International Civil Aviation Organization

The Fourth Meeting of the South Asia/Indian Ocean ATM Coordination Group (SAIOACG/4) and the Twenty first Meeting of the South East Asian ATM Coordination Group (SEACG/21)

Hong Kong, China, 24 – 28 February 2014

Agenda Item 5: ATS Route Development

COLLABORATIVE PBN IMPLEMENTATION IN THE SUB-REGION

(Presented by Airports Authority of India)

SUMMARY

This paper presents the changes to the Indian Airspace and Air route structures in the period between July, 2012 and October, 2013. It further details the plans for near term, including the plan to introduce RNAV 2 ATS Routes between major airports including Delhi-Chennai extended to Colombo, Delhi-Bengaluru, Mumbai-Kolkata and Delhi-Kolkata extended to Dhaka.

This paper presents brief overview of the PBN implementation progress in India and the benefits achieved through such initiatives. The paper highlights India's willingness to collaborate in developing and implementing PBN in en-route and terminal airspaces of neighboring States, specific potential benefit areas have been identified.

1. INTRODUCTION

1.1 In its 37th session in September 2010, ICAO Assembly reiterated the importance of PBN in its Resolution A37-11 requesting ICAO contracting States to implement PBN as a matter of urgency. APANPIRG, through its Conclusion 18/52, established a Regional Performance Based Navigation Task Force (PBN/TF) to address PBN related regional implementation issues. In its Conclusion 18/53, APANPIRG stipulated development of State's PBN Implementation Plans in harmony with the Asia/Pacific Regional PBN Implementation Plan. In June 2013, APANPIRG 24 adopted the fourth (current) version of the Asia/Pacific Regional PBN Implementation Plan.

1.2 In accordance with ICAO Global Plan Initiatives and recommendations of a various high level committees, India progressed with the implementation of LNAV/LNAV- VNAV approach procedures, PBN RNAV-1 SID & STAR in terminal area and PBN based RNP-10, RNAV-5 and RNAV-2 city-pair ATS routes in enroute phase with the objective to enhance safety and efficiency of the airspace and provide quantifiable benefits to airspace users.

1.3 The Indian Airspace and Air Route structure has undergone positive changes with the introduction of new ATS Routes which are either a part of the regional network or not a part of regional network, as well as either Area Navigation Routes or otherwise. The changes are demand driven and the principles of FUA, RNAV and RNP (Performance- based navigation), Dynamic and flexible ATS route management and Collaborative airspace design and management have been successfully employed to generate huge user benefits.

1.4 In the period between April, 2012 and October, 2013 six connector routes with ATS Route designator “V”; one RNP 10 connector route with ATS Route designator “T”; thirteen RNAV 5 routes with ATS Route designator “Q”; six domestic routes and a realignment of a domestic route with ATS Route designator “W”; three area navigation routes (RNAV) which form part of the regional networks of ATS routes with ATS Route designator “L”, have been introduced.

1.5 Environmental challenges and need for system-wide efficiency in aviation operations have triggered adoption of new technology, development of new flying techniques and establishment of efficient airspace procedures. PBN is one such effort in CNS/ATM domain utilizing Global Navigation Satellite System (GNSS). GNSS is capable of providing accurate, reliable and seamless position determination and navigation capabilities to all airspace users. PBN and GNSS together facilitate in developing efficiently flexible flight procedure enhancing safety, access, capacity, predictability, operational efficiency, fuel economy and environmental benefits.

2. DISCUSSION

PBN Implementation Status-Terminal

2.1 PBN RNAV-1 SIDs & STARs are being designed to facilitate Continuous Climb Operations (CCO)/Continuous Descent Operations (CDO); such procedures are expected to provide significant improvement in operational efficiency. Design work on number of LNAV/LNAV-VNAV approaches has been completed and regulatory process for the approval of the procedures has been initiated.

2.2 Till date RNAV-1/RNP-1 SIDs and STARs at 10 international airports have been implemented. It has been possible to streamline traffic flows, avoid delays due to holding and enable effective management of airspace. The reduction in track miles achieved through these procedures have provided significant fuel savings and reduction in emissions. Implementation of CDO have provided significant fuel savings, which is demonstrated by the details provided in the table below

Table 2 –Fuel savings and emission reduction due to CDO

Airport	Month	No. of flights performing CDO	Fuel savings (Kg)	Carbon Emission savings (Kg)
Ahmedabad Airport	May 2013	576	81931	258050
	Jun 2013	277	40061	126176
Shamsabad Airport	Feb 2013	11	1925	6063
	Mar 2103	86	14235	44840
	Apr 2013	46	8035	25310
	May 2013	111	8532	26875
Mumbai Airport	Feb 2013	11	1925	6063
	Mar 2013	86	14235	44840
	Apr 2013	46	8035	25310
	May 2013	111	8532	26875
Total savings			**187446**	**590402**

2.3 The latest implementation of RNAV-1(GNSS) SID & STAR is at Guwahati airport. The procedures have been implemented from 17-10-2013.

