CONTENTS

Executive Summary

1. Passenger traffic both international and domestic during 2007 in the country grew at a phenomenal rate of 15.6% and 32.5% respectively which was well above the world average of 5%, a trend which is continuing for the last 3-5 years. It is further expected that air traffic will continue to grow at a rate which is faster than the world. At present, our airports are able to accommodate only constrained movements of aircraft due to infrastructure and procedural constraints leading to overcrowding, flight delays and wasteful burning of fuel by aircraft hovering over airports awaiting permission to land. The congestion of aircraft also raises safety concerns in civil aviation operations.

2. The country needs a futuristic Master Plan of Air Navigation Services which operates automatically and is periodically self-triggered by traffic requirements and based on Next Generation Technologies. Ministry of Civil Aviation, therefore, constituted a Committee for formulating next generation futuristic Air Navigation Services Master Plan.

3. The Terms of Reference of the Committee were to examine/review the following aspects with a view to formulate next generation futuristic ANS Master Plan and make recommendations thereafter:

i) Assessment of Air Navigation Services (ANS) in the country based on the requirements specified by lCAO in Regional Air Navigational Plans.

ii) Assessment of the weather work stations based on the standards and recommended practices prescribed by ICAO.

iii) Recommend a futuristic Master Plan of Air Navigation Services based on the latest technologies in the field and the forecast of the future requirements.

iv) Recommend ways and means of harmonisation of ANS in the country with the ANS systems of other countries/regions.

4. Any planning activity requires consultations with the stakeholders. The Committee, therefore, interacted with various stakeholders like airline representatives including IATA, Private Aerodrome Operators, IAF/MOD, IMD and AAI and had detailed discussions to understand their perception and concerns. The Committee also interacted with Experts from ICAO, Montreal, Canada, representative of India in ICAO, DGCA, Air Navigation Service Providers, aircraft manufacturers and Networking Solutions Providers.

5. The Committee had also taken into consideration material available in many ICAO documents on CNS/ATM and many reference materials on the subject like Next Gen (Next Generation Air Transport Systems) of USA, SESAR (Single

European Sky ATM Research) of European Union and other material available on the Internet web sites.

6. The Global Air Navigation Plan developed by ICAO (Doc 9750, Third Edition – 2007) as a strategic document to guide States for implementation of the global plan with horizon up to and beyond 2025 was taken into consideration. The document lists out several "Global Plan Initiatives" (GPIs) to be taken by the States to ensure that a safe, secure, efficient and environmentally sustainable air navigation system is available at global, regional and national levels.

7. Airports Authority of India (AAI) is entrusted with the responsibility of providing Air Navigational Services (ANS) over the designated airspace. The Committee sought from AAI details of the existing CNS/ATM Infrastructure and their future plans. The discussions on Communication, Navigation, Surveillance and Air Traffic Management systems and the view of the Committee are at Chapters 5, 6, 7 & 8 respectively. Chapter 9 of the report discusses Organisation of AAI and Human Resources and contains recommendations on the subject.

8. The airspace of a nation being a finite asset, its sharing on a need basis, by civil and military users is an urgent national requirement. Chapter 10 of the report contains the views of the Committee and its recommendations on the subject.

9. Terms of reference also required the Committee to specifically examine/ review and assess the "Weather Work Stations" and their compliance with the standards and recommended practices stipulated by ICAO. As many civil flights operate to defence airfields, interactions were held with both IMD and the Met Division of IAF to obtain their perception and future plans with a view to synchronise the seamless transfer of aviation meteorological data on both sides through networking and increased coordination. Chapter 11 discusses Aviation Weather Services and recommendations on the subject.

Future Air Navigation System – Master Plan

10. The Committee examined the various CNS/ATM plans of the AAI with a view to identify the gaps which need to be filled for requirements of a modern Air Traffic Managements System. The basis of the CNS plan should be to meet the needs of the public, the stakeholders and the requirements of Air Traffic Management system rather than to plan for CNS infrastructure and then administer air traffic control (ATC) on that basis. The objectives of the ATM system including the operational concepts, should be spelled out clearly and then the required CNS infrastructure should be planned accordingly.

11. At present, the flights are being significantly delayed due to considerable increase in air traffic and a public perception is growing that Indian skies are not safe due to reported near misses and various failures of equipments. The objectives of the Master Plan, therefore, must address the safety issues and significant delays.

An ATC delay of more than five minutes should be considered as significant and accordingly the capacity to handle the air traffic should be determined. Once a capacity is analysed scientifically, the system should not be overloaded. The objectives of the Master Plan are as follows, which are also in harmony with the Global and Regional Plans of ICAO:

i) To maintain and enhance safety levels in the face of higher traffic densities.

ii) To provide ATC capacity to handle air traffic that would meet the forecasted demand without significant delays.

iii) To enable all airspace users to operate efficiently while accommodating both civil and military operators' needs.

iv) To provide the required ATM services in a cost-effective manner.

v) To provide interoperability with adjacent airspaces.

vi) To adopt ICAO standards, specifications and functionalities that will standardise the ATM environment.

12. The Master Plan has been considered in three parts namely, Near Term/ Immediate, Medium Term and Long Term. The Near Term Plan is based on **what we have today** and involves application of procedures, processes and capabilities. It identifies potential gaps to be filled immediately. Time frame should be not more than 2 years. The Medium Term Plan is based on **what we know today** and involves emerging procedures, processes and capabilities. It identifies gap requirements and action to be planned to implement the same. Time frame should be 11th Five Year Plan i.e. up to year 2012. The Long Term Plan is **based on concepts** and involves new procedures and requirements based on Research. The Master Plan and Recommendations have been discussed in detail at Chapter 12 of this report.

13. The vision that the Committee has adopted is that India would have to accommodate increasing amount of traffic, both passenger and cargo, in the foreseeable future and this has to be achieved with no compromise on safety and efficiently without the delays that are being experienced currently. The various strategies and recommendations contained in the report are instruments towards achieving this goal whether by consolidation of airspace and reduction in number of FIRs & ACCs, greater automation and adaptation of state-of-the-art technology with an integrated automated ATM system including a centralised Air Traffic Flow Management with networked VHF and Radars capable of providing dynamic sectors, which permits alignment with traffic pattern i.e. North-South flow of domestic traffic during day time and East-West flow of International traffic during night. The Committee would urge the Government and AAI to achieve these goals in the shortest time frame possible.

14. It is anticipated that the Future Air Navigation Systems would take the following shape:

Communication

15. A shift from Voice Communication to Data Communication is envisaged. At present voice is used through VHF & HF radios and is analogue in nature. In future the digital voice may be used through communication satellite and finally voice may be retained as a back-up when complete data communication is used.

16. ACARS technology is being mainly used by the airlines and to some extent by ATS for DATIS and departure clearances. ACARS is an analogue technology and has industry standards, which would be replaced by digital technology using ICAO SARPs. It is unlikely that ACARS would be used in future.

17. Aeronautical Telecommunication Network (ATN) would replace present AFTN systems, which are character-based communication whereas ATN is digital based communication technology and connects aircraft, ground-based network of airlines and ground-based network of ATS. ATN has a limited bandwidth and may not be able to accommodate all communications of airlines with their aircraft, it may force broadband Internet Protocol (IP) format to be used by airlines in future. However, ATS would continue to use ATN and also have broadband IP.

Navigation

18. In future, satellite based navigation system complimented with Flight Management Systems would be used for navigating the aircraft. The ground based navigation equipments like NDB, VOR/DME and ILS may be retained as a back-up for some time before being phased out. GAGAN would play an extremely important part in the future navigation systems.

Surveillance

19. Surveillance is primarily carried out through radars, which are very expensive. Surveillance in non-radar coverage area is through procedural process by obtaining position reports from the aircraft, which cannot be used in a high density air traffic area as the separations required between the aircraft are much higher than in the radar covered area. The new technologies have not yet matured. Therefore, in near future requirements of radars would increase till cheaper options of surveillance are available.

20. The upcoming technologies in surveillance are ADS-B and wide area multilateration and both can be used in combination to provide extended surveillance. These technologies would be much cheaper than radars, with less maintenance requirements and more accuracy and are future surveillance systems.

21. At present, for surveillance of oceanic, remote and mountainous regions ADS-C is used for FANS 1/A compliant aircraft, using ACARS technology. After ACARS is phased out, ADS-C would use ATN for data transfer.

Air Traffic Management

22. In future also, ATM core functions would remain same i.e. Airspace Management, Flow Management, Traffic Management, Separation Management and Aircraft Systems and complemented by state-of-the-art technology for CNS and weather systems. These ATM functions, however, would be fully automated to increase capacity, improve safety and efficiency. All core functions and the support systems would be networked and configured as System Wide Information Management (SWIM).

Implementation & Review of Master Plan

23. This Master Plan like any other plan can be successful only if it is implemented and reviewed from time to time taking into consideration the users and aviation community requirements and advent of new technology. A Standing Committee should, therefore, be constituted under the Secretary, Ministry of Civil Aviation for timely implementation of the plan. The Committee should be assisted by an 'Operational Group' having members from AAI, IAF, IMD, DGCA and scheduled airlines.

AAI Organisation

24. The present structure of AAI does not clearly demarcate its functional responsibility of an 'Aerodrome Operator' and of ANS provider. This issue was debated at length by the Committee and it is our view that the present arrangement needs to be modified to bring the required focus and importance to this critical area.

25. This Committee notes that recently AAI has commissioned a Study through KPMG to examine various options available for corporatisation of Air Navigation Services including the question of the financial viability of the new entity as well as the impact on the AAI. This is a welcome step and once the findings of such a study become available, further steps should be taken urgently for putting the recommendations into effect.

26. This Committee recommends that pending any final decision on the findings of the KPMG study, the process of bringing about the necessary organisational changes in AAI be taken up immediately. As a first step, independent directorates for (i) Airspace Management & Procedures and (ii) ATM Strategic Planning & System Development with adequate manpower should be established. The organogram of the AAI should also be suitably modified to bring about unity of control and responsibility in all work related to provision of ANS including planning, acquisition of technology and equipment and O&M aspects.

CHAPTER – 1
INTRODUCTION

1.1 Passenger traffic both international and domestic during 2007 in the country grew at a phenomenal rate of 15.6% and 32.5% respectively which was well above the world average of 5%, a trend which is continuing for the last 3-4 years. It is further expected that air traffic will continue to grow at a rate which is faster than the world average up to 2025 – 7.7% against 4.8% of the world average.

1.2 The civil aviation infrastructure both for the ground and airspace in the country requires up-gradation and modernisation based on new and emerging technologies to cater the growing needs of air traffic. At present, our airports are able to accommodate only constrained movements of aircraft per hour due to infrastructure and procedural constraints leading to overcrowding, flight delays and wasteful burning of fuel by aircraft hovering over airports awaiting permission to land. The congestion of aircraft also raises safety concerns in civil aviation operations.

1.3 At present India does not have a futuristic, systematic, integrated master plan of Air Navigation Services (ANS) based on the International Civil Aviation Organisation (ICAO) requirements as specified in Regional air navigational plans. The country needs a futuristic Master Plan of Air Navigation Services which operates automatically and is periodically self-triggered by traffic requirements and based on Next Generation Technologies. In the absence of such a plan, a mismatch between the air traffic requirements and air navigation system is likely to occur leading to congestion and cost inefficiencies.

1.4 In view of the above, Ministry of Civil Aviation constituted a Committee vide Order No.AV.15012/5/2005-A dated 20th March, 2006 for formulating next generation futuristic Air Navigation Services Master Plan.

1.5 The Terms of Reference of the Committee were to examine/review the following aspects with a view to formulate next generation futuristic ANS Master Plan and make recommendations thereafter:

i) Assessment of Air Navigation Services (ANS) in the country based on the requirements specified by lCAO in Regional Air Navigational Plans.

ii) Assessment of the weather work stations based on the standards and recommended practices prescribed by ICAO.

iii) Recommend a futuristic Master Plan of Air Navigation Services based on the latest technologies in the field and the forecast of the future requirements.

iv) Recommend ways and means of harmonisation of ANS in the country with the ANS systems of other countries/regions.

1.6 A copy of the order of Ministry of Civil Aviation constituting the Committee and listing the terms of reference is at Annexure – 1.

1.7 In addition, Dr. Arjun Singh, Joint General Manager, Airports Authority of India was appointed as a Secretary to the Committee.

CHAPTER – 2

Methodology & Perspectives

2.1 The Communications Navigation Surveillance/Air Traffic Management (CNS/ATM) planning activity requires consultations with the stakeholders. The Committee considered it important to interact with various stakeholders like airline representatives including IATA, Private Aerodrome Operators, IAF/MOD, IMD and AAI. The Committee invited them for detailed discussions to understand their perception and concerns.

2.2 The Committee also interacted with the following:

- Experts from ICAO, Montreal, Canada
- Representative of India in ICAO
- DGCA

Air Navigation Service Providers

- Representatives of FAA, USA
- Representatives of NATS, UK

Manufacturers of Aircraft

- Representatives of Airbus
- Representatives of Boeing

CNS/ATM and Networking Solutions Providers

- Representatives of SITA
- Representatives of Lockheed Martin
- Representatives of Thales
- Representatives of ERA

2.3 The Chairman of the Committee, Shri Ajay Prasad during his personal visit to UK had visited the NATS facility at Southampton, UK. Similarly, Air Marshal (Retd) Ajit Bhavnani, member of the Committee during his personal visit to USA had visited the National Air Control Centre, Dulles, USA.

2.4 The list of organisations and their representatives with whom the Committee had interacted is at Annexure-2.

2.5 The Committee had taken into consideration material available in many ICAO documents on CNS/ATM and Global Air Navigation Plans. The Committee had also considered many reference materials on the subject like Next Gen (Next Generation Air Transport Systems) of USA, SESAR (Single European Sky ATM Research) of European Union and other material available on the Internet web sites.

Perspective of Domestic Scheduled Airlines and IATA

2.6 Operational Chiefs of Scheduled Airlines of India were invited to provide their views. They unequivocally stated that there were significant delays to the

flights in air and wanted that infrastructure should be strengthened and the capacity of air traffic systems to be enhanced to avoid excessive delays.

2.7 Airline representatives also wanted that any further equipage necessary for navigation should be mandated by the Government otherwise it would not be possible for the airlines to install them due to cost considerations.

2.8 To obtain the views of international scheduled airlines discussions were held with IATA, which represents these airlines. It was pointed out by IATA that even 4% – 6 % per annum growth means a doubling of traffic in 15 years, whereas the growth in India has been considerably higher. Global position at present is that there are more than 200 FIRs with 180 ANSPs and the same number of regulators, which is leading to different equipage requirements, different systems & technologies and global airspace is fragmented and un-harmonised.

2.9 IATA was of the opinion that there was a need to:

- rationalise equipage, and operating practices;
- take equipment off the aircraft if it was not required; and
- properly utilise the existing aircraft capabilities (performance)

2.10 IATA stressed that there was a need for global harmonisation and standardisation of ATM to enhance safety and efficiency.

