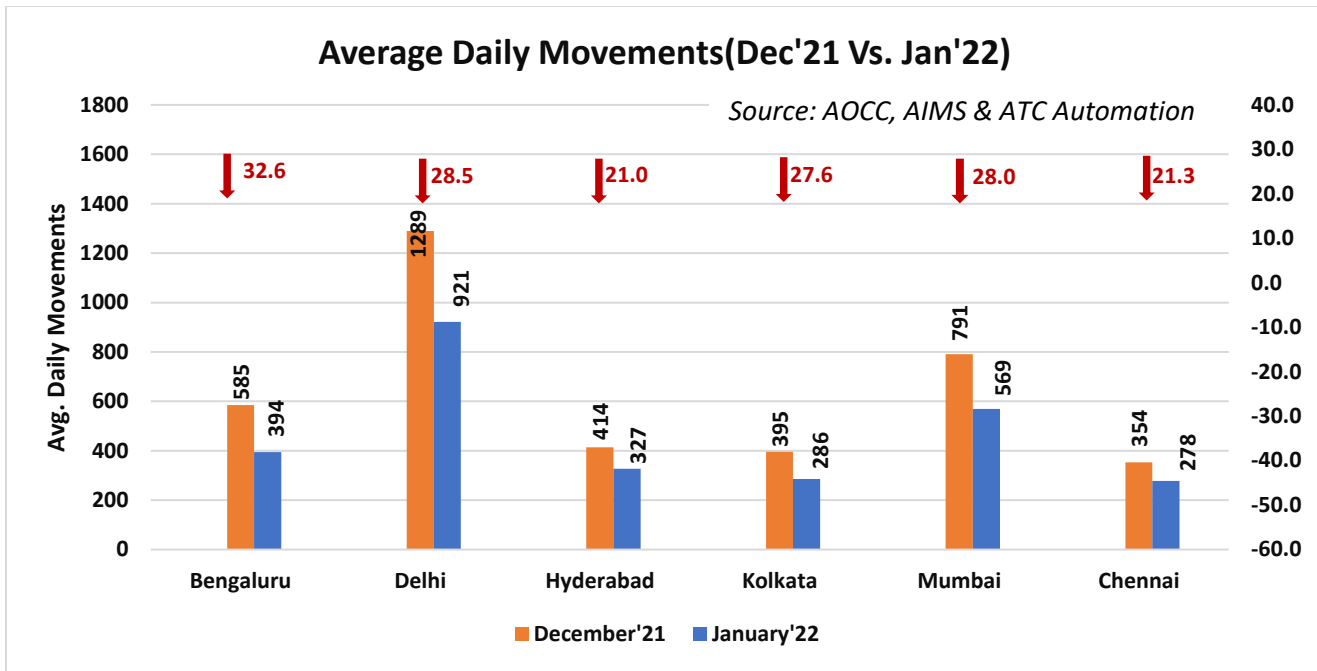


Figure 3: Average Daily Movements(Dec'21 vs. Jan'22)

## II. Flight Operations – Airlinewise

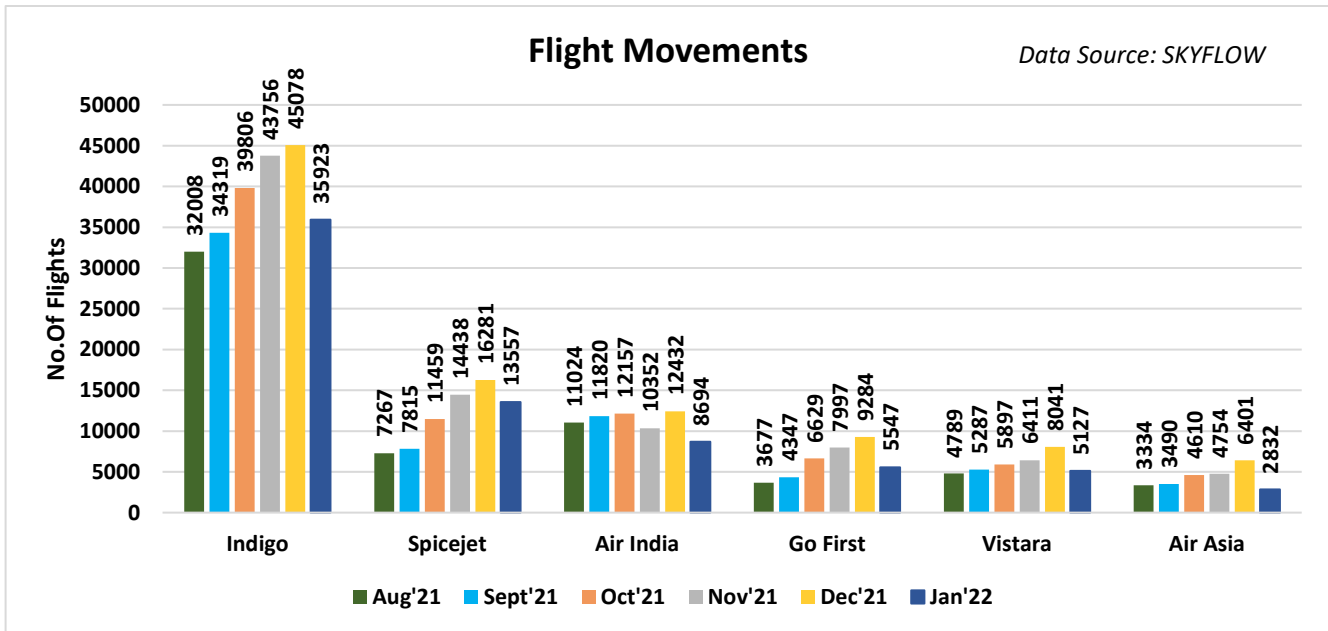


Figure 4: Flight Movements –Airlinewise



## C. ATFM Post Operations – CDM Analysis

### I. Introduction

**Analysis Period** 1<sup>st</sup> – 31<sup>st</sup> January'22

**Back Ground** During the above mentioned period, **six(6)** ATFM measures were applied for **Delhi Airport** due to the following reason as illustrated in the bar chart below:-