2.4 RNAV-1/RNP-1 SID & STAR are under development at Mangalore, Calicut, Coimbatore, Nagpur airport with the implementation planned by the end of 2013/beginning of 2014.

PBN Implementation Status-En-Route

2.5 The first **RNAV-5** city pair route Delhi-Mumbai-Delhi was implemented in May 2012; Delhi-Mumbai segment represents one of the busiest (seventh) routes in the world and followed by Chennai-Mumbai RNAV-5 route on May 2013.

2.6 RNAV 5 ATS Routes have been introduced, primarily, as city pairs between Delhi and Mumbai with connectivity to Ahmadabad, Vadodara, Jaipur and Udaipur; Mumbai and Chennai with connectivity to Bengaluru; Kolkata and Chennai; and recently Mumbai and Trivandrum with connectivity to Goa, Mangalore, Calicut, Cochin and Coimbatore.

2.7 The RNAV 5 city pairs , although may not provide a significant savings due to reduction in track miles, since many of the major airports were already connected through almost straight routes, with suitable placement of terrestrial navigational aids, definitely provide an opportunity to increase airspace capacity through the application of a 50 NM longitudinal separation, in comparison to the erstwhile 10 minutes Longitudinal separation minimum and consequently the availability of optimum flight levels and sizeable fuel and environmental savings. The deployment of these Performance-Based Area Navigation routes allow the aircraft to fly their optimum aircraft profile, additionally by virtue of their being unidirectional, provide an opportunity for improved flexibility and efficiency in Departure and Descent Profiles (CCOs & CDOs) and add to Safety by eliminating the risk of encountering opposite direction traffic. (Refer Annexure 1)

2.8 A proposal for a RNAV 5 city pair between Delhi and Srinagar is likely to be cleared by the Air Headquarters, since it involved conditional transitioning through several major military airspace(s). This will ease the traffic congestion on international ATS Routes A589 and A466 Northwest of Delhi and increase the availability of optimum flight levels to flights operating along these ATS Route into Pakistan and Afghanistan airspace(s).

2.9 India has planned to implement the following RNAV-5 city pair routes within a definite time frame and the possible fuel savings/month are given below:

Savings due to introduction of new ATS Routes/RHS in last 5 years

ATS Route/RHS	Fuel Savings/day (Kg)	Carbon emission reduction/day (Kg)	Cost Savings/day ($ Million)	Remarks*
50NM RHS	286500	905340	0.315	L301,L507,L759,L510,M770,P628, P646,N895, L509, M300, N877, N563, P570, P574, P762
40NM RHS	39700	125452	0.040	W20, R460
RNAV 5	40100	126716	0.044	Q1 to Q13
Domestic	27092	85611	0.030	W122,W123,W124,W126,W134,W136,W138,W140
RNP 10	31950	100962	0.035	L875, L756, L516, L899, L518
Connector	11220	35455	0.010	V1 to V32
Total	**436562**	**1379536**	**0.474**	

2.10 **PBN IMPLEMENTATION RNAV 2**: In the 24th meeting of the APANPIRG, India reaffirmed its commitment to introduce RNAV 2 Routes in continental airspace. With the introduction of redundant surveillance coverage from a combined network of SSRs and ADS-Bs and improved DCPC, The SAIOACG/SEACG meeting noted that the use of RNAV5 routes should be considered with respect to RNAV2 and RNP2 navigation specifications, which would become increasingly preferred in the near future. India is in the final stages of implementation of RNAV 2 city pairs with 20 NM lateral spacing between the routes and a proposed 20NM Longitudinal Separation, for which TLS studies have been undertaken through simulation models, by BOBASMA, India's Enroute Monitoring Agency.

2.11 Republic of Korea implemented RNAV 2 unidirectional routes Y711 and Y712 in June 2012 with 8NM spacing and subsequently established ten RNAV 2 routes viz Z50, Z51, Z52, Z53, Z54, Z81, Z83, Y233, Y253 and Y744.