2.11 IATA suggested alignment of upper airspace with:

- flexible and dynamic management of airspace;
- introduction/utilisation of data link communications; and
- improved flight plan processing systems, advanced airspace management coordination tools and message exchange capabilities

Private Aerodrome Operators Perspective

2.12 Representatives of DIAL, MIAL, BIAL, CIAL and HIAL were invited to share their views with the Committee. Except CIAL, all others participated in the discussions. They were of the view that there was a considerable scope to improve Air Traffic Services as presently handled by AAI. They considered it possible to significantly increase the capacity of runways by following proper procedures. To substantiate their views Excel charts were provided which reflected total movements of arrivals and departures in each hour of the day at Gatwick Airport, which has a single runway. The charts show the total movements could reach up to 50 per hour. The normal movements recorded were about 45 and above per hour. DIAL provided some technical details of ATC Tools like ‘Arrival Manager’ and ‘Departure Manager’ being used at Frankfurt Airport to assist the air traffic controllers in managing the traffic. These tools will enable the controllers to manage the flow of air traffic efficiently and thereby to enhance the capacity.

India Meteorological Department (IMD)

2.13 Terms of reference of the Committee required it to specifically examine/ review and assess the "Weather Work Stations" and their compliance with the standards and recommended practices stipulated by ICAO. DG MET was, therefore, invited and requested to provide the details of their existing infrastructure and their future plans regarding aviation meteorology. Recently Government has agreed to provide substantial budget to IMD. Ministry of Earth Sciences informed that the Cabinet has approved modernisation of observation and forecast facilities of IMD (Phase I) at an estimated cost of Rs.920 crores to be implemented during first two years.

2.14 As many civil flights operate to defence airfields, interactions were held with the Met Division of IAF to obtain their perception and future plans with a view to synchronise the seamless transfer of aviation meteorological data on both sides through networking and increased coordination.

2.15 Info-Electronics Systems Inc. approached the Committee and provided details of their Aviation Weather Decision Support System (AWDSS) & Related Equipment.

2.16 The information obtained on the subject is dealt in detail in a later chapter on Aviation Weather Services.

Indian Air Force (IAF)

2.17 IAF is a major user of Indian airspace and has reserved airspace for them but they also operate in civilian airspace. Similarly, many civilian flights operate through restricted defence airspace. Interactions were held with IAF and MOD with a view to enhance civil-military coordination, leading to flexible use of airspace which has been dealt in detail in a subsequent chapter.

Manufacturers of Aircraft

2.18 Detailed discussions were held with both major manufactures of aircraft namely Airbus and Boeing to understand their perceptions of future CNS/ATM Systems and their plans to equip the aircraft for these systems. Both manufacturers promoted trajectory based operations and suggested that ATM should take full advantage of aircraft current and future capabilities of improved navigation capabilities, extended use of GPS augmentation system and improved communication. Their views have been considered in the report.

CNS/ATM and Networking Solutions Providers

2.19 The Committee interacted with CNS/ATM and Networking Solutions Providers like Lockheed Martin, SITA, Thales and ERA.

2.20 Lockheed Martin considered the three key elements to success as increased capacity, greater efficiency and improved security & safety and these are also ***India's Airspace Management Challenges***. In their opinion India should focus on technologies that increase/improve these key elements and today automation capabilities are available for them, which can be achieved by:

- Improving communications across airspace to facilitate inter-facility transfer and flow of air traffic;

- Accelerate application of satellite technology in navigation and surveillance to allow for more flexible routings and enhanced situational awareness; and

- Implement integrated ATM automation systems nationwide to improve efficiency and realise maximum benefits of modern CNS systems

2.21 SITA provides global VHF and Satellite data link coverage that has been driven by airline requirements. It also provides ATS data link systems to enable ANSPs to deliver immediate safety and efficiency benefits. SITA informed the Committee that growth in air/ground data link traffic continues at very high rates and ATS data link is growing at 100% per annum, which is just the beginning of the global ATS use of Data Link.

2.22 ACARS (Aircraft Communications Addressing and Reporting System) permits information to be shared between aircraft and all groups of the commercial airlines namely Dispatch, Operations, Maintenance, Engineering, Catering and Customer Service. ACARS also permits communication between the aircraft and Air Traffic Service units for D-ATIS, Pre Departure Clearance, CPDLC and ADS-C reports. It was pointed out that whereas ACARS is analogue and has industry standards; ATN/VDL Mode 2 is digital and has ICAO Standards. VDL Mode 2 supports ATS application through FANS 'B' equipment, which is available on both Airbus and Boeing as factory fit. SITA has a standard VHF Data Link Partnership architecture connecting ANSP national network with SITA network.

2.23 SITA recommended regarding Air/Ground Data Link and ADS – B as follows:

- Accelerate deployment of DCL (Departure Clearance) and D-ATIS services
  - Feasible by 2008/09

- Initiate trials of ATN/CPDLC services
  - Feasible by 2008

- Establish VHF Data Link Partnership with Service Provider
  - Feasible by 2008

- Introduce operational ATN/CPDLC in domestic airspace

- Feasible by 2011/12

- Introduce operational ADS-B services in domestic airspace
  - Feasible from 2012

- Ensure aircraft operators are fully briefed so they may order necessary equipment/services

2.24 Thales in their presentation stressed that expansion of airport and airline operations is only possible with a fully integrated Air Traffic Management (ATM) infrastructure enabling high increase in passenger and freight traffic demand over time. Thales was of the opinion that new ATM infrastructure must be designed for integrated airspace & airport operations, which would allow efficient and predictable airport to airport (city pairs) or 'Gate-to-Gate' travel ensuring a high level of safety and security.

2.25 Thales believes that an integrated ATM system stands on the following 4 pillars:

Communications

- Voice Switch Communication Systems and VHF/UHF radios
- Air/Ground Datalink: ATN/ACARS and ADS-B / Mode S

Navigation

- Landing aids: ILS
- En-route Navigation: DVOR, DME
- Satellite-based Navigation: SBAS and GBAS

Surveillance

- Primary/Secondary radars, Mode S
- Automatic Dependent Surveillance Broadcast (ADS-B) and Contract (ADS-C) systems
- Advanced Surface Detection Equipment (ASDE) – for airports

Automation centres

- En-route (ACC) and Approach (APP) ATC centres – interconnected
- Tower ATC systems integrated into ACC/APP centres
- Integrated Flow Management - Safety nets

2.26 Thales gave detailed presentation about their system and described benefits of Integrated ATM solutions as follows:

- Increased capacity of en-route and terminal airspace

- Seamless transfer of aircraft control between sectors of the national airspace

- Efficient aircraft airport Arrival and Departure Flow management:
  - Minimise delays – Predictable Flight Schedules
  - Optimise landing procedures (noise, pollution)

- Efficient and safe airport surface management:
  - Controlling surface movements to prevent runway incursions
  - Flight Data available to airports & airlines
  - Aircraft turnaround data shared with ATC

2.27 ERA Corporation provided excellent details about next generation surveillance and flight tracking solutions with Multilateration, ADS-B and ADS-X technologies.

2.28 Multilateration, or hyperbolic positioning, is the process of locating an object based on the Time Difference of Arrival (TDOA) of a signal emitted from that object to three or more sensors. When a signal is transmitted from an object, it will be received by two spatially separate sensors at different times. The time difference is then used to calculate the objects position. By using three or more sensors, a complete position analysis can be attained. For ATC applications, multilateration provides the same level of fleet coverage as traditional SSR (i.e. all aircraft or vehicles equipped with an operational Mode A, Mode C or Mode S transponder). Multilateration will generally provide higher accuracy, greater update rate, better coverage and improved reliability when compared to traditional SSR, and will do so at a much lower initial cost and with lower annual maintenance costs.

2.29 ADS-B relies on avionics system capability of the aircraft to provide current flight information such as altitude, airspeed, position, aircraft type, identification and direction. The system transmits this information through a dedicated radio data link to all receivers capable of decoding ADS-B signals.

2.30 Extended ADS (ADS-X) refers to the integration of multilateration techniques into an ADS-B surveillance infrastructure to mitigate the equipage, validation and backup issues surrounding ADS-B and to enable a faster, more comprehensive and more cost-effective ADS-B implementation. ADS-X has two advantages over ADS-B. First, ADS-X supports coverage of aircraft not having ADS-B capability because multilateration technique processes transponder Mode A/C/S signals from which the network of ground stations is able to determine the position of aircraft. The second ADS-B implementation challenge - the need for independent backup and validation of ADS-B self-reported position, is also addressed by the inclusion of multilateration capability in the ADS-B network, as each ADS-B position report is validated in real-time by TDOA triangulation.

CHAPTER – 3

Existing CNS/ATM Infrastructure

3.1 Article 28 of Chicago Convention states that each contracting State undertakes to:

> "(a) Provide, in its territory, airports, radio services, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with the standards and practices recommended or established from time to time, pursuant to this Convention;
>
> "(b) Adopt and put into operation the appropriate standard systems of communications procedure, codes, markings, signals, lighting and other operational practices and rules which may be recommended or established from time to time, pursuant to this Convention;
>
> "(c) Collaborate in international measures to secure the publication of aeronautical maps and charts in accordance with standards which may be recommended or established from time to time, pursuant to this Convention."

3.2 Airports Authority of India (AAI) is entrusted with the above responsibility and provides Air Navigational Services (ANS) over the designated airspace. Besides the sovereign Indian airspace, India is also responsible to provide ATS over the Arabian Sea, Bay of Bengal and Indian Ocean in accordance with ICAO rules governing designation of airspace over high seas. AAI is responsible for providing ATS at all civil airports in India where scheduled civil commercial flights operate, including Greenfield airports. AAI also provides limited CNS facilities and services at Defence airports where scheduled civil commercial flights operate.

3.3 AAI was, therefore, requested to provide their future plans of Air Navigation Services, especially covering 11th Five Year Plan and the budget allocations. A presentation was given by Dr. K. Ramalingam, Chairman, AAI on 11 April, 2007. Before finalising the report the matter was again discussed with AAI representatives. Dr. Ramalingam gave another presentation on 7 January, 2008 updating the CNS/ATM plans of AAI. The presentation provided the following details.

3.4 The entire civil airspace has been divided into 4 FIRs namely Mumbai, Delhi, Chennai and Kolkata, (which has Guwahati as Sub FIR). There are 90 International and 111 Domestic ATS routes out of which 31 routes are RNP-10 routes. All International routes are direct routes with shorter distance. Entire airspace is RVSM airspace.

3.5 Eleven Area Control Centres have been established at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Ahmedabad, Nagpur, Mangalore,

Thiruvananthapuram, Guwahati and Varanasi, which are equipped with en-route radar (MSSR), for the provision of area control service.

3.6 AAI informed that the National CNS Transition Plan developed in 2000 is based on the global plan developed by ICAO and endorsed by the contracting States. During the period 2000-12, the plan envisages replacing ground based CNS system progressively with predominantly space based system. AAI has stated that they have been developing Air Navigational Plans to meet the projected growth of passenger/aircraft movement which are in accordance with the ICAO Regional plans and is being reviewed from time to time taking into consideration users and aviation community requirements and advent of new technology.

3.7 AAI has also informed that under the satellite based CNS/ATM environment

- A shift from Voice Communication to Data Communication is envisaged by implementing ATN, VHF Data Link, HF Data Link over oceanic airspace.

- Navigation based on satellite system for terminal and non precision approach phases of flight with suitable augmentation is also planned.

- Surveillance through MSSR with Mode-S and ADS-C over oceanic airspace was planned.

- Architecture milestone for various communication, navigation and surveillance objectives were defined for a period up to 2012.

Existing Communication Infrastructure

3.8 The communication infrastructure consists of air-ground communication, ground-ground communication, aeronautical telecommunication network and recording equipments. AAI informed that the present status of communication infrastructure is as follows:

- Continental Airspace

  - VHF air-ground at all operational airports
  - Remote Controlled Air Ground (RCAG) VHF at 11 selected locations for extended VHF coverage
  - HF R/T at four airports – Delhi, Mumbai, Kolkata & Chennai

- Oceanic Airspace

  - CPDLC (FANS-1A) – Primary means; and
  - HF – secondary means in Mumbai, Kolkata, Chennai Oceanic control centres

- Voice Communication Control System (VCCS) at 11 airports
- Digital Automatic Terminal Information System (DATIS) at 16 airports
- Multi-channel Digital Voice Tape Recorders at 40 airports
- Automatic Message Switching System (AMSS) at 16 airports.

Existing Navigation Infrastructure

3.9 Navigation systems permit the crew to pinpoint the position of their aircraft and follow the desired path. It is conventionally carried out by ground aids VOR/ DME & NDB. The satellite-based navigation systems also provide accurate, reliable and seamless position determination capability worldwide. AAI informed the present status of navigation systems as follows:

- 43 Instrument Landing System (ILS) installed at 37 airports
  - Cat-**IIIB ILS** – One, installed at Delhi (RWY28).
  - Cat-**II ILS** – Two, installed at Kolkata & Lucknow.
  - Cat-**I ILS** – Rest all
- 79 Doppler VHF Omni Range (DVOR) equipments installed all over India
  - 60 Terminal DVOR at airports for arrival/departure.
- 19 En-route DVOR at as many locations
- 80 Distance Measuring Equipment (DME) installed all over India.
- 59 Non Directional Beacons (NDB) installed all over India. These NDBs are being phased out progressively.

Existing Surveillance Infrastructure

3.10 Surveillance systems permit air traffic controllers to pinpoint the location of the aircraft and it includes communication and navigation information from aircraft to air traffic control centres that facilitates the continuous mapping of the relative positions of aircraft. AAI informed the present status of surveillance systems as follows:

- Surveillance Systems (Continental)
  - 10 Primary Radars (8 ASR + 2 ARSR)
  - 10 Secondary Radars (MSSR) co-located with Primary radars
  - 4 only Secondary Radars (MSSR)

- ADS-C/CPDLC Systems available at Delhi for surveillance in mountainous terrain in the northern parts of India.

- Surveillance Systems (Oceanic)
  - ADS-C/CPDLC systems available at Mumbai, Kolkata & Chennai for surveillance in Bay of Bengal and Arabian Sea.

- ASMGCS (Advanced Surface Movement Guidance and Control System)
  - Used for surface movement guidance & control of aircrafts & vehicles on ground to provide surveillance under all weather conditions while improving required level of safety.
  - System functional at Delhi.

3.11 AAI provided the details of their up gradation plans during 11th Five Year Plan. AAI also provided the expectations and requirements of its ATM Directorate, which were considerably higher than the AAI plans. In this regard information provided by AAI has been dealt in detail in next chapters.

CHAPTER – 4

CNS/ATM System Overview

Background

4.1 The process of getting an aircraft safely and efficiently from its origin to destination requires effective ***air traffic management systems*** supported by three key functions: ***communications***, ***navigation*** and ***surveillance***.

- Communications is the *exchange of voice and data information* ***between the pilot and air traffic controllers***.
- ***Navigation*** pinpoints the location of the aircraft ***for the flight crew***.
- ***Surveillance*** pinpoints the location of the aircraft ***for air traffic controllers***; it *includes* communication and navigation information from aircraft to air traffic control centres that facilitates the continuous mapping of the relative positions of aircraft.

4.2 ICAO calls these functions the CNS systems and regards them as forming the basic support services of air traffic management (ATM) systems.

4.3 While the functions are not new, both aircraft and their avionics have become more sophisticated. The future CNS systems now permit utilisation of ***aircraft*** as a common global component for the ATM system.

4.4 Further, ICAO Annex 11, which stipulates 'International Standards and Recommended Practice' in respect of Air Traffic Services makes it mandatory to implement ***Air Traffic Flow Management (ATFM)*** for airspace where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services. Accordingly, AFTM has also become a part of CNS/ATM system.