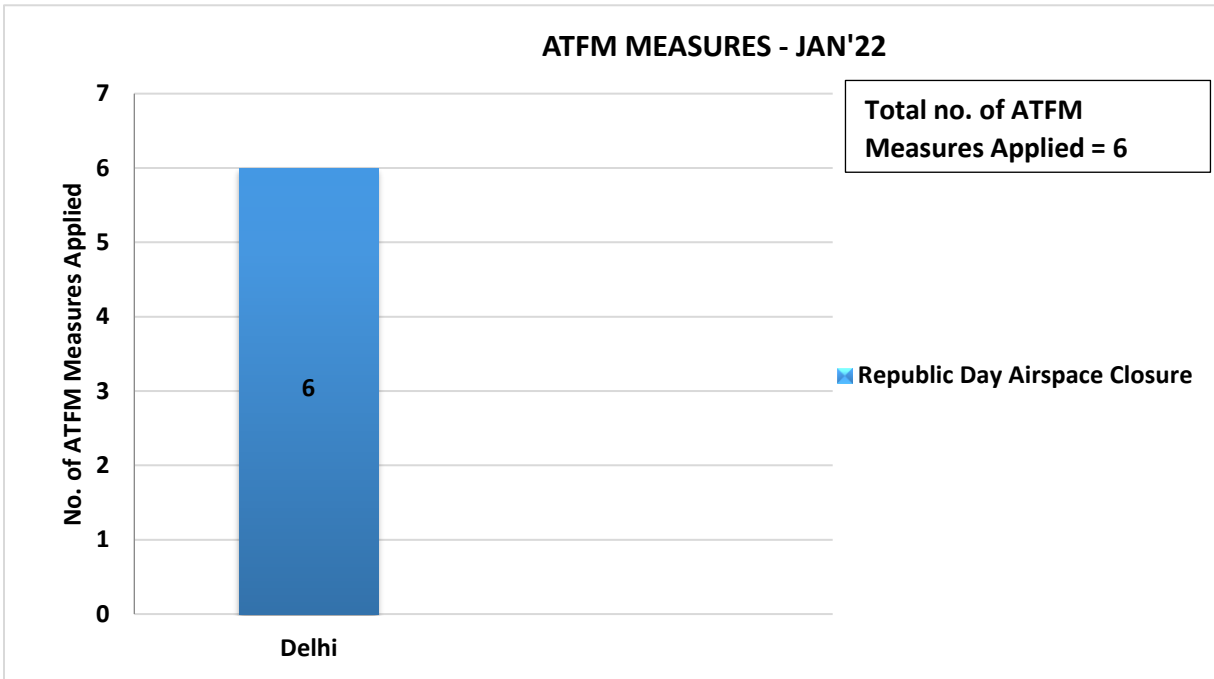


Figure 5: ATFM Measures –Jan'22





## II. ATFM Measures Overview

Constrained Airport	Delhi Airport
Number of ATFM measures applied	6
Average ATFM Ground delay due to measures*	8 Min
Maximum ATFM Ground delay due to measures	27 Min
% Compliance	81

Note: \* *Average ATFM Delay* =  $\frac{\text{Total ATFM Delay}}{\text{Total Domestic Arrivals}}$

Total Arrivals	395
Total International Arrivals(Exempted)	56
Total affected flights in scenario (Domestic Arrivals)	339
Total Domestic Arrivals with zero ATFM delay	74
Total Domestic Arrivals with ATFM delay	265