2.12 Korea presented a working paper (WP-308) on cost- benefit analysis of RNAV 2 parallel routes Y711 and Y712 in the ICAO assembly 38th session held in Sep' 2013. Through the presentation ROK has invited the assembly to encourage States to implement RNAV 2 parallel routes to improve operational efficiency, airspace capacity and operational benefit.

2.13 In accordance with Regional PBN Implementation plan, taking into consideration the reliable surveillance and VHF coverage, availability of CAR guidelines for RNAV 2 approval by DGCA, having most of the Aircraft currently operating in the level band of F290/F460 are RNAV 1 certified, being identical, it is expected that they will be able to obtain RNAV 2 Certification, India has considered ideal for the introduction of RNAV 2 Routes between Delhi to Bengaluru extended to Trivandrum, Delhi to Chennai extended to Colombo and between Delhi and Kolkata extended to Dhaka , which will double the capacity. (Refer Annexure 2 and 3).It is also expected that Delhi – Colombo RNAV 2 will connect 12 Airports and Delhi – Dhaka RNAV 2 will connect 7 Airports

Route Length Comparison

Route	Delhi - Trivandrum	Trivandrum-Delhi	Delhi – Chennai	Chennai - Delhi	Delhi – Kolkata	Kolkata - Delhi
Present	1242 NM	1221 NM	971 NM	972 NM	711 NM	711 NM
Proposed	1210 NM	1214 NM	969 NM	957 NM	709 NM	712 NM
Saving	32 NM	7 NM	2 NM	15 NM	2 NM	-1 NM

PBN Implementation at Defence Airports

2.14 At several defence airports civil commercial flights operate regularly and segregated hours of operations are maintained for civil and military operations resulting in constraints on both military and civil airspace users. The application of PBN can be extended to such airs GNSS as a sensor can provide precise and repeatable 3D trajectories. Such procedures will minimize the airspace requirements for civil operations thereby facilitating unrestricted military operations

2.15 To promote civil-military cooperation; AAI took the lead and highlighted the benefits provided by PBN procedures and offered to develop such procedures at in collaboration with defense aviation experts. As a pilot project, Goa (Dabolim) which is also an important tourist destination was selected for development of PBN RNAV -1 SIDs & STARs, LNAV, LNAV procedures. The project is on–going.

Collaboration with Neighboring States

2.16 Neighbouring States and India can jointly develop PBN RNAV arrival/departure procedures to form a seamless network of PBN routes and arrival/departure procedures in the sub - continent. Adjoining airspaces such as Dhaka Control Area in the east and Colombo Control Area in the south have potential for benefits to be achieved through implementation of PBN in en-route and terminal airspace

2.17 Bangladesh and India can collaborate in jointly implementing PBN by establishing RNAV-2 (20-20) route between Dhaka-Kolkata. Such routes will promote safety by segregating arrival and departure flows on unidirectional parallel routes and route capacity, facilitate in implementation of CDO/CCO.

2.18 Development of RNAV -1 or RNP-1 as appropriate for Dhaka terminal area in order to provide segregated, efficient arrival and departure trajectories to RWY14/32 at Hajrat Shah Jalal Intl. Airport, Dhaka.

2.19 Sri Lanka and India can collaborate in jointly implementing PBN by Establishing RNAV-2 Thiruvananthapuram, Colombo route capacity and facilitate in the implementation of CDO/CCO.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Propose a collaborative mechanism for joint design of RNAV 5 and RNAV 2 city pairs between major airports in the neighbouring States and/or improvements in ATS Routes Regional Network

b) urge airline operators to obtain PBN approval as appropriate and

c) discuss any relevant matters as appropriate.