4.5 It is becoming increasingly difficult to safely handle increase of air traffic manually. The only way to handle increased demand of higher air traffic density is through automation. Automation integrates Area Control Center (ACC), Approach (APP) ATC centres, and Tower ATC systems controlling en-route phase of flight, climb/descent phase of flight and take-off/landing phase of flight respectively. The automation not only ensures integrated flow management between different phases of flight for increased efficiency but also performs functions of 'Safety Nets' to cater for safety in case of failures. ***Automation***, therefore, has become an integral part of CNS/ATM systems.

4.6 Automated solutions for handling the air traffic in different phases of flight are readily available. Some of the automated solutions are as follows:

- ***Surface Management systems:*** for aircraft movement at airport ramp area

- ***Terminal Automation augmented with departure management:*** for take-off and departure procedures

- ***Integrated Automation:*** for coordinated flight trajectories and strategic flight planning across entire Indian airspace

- ***'Medium Term Conflict Detection' tools:*** for en-route phase of the flight

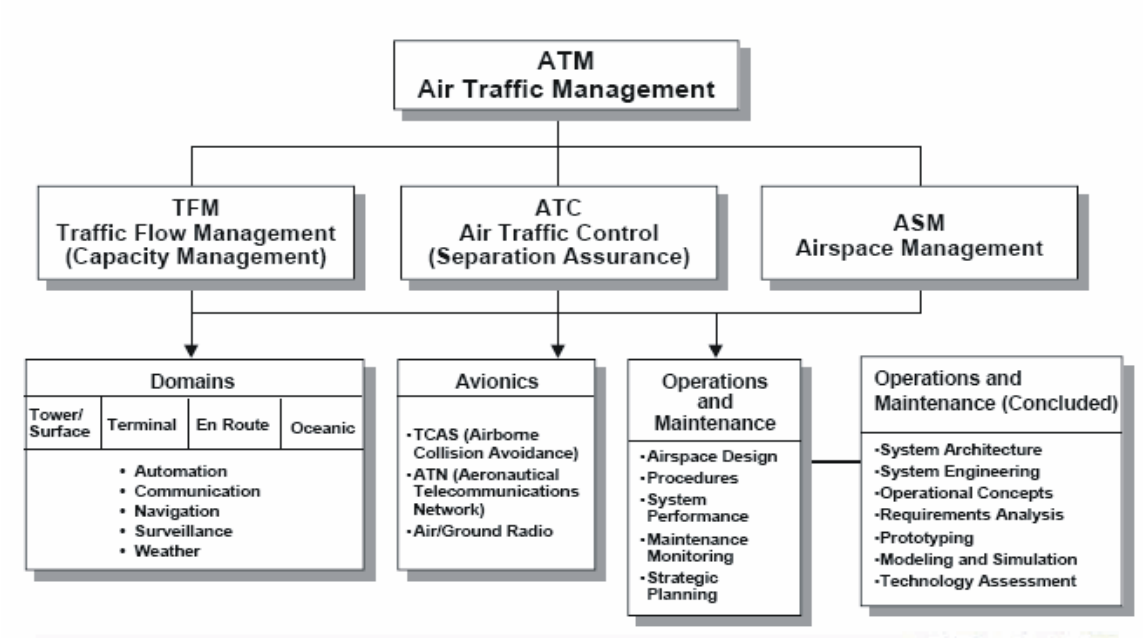
- Arrival ***Management tools:*** to improve the capacity and efficiently handling arriving and landing aircraft

4.7 The automation and the integration of the CNS/ATM systems require ***Network Centric Architecture*** of full system.

Elements of the ATM system

4.8 The several sub-elements of the ATM system are as follows:

ICAO ATM Definition



4.9 To ensure safety, it is extremely essential to have proper operations and maintenance components are given due importance and are followed scrupulously.

4.10 The next chapters are devoted to CNS systems and thereafter ATM systems.

CHAPTER – 5

Communication Systems

Planned Communication Infrastructure

5.1 AAI informed that they have plans to upgrade the existing communication equipment during 11th Five Year Plans as follows:

- 12 additional locations for VHF – RCAG to augment en-route VHF coverage in terrestrial airspace over India and large part of oceanic airspace.
- DSCN (Dedicated Satellite Communication Network) systems at 80 airports.
- ATS Message Handling System (AMHS) at Mumbai to handle ground sub-network of Aeronautical Telecommunication Network (ATN)
- VCCS planned at 3 more airports.
- 12 DATIS & 31 DVTR (Digital Voice Data Logger) to be installed.
- Networking of all DATIS at 16+12 airports to enable download of Terminal Information of any airport from any where through data communication.

Communication Requirements of ATM and its Status:

5.2 The requirements of ATM Directorate for Communication Systems are much higher than the present plans of AAI. The requirements for continental airspace projected by ATM Directorate are as follows:

- VHF coverage to be augmented to fill gaps and complete VHF coverage throughout the ACCs from 10,000 ft and above
  - AAI informed that requirements being worked out. The present plans of AAI would cover continental airspace above 20,000 feet through VHF RCAGs.
- Overlapping VHF coverage in ACCs to ensure positive control to effect dynamic sectorisation
  - AAI informed that with augmented RCAG, VHF coverage above 20000 feet to be available by March 2008

- VHF networking & retransmission capability to support consolidation/ deconsolidation of sectors
  - AAI informed that requirements being worked out

- To provide VHF coverage in oceanic airspace
  - AAI informed that feasible coverage in oceanic airspace provided by RCAG

5.3 The discussion and the views of the Committee on VHF Coverage are at para 5.14.

5.4 The ATM requirements in respect of Communication (Voice and Data Link) are as follows:

Communication (Voice & Data Link)

- DATIS (VOICE) to be extended to all operational airports.
  - AAI has informed that the equipment has been installed at 16 airports and 12 more equipments are under order.

- DATIS (VOICE+ DATALINK) – to be implemented at all major airports on priority and further extended to other airports.
  - AAI has informed that new DATIS equipment has data link capability.

- Data link for clearance delivery should be implemented at Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Ahmedabad and Calicut airports.
  - AAI has informed that the project is under implementation for Mumbai & Delhi. Initial PDC of October, 2007 – revised to September, 2008

- AIDC/Data link communication in all ACCs and ATC units to be implemented at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Bangalore, Ahmedabad, Varanasi, and Nagpur airports.
  - AAI has informed that the project is under implementation for Mumbai & Delhi – Initial PDC of October, 2007 – revised to September, 2008

- Progressive transition to ATN.
  - AAI has informed that it is under implementation at Mumbai as a Gateway. Detailed discussions, however, revealed that the project would facilitate only international traffic passing through India and not for domestic traffic.

5.5 The discussions and the views of the Committee on Data Link Services are at para 5.32.

ICAO's Global Plan Initiatives (GPIs) of Communication Systems

5.6 Global Air Navigation Plan developed by ICAO (ICAO Doc 9750, Third Edition – 2007) as a strategic document to guide States for implementation of the global plan with horizon up to and beyond 2025 was taken into consideration. The document lists out several "Global Plan Initiatives" (GPIs) to be taken by the States to ensure that a safe, secure, efficient and environmentally sustainable air navigation system is available at global, regional and national levels.

5.7 There are two Global Plan Initiatives (GPIs) dealing with the Communication Systems namely GPI-17 dealing with Data Link Applications and GPI-22 dealing with Communication Infrastructure.

5.8 *The **scope** of GPI-17 of Data Link Application is to increase the use of data link applications and **describes the strategy*** as follows:

> "1.79 The implementation of less complex data link services (e.g. pre-departure clearance, oceanic clearance, D-ATIS, automatic position reporting, etc) can bring immediate efficiency benefits to the provision of ATS. Transition to the use of data link communications for more complex safety related uses that take advantage of a wide variety of Controller Pilot Data Link Communication (CPDLC) messages, including ATC clearances is already being successfully implemented.
>
> "1.80 Use of CPDLC and implementation of other data link applications can bring significant advantages in terms of workload and safety over voice communication for both pilots and controllers. In particular, they can provide efficient linkages between ground and airborne systems, improved handling and transfer of data, reduced channel congestion, reduced communication errors, interoperable communication media and reduced workload. The reduction of workload per flight translates into capacity increases and enhances safety.
> "1.81 Communication data link and data link surveillance technologies and applications should be selected and harmonized for seamless and interoperable global operations. ADS-C, ADS-B and CPDLC are in service in various regions of the world but lack global harmonization. Current regional initiatives, including utilizing unique message subsets and CPDLC procedures, hinder efficient development and acceptance for global aircraft operations. Existing and emerging technologies should be implemented in a harmonized global manner in the near term to support long-term goals. Harmonization will define global equipage requirements and therefore minimize user investment.
>
> "1.82 FANS-1/A and ATN applications support similar functionality, but with different avionics requirements. Many internationally operated aircraft are equipped with FANS-1/A avionics initially to take advantage of data link services offered in certain oceanic and remote regions. FANS-1/A equipage on international business aviation aircraft is underway and is expected to increase."

5.9 The ***scope*** of GPI-22 on Communication Infrastructure is to evolve the aeronautical mobile and fixed communication infrastructure, supporting both voice and data communications, accommodating new functions as well as providing adequate capacity and quality of service to support ATM requirements and ***describes the strategy*** as follows:

> "1.96 ATM depends extensively and increasingly on the availability of real-time or near real-time, relevant, accurate, accredited and quality-assured information to make informed decisions. The timely availability of appropriate aeronautical mobile and fixed communication

capabilities (voice and data) to accommodate ATM requirements and to provide the adequate capacity and quality of service requirements is essential. The aeronautical communication network infrastructure should accommodate the growing need for information collection and exchange within a transparent network in which all stakeholders can participate.

"1.97 The gradual introduction of performance-based SARPs, system-level and functional requirements will allow the increased use of commercially available voice and data telecommunication technologies and services. In the framework of this strategy, States should, to the maximum extent possible, take advantage of appropriate technologies, services and products offered by the telecommunication industry.

"1.98 Considering the fundamental role of communications in aviation as an enabler, the common objective is to seek the most efficient communication network service providing the desired services with the required performance and interoperability required for aviation safety levels at minimum cost."

5.10 IATA during their presentation to the Committee suggested that following points on Communication System should be considered by India:

- Full VHF coverage on all international routes for air-ground communications at or above FL210 or the minimum en-route altitude (MEA), whichever is higher.
- Full VHF coverage for air-ground communications for the terminal airspace at international airports.
- CPDLC for the entire oceanic airspace of Bay of Bengal and Arabian Sea on H24 basis as primary air-ground communications, with HF as backup/secondary means of communications.
- IP based telephone service accessible to controllers at all ACCs for coding into the INMARSAT GES ATS abbreviated dialling service for aircrew emergency contact.
- Implementation of a VSAT based aeronautical telecom network (ATN) throughout the Indian AOR (Area of Responsibility)

5.11 Boeing during their presentation suggested the following means of communication:

Area of Operation	Communication
Airport	Voice
Terminal Area	Voice
Enroute	Voice, ACARS
Oceanic	ACARS, FANS, ATN
4D-Trajectory Operations	Broadband IP

5.12 Airbus during their presentation stressed that full benefit of aircraft current and future capabilities should be utilised and suggested improved communications with all ATM actors by deploying FANS A+ capabilities for oceanic/remote areas and FANS B capability for continental area.

5.13 Lockheed Martin informed that solutions available today in respect of Communications component of CNS are

- Analog ***VHF Radio*** (Presently being used with 25 KHz spacing)
- ***8.33 KHz Spacing, Digital Radio*** (Increased number of frequencies due decreased spacing)
- Datalink ***with VDL-Mode 2*** (Permits data transfer between aircraft and Air Traffic Control)
- Future**: *Broadband datalinks***

Communication Infrastructure for Continental Airspace*:*

VHF Coverage

5.14 In accordance with the International Standards stipulate in ICAO Annex 11, which deals with Air Traffic Services civil airspace of India has been classified and designated in four classes namely Class 'D', 'E', 'F' & 'G'. Flights operating under Instrument Flight Rules (IFR) are required to have "continuous two-way communication" with ATC and flights operating under Visual Flight Rules (VFR) need not have two-way communication, except while operating in Class 'D' airspace. AAI, therefore, is required to provide the two-way communication to aircraft in accordance with the flight rules.

5.15 AAI has informed that air-ground VHF communication is available at all operational airports and HF "RDARA" frequencies, which were used for domestic traffic, have been phased out in 2003 in continental airspace. VHF air-ground communication is the only means to communicate with the aircraft in continental airspace. At present, Indian airspace does not have a full VHF coverage. There is no way for an aircraft to communicate an emergency to ATC if its location does not have VHF coverage. Same is true for the ATCO to communicate with the aircraft regarding information to be passed in an emergency situation.

5.16 ACCs are designated under Class 'D' airspace, where it is mandatory for the AAI to provide air traffic control service and a two-way communication to both IFR & VFR flights. Designated ATS routes outside ACCs are designated as Class 'E' airspace, where it is mandatory for AAI to provide air traffic control service and two-way communication for IFR flights. It is understood that ATCOs are not able to contact IFR flights in some areas of Class 'E' airspace.

5.17 AAI has planned to augment en-route VHF coverage in continental airspace by adding VHF equipments at 12 more RCAG stations for which AAI had initially informed the PDC date to be March 2008. It has now been informed that the equipment is likely to be released shortly from customs and as shifting the equipment from Delhi to all stations would take some time, the PDC date is revised to May 2008. AAI has also ordered 250 new VHF sets and their installation target date is December 2008.

5.18 AAI has informed that with the installation of these VHF equipments at 12 RCAG stations, complete VHF coverage would be available throughout the continental airspace at a height of 20,000 feet and above.

5.19 IATA, which represents major international airlines, in their presentation has asked for full VHF coverage on all international routes for air-ground communications at or above FL210 (i.e. 21,000 feet) or the minimum en-route altitude (MEA), whichever is higher. The AAI plans, therefore, meet the requirements of the international airline operators.

5.20 ***AAI plan of complete VHF coverage throughout the continental airspace at a height of 20,000 feet and above should be implemented on priority but not later than the new targeted date of May 2008.***

5.21 ***AAI, in order to meet international standards of ICAO, should provide VHF coverage in the Area Control Centres, which have been declared as Class 'D' airspace by AAI and are required to provide VHF coverage to all IFR & VFR flights operating there.***

5.22 ATM Directorate of AAI has projected their requirements of complete VHF coverage in the Area Control Centres (ACCs) at 10,000 feet and above, overlapping VHF coverage in ACCs to ensure positive control and to permit dynamic sectorisation and VHF networking & retransmission capability to support consolidation/ deconsolidation of sectors.

5.23 The matter regarding the ATM Directorates requirement of complete coverage in the ACCs at 10,000 feet and above was discussed. Air Traffic Control Services are provided from ground up to 10,000 feet by the Tower Controller, who handles take-offs and landings. ACCs provide the approach control service above 10,000 feet. Approach Controller, therefore, is required to provide air traffic control service to a landing aircraft up to 10,000 feet and thereafter handover the aircraft to tower controller below 10,000 feet for the landing. Similarly, an aircraft which is taking off from an airport is required to be under the control of tower controller up to 10,000 feet and then it is handed over to an approach controller in ACC for further climb and enroute clearances. It was under this background that ATM Directorate requires VHF coverage up to 10,000 feet in the ACCs.