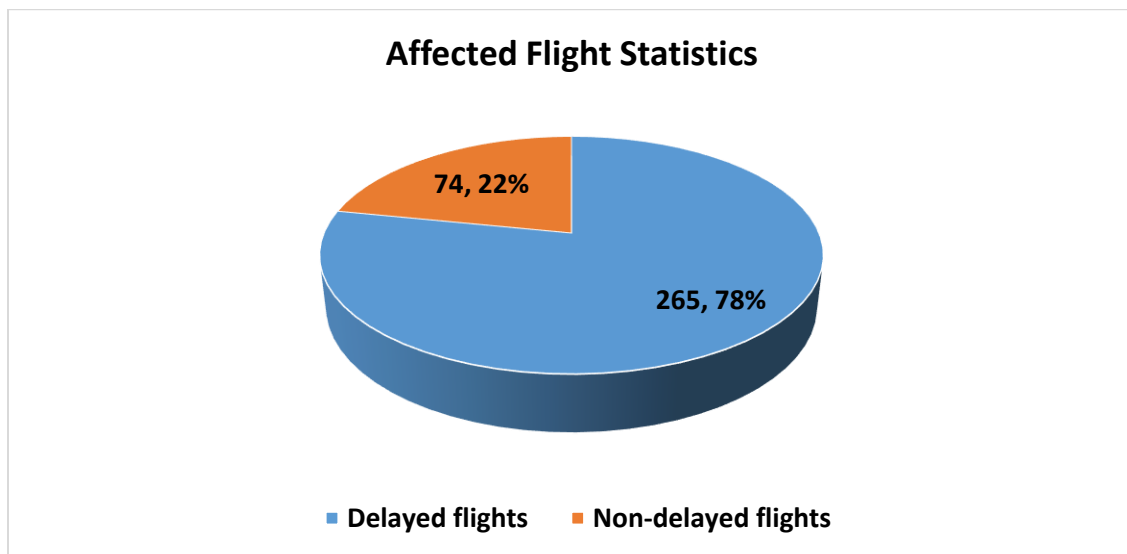


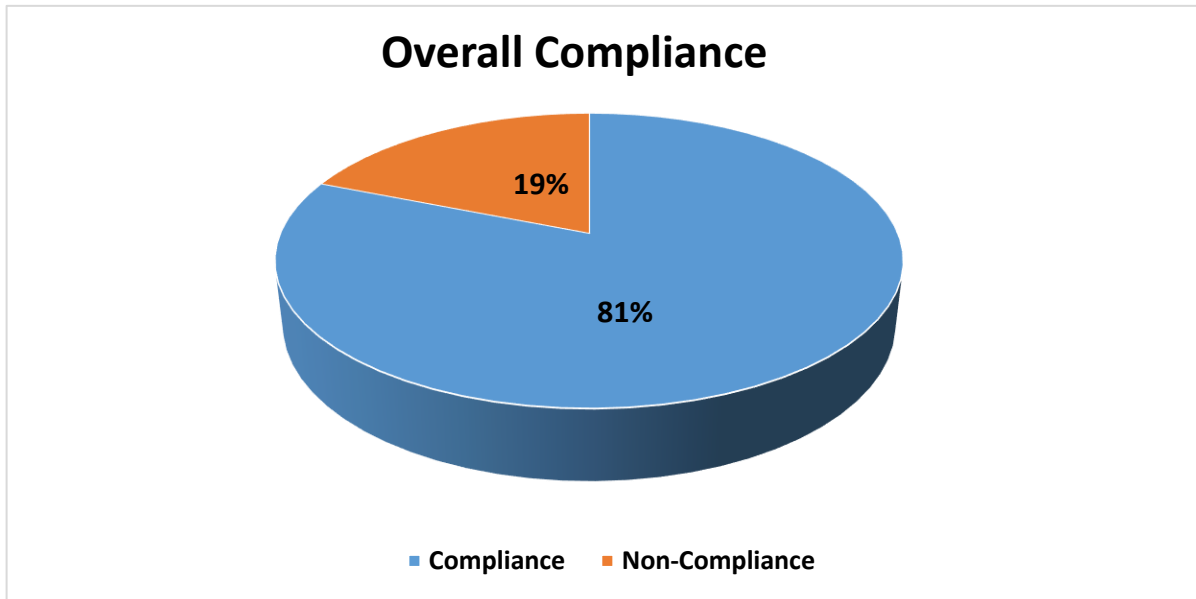
Figure 6: Affected Flight Statistics –Jan'22



### III. Overall Compliance

<b>Total arrivals</b>	395
<b>Domestic arrivals</b>	339
<b>Flights with complete data (ATOT)</b>	323
<b>Flights with incomplete data</b>	1
<b>Flights Not Operated</b>	15
<b>Compliant*</b>	261
<b>Non-Compliant</b>	61

\*Total No. of Revised CTOTs issued = 34 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)



**Figure 7: Overall Compliance – Jan'22**

*NOTE: Flights with required data (i.e. ATOT) are only considered for compliance measurement*

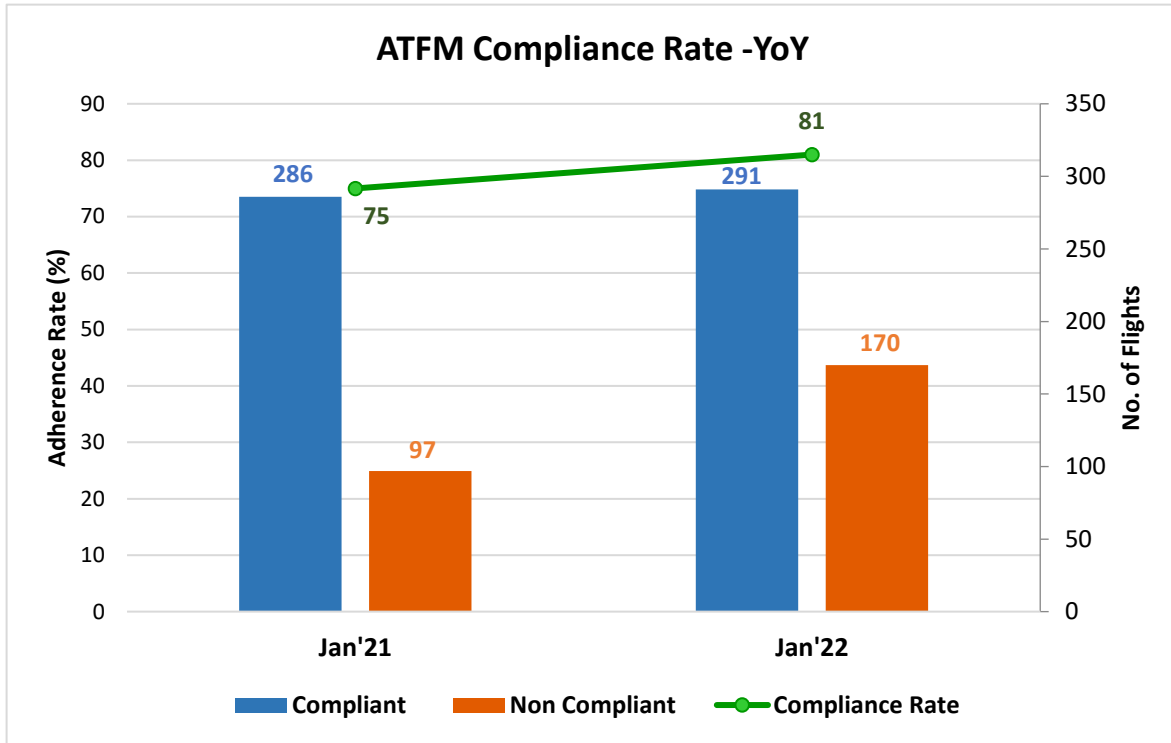


Figure 8: ATFM Compliance(YoY)

### Inference

1. Out of the total arrivals captured for the constrained Airports during the CDM scenario, 86% of flights i.e. Domestic arrivals, are participating.
2. Out of these Domestic Arrivals, 78% of arrivals are assigned ATFM ground delay.
3. Out of the total arrivals captured to the constrained Airport during the ATFM scenario, 67% of flights are assigned ATFM Ground Delay.



## IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (92%)*	Compliant	Non Compliant	%Compliant
Pune	4	2	67
Mumbai	26	0	100
Bhopal	2	1	67
Indore	5	1	83
Udaipur	0	1	0
Rajkot	9	1	90
Surat	2	1	67
Ahmedabad	1	0	100
<b>KOLKATA FIR (87%)*</b>			
Varanasi	9	1	90
Kolkata	18	4	82
Bagdogra	4	0	100
Gorakhpur	2	0	100
Guwahati	7	0	100
Prayagraj	1	0	100
Bhubhaneshwar	6	0	100
Raipur	6	0	100
Imphal	5	1	83
Patna	15	3	83
Ranchi	4	3	57
<b>DELHI FIR (59%)*</b>			
Chandigarh	9	6	60
Thoise	0	1	0
Gwalior	2	1	67
Gaggal	3	3	50
Leh	9	9	50
Jammu	8	0	100
Jaisalmer	0	1	0
Jaipur	0	1	0
Lucknow	2	0	100
Srinagar	18	13	58
Bareilly	0	3	0
Amritsar	4	1	80
<b>CHENNAI FIR (93%)*</b>			
Goa	1	1	50
Bangalore	24	0	100
Coimbatore	5	1	83
Cochin	10	0	100
Calicut	2	0	100
Chennai	18	1	95
Shamshabad	16	1	94
Begumpet	1	1	50
Port Blair	1	0	100
Kannur	2	1	67

\*FIR wise compliance rate

Note: The above list contains only those airports which had flights to the Constrained Airport and affected by ATFM measures.



## V. Reason For Non Compliance



Figure 9: Reason for Non-Compliance as provided by FMPs

### Inference

1. Airline Operational Reason is one of the biggest factor identified by FMPs as a reason for Non-Compliance from their station.
2. Absence of Updated demand in SKYFLOW is the 2<sup>nd</sup> contributing factor cited by FMPs as the reason for Non-Compliance.(Flights are allocated a CTOT based on earlier shared EOBT but there late arrival and hence subsequent late estimated off block time is not captured in SKYFLOW)



## VI. CTOT Compliance rate – Airlinewise

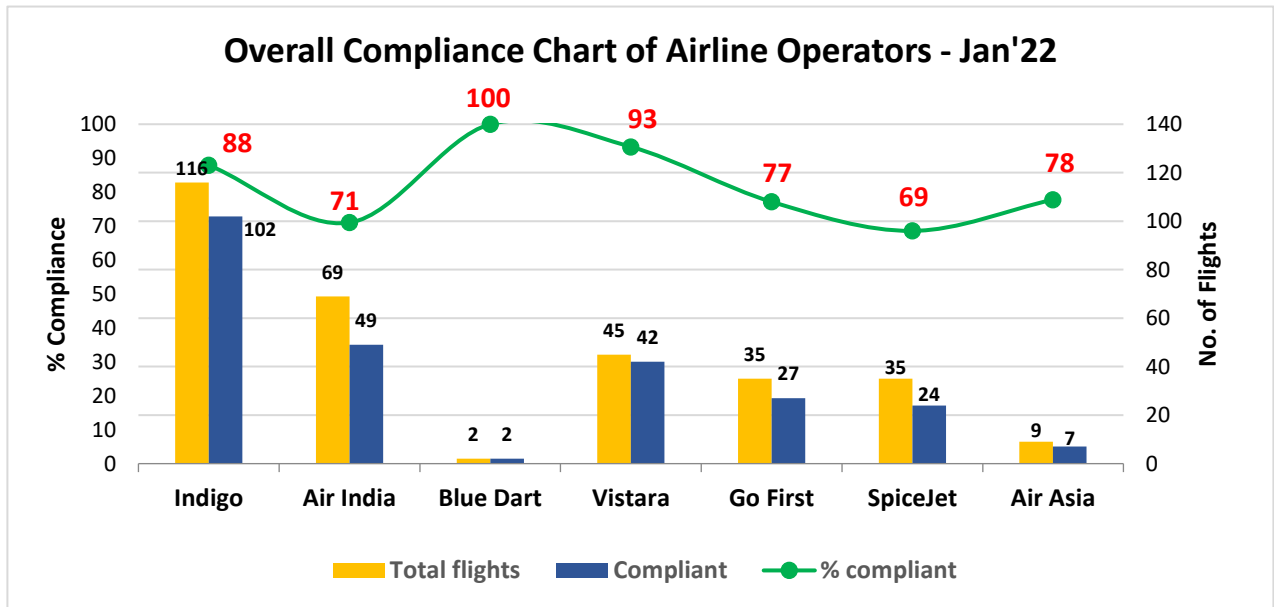


Figure 10: Airlines Overall Compliance –Jan'22

### Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 81% arrivals are compliant.
2. Delhi region has the lowest compliance rate of 59% whereas Chennai region has highest compliance rate of 93%.
3. Vistara, Indigo and Blue Dart Airlines have a CTOT Compliance better than the average recorded compliance for the month of Jan'22.



## VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals\* within the CDM Scenario period for Delhi is 4 minutes.

\*Note: Only calculated for domestic arrivals with both ATOT and ALDT information

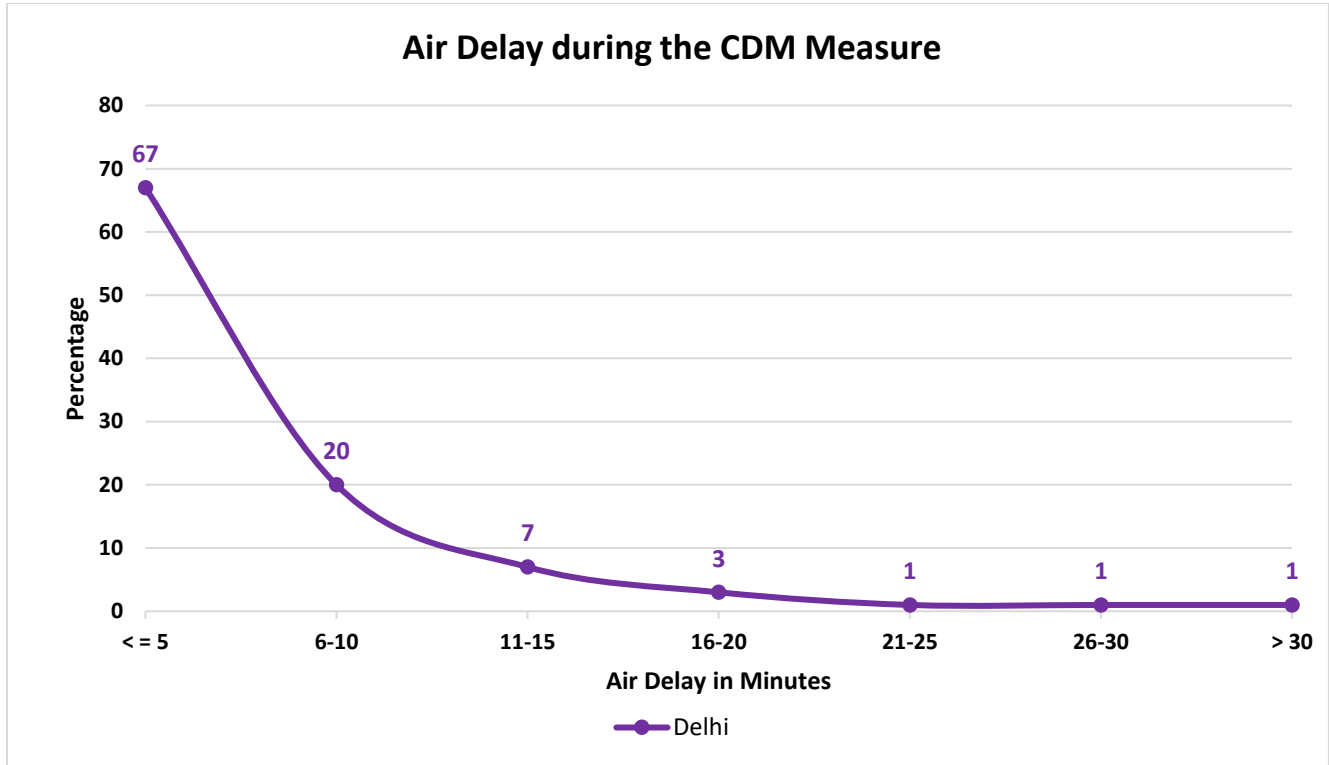


Figure 11: Air Delay distribution during the CDM period

### Inference

1. 94% of arriving flights to Delhi had an Air delay of equal to or less than 15 minutes during the CDM period.



## D. Glossary

<b>ATFM Parameters</b>	<b>Definition</b>
<i>Affected Flight statistics</i>	An insight of participating traffic in the scenario i.e. ratio of the domestic arrivals to the constrained airport affected by ATFM measures (assigned delay by the Ground Delay Program) to the domestic arrivals not affected by ATFM measures (not assigned any delay) within the CDM scenario.
ATFM Ground delay	ATFM ground delay defined as CTOT-ETOT (Calculated take off time – Estimated take off time)
<i>Average ATFM delay</i>	$\frac{\text{Total monthly ATFM delay (in minutes)}}{\text{Total Domestic Arrivals}}$
<i>Maximum ATFM delay</i>	Maximum ATFM delay (in minutes) assigned in the month
<i>Overall compliance rate</i>	Defined as monthly ATFM departure slot adherence rate of regulated flights. Flights having ATOT within the ATFM Slot Tolerance Window (STW) of minus 5 to plus 10 minutes of CTOTs, are considered as compliant flights
<i>CTOT Compliance rate of Airline operators</i>	An overview of CTOT compliance rate of various Airline operators
<i>CTOT Compliance rate of Airports within different Regions</i>	An overview of CTOT compliance rate of Airports within 4 FIRs
Air delay statistics	<p>Air delay defined as difference between AET &amp; EET, where AET (actual elapsed time) can be obtained from (ALDT-ATOT) and estimated elapsed time (EET) can be obtained from FPL/RPL or (CLDT-CTOT). <b>Therefore, Air delay = AET-EET</b></p> <p>Average Air Delay is calculated as:</p> $\text{Average Air Delay} = \frac{\text{Total Air Delay to domestic arrivals (with values greater than zero)}}{\text{Total Domestic Arrivals}}$ <p>CLDT: Calculated Landing Time CTOT: Calculated Take off Time ALDT: Actual Landing Time ATOT: Actual Take off Time</p>





Annexure-I

**CASE STUDY**  
**Republic Day Airspace Closure(2022)**



## **A. Introduction:**

Due to the Republic Day celebrations, Delhi Airport/Airspace was closed as specified vide NOTAM no. A0145/22 & A0144/22. Restrictions were also imposed on domestic non-scheduled movements vide A0172/22

### **(A0145/22 NOTAMN**

Q) VIDF/QFAXX/IV/BO/A/000/999/

A) VIDP B) 2201190505 C) 2201260715

D) 19 20 21 0505-0715,

22 23 24 26 0535-0715

E) NO LDG AND TKOF PERMITTED AT IGI AP, NEW DELHI (VIDP) DUE REPUBLIC DAY CELEBRATIONS.)