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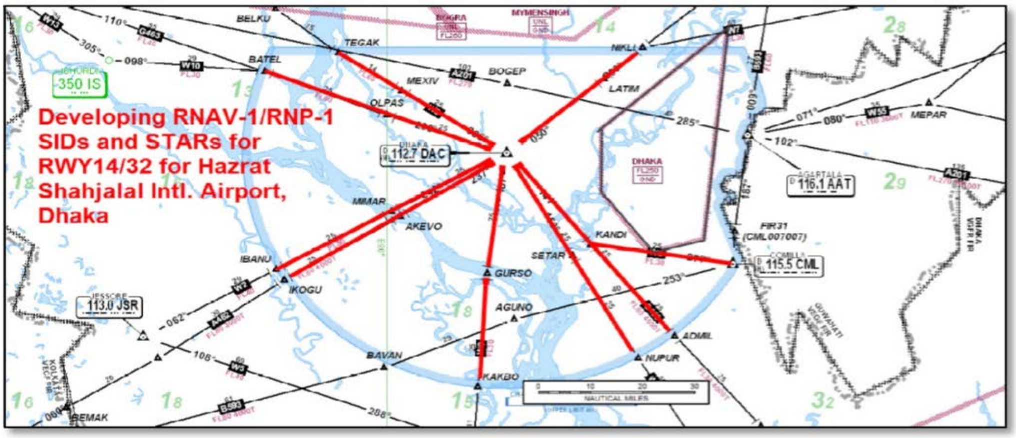
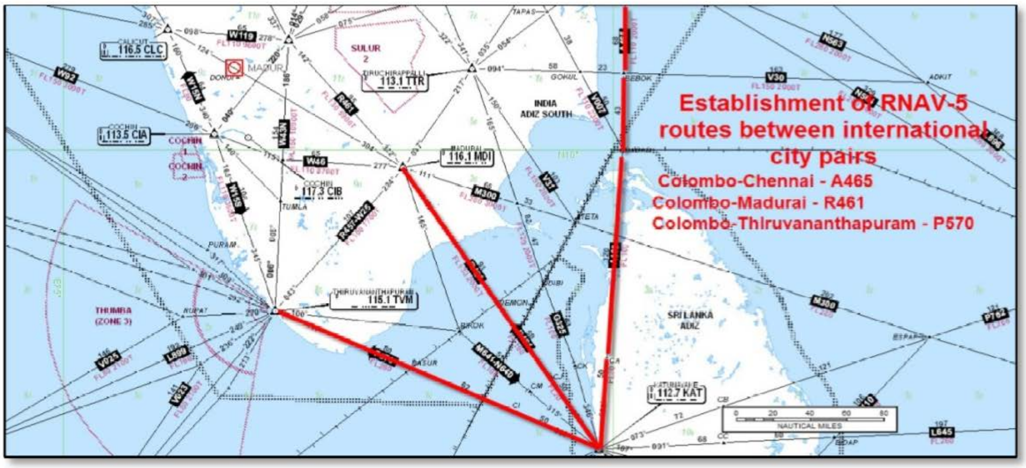
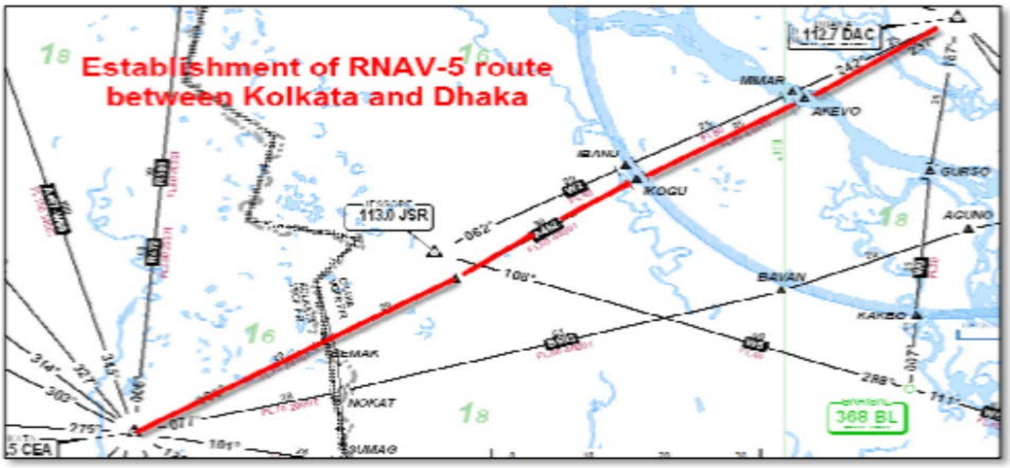
ANNEXURE-1


Developing RNAV-1/RNP-1
SIDs and STARs for
RWY14/32 for Hazrat
Shahjalal Intl. Airport,
Dhaka
112.7 DAC
113.0 JSR
115.5 CML
116.1 AAT


Establishment of RNAV-5
routes between international
city pairs
Colombo-Chennai - A465
Colombo-Madurai - R461
Colombo-Thiruvananthapuram - P570