5.24 In case the aircraft is not able to contact an ACC at 10,000 feet, the only solution is that airport in addition to the tower control function is given approach

control function because contacting ACCs through HF "RDARA' frequencies is not now possible as the HF has been withdrawn from the continental airspace. This is not appropriate as it leads to further bifurcation of airspace, which should be avoided.

5.25 AAI has informed that at present 12 more RCAG VHF stations are being added for providing VHF coverage at 20,000 feet or above with a revised PDC date is May 2008. As regards ATM requirements of complete VHF coverage in the ACCs at 10,000 feet & above and also overlapping coverage to ensure positive control and to permit dynamic sectorisation, AAI has informed that ATM requirements would be met after DSCN network covering 80 airports become operational in the year 2008. Thereafter more RCAG stations would be added to not only provide coverage up to 10,000 feet but also overlapping coverage in accordance with the ATM sectorisation requirements with a PDC of end of 2009.

5.26 ATM Directorate also requires VHF networking & retransmission capability to support consolidation/deconsolidation of sectors. Normally every sector has a dedicated VHF frequency. However, during lean traffic period if the two sectors are consolidated then the ATCO should be able to simultaneously transmit on two frequencies allotted to the sectors and also receive communication from aircraft operating on two different frequencies. AAI has informed that ATM requirement for consolidation/deconsolidation would be incorporated through Voice Communication Systems at the Area Control Centers.

5.27 AAI has been planning and providing VHF equipment according to their plan to cover the continental airspace at 20,000 feet, which does not meet the ATM requirements.

5.28 ***AAI should meet the following requirements of ATM Directorate in the continental airspace:***

a) VHF coverage up to 10,000 feet & above in ACCs;

b) Overlapping VHF coverage in ACCs to ensure positive control and dynamic sectorisation; and

c) VHF networking to support consolidation of sectors during lean traffic periods and deconsolidation during peak traffic hours

Dedicated Satellite Communication Network (DSCN) Systems

5.29 VHF communication, being a line-of-sight system, covers an area of about 200 NM at 30,000 feet. The area of coverage of 200 NM reduces at lower heights. The extension of propagation is achieved through Remote Controlled Air Ground (RCAG) VHF, which ***requires a linkage*** to operate the remote equipment and to transmit/receive voice communication to/from the equipment. At present some RCAG linkages are through MTNL lines, which are not as reliable as required for

aviation services. However, some linkages like Port Blair are provided through leased Satellite circuits are functioning properly.

5.30 The AAI plan to connect 80 airports through DSCN is a milestone in aviation communication and has an excellent reliability. AAI has informed that site acceptance tests are commencing shortly and phased commissioning of DSCN would start from May/June 2008. Through DSCN linkage it is possible to have VHF communication with any aircraft in Indian airspace from a single position, say Delhi. As the experience with the leased satellite channels also is positive, AAI should use these DSCN for RCAG VHF equipment.

5.31 ***AAI should use this satellite communication network for operating RCAG VHF equipments.***

Data Link Services

5.32 Voice communication between the pilot and the air traffic controller was the only mode to provide air traffic control services. To face the increase of air traffic and the limits of existing systems (congestion, delays, security), ICAO in 1992 endorsed a project to provide capability for air/ground Data link operations (ATC communications). The biggest change is the way pilot & controllers communicate like Controller Pilot Data Link Communication (CPDLC) instead of traditional voice exchanges through VHF or HF radios and Automatic Dependent Surveillance-Contract (ADS-C), Automatic position reporting though FMS of aircraft by Data link for ground surveillance.

5.33 India is in urgent need to use Data Link Services to reduce the voice congestion at busy airports. At present, data link communication (CPDLC) is being used as a primary means of communication only in the oceanic region (Para 3.8 of this report) with aircraft equipped with FANS-1/A equipment. Data link communication (in VDL Mode 2) can be used for ATC clearances with aircraft equipped with FANS-B equipment.

5.34 GPI -17 of ICAO Global Plan states that the implementation of less complex data link services (e.g. pre-departure clearance, oceanic clearance, D-ATIS, automatic position reporting, etc) can bring immediate efficiency benefits to the provision of ATS. It further states that use of data link communications for more complex safety related tasks of a wide variety of CPDLC messages, including ATC clearances are already being successfully implemented.

5.35 Use of CPDLC and implementation can bring significant advantages in terms of workload and safety over voice communication for both pilots and controllers and can provide efficient linkages between ground and airborne systems, improved handling and transfer of data, reduced VHF channel congestion, reduced communication errors, interoperable communication media and reduced workload. The reduction of workload per flight translates into capacity increases and enhances safety.

5.36 IATA has also suggested implementation of a VSAT based aeronautical telecom network (ATN) in Indian airspace, through which data exchange is possible between aircraft, air traffic control and the airlines.

5.37 ***AAI should provide Data Link Services like pre-departure clearance, automatic position reporting and ATC Clearances.***

5.38 The requirements of ATM Directorate in respect of Data Link services are being dealt in detail.

Digital - Automatic Terminal Information Service (D-ATIS)

5.39 ***ATIS*** is a continuous broadcast of recorded non-control information in high activity terminal areas. Its purpose is to improve pilot and controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information. ATIS broadcasts contain essential information, such as weather information, which runways are active, available approaches, and any other information required by the pilots, such as important NOTAMs. D-ATIS is a transcribed, digitally transmitted version of the ATIS audio broadcast, usually accessed from a digital display such as an EFB (Electronic Flight Bag) or an FMS (Flight Management System).

5.40 ATM Directorates requirements regarding D-ATIS are as follows:

- D-ATIS (VOICE) to be extended to all operational airports. There are about 80 operational airports and the equipment has been installed at only 16 airports. Twelve more D-ATIS equipments have been received, which are awaiting custom clearance, and would be commissioned by May-June 2008. Further, a tender has been released for another 16 airports, which are likely to be available by December 2008. The PDC date for all operational airports has not been provided by AAI.
- DATIS (VOICE+ DATALINK) – to be implemented at all major airports on priority and further extended to other airports. AAI has informed that new DATIS equipment has DATALINK capability. Even though the capability of the equipment exists, the same is not being used. AAI has informed that after networking of all D-ATIS equipments is implemented by March 2009, it would pave the way for utilising DATALINK capability of all D-ATIS equipment.

5.41 AAI informed that networking of all DATIS at 16+12 airports would enable download of Airport Terminal Information of these airports from any where through data communication. However, while updating information AAI informed that proposal is under examination and PDC is March 2009.

5.42 Such a facility permits immediate retrieval of information regarding the status of airport facilities and the prevailing weather by the aircraft and as stated above its

purpose is to improve pilot and controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information. The Committee is of the opinion that such a facility even though available but not being used is not proper especially when it is used to pass accurate information regarding essential terminal information.

5.43 ***The Committee is of the opinion that AAI should upgrade the ATIS facility to D-ATIS facility having both Voice and Data Link capabilities at the earliest as the equipment bought has a capability to provide the same.***

Air Traffic Control – Clearance Delivery

5.44 Implementation of data link services like pre-departure clearance, oceanic clearance, automatic position reporting, etc can bring immediate efficiency benefits to the provision of ATS. ATM Directorates requirements regarding clearance delivery are as follows:

- Data link for clearance delivery should be implemented at Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Ahmedabad and Calicut airports. AAI had initially informed that the project is under implementation for Mumbai & Delhi with the PDC of **October 2007**. AAI has now informed that the DATALINK for clearance delivery for Mumbai and Delhi was part of automation upgradation project, which is delayed due additional requirements and the revised PDC is August 2008. For rest of the airports the PDC is August 2009.

AIDC/Data link communication in all ACCs and ATC units

5.45 ATS Inter-facility Data Communication (**AIDC**) permits exchange of information through a data link. ATM Directorate requires that this facility to be provided in all ACCs and ATS units to be implemented at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Bangalore, Ahmedabad, Varanasi, and Nagpur airports. AAI had informed that the project is under implementation for Mumbai & Delhi – PDC **October 2007**. AAI has informed that due to delay in automation upgradation project as explained in para 5.41, the revised PDC is August 2008. It was also informed that for Chennai and Kolkata AIDC facility has been planned as part of ATC automation modernisation programme to be implemented by September 2009.

5.46 ***It is essential that AAI provides AIDC to communicate with all ACCs and ATS units.***

Communication Infrastructure for Oceanic Airspace

5.47 AAI informed the Committee that the existing communication infrastructure is as follows:

- Oceanic Airspace
  - CPDLC (FANS-1/A) – Primary means; and
  - HF – secondary means in Mumbai, Kolkata, Chennai Oceanic control centres

5.48 The ATM Directorate also desires that VHF coverage should also be provided in oceanic airspace to which AAI has replied that feasible coverage in oceanic airspace provided by RCAG. It is technically difficult to achieve such coverage. Oceanic airspace is normally covered through CPDLC when the aircraft are equipped with FANS-1/A equipment, otherwise through HF communication.

5.49 IATA has suggested that India should provide CPDLC for the entire oceanic airspace of Bay of Bengal and Arabian Sea on 24 hours basis as primary air-ground communications, with HF as backup/secondary means of communications.

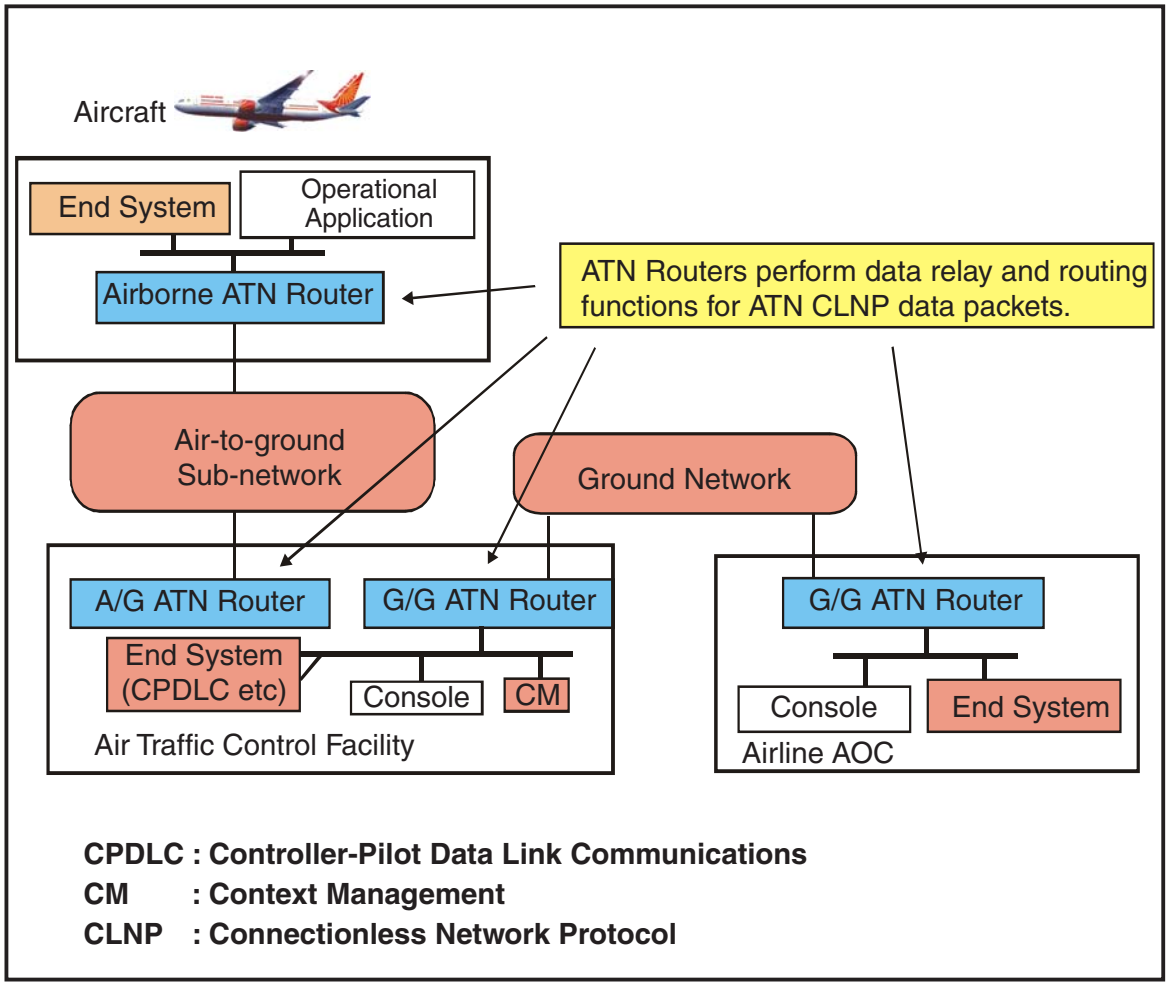
5.50 AAI, therefore, meets the requirements Oceanic communication systems. Aircraft equipped with FANS equipment are able to use CPDLC system and other aircraft are required to use HF Communication. It is understood that the present HF coverage is congested and not reliable due to which difficulty is being faced by the pilots in reporting their positions and obtaining clearances from ATC. The major difficulty is being reported for Mumbai HF radio.

5.51 ***It would be necessary to conduct detailed studies of the difficulties faced by pilots operating in the Mumbai FIR and take appropriate action to rectify the transmission/reception on HF 'MWARA' frequencies for international operations in the Mumbai region.***

5.52 CPDLC systems communicate nearly in real time, but are not considered adequate for passing emergency messages. Such emergency messages can be passed though broadband IP based systems. ***It is, therefore, necessary that AAI should provide IP based telephone service accessible to controllers at all ACCs for coding into the IMARSAT GES ATS abbreviated dialling service for aircrew emergency contact.***

Aeronautical Telecommunication Network (ATN)

5.53 ATN is going to be the basic data connectivity in aviation. It would provide connectivity between Aircraft, Airline, Air Traffic Control, Aviation Weather Services and Flight Information Services through air-to-ground sub-networks of VHF, HF, Mode S and Satellite and also ground-to-ground sub-networks of airlines and ATM. ATN would tremendously increase the communication capacity and reliability as different networks could be used in event of failure of any network.



5.54 ATM Directorate has also asked for progressive transition to ATN. AAI has informed that it is under implementation at Mumbai as a Gateway. Detailed discussions, however, revealed that the project would facilitate only international traffic passing through India and not for domestic traffic.

5.55 AAI has already provided an ATN gateway at Mumbai for international communication traffic to pass from West to East and vice-a-versa through India. ***AAI should immediately upgrade domestic communication connectivity through ATN***.

CHAPTER – 6

Navigation Systems

Planned Navigation Infrastructure

6.1 AAI has informed that they have plans to upgrade the existing navigation equipment during 11th Five Year Plans as follows:

- 20 new DVOR/DME as new facilities.
- 7 more ILS (with low power DME) are planned at Delhi (2), Kolkata, Gaya, Silchar, Lilabari & Vizag.
  - ***Cat-IIIB ILS*** – 2 more planned at Delhi for the new runway.
  - ***Cat-II ILS*** – Planned up-gradation for Amritsar, Jaipur and Jammu
- GAGAN under implementation.
- GBAS under implementation at Delhi and Mumbai. The technical evaluation of the bids completed and PDC is December 2008.