### **(A0144/22 NOTAMN**

Q) VIDF/QRACA/IV/NBO/W/000/200/

A) VIDF B) 2201190515 C) 2201260715

D) 19 20 21 0515-0715,

22 23 24 26 0545-0715

E) AIRSPACE WI A RADIUS OF 50NM AROUND DELHI VOR (DPN), EXCLUDING AREAS OF 10NM RADIUS AROUND SIKANDRABAD VOR (SSB) AND 10NM AROUND SAKRAS VOR (SKA), NOT AVBL DUE REPUBLIC DAY CELEBRATIONS.

F) GND G) FL200)

### **(A0172/22 NOTAMN**

Q) VIDF/QFAXX/IV/BO/A/000/999/

A) VIDP B) 2201190445 C) 2201240745

D) 19 20 21 22 23 24 0445-0745

E) IN VIEW OF AIRSPACE CLOSURE AND EXP TFC CONGESTION, DOM NON-SKED FLT NOT PERMITTED TO OPR AT IGI AP (VIDP)



## B. Executive Summary

A virtual meeting was conducted on 18<sup>th</sup> Jan'22 with all stakeholders' including senior officers from Delhi ATC to discuss the modalities for the upcoming Delhi Airspace/Airport closure and review last year's Airspace closure to identify bottlenecks and resolve them and incorporate best practices.

It was agreed that no ATFM measure would be applied pre Closure and Delhi ATC will tactically manage the traffic. Revised schedule as approved by DIAL was already available with ATFM team. Airlines shared their fortnightly data incorporating the changes w.r.t. Airport closure by evening of 18<sup>th</sup> Jan'22.

A representative from Air India, Air Asia & Indigo Airlines was present in CCC for all days of the Republic Day Airspace closure. Go First Representative was present on initial days of the exercise only. Their presence helped in timely and effective coordination with the Flight dispatch and operations.

All ATS in-charges/FMPs were informed to be abreast with the latest NOTAM w.r.t. republic day celebration and ensure that FMP position was manned by SKYFLOW trained staff.

,CCC apprised all FMPs regarding the availability of CTOTs through the SKYFLOW system through planned Teleconferencing conducted on each day of the exercise.

Exercise was called off on 22<sup>nd</sup> Jan'22 by Indian Airforce.

## C. Challenges:

1. Technical glitch was faced in uploading of Flight intent in the SKYFLOW system and help of the vendor was sought.
2. Non-compliance of CTOT was observed from Imphal, Leh, Chandigarh, Pune and Kolkata on initial days of exercise.
3. Few IAF flights which were likely to operate within the CDM period were cancelled with no intimation to CCC and no ATS Cancel message. Such ghost flights contribute to slots lost which can not be regained.
4. CTOT dissemination to smaller Airports (under the Regional Connectivity Scheme) still remains a challenge.

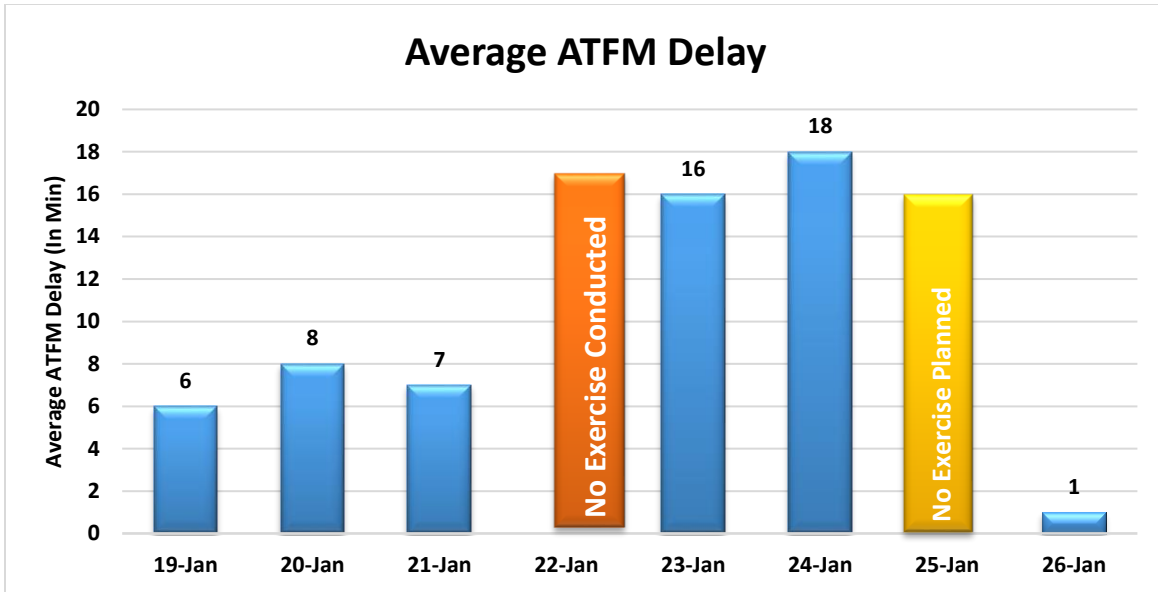
## D. Highlights:

1. Stakeholder's meeting prior to the closure helped in raising awareness about the applicable NOTAM and proposed ATFM measures.
2. Better coordination with Delhi ATC as per the agreed plan. Pre closure traffic was handled tactically by Delhi ATC as agreed in Stakeholders Meeting and hence no measure was applied.
3. Presence of Airline representatives from 4 major Airlines helped in communication flow.
4. Regulated flow of Air traffic to Delhi ATC post the reopening of Airspace ensured less airborne holdings.