Establishment of RNAV-5 route
between Kolkata and Dhaka
112.7 DAC
113.0 JSR
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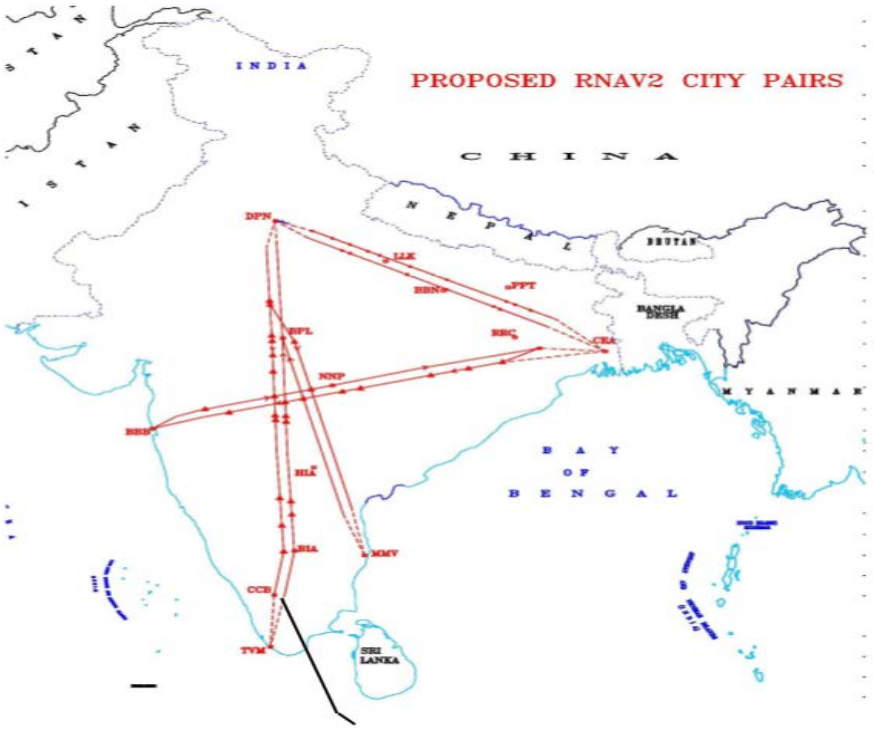
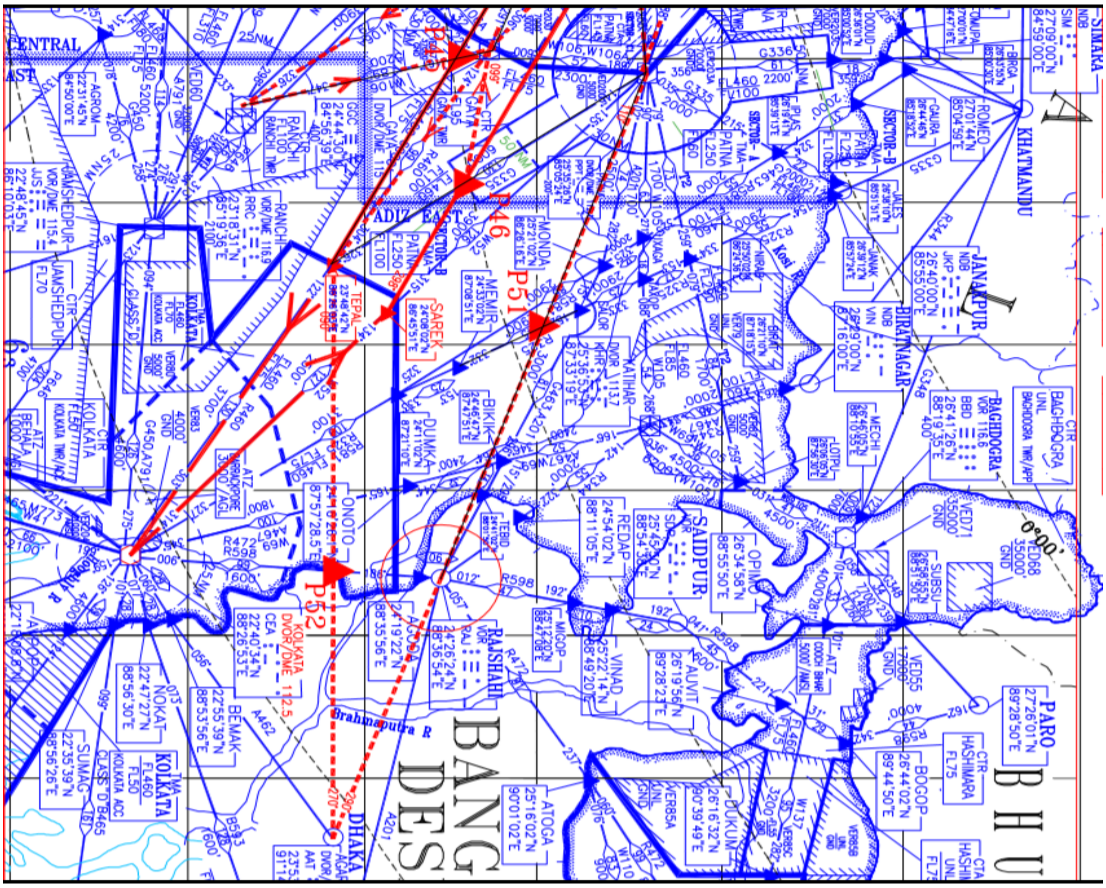