Navigation Requirements of ATM and its Status

6.2 The navigation requirements projected by ATM Directorate are as follows:

- Navigation Systems
  - All terminal facilities should have VOR/DME. AAI informed that current requirement will be met after provision of 20 new DVOR/DME under procurement. The PDC is 2010.
  - Performance Based Navigation (PBN) using DME/DME, GNSS, IRS (on-board) need to be implemented. AAI informed that these would be implemented in a phased manner.
- GBAS, GAGAN implementation to be expedited

ICAO's Global Plan Initiatives (GPIs) of Navigation Systems

6.3 A reference has already been made to the Global Air Navigation Plan developed by ICAO and the Global Plan Initiatives contained therein. One of the Global Plan Initiative (GPI - 21) deals with the Navigation Systems, *with a* ***scope*** to enable the introduction and evolution of performance-based navigation supported by a robust navigation infrastructure providing an accurate, reliable and seamless global positioning capability *and* ***describes the strategy*** as follows:

> "1.90 Airspace users need a globally interoperable navigational infrastructure that delivers benefits in safety, efficiency and capacity. Aircraft navigation should be straight-forward and conducted to the highest level of accuracy supported by the infrastructure.

"1.91 To meet those needs, the progressive introduction of performance-based navigation must be supported by an appropriate navigation infrastructure consisting of an appropriate combination of global navigation satellite systems (GNSS), self-contained navigation systems (inertial navigation system) and conventional ground-based navigation aids.

"1.92 GNSS provides standardised positioning information to the aircraft systems to support precise navigation globally. One global navigation system will help support a standardisation of procedures and cockpit displays coupled with a minimum set of avionics, maintenance and training requirements. Thus, the ultimate goal is a transition to GNSS that would eliminate the requirement for ground-based aids, although the vulnerability of GNSS to interference may require the retention of some ground aids in specific areas.

"1.93 GNSS-centered performance-based navigation enables a seamless, harmonised and cost effective navigational service from departure to final approach that will provide benefits in safety, efficiency and capacity.

"1.94 GNSS implementation will be carried out in an evolutionary manner, allowing gradual system improvements to be introduced. Near-term applications of GNSS are intended to enable the early introduction of satellite-based area navigation without any infrastructure investment, using the core satellite constellations and integrated multi-sensor airborne systems. The use of these systems already allows for increased reliability of non-precision approach operations at some airports.

"1.95 Medium/longer term applications will make use of existing and future satellite navigation systems with some type of augmentation, or combination of augmentations required for operation in a particular phase of flight."

6.4 Another GPI–5 also deals with Performance-Based Navigation with a ***scope*** that the incorporation of advanced aircraft navigation capabilities into the air navigation system infrastructure and ***describes the strategy*** as follows:

"1.33 The implementation of the concept of performance based navigation will lead to increased capacity and enhanced efficiency through reductions in separation minima, bringing benefits to aircraft operators that equip to meet performance requirements. Performance-based navigation will also improve safety, particularly on approach through a reduction of controlled flight into terrain.

"1.34 A significant number of aircraft are capable of area navigation (RNAV) and required navigation performance (RNP). Where warranted, these capabilities should be further exploited to develop more efficient routes and aircraft trajectories that are not directly tied to ground-based navigation aids. Certain RNAV equipped aircraft also have a significantly enhanced capability to achieve sequencing requirements to runways, particularly through the use of the "required time of arrival" function within the flight management system (FMS).

"1.35 The performance-based navigation concept, which comprises RNAV and RNP operations recognizes that a clear distinction must be made in the designation of operations, between those aircraft operations that require onboard self-contained performance monitoring and alerting and those that do not.

"1.36 In accordance with the performance-based navigation concept, all phases of flight are addressed including enroute (oceanic/remote and continental), terminal and approach. The concept, its implementation processes, navigation applications, as well as the operational approval and aircraft qualification requirements is described in the performance-based navigation manual which will be published as a new edition of Doc 9613."

6.5 IATA perspective about the navigation systems is that increasingly, the navigation capability of aircraft has outstripped the service capabilities of the ATM

system, with its ground-based infrastructure. IATA Member airlines support global implementation of the concept of Required Navigation Performance (RNP) developed by ICAO, and fully support GNSS as the primary radio navigation system for positioning and timing in the near future – subject to rigorous cost justification.

6.6 Boeing has the following perception for navigation systems:

Area of Operation	Navigation
Airport	ILS, GBAS, SBAS
Terminal Area	RNP
Enroute	VOR, DME, RNAV, RNP
Oceanic	RNP
4D-Trajectory Operations	RNP

6.7 Airbus during their presentation stressed that full benefit of aircraft current and future capabilities should be utilised and suggested

- Improved Navigation performance
  - RNP APP procedures to be implemented in priority : RNAV(GNSS), RNP RNAV 0.3
  - RNP AR (Approval Required) procedures to be implemented where further benefits can be achieved
- Extended use of GPS augmentation systems
  - Deployment of GBAS providing up to CAT II/CAT III capability

En-route Navigation

6.8 The aircraft are required to navigate on the designated ATS routes. AAI has informed that there are 90 International and 111 Domestic ATS routes out of which 31 routes are RNP-10 routes. Aircraft are required to navigate on these routes with the help of conventional ground based aids like VOR/DME and NDB due to which the width of these routes is much larger. The new generation aircraft are able to navigate more accurately through Inertial systems on board and are able to monitor their performance with the help of aircraft Flight Management Systems (FMS). It is, therefore, possible to design ATS route demanding accurate navigation, like RNP-10, RNP-5 and RNP-1, which would considerably reduce the width of the ATS routes and permit addition of more routes resulting in enhanced capacity of the airspace.

6.9 ***AAI should design ATS routes with required navigation performance like RNP-10, RNP-1 for enhancing the airspace capacity.***

6.10 GPI-21 of the ICAO Global Plan dealing with navigation systems states that navigation must be supported by an appropriate navigation infrastructure consisting of an appropriate combination of Global Navigation Satellite Systems (GNSS), self-contained navigation systems (inertial navigation system) and conventional ground-based navigation aids. GNSS provides standardised positioning information to the aircraft to support precise navigation globally. GNSS would support standardisation of procedures and cockpit displays coupled with a minimum set of avionics, maintenance and training requirements. Thus, the ultimate goal is a transition to GNSS that would eliminate the requirement for ground-based aids.

6.11 GPI–5 deals with Performance Based Navigation and states that the implementation of the performance based navigation would lead to increased capacity and enhanced efficiency through reductions in separation minima, bringing benefits to the aircraft, which meet performance requirements. Significant numbers of aircraft are capable of RNAV and RNP. These capabilities should be exploited to develop more efficient routes trajectories that are not directly tied to ground-based navigation aids. Certain RNAV equipped aircraft also have a significantly enhanced capability to achieve sequencing requirements to runways, particularly through the use of the "required time of arrival" function within the flight management system (FMS).

6.12 Perspective of IATA is that the navigation capability of aircraft has outstripped the service capabilities of the ATM system, with its ground-based infrastructure. IATA supports global implementation of the concept of RNP and fully supports GNSS as the primary navigation system for positioning and timing in the near future.

6.13 Airbus during their presentation stressed that full benefit of aircraft current and future capabilities should be utilised and suggested that RNP APP procedures to be implemented in priority: RNAV (GNSS), RNP RNAV 0.3.

6.14 ***In view of the above, the Committee is of the view that AAI should develop capability to design Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures and enhance the capacity of airspace by implementing these procedures.***

6.15 ***While preparing these procedures, AAI should take into account the aircraft capability to achieve sequencing requirements to runways through use of the "required time of arrival" function within the flight management system (FMS).***

Approach and Landing Navigation

6.16 Aircraft is required to have precise guidance during approach and landing phase as compared to en-route phase of the flight. Approach and landing procedures with the help of ground equipment like VOR/DME and NDB permit only non-precision approaches. Precision approaches can be made through ILS equipment, which provides vertical guidance through the 'glide slope' component of the ILS.

6.17 AAI has informed that 43 Instrument Landing Systems (ILS) are installed at 37 airports out of which Delhi has a Cat-IIIB ILS and Kokata and Lucknow have Cat-II ILS. AAI plans to install 7 more Cat-I ILS equipments, 2 Cat-III ILS at new runway of Delhi airport and upgrade 3 ILS equipments to Cat-II at Amritsar, Jaipur and Jammu airports.

6.18 Ideally each runway end should have an ILS equipment to provide a precision approach for landing the aircraft. ILS equipment is very costly and the cost recovery from the airlines is difficult if the number of flights operating from the airport is not large. A near precision approach with vertical guidance known as 'APV Baro VNAV Approach' can be designed to be used by modern aircraft equipped with FMS computers providing constant descent glide-path. This would be the most cost effective and quickest way to enhance safety and efficiency at airports with insufficient or no landing aids and runways with Non-Precision Approaches only.

6.19 ***The Committee, therefore, is of the opinion that AAI should on priority design and provide approaches with Vertical Guidance for runways not equipped with ILS. Such approaches are close to Cat I ILS and reduce risk of CFIT accidents.***

Augmentation Systems

6.20 Global Navigation Satellite System (GNSS) provides to the aircraft its position for navigation. The GNSS signal is accurate for en-route navigation but its accuracy does not permit navigating the aircraft for a precision landing.

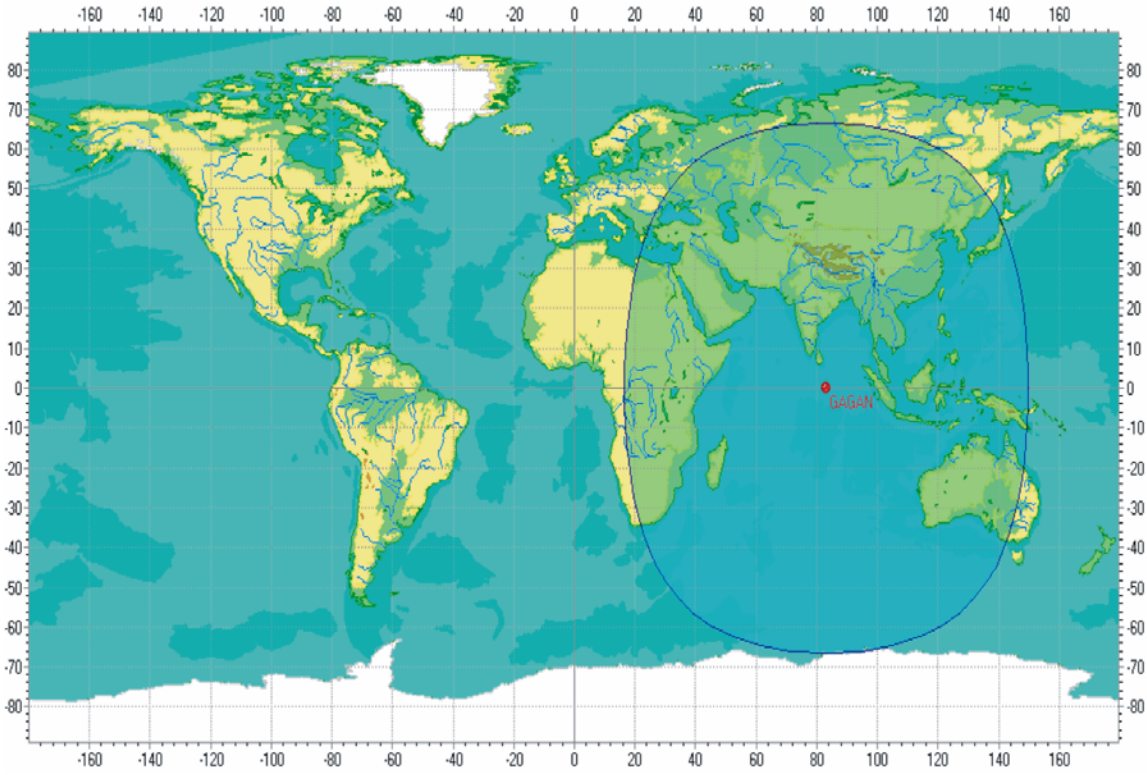
6.21 An ILS is needed for a precision approach. The drawback of an ILS is that it needs to be installed at each end of the runway and some times it is not possible to meet the site requirements of an ILS at the airport. In India we have about 80 operational airports and 43 ILS have been installed at 37 airports with a plan to install 7 more ILS with 4 new stations. After the planned installations there would be 50 ILS at 41 airports i.e. about half of the operational airports.

6.22 It is, however, possible to augment the GNSS signal for a precision approach with the help of additional "Ground Based Augmentation System" (GBAS) or a "Space Based Augmentation System" (SBAS). With the help of a GBAS installed at an aerodrome it is possible to make a precision approach landing at all runway ends of the airport. It, therefore, is used at an airport having many runways to be economical. Air Services Australia is successfully using GBAS system at Sydney airport.

6.23 AAI also has future plans to install GBAS at airports having more than two runways to provide precision approaches. Further, GBAS equipment does not have limitation of the site requirements near the runway ends as in case of ILS equipment.

6.24 ***AAI should install GBAS system at Delhi and Mumbai where at least two runways are operational and one end has a problem of site requirements for installation of ILS equipment.***

6.25 SBAS is a space based augmentation system, which ISRO and AAI are jointly developing to have India's own SBAS which is known as GAGAN (GPS Aided Geo Augmented Navigation). The initial results of the GAGAN project are very encouraging and the project would be implemented by 2009. The coverage area of GAGAN is vast as shown below.



6.26 ISRO was requested to update the Committee regarding the GAGAN project. ISRO's Vision 2025 for Satellite Navigation states "Provide high accuracy navigational support using GEO Overlay System for critical National applications and Self reliance in satellite-based positioning, navigation & timing services".

6.27 ISRO informed that under Indian Satellite Navigation Programme besides the GAGAN project, ISRO is implementing IRNSS, which is an independent 7 satellite constellation, built and operated by India with indigenous capability. ISRO also informed that GAGAN would maintain inter-compatibility between and other regional augmentations to GPS for global navigation.

6.28 With the help of GAGAN it would be possible to make a precision approach at any runway of India without an ILS system and would result in a significant savings. It is also possible for India to provide similar facility to the countries in the area covered by GAGAN.

6.29 ***The Committee is of the opinion that GAGAN project has a national prestige and India should make efforts to commercially exploit its signal for extending this facility to the countries, which fall in the coverage area.***

CHAPTER - 7

Surveillance Systems

Planned Surveillance Infrastructure

7.1 AAI has informed that they have plans to upgrade the existing surveillance equipment during 11th Five Year Plans as follows:

Proposed new Radars

- 3 new Primary + Secondary Radars (ASR/MSSR) planned at Cochin, Amritsar & Bangalore (BIAL) airports. Initially AAI informed the PDC 2008-09 but at the end of January, 2008 revised the PDC to September 2009
- 7 new Secondary Radars (MSSR) planned at Jodhpur, Bhopal, Porbandar, Bellary, Vizag, Jharsuguda & Katihar/Kishanganj. Induction of new MSSR to fill up radar gaps. Initially AAI informed the PDC 2008-09 but at the end of January, 2008 revised the PDC to December, 2009

Radar Networking

- Initially AAI informed PDC to be 2008-09, but at the end of January, 2008 AAI revised the PDC to be December, 2009

Advanced-Surface Movement Guidance and Control Systems (ASMGCS)

- New systems proposed at Mumbai & Chennai airports. Initially AAI informed the PDC 2008 but at the end of January, 2008 revised the PDC to September 2009
- 2 systems to be installed at new airports HIAL & BIAL. Initially AAI informed the PDC March 2008 but at the end of January, 2008 revised the PDC to April/May 2008

Automatic Dependent Surveillance – Broadcast (ADS-B)

- ADS-B trial has been conducted in India
- Trial was successful but only 10.36 % of aircrafts were equipped with ADS-B transponders and used the facility. Therefore facility recommended for use after significant improvement in aircraft equipage.