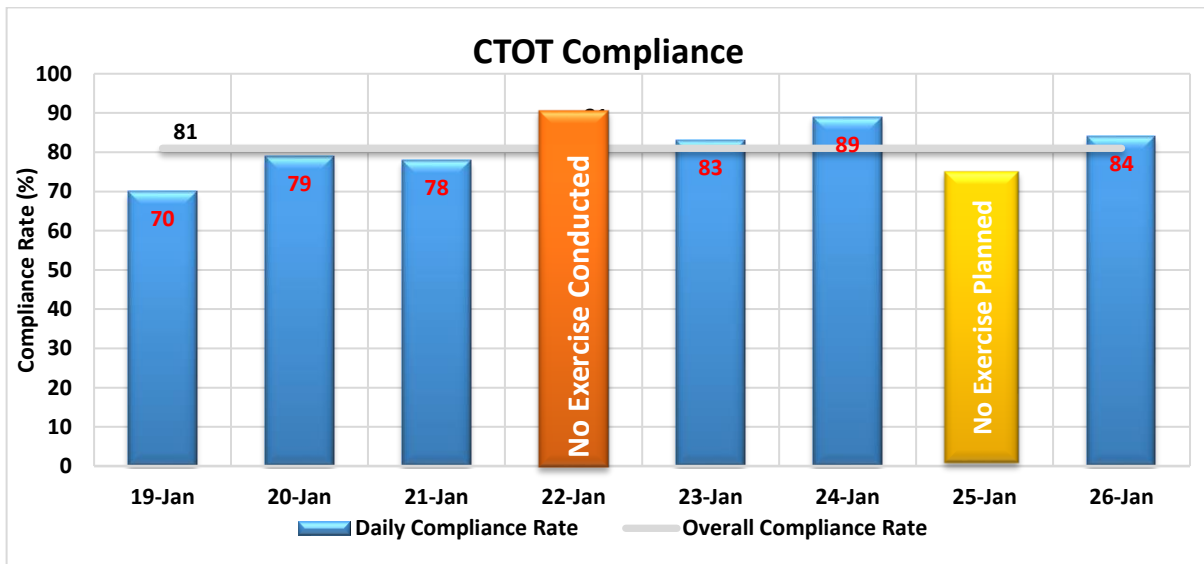


### E. Overview:

1. Average delay due to ATFM measures during the CDM period on various days of exercise are as presented below:



2. CTOT Compliance on various days of Republic Day Celebration is as follows:





## F. Fuel Saving due to ATFM Measures on 26<sup>th</sup> Jan'22

A modest attempt is made to find out the tangible benefit of ATFM measures applied. Republic day closure in Delhi entailed a closure of the Delhi Airport/Airspace for almost 0140 hours on 26<sup>th</sup> Jan'22.

A Sample study was conducted to calculate Fuel Saving due to ATFM measures on 26<sup>th</sup> Jan'22 (0700-0900 UTC) due to the reduction in Air delay by the application of Ground Delay measures.

As coordinated tactically at 0330 UTC on 26<sup>th</sup> Jan'22 with Delhi ATC, the Airport was likely to be available for civil traffic from 0650 UTC and ATFM measures were planned to address any congestion arising soon after the availability of Airspace.

### Assumptions:

- When ATFM measures are not in force, all flights take off at their ETOT where Estimated take off time(ETOT)= Estimated off block time(EOBT) + default taxi time
- All flights have an Estimated elapsed time(EET) as calculated by SKYFLOW using the Flight Plan information and Basic Aircraft data.
- Landings at IGI Airport take place every 100 seconds, considering an Airport acceptance rate of 36 in two Runway configuration.

### Methodology:

**Air delay (with ATFM measures in force)** is calculated during the period when ATFM measures are in force by summing the air delay for all the flights landing at Delhi Airport.

i.e. **Total Air Delay =  $\sum$  (Actual Flying time – SKYFLOW calculated EET)**

Air delay (with no ATFM measures) is calculated as the sum of Air delay for all the flights during the above said period with no ATFM measures in place and the air delay for each flight is the difference in its ideal landing time and its ideal estimated landing time.

**Total Air Delay (with no ATFM measures) =  $\sum$  (Ideal LDT - Ideal ELDT)**

\*Ideal LDT is taken by assuming every flight is landing at Delhi with alternate spacing interval of 1.5 minutes.

\*Ideal ELDT = ETOT + SKYFLOW calculated Flying time

### Fuel Saving Calculation during the CDM Period 26.01.2022 (0700 UTC to 0900 UTC):

Great Circle Distance(GCD)\* was calculated for all the arrivals during the ATFM Measure from the point of origin to destination. Assuming Airbus 320 as reference for domestic flights (flight distance less than 1500 nm) and B777 for international flights (flight distance more than 5000nm):



Fuel consumption (Kgs / nm) for each affected flight in the scenario was then calculated using the Reference document: ICAO Carbon emissions calculator methodology, version10, Appendix C: ICAO Fuel Consumption Table.

The Fuel consumed per minute(Kg/min) was calculated for each affected flight.