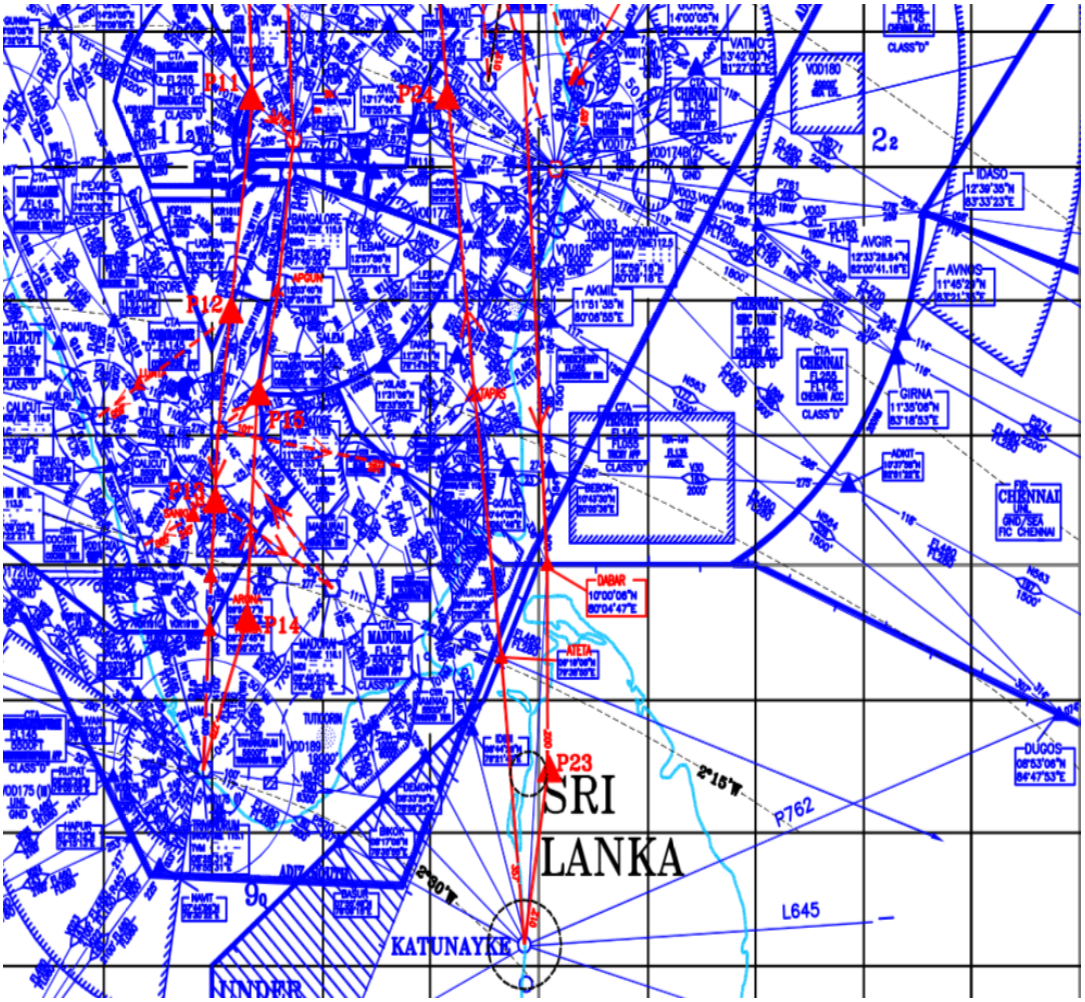
ANNEXURE-2





ANNEXURE-3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DUGOS
CHENNAI
GIRNA
AVGIR
IDASO
AVNIG
AKMAL
MADURAI