Surveillance Requirements of ATM and its Status

7.2 The surveillance requirements projected by ATM Directorate are as follows:

Surveillance (Continental)

- Independent TAR (PSR+MSSR) to be implemented at all high density traffic terminal approach control areas i.e. Chennai, Kolkata, Hyderabad, Ahmedabad.
  - To be implemented during planned replacement. – PDC 2009-2011.
- ADS-B & Multilateration system to be implemented to supplement en-route MSSRs initially in low density traffic areas and progressively extended to other areas. Aircraft equipage should also go hand in hand.
  - ADS-B Trials conducted at Chennai. Implementation plan to be worked out in accordance with Regional plan.
- Overlapping multiple radar cover and back up radars should be available in high density traffic areas to ensure uninterrupted radar service
  - Detailed plan being worked out
- The entire control areas should be under radar cover and matching seamless air-ground communication should be available for efficient ATM.
  - Process under implementation by adding new radars – by 2009
- All radars should be networked to ensure entire continental airspace is covered under radar surveillance and seamless radar separation is achievable.
  - Scheme approved, to be implemented by December, 2009.
- Networked radar data should be available at all centres or alternately all centres should be amalgamated at one or two centres with multiple sectors. Dynamic consolidation and deconsolidation of sectors should be facilitated with supporting communication capabilities.
  - Detailed plan to be worked out – PDC 2009
- Two and more approach radars (TAR -PSR+MSSR) should be available at busy terminal approach control areas, especially at Mumbai and Delhi to support reduced spacing on final approach (3NM) and multiple runway operations to enhance capacity. This is essential from the back up point of view and also from maintenance point of view.
  - Under consideration for Delhi and to be planned for Mumbai.

- Provision of TAR at all approach control units where traffic density has reached 50 or more per day.
  - Already planned.

- ASMGCS needs to be implemented at Mumbai, Chennai, Kolkata, Hyderabad, Bangalore.
  - At Hyderabad and Bangalore airports the equipment is under installation. Mumbai, Chennai and Kolkata new equipment being procured.

Surveillance (Oceanic)

- To provide surveillance capabilities in Bay of Bengal airspace in Chennai and Kolkata FIRs and in Arabian Sea airspace in Mumbai FIR.
  - ADS-C/CPDLC provided for the purpose.

- To provide improved surveillance in huge mountainous terrain and remote areas in Delhi FIR also.
  - ADS-C/CPDLC provided for the purpose.

- ADS-B may be considered in Port Blair and Agatti.
  - Proposal under examination.

ICAO's Global Plan Initiatives (GPIs) of Surveillance Systems

7.3 Global Plan Initiative on 'Situational Awareness' (GPI-9) contained in the Global Air Navigation Plan of ICAO deal with Surveillance Systems. The ***scope*** and ***strategy*** of which is as follows:

7.4 The scope of Situational Awareness is operational implementation of data link-based surveillance. The implementation of equipment to allow traffic information to be displayed in aircraft supporting implementation of conflict prediction and collaboration between flight crew and the ATM system. Improve situational awareness in the cockpit by making available electronic terrain and obstacle data of required quality. The GPI describes the strategy as follows:

> "1.51 The further implementation of enhanced surveillance techniques (ADS-C or ADS-B) will allow reductions in separation minima and an enhancement of safety, increase in capacity, improved flight efficiency, all on a cost-effective basis. These benefits may be achieved by bringing surveillance to areas where there is no primary or secondary radar, when cost-benefit models warrant it. In airspaces where radar is used, enhanced surveillance can bring further reductions in aircraft separation minima and improve, in high traffic density areas, the quality of surveillance information both on the ground and in the air, thereby increasing safety levels. The implementation of sets of quality assured electronic terrain and obstacle data necessary to support the ground proximity warning systems with forward looking terrain avoidance function as well as minimum safe altitude warning (MSAW) system will benefit safety substantially.

"1.52 Implementation of surveillance systems for surface movement at aerodromes where weather conditions and capacity warrant will also enhance safety and efficiency while implementation of cockpit display of traffic information and associated procedures will enable pilot participation in the ATM system and improve safety through greater situational awareness.

"1.53 In remote and oceanic airspace where ADS-C is used, FANS capabilities exist on many air transport aircraft and could be added to business aircraft. ADS-B can be used to enhance traffic surveillance in domestic airspace. In this respect, it should be noted that 1090 extended squitter is both available and should be accepted as the global choice for the ADS-B data link.

"1.54 At terminal areas and at aerodromes surrounded by significant terrain and obstacles, the availability of quality assured terrain and obstacle databases containing digital sets of data representing terrain surface in the form of continuous elevation values and digital sets of obstacle data of features, having vertical significance in relation to adjacent and surrounding features considered hazardous to air navigation, will improve situational awareness and contribute to the overall reduction of the number of controlled flight into terrain related accidents."

7.5 The details of various surveillance technologies are as follows:

Surveillance Technologies		
Primary Surveillance Radar (PSR), Surface Movement Radar (SMR)	***Independent***: Surveillance data calcu - lated by the ground	***Non-cooperative***: Does not depend on aircraft equipment
Secandory Surveillance Radar (SSR/MSSR)	***Independent***: Surveillance data calcu - lated by the ground	***Cooperative***: Requires air craft to have a transponder
Multilateration	***Independent***: Surveillance data calcu - lated by the ground	***Cooperative***: Requires air craft to have a Mode S transponder
Automatic Dependent Surveillance (ADS-B)	***Dependent;***: Surveillance data pro - vided by aircraft	***Cooperative***: Requires air craft to have ADS-B avionics
Data Link-based Surveillance (ADS-C/CPDLC)	***Dependent;*** Surveillance data pro - vided by aircraft through CPDLC data link	***Cooperative:*** Requires FANS 1/A equipped aircraft

7.6 IATA in their presentation has suggested the following for surveillance:

- Mode S capable SSR transponders should be installed in all aircraft, both to facilitate the provision of air traffic services, and to facilitate the operation of Traffic Collision Avoidance Systems (TCAS);

- Consider benefits offered by on-board surveillance support capabilities, including Data Link, RNAV, GNSS and ADS, before refurbishing existing radars;
- Consider the option of replacing existing en-route surveillance radar systems with ADS and ADS-B, or where there is no radar, installing ADS and ADS-B surveillance.

Surveillance (Continental)

7.7 Surveillance pinpoints the location of the aircraft for air traffic controllers. In continental airspace, it is conventionally performed through radars and it includes communication and navigation information from aircraft to air traffic control centres that facilitates the continuous mapping of the relative positions of aircraft. Radars are very expensive and now ADS-B and multilateration technologies are now available permitting surveillance of aircraft.

7.8 At present there are 12 radars in the country. The displays of all radars, except Behrampur, are at the station where these radars are installed. The display of Behrampur radar is at Kolkata airport. Even though the Berampur radar has been installed and working for about 5 years, it could not be declared operational because of the low reliability of the data-link between Behrampur and Kolkata. It is now possible to make the Behrampur radar operational through DSCN, which is highly reliable data-link and would be available shortly. ***AAI, therefore, should immediately use DSCN circuit to operationalise Behrampur radar.***

7.9 The present 12 radars do not cover the entire continental airspace of India. AAI has planned additional 10 radars to be installed to cover the entire continental airspace at a height of 20,000 feet. The separation between aircraft in a radar covered area is much lower than the non-radar covered area. Therefore, if on an ATS route, there are some areas, which are not covered under radar then procedural separations need to be applied leading to uneven flow in the same ATS route. The plan of providing the additional radars should be such that it would provide the radar coverage on the route including take-off and landing phase rather than simply providing radar coverage at a certain height of 20,000 feet.

7.10 Even though the plan of AAI to bring entire Indian airspace under radar coverage at a height of 20,000 feet by providing additional 10 radars is a welcome step, but the effective use of these radars can be achieved only through networking. Stand alone radars would need creation 10 more ACCs, which would lead to substantial bifurcation of airspace and should be avoided. It would be appropriate that AAI resorts to networking of these radars.

7.11 AAI has informed that the Radar Networking project has a PDC of December 2009. It may be pointed out in this regard that a proposal of networking the radars

was approved by AAI Board during their 76th Board Meeting held on 19 April, 2004, which passed a resolution as follows:

> *"**RESOLVED that Administrative Approval and Expenditure Sanction of the Board be and is hereby accorded for the Radar Networking project at an estimated cost of Rs. 36.94 Crores."***

7.12 AAI Chairman had informed the Board during the meeting that the estimated cost is based on budgetary quote and procurement would be done through international competitive bidding procedure.

7.13 The Radar Networking project was considered extremely important and the Board during the discussions "suggested that a senior Officer be nominated as Project Manager for timely implementation and completion of this project", which was to be completed by December 2005. As a matter of fact sufficient funds were not available for the project and re-appropriation of funds was sought by AAI and was approved by the Board.

7.14 It is evident from the above that agencies were available to execute this extremely important project and AAI sought Board approval in April 2004 for the project and also for re-appropriation of funds but, the project has not started as yet even though it was to be completed by December 2005.

7.15 ***AAI should ensure seamless radar coverage in Indian airspace, especially on ATS routes on priority through Radar Networking.***

7.16 AAI informed that ADS-B is a surveillance technique for aircraft and ground users which requires a data link and on-board system. It provides parameters such as position, track and ground speed via broadcast mode at specified intervals. Position information can be used to simulate radar-type surveillance for ATC use and ADS-B can be used as radar coverage gap filler and also as backup to radar facility.

7.17 ADS-B is a cheaper proposition and IATA suggests considering the option of replacing existing en-route surveillance radar systems with ADS-B, or where there is no radar, installing ADS-B surveillance. The ATM Directorate has also suggested similar installation of ADS-B systems. The AAI, however, is of the opinion that even though ADS-B trials were successful, only 10% of the aircraft used it because of equipage of the aircraft and suggest using after significant improvement in aircraft equipage.

7.18 ICAO's GPI - 9 states that implementation of enhanced surveillance techniques (ADS-C or ADS-B) will allow reductions in separation minima and an enhancement of safety, increase in capacity, improved flight efficiency, all on a cost-effective basis. GPI - 9 further states that ADS-B can be used to enhance traffic surveillance in domestic airspace. In this respect, it should be noted that 1090 extended squitter is available and should be accepted as the global choice for the ADS-B data link.

7.19 New generation aircraft are being imported in India and these aircraft are equipped with ADS-B equipment. In accordance with the plans of domestic airlines, the expected growth of these aircraft is extremely high.

7.20 ***It would, therefore, be appropriate for AAI to start planning the ADS-B with multilateration infrastructure now rather than wait for regional plans, which are essentially to cater for international traffic. While planning the infrastructure following should also be considered:***

- It is essential to have back up radars to cover high traffic density areas to ensure uninterrupted radar service and also from maintenance point of view.

- Two and more overlapping Terminal Approach Radars (TAR) i.e. PSR+MSSR should be available at Mumbai and Delhi to support reduced spacing on final approach (3NM) and multiple runway operations to enhance capacity.

- Independent TAR (PSR+MSSR) at all approach control units where traffic density has reached 50 or more per day.

- The entire control areas should be under radar coverage and matching seamless air-ground communication should be available for efficient ATM

- All ***radars should be networked*** to ensure entire continental airspace is covered under radar surveillance and seamless radar separation is achievable and all centres should be amalgamated at one or two centres with multiple sectors. Dynamic consolidation and deconsolidation of sectors should be facilitated with supporting communication capabilities

Surveillance (Oceanic)

7.21 ADS-C/CPDLC provides surveillance in the remote and oceanic airspace. Mumbai, Chennai and Kolkata have CPDLC equipment for the surveillance of FANS equipped aircraft. Delhi also has the equipment and can be used for mountainous terrain and remote areas in Delhi FIR.

7.22 ***It would be appropriate to have ADS-B surveillance system at Port Blair and Agatti.***

7.23 FAA has recently operationalised a single, satellite based, integrated oceanic system at three oceanic Air Traffic Control Centres (New York, Oakland, Anchorage) which combines common procedures, training, maintenance & support. The system has following capabilities:

- Fully integrates flight & radar data processing
- Automatic SIGMET/PIREP dissemination
- Enhanced Conflict Probe detects aircraft to aircraft & aircraft to airspace conflicts
- Provides CPDLC, AIDC & ADS-B/C surveillance capabilities
- Electronic Flight Strips automatically updated
- Automates numerous manual processes

7.24 ***AAI may carry out a feasibility study for a system similar to FAA oceanic system to be provided in oceanic airspace of India.***

CHAPTER - 8

AIR TRAFFIC MANAGEMENT

8.1 The process of getting an aircraft safely and efficiently from its origin to destination requires effective ***air traffic management systems*** supported by four key functions: ***communications***, ***navigation, surveillance and automation***. CNS systems have been discussed in Chapters 5, 6 and 7 respectively. Three basic elements of Air Traffic Management namely Airspace Management (ASM), Air Traffic Services (ATS) and Air Traffic Flow Management (ATFM) and the Automation are discussed in this chapter.

Airspace Management (ASM)

8.2 ASM has traditionally been recognised as a dynamic sharing of airspace by civil and military users. In a seamless, global ATM system, however, ASM is not limited only to tactical aspects of airspace use. Its main scope is toward a strategic planning function of airspace infrastructure.

8.3 The coordination between civil military users for dynamic sharing of airspace is dealt in another chapter. The main issue being discussed here is regarding the restructuring of civil airspace.

8.4 ICAO requires that classification of airspace be decided by the States. Air Traffic Services and the CNS infrastructure are required to be provided according to airspace classification. ICAO Annex 11 states at para 2.6 regarding Classification of airspaces as follows:

> **"2.6 Classification of airspaces**
>
> 2.6.1 ATS airspaces shall be classified and designated in accordance with the following:
>
> ***Class A***. IFR flights only are permitted, all flights are provided with air traffic control service and are separated from each other.
>
> ***Class B***. IFR and VFR flights are permitted, all flights are provided with air traffic control service and are separated from each other.
>
> ***Class C***. IFR and VFR flights are permitted, all flights are provided with air traffic control service and IFR flights are separated from other IFR flights and from VFR flights. VFR flights are separated from IFR flights and receive traffic information in respect of other VFR flights.
>
> ***Class D***. IFR and VFR flights are permitted and all flights are provided with air traffic control service, IFR flights are separated from other IFR flights and receive traffic information in respect of VFR flights, VFR flights receive traffic information in respect of all other flights.
>
> ***Class E***. IFR and VFR flights are permitted. IFR flights are provided with air traffic control service and are separated from other IFR flights. All flights receive traffic information as far as is practical. Class E shall not be used for control zones.

Class F. IFR and VFR flights are permitted, all participating IFR flights receive an air traffic advisory service and all flights receive flight information service if requested.

Class G. IFR and VFR flights are permitted and receive flight information service if requested."

8.5 At present, Indian airspaces have been designated as Class D, E, F & G and air traffic services are required to be provided accordingly. However, with restructuring of airspace and increase in CNS infrastructure to cope with the dense traffic, the present classification may be changed to a higher classification depending upon the traffic density.

8.6 Initially India had 4 FIRs and 4 ACCs at Delhi, Mumbai, Chennai and Kolkata where Radar services were available. An aircraft going from Delhi to Mumbai was provided radar services with lower separations between the aircraft at these 4 airports but on the route procedural separations were provided which are much higher than the radar separations. Where ever a new radar was installed an ACC was created. Today there are 12 radars and 11 ACCs at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Ahmedabad, Nagpur, Mangalore, Thiruvananthapuram, Guwahati and Varanasi. The only exception is Behrampur, which is being operated from Kolkata.

8.7 Even with these 12 radars there is gap between Delhi and Ahmedabad at a height of 20,000 feet. Any aircraft going from Delhi to Mumbai at a height of 20, 000 feet or below would have to be provided procedural separation due to gap in the radar coverage.

8.8 Proposed additional radar at Jodhur would cover the radar gap at height of 20, 000 feet and above (but not below) and to use it effectively an establishment of another ACC would be required. AAI plans to add 10 more radars but there are no plans to say that these many more ACCs would be required and radar trained ATCOs to man them. It is evident that the system of AAI planning is to provide the CNS equipment through which air traffic services to be provided rather than to plan the ATM and provide the CNS equipment to cater for it.

8.9 Addition of ACCs leads to bifurcation of airspace and requires additional air-ground communication between pilots and the ATCOs. Each aircraft when there is a change of ACC is required to report again not only its position but also its estimates of the reporting points. It increases the ground-to-ground communication between ACC to ACC for handing over/taking over the control of the aircraft. The communication channels become congested due to additional communication. With the growth of air traffic there is a requirement globally for a seamless airspace, which is achieved through consolidation of airspace. Addition of new ACCs leads to bifurcation of airspace but the practice followed these days is just opposite i.e. consolidation of airspace to make the airspace seamless.

8.10 An excellent example is of Air Services Australia, which has an area of 2½ times that of India. They have reduced 6 FIRs to just 2 FIRs and 2 ACCs. Even

one ACC is capable of handling the entire air traffic of Australia but two are kept as backup for an emergency situation.

8.11 Similar is the situation with respect to VHF communication. At present a gap exists between ACCs of Delhi and Ahmedabad at 20,000 feet, where the pilot does not have any VHF communication. The communication between the pilot and ATCO can be achieved only through a HF operator operating HF frequency and passing messages between the pilot and the ATCO, which is not a satisfactory position.

8.12 AAI has informed that it has a plan to install Dedicated Satellite Communication Network (DSCN) systems at 80 airports, which would provide extremely reliable communication link between these airports. DSCN link besides the voice links can be used for ATS Inter connectivity Digital Communication (AIDC), Message exchange service (AMSS), Data Networking Radar Service, Remote Control Air-Ground (RCAG) service, and even support data channels of GAGAN. During the AAI presentation it was agreed by the Chairman, Dr. K. Ramalingam, that with the availability of such an excellent link, it is possible to have a single FIR with a single ACC controlling the entire traffic of Indian airspace.

8.13 AAI, however, does not have any plans to use this excellent communication connectivity for networking of radars or even using it as a RCAG link for VHF coverage, which at present is not reliable because telephone lines are used for the purpose. AAI only plans to use this DSCN for voice communication (telephones) and AMSS facilities, which are at present connected though MTNL/BSNL connectivity. This cannot be considered as a optimum use of DSCN.

8.14 AAI has now informed in February 2008 that the DSCN project would support voice and data for all facilities like VHF RCAG, Radar Networking, Ground-Ground voice and data communication like speech circuits & AMSS and this would be the primary media for all types of data.

8.15 The presentations of AAI clearly indicated the plans for CNS systems and added ***'ATM Present Requirements & Status'*** for each of the components of CNS. It was evident that 'Present Requirements' of ATM were being considered and clearly laid out objective or strategy or future plans of ATM do not exist.

8.16 The existing airspace structure of four FIRs, one sub-FIR and 11 ACCs should be restructured to increase the capacity and efficiency and enhance the safety of the airspace. ***The Committee is of the opinion that it would be appropriate to consolidate the airspace to have two FIRs and two ACCs capable of handling the entire airspace of India independently. The design should permit that in event of failure one ACC, the other ACC should be able to takeover as a backup.***

8.17 Each ACC should have multiple sectors depending upon the routes traffic. It should be possible to combine sectors when the traffic is lean and have

independent sectors during heavy traffic on routes. Such a structure would need combining the frequency transmissions by the controller i.e. a controller should be able to transmit on more than one frequency when the sectors are combined during lean traffic periods. Such requirements have been reflected by ATM directorate.

8.18 The ATM navigation requirements specify area navigation (RNAV) capability of aircraft. At present RNAV capability is provided by airborne systems that rely on ground-based navigation aids. However, there will be an increasing trend towards GNSS-based systems. This will lead to one of the main economic benefits of CNS/ATM systems, with the eventual withdrawal of a portion of the current ground-based navigation system. ATM requirements for navigation capability and performance for en-route operations have been developed as RNP. ICAO Annex 11, which stipulates SARPs for Air Traffic Services states at Para 2.7 on RNP for en-route operations as follows:

> "2.7.1 RNP types shall be prescribed by States. When applicable, the RNP type(s) for designated areas, tracks or ATS routes shall be prescribed on the basis of regional air navigation agreements.
>
> 2.7.2 ***Recommendation***.— For the en-route phase of flight, RNP types RNP 1, RNP 4, RNP 10, RNP 12.6 and RNP 20 should be implemented as soon as practicable.
>
> 2.7.3 The prescribed RNP type shall be appropriate to the level of communications, navigation and air traffic services provided in the airspace concerned."

8.19 India in accordance with the ICAO regional plan has promulgated EMMARSH Routes, which pass through Indian airspace in East-West direction. Only these have been specified as RNP-10 routes.

8.20 ***RNP routes significantly enhance the capacity of airspace and should be adopted by AAI for other domestic and international routes.***

Air Traffic Services (ATS)

8.21 ATS will continue to be the primary element of ATM. ATS itself is composed of several sub-elements. These are the alerting service, flight information service (FIS) and ATC. The main objective of ATC services is to prevent collisions between aircraft and between aircraft and obstructions on the manoeuvring area and to expedite and maintain an orderly flow of air traffic. The objective of FIS is to provide advice and information useful for the safe and efficient conduct of flights. The objective of the alerting service is to notify appropriate organisations regarding aircraft in need of search and rescue aid and assist such organizations as required.

8.22 Significant progress has been made on the development of provisions related to ATS in CNS/ATM systems. Standardisation and implementation planning will ensure that ATS systems supporting ATM are developed so as to provide harmonisation and integration into a regional and global network of continuous service. This requires harmonisation of radar data and flight data processing systems

(FDPS), among others. The functional capabilities of ATS support systems such as conflict prediction, detection, advisory and resolution needs to be standardised and should be made available to ATCOs.

8.23 ***AAI should provide functional capabilities of ATS support systems such as conflict prediction, detection, advisory and resolution needs to be standardised and should be made available to ATCOs.***

Air Traffic Flow Management (ATFM*)*

8.24 The objective of ATFM is to ensure an optimum flow of air traffic to or through areas during times when demand exceeds or is expected to exceed the available capacity of the ATC system. An ATFM system should therefore reduce delays to aircraft both in flight and on the ground and prevent system overload. The ATFM system assists ATC in meeting its objectives and achieving the most efficient utilisation of available airspace and airport capacity. ATFM should also ensure that safety is not compromised by the development of unacceptable levels of air traffic congestion and, at the same time, to assure that air traffic is managed efficiently without unnecessary flow restrictions being applied.

8.25 Both ICAO Annex 11 and ICAO Doc. 4444 on Air Traffic Management provide detailed International Standards on the Air Traffic Flow Management. Chapter 3 of ICAO Doc. 4444 deals with the 'ATS System Capacity and Air Traffic Flow Management'. The relevant extracts of the states as follows:

"3.2 AIR TRAFFIC FLOW MANAGEMENT

3.2.1 General

3.2.1.1 An air traffic flow management (ATFM) service shall be implemented for airspace where traffic demand at times exceeds the defined ATC capacity.

3.2.1.2 ATFM should be implemented on the basis of a regional air navigation agreement or, when appropriate, as a multilateral agreement.

3.2.1.3 The ATFM service within a region or other defined area, should be developed and implemented as a centralized ATFM organization, supported by flow management positions established at each area control centre (ACC) within the region or area of applicability.

3.2.1.4 Certain flights may be exempt from ATFM measures, or be given priority over other flights.

3.2.1.5 Detailed procedures governing the provision of the ATFM measures, and service within a region or area should be prescribed in a regional ATFM manual or handbook.

3.2.2 Flow management procedures

ATFM should be carried out in three phases:

a) strategic planning, if the action is carried out more than one day before the day on which it will take effect. Strategic planning is normally carried out well in advance, typically two to six months ahead;

b) pre-tactical planning, if the action is to be taken on the day before the day on which it will take effect;

c) tactical operations, if the action is taken on the day on which it will take effect."

8.26 The above standards make it obligatory on the part of India to have a centralised Air Traffic Flow Management. Chairman AAI during presentation informed that an approval from the Board has been obtained for implementation of an ATFM system.

8.27 Global Plan Initiative (GPI–6) describes the ***scope*** of Air Traffic Flow Management as the implementation of strategic, tactical and pre-tactical measures aimed at organising and handling traffic flows in such a way that the totality of the traffic handled at any given time or in any given airspace or aerodrome is compatible with the capacity of the ATM system. Description of its ***strategy*** is as follows:

"1.37 The implementation of demand/capacity measures, commonly known as air traffic flow management (ATFM), implemented on a regional basis where needed, will enhance airspace capacity and improve operating efficiency.

"1.38 In the event that traffic demand regularly exceeds capacity, resulting in continuing and frequent traffic delays, or when it becomes apparent that forecast traffic demand will exceed the available capacity, the appropriate ATM units, in consultation with aircraft operators, should consider implementing steps aimed at improving the use of the existing system capacity, and developing plans to increase capacity to meet the actual or forecast demand. Any such planning to increase capacity should be undertaken in a structured and collaborative manner.

"1.39 Where warranted, States and regions should evolve to a collaborative based approach to capacity management. The ATM Operational Concept envisages a more strategic approach to ATM overall, and through collaborative decision-making, a reduction in the reliance on tactical flow management. It is inevitable that tactical flow intervention will continue to be required; however closer coordination between airspace users and ATM service providers can reduce the need for routine tactical intervention which is often disruptive to aircraft operations."

8.28 ***As International Standards of ICAO stipulated in Annex 11, which deals with Air Traffic Services and Doc 4444, makes it obligatory for India to have Air Traffic Flow Management System, AAI needs to implement AFTM system expeditiously***.

ATM Automation

8.29 Automation is seen as one of many resources available to the human operators - controllers and pilots alike - who retain the responsibility for management and direction of the overall ATM system. Additionally, unexpected or unplanned events must be a required part of planning and design, when considering the systems that would replace the cognitive and adaptive capabilities of controllers or pilots.

8.30 The air traffic controller's job consists of complex tasks demanding a high degree of skill and active application of unique cognitive abilities such as spatial perception, information processing, reasoning and decision-making. The controller must know where all of the aircraft under his/her responsibility are, and determine how and when to take action to ensure that they remain separated from each other, while also seeing to their requests and needs for descent, climb, take-off, departure, etc.

8.31 Although it is well accepted that the human controller in the system has performed these tasks more than adequately over the years, it is also accepted that improvements could be made by using decision support software tools. These tools assist the controller to some degree with conflict prediction, detection, advisory and resolution.

8.32 The expectation is that greater degrees of accuracy could be achieved through the sophisticated data processing associated with automation. Furthermore, conflict prediction and detection, based on advanced computational methods should allow more direct routings.

8.33 GPI-16 of ICAO Global Plan regarding "Decision Support and Alerting Systems", the scope of which is to implement decision support tools to assist air traffic controllers and pilots in detecting and resolving air traffic conflicts and in improving traffic flow, describes the strategy as follows:

> "1.75 Decision support systems facilitate early resolution of potential conflicts, provide basic levels of explorative probing to optimize strategies and reduce the need for tactical action. The executive role of controllers is thereby enhanced, giving scope for management of more traffic within acceptable workload limits.
>
> "1.76 Several tools are available that have the ability to substantially enhance safety. These include minimum safe altitude warning systems, short term conflict alert and runway incursion alerting tools. Tools that can improve efficiency include automated flight data processing systems, longer term conflict prediction and sequencing tools and online data interchange systems.
>
> "1.77 Conflict prediction tools span several sectors and permit improved sectoral planning, thereby providing the advantage of more expeditious traffic flow and less potential conflicts within established arrival schedules. This will allow sector teams to operate more effectively and will result in more optimum and efficient arrival flows.
>
> "1.78 The automation of coordination tasks between adjacent sectors improves the quality of information on traffic transiting between sectors and makes it more predictable, thereby allowing reduced separation minima, decreased workload, and increased capacity and more efficient flight operations."

8.34 Many of the automation tools are readily available. Most commonly used are "Arrival Manager" and "Departure Manager" which minimise delays, provides predictable flight schedules and optimise landing procedures. ICAO's GPI -16 provides details of other tools and states that automation reduces separation minima, increases capacity, decreases workload and improves efficiency of flight operations.

8.35 ***AAI must provide ATM automation tools for enhancing the capacity of the Indian airspace.***

Functional Integration

8.36 ATM consists of a ground part and an air part, where both are needed to ensure a safe and efficient movement of aircraft during all phases of operations. The airborne and ground components of the system must have the functional capability of interfacing with each other in order to attain the objectives of ATM. The ground part includes ATS, ATFM and ASM, where ATS is considered to be the primary component. The air part consists of aircraft avionics where Flight Management System is the primary component. Functional compatibility of the data exchanged between the airborne and the ground elements is essential to ensure the efficiency of the system.

8.37 Global Plan Initiative (GPI-12) dealing with Functional Integration of Ground Systems with Airborne Systems has a ***scope*** for the optimisation of the terminal control area (TMA) to provide for more fuel efficient aircraft operations through FMS-based arrival procedures and functional integration of ground and airborne systems and describes the ***strategy*** as follows:

> "1.62 In recent years there have been several efforts to develop flight procedures that provide the most efficient trajectory during an aircraft's approach to the destination aerodrome. These procedures allow an uninterrupted flight trajectory from top of descent until the aircraft is stabilized for landing. For the purposes of design work, it may be necessary to implement these procedures in phases.
>
> "1.63 The design of en-route and arrival air routes and associated procedures should facilitate the routine use of continuous descent procedures. Similarly, the design of departure procedures should facilitate the routine use of unrestricted climb procedures.
>
> "1.64 In order to maximize efficiency in TMA airspace, taking advantage of improved TMA design and making best use of automation is critical. Therefore, in addition to continuous descent capabilities, aircraft will increasingly be equipped with time of arrival computation. This capability will integrate with ground automation to deliver time of arrival over fixes to assist in the sequencing process allowing aircraft to remain closer to their 4-D preferred trajectory."

8.38 ***In view of the above, AAI should design ground part of ATM to integrate effectively with the aircraft equipped with new technology CNS systems and ensure homogeneous, continuous and efficient service to the user from pre-flight to post flight.***

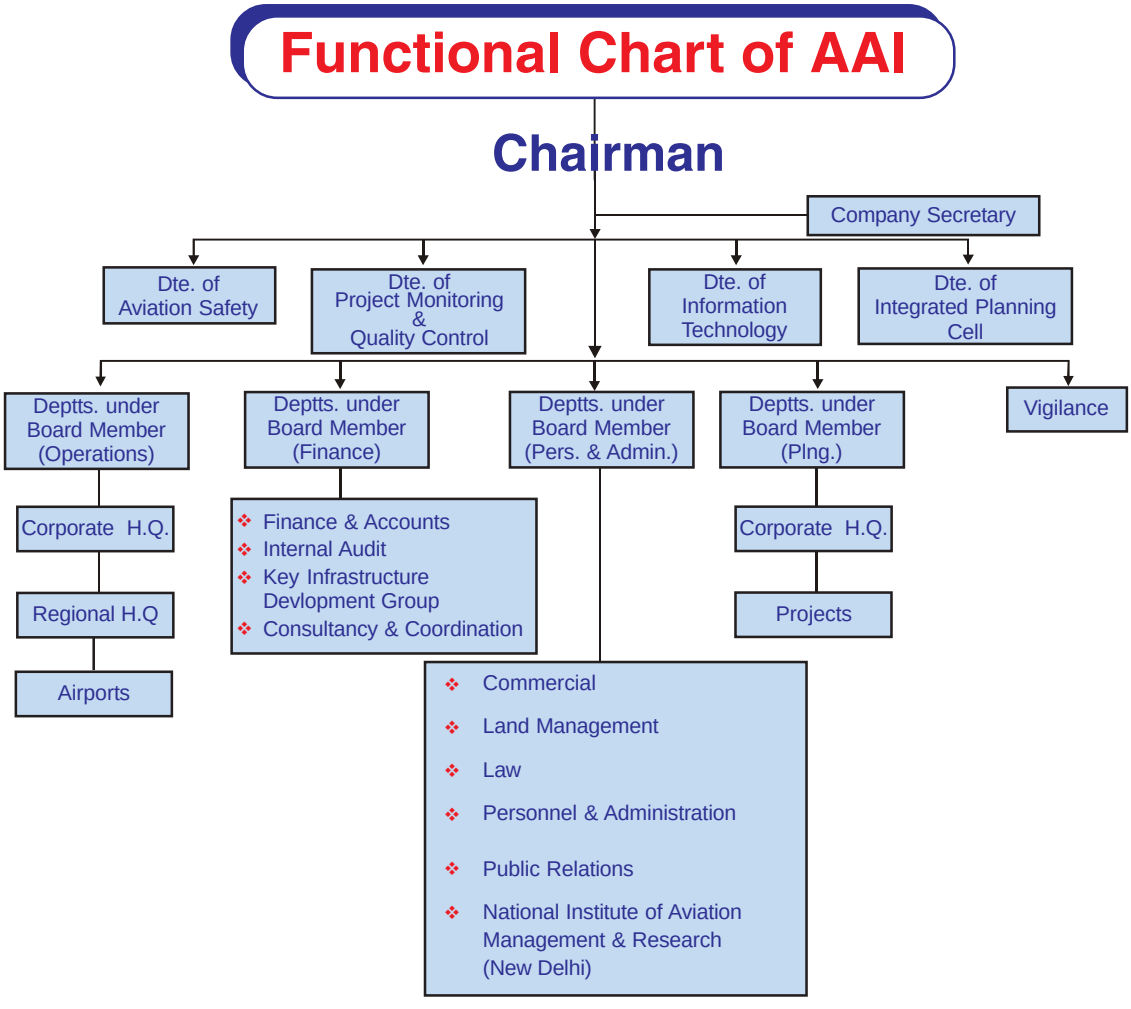
Chapter – 9

Airports Authority of India – Organisation & Human Resources

9.1 Airports Authority of India (AAI) was constituted by an Act of Parliament and came into being on 1st April, 1995 by merging erstwhile National Airports Authority and International Airports Authority of India. The merger brought into existence a single organisation entrusted with the responsibility of creating, upgrading, maintaining and managing Civil Aviation infrastructure both on the ground and airspace in the country.

9.2 AAI manages 124 airports, which include 10 international airports, 85 domestic airports and 29 civil enclaves at Defence airfields. As stated earlier, AAI also provides Air Traffic Services over entire Indian airspace and adjoining oceanic areas with ground installations at all airports and 25 other locations to ensure safety of aircraft operations.

9.3 The functional flow chart of AAI as given on their web site is as follows:



ANS Planning & Procurement Philosophy

9.4 The organisational structure of AAI does not have a demarcation of ANSP functions and Aerodrome Operator functions. The Directorate of Integrated Planning Cell, which was performing integrated CNS/ATM planning functions, is not functioning effectively. It is understood that this directorate has now been reporting through Member (Planning).

9.5 The present system being followed by AAI is to procure independent equipment like VHF Radios for Communication, VOR/DME ILS for Navigation, Radars for Surveillance and AFTN Network for messaging. These stand alone equipments are installed and maintained by Communication Directorate. The future CNS/ATM infrastructure requires networking of all equipments, and data-links through Aeronautical Telecommunication Network (ATN). The automation tools and central Air Traffic Flow Management (ATFM) systems require complete networking of all Radars, VHF Radios and the computers for delivery of services. AAI, therefore, need to change the concept from procuring the equipments to providing the services in completely integrated network centric seamless environment of ATM, Aircraft, Airlines and Aerodrome operators.

9.6 ***It is essential that organisational structural changes are made for the delivery of future network centric CNS/ATM systems, which lays emphasis on delivery of service rather than purchase of independent equipments.***

Human Resources – ATM

9.7 In view of the increase in traffic growth, provision of CNS/ATM facilities alone will not adequately meet the challenges posed by the industry demand. Airspace restructuring, sectorisation and implementation of new technology ATM systems, air traffic flow management have become key priorities areas. AAI would require highly specialised trained ATM manpower for effective planning and training of their officers in these concepts which enhance safety and efficiency and augment airspace capacity.

9.8 Air traffic management is a highly specialised job requiring both mental and physical alertness and quick decision making ability. Recruitment and training plays a vital role in identifying the correct candidates for these safety critical jobs and separate set of policy guidelines on manpower planning, recruitment, training, promotion and remuneration is essential. ICAO ATS planning manuals states that "ATCO manpower planning must provide a sufficient number of qualified personnel, on a timely basis, to ensure the provision of air traffic control service."

9.9 ICAO Annex 1 on Personnel Licensing stipulates International Standards and Recommended Practices of knowledge, training, skill and medical standards for Air Traffic Controllers, which need to be ensured by the States. With the recent amendment to the **Aircraft Act,** Air Traffic Controllers are now required to be licensed by the Central Government. AAI, therefore, is required to ensure not only the

knowledge, training and the skill of ATCOs meet the international standards but also they meet the medical standards stipulated by ICAO. AAI should have a well defined health policy for the ATCOs to maintain their health and fitness to perform ATC duties. It would be essential to ensure that the investment made on ATCOs is not lost due to medical disqualification and therefore should give due regard to their work load, rest and the factors that affect the health of the controllers like environment and amenities at the place of duty.

9.10 The manpower planning must allow for intake of sufficient numbers of staff in a timely manner and must take account the actual requirements for ATCOs for various units, airspace complexities and current and future traffic load, leave, training and retirement, medical fitness of ATCOs and redeployment/cross deployment of ATCOs on other non-ATC jobs.

9.11 The recruitment rules, selection process and training of ATCOs should be based on the nature of duties and responsibilities, which should not be equated with other disciplines. There should be a clear cut management policy for manpower planning, recruitment, training, promotion, remuneration and incentive for the ATCOs as a separate entity as the nature of job, responsibility and accountability is entirely different from other category of personnel within the organisation.

Human Resources - CNS

9.12 New technologies of CNS System are now being introduced in India in consonance with ICAO Global Air Navigation plan. Ground based systems of Communication, Navigation and Surveillance would be gradually replaced by Satellite based systems. Similarly, digital communication technology would take over the present analogue communication. Ground and airborne system would directly exchange routine messages at much faster rate for conduct of safe operation of flights.

9.13 These systems consist of advanced and state-of-the-art technology and would require educated, technically qualified, competent and highly skilled manpower to install, flight inspect and maintain them. Besides, as the technology gets upgraded at a very rapid pace it requires continuous up-gradation of technical knowledge and skill of the persons engaged in the maintenance of CNS equipment.

9.14 To meet the above requirements, the present system of developing and deploying CNS manpower is required to be reviewed to ensure that the induction level of CNS manpower is at appropriate level to attract engineering graduate from reputed institutions like IIT, regional engineering colleges etc. career progression in the organisation should be restructured to ensure time bound promotions. Factory training particularly of imported equipments should be properly designed to meet the maintenance requirement. Personnel should be sent for factory training at regular interval to upgrade their knowledge and skill.

9.15 AAI has variety of equipments of different manufacturers installed at airports. Further, at some airports one system has different models of different manufacturers.

It becomes difficult for CNS personnel to have proficiency in all types of equipments and leads to less than optimum performance and sometimes to breakdown. This is likely to create mental pressure on CNS personnel who become target for non-functioning/ malfunctioning of the system. AAI should carry out the study and reduce such equipage of the airports.

9.16 Personnel proficient on the equipment should only be deployed for installation and maintenance work. Proficiency allowances may be enhanced so that CNS personnel continuously develop their knowledge and skill. Suitable mechanism like enhanced pay and perks, system for better motivation should be put in place to retain the highly qualified and trained engineers in the organisation.

9.17 AAI should follow, Civil Aviation Requirements (CARs) issued by DGCA regarding the training of CNS personnel.

Centre of Excellence

9.18 In-house training capacity at CATC, Allahabad and regional training centre should be enhanced in time bound manner so that induction level training, specialist training on equipments and refresher courses can be organised at appropriate interval particularly in view of expanding CNS/ATM system. The institution should have a capability to train the trainers and only qualified instructors should impart the training, who may be given appropriate allowances to make the training work attractive.

9.19 AAI should upgrade the training infrastructures at CATC at par with internationally accepted norms. The CATC may involve field experts for conduction of classes, seminars and workshop and preparation of study material from time to time to cope up with changing technologies.

9.20 The Committee is of the opinion that Civil Aviation Training College (CATC) should be made centre of excellence in the field of CNS/ATM to be developed as CNS/ATM training hub in the Asia Pacific Region that would attract the foreign ANSPs for training their Controllers and Engineers. AAI should develop the course materials of international standards for domestic and international trainees.

9.21 Flight Inspection Unit of AAI carries out flight calibration of the CNS facilities along with Radio Construction & Development Unit, which conducts site survey, installation, ground testing and adjustments required the flight calibrations. The function of these units is to commission the facility and carry out the periodic checks to ensure their performance is in accordance with the ICAO SARPs and as such directly related to safety of aircraft operations. AAI should upgrade the infrastructure of these units and develop them as a centre of technical excellence.

Chapter – 10

Civil Military Coordination – Flexible Use of Airspace

Introduction

10.1 Policy decisions taken during the last few years like permitting private airlines to operate on international sectors and open sky policy have resulted in emergence of large number of domestic airlines and operations by new foreign airlines. It has also resulted in induction of many aircraft by scheduled & non-scheduled airlines and even for private use. It has boosted up the of civil aviation sector, which has registered a significant growth in civil aviation both in domestic and international traffic.

10.2 Today many civil airports are catering for both domestic and international flights, which have resulted in infrastructure constraints. Government has taken decisions to permit Greenfield airports, privatised Delhi & Mumbai airports and planned for enhancement of non-metro airports but it takes time to build up the infrastructure and civil aviation is growing much faster resulting in flight delays.

10.3 Increase in air traffic density has also caused congestion in the available civil airspace. Efficient and effective airspace management is the only way to resolve the issue. To increase the capacity of civilian airspace vertical separation between the aircraft has been reduced from normal 2,000 feet to 1,000 feet above 29,000 feet. This is not sufficient to cope up with the growth.

10.4 In India, out of a total airspace area of 10.5 lakhs sq. nautical miles over land approximately 3.7 lakhs sq. nautical miles (i.e. 35%) has been designated as reserved airspace for military activities in the form of restricted and danger areas. In Delhi FIR, approximately 70% of the total airspace is reserved for military use.

10.5 The airspace of a nation is a finite asset, which is used for the civil and military flights together or individually. Today the national economy demands flexibility in the airspace utilisation for the operation of the civil flights depending on their requirement, which is ever increasing with the growth registered in the civil aviation sector. At the same time there is also need to fulfil the demand of national security, where the use of airspace by the military needs to be fulfilled in the fast changing environment of air warfare. Therefore, sharing of airspace on a need basis, by civil and military users is an urgent national requirement.

10.6 The civil and military are the prime users of the national airspace and under the existing system the airspace is used by both in isolation from each other. However, with increased demand from both military and civil aviation sector of the available airspace needs to be effectively utilised to enhance the airspace capacity and to facilitate the demands of both the sectors. This can be achieved by the introduction of Flexible Use of Airspace (FUA) in the country's airspace.

10.7 FUA permits the airspace available with both military and civil users to be effectively utilised on sharing basis to gain optimum usage thereby enhancing its capacity and derive economic benefits to flights operating within a nation's airspace. In this model a coordination procedure between the civil and the military authorities is required for transferring the airspace from one user to another i.e. military to civil and vice versa, when not used by the user assigned with the responsibility of its control. The element of surveillance by the military authorities of the airspace and the traffic therein continues as per the existing system.

10.8 The situation is not unique to India. Air Traffic Services Planning Manual of ICAO enumerates that it is not always possible to envisage a single solution to the problem of co-ordination between civil and military authorities.

ICAO's Global Plan Initiatives (GPIs)

10.9 Global Plan Initiative (GPI-1) deals with 'Flexible Use of Airspace' and has ***scope*** for optimization and equitable balance in the use of airspace between civil and military users, facilitated through both strategic coordination and dynamic interaction. The GPI ***describes the strategy*** as follows:

> "The use of airspace could be optimized through the dynamic interaction of civil and military air traffic services including real-time civil/military controller-to-controller co-ordination. This requires system support, operational procedures and adequate information on civilian traffic position and intentions.
>
> "The flexible use of airspace (FUA) concept is based on the principle that airspace should not be designated purely as civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent. FUA should result in the removal of large tracts of permanent or transient restricted airspace or special use airspace.
>
> "Where there are continued requirements to accommodate specific individual airspace uses, thereby blocking airspace of certain dimensions, this should be accommodated on a transient basis. Airspace should be released immediately after the operation requiring the restriction is complete.
>
> "Greater benefits associated with implementation of FUA will be obtained through inter-State cooperation which may entail regional and sub-regional agreements as reserved airspace is often established along critical flight paths at national boundaries."

10.10 The above FUA concept enlarges the application to neighbouring countries, which may be difficult to accept at this stage for India.

10.11 Another Global Plan Initiative (GPI–4) deals with Alignment of Upper Airspace Classification with a ***scope*** of harmonization of upper airspace and associated traffic handling through application of a common ICAO ATS Airspace Class above an agreed division level. The description of ***strategy*** is as follows:

> "1.30 To the extent possible airspace should be structured as a continuum, free from