Total Air delay (with ATFM measures) = 64 min

Total Air delay (with no ATFM measures) = 231 min

Total amount of Air delay reduced due to ATFM measures= 231-64= 167 min

#### **Fuel Saving Calculation:**

Fuel saved for each affected flight : as per sheet attached

Total Fuel saved during the ATFM Measure: **8379.76 Kgs**

**Total reduction in CO<sub>2</sub> emission : 3.16(KgCO<sub>2</sub>/kg fuel)\*8379.76 Kgs= 26,480 Kg**

*\*GCD (Great Circle Distance): The distance between origin and destination airports is derived from latitude and longitude coordinates originally obtained from ICAO Location Indicators database.*

*3.16 = constant representing the number of tonnes of CO<sub>2</sub> produced by burning a tonne of aviation fuel.*



Indicative	ADEP	ALDT	Air Delay(with ATFM)	Ideal ELDT	Ideal LDT (with NO ATFM)	AIR DELAY (With no ATFM)	Time Saved	Fuel consumption/min	Fuel Saved(Kgs)	
AIC430	VOMM	07:11	0	07:01	07:06		5	5.00	48.69	243.45
FDB451	OMDB	07:31	1	07:01	07:08		7	6.00	57.01	342.06
AIC402	VECC	07:30	-4	07:05	07:09		4	8.00	46.98	375.83
VTI994	VABB	07:08	1	07:07	07:11		4	3.00	55.66	166.97
IGO6281	VIAR	07:37	10	07:08	07:12		4	-6.00	72.91	-437.47
VTI884	VOCI	07:14	9	07:08	07:14		6	-3.00	50.68	-152.04
GOW193	VISR	07:20	-6	07:10	07:15		5	11.00	76.57	842.23
GOW424	VOHS	07:15	-2	07:10	07:17		7	9.00	47.80	430.21
VTI830	VOHS	07:06	-5	07:10	07:18		8	13.00	47.80	621.41
SEJ3236	VIGG	07:46	9	07:12	07:20		8	-1.00	45.05	-45.05
ALK195	VCBI	07:25	3	07:13	07:22		9	6.00	47.90	287.39
AIC106	KEWR	07:11	-5	07:16	07:23		7	12.00	123.37	1480.48
IGO2276	VOCB	07:27	5	07:16	07:25		9	4.00	50.62	202.48
AIC505	VOBL	07:33	9	07:18	07:28		10	1.00	53.73	53.73
VTI706	VECC	07:18	-5	07:18	07:29		11	16.00	46.98	751.67
ETD210	OMAA	07:23	1	07:19	07:31		12	11.00	57.38	631.21
SEJ8475	VISR	07:42	15	07:23	07:32		9	-6.00	76.57	-459.40
IGO2372	VOCI	07:36	6	07:24	07:34		10	4.00	50.68	202.72
SEJ8939	VEGK	07:48	10	07:27	07:35		8	-2.00	67.65	-135.29
VTI718	VEPT	07:22	-5	07:28	07:37		9	14.00	43.75	612.52
SEJ3703	VARK	07:40	4	07:32	07:38		6	2.00	57.51	115.02
GOW226	VILH	08:44	7	07:34	07:40		6	-1.00	77.82	-77.82
IGO2098	VERC	07:34	0	07:35	07:41		6	6.00	46.60	279.57
IGO374	VERP	07:49	7	07:37	07:43		6	-1.00	50.70	-50.70
AIC425	VOKN	07:25	-1	07:38	07:44		6	7.00	46.22	323.51
IGO5004	VEPT	07:39	1	07:39	07:46		7	6.00	43.75	262.51
AIC188	CYYZ	07:43	3	07:40	07:47		7	4.00	120.22	480.87
LLR702	VIBY	07:45	8	07:40	07:49		9	1.00	48.54	48.54



AIC809	VABB	07:50	8	07:46	07:50	4	-4.00	55.66	-222.62
IGO7406	VIGR	07:55	1	07:56	07:56	0	-1.00	43.62	-43.62
ADY161	OMAA	08:06	10	07:57	07:57	0	-10.00	57.38	-573.82
IGO168	VABB	08:13	5	07:59	07:59	0	-5.00	55.66	-278.28
VTTRY	VABP	08:11	9	08:00	08:00	0	-9.00	78.83	-709.45
AIC405	VEBN	08:03	-4	08:01	08:02	1	5.00	64.99	324.95
IGO175	VAID	08:01	-4	08:01	08:03	2	6.00	68.99	413.92
AIC826	VISR	08:08	-1	08:02	08:05	3	4.00	76.57	306.27
IGO2096	VOPB	08:10	-1	08:06	08:06	0	1.00	44.49	44.49
GOW238	VERC	08:04	-8	08:07	08:08	1	9.00	46.60	419.36
LLR714	VICG	08:15	-17	08:07	08:09	2	19.00	60.80	1155.20
IGO599	VECC	08:31	3	08:10	08:11	1	-2.00	46.98	-93.96
IGO5002	VOMM	08:18	1	08:11	08:12	1	0.00	48.69	0.00
AIC3427	VEGT	09:02	-5	08:13	08:14	1	6.00	39.98	239.85
IGO842	VICG	08:23	4	08:13	08:15	2	-2.00	60.80	-121.60
GOW2512	VEPT	08:17	-3	08:17	08:17	0	3.00	43.75	131.25
LLR806	VICG	07:57	-20	08:27	08:27	0	20.00	60.80	1216.00
AIC126	KORD	08:37	8	08:29	08:29	0	-8.00	118.73	-949.86
IAD741	VOBL	08:21	-7	08:29	08:31	2	9.00	53.73	483.59
GOW174	VAPO	08:27	6	08:34	08:34	0	-6.00	54.84	-329.06
IGO2024	VILK	08:28	-8	08:35	08:36	1	9.00	52.16	469.43
IGO6738	VIJU	08:55	14	08:35	08:37	2	-12.00	94.94	-1139.31
IGO2337	VOBL	08:38	-2	08:38	08:39	1	3.00	53.73	161.20
VTI958	VABB	08:46	3	08:38	08:40	2	-1.00	55.66	-55.66
IGO2084	VEIM	08:41	-5	08:42	08:42	0	5.00	38.64	193.20
IGO5072	VEBS	08:43	4	08:43	08:43	0	-4.00	46.40	-185.59
CENTRL1	VEAB	08:52	1	08:47	08:47	0	-1.00	36.77	-36.77
SEJ8904	VEBD	08:48	-5	08:53	08:53	0	5.00	43.56	217.79
IGO2027	VOBL	08:58	1	08:57	08:57	0	-1.00	53.73	-53.73

8379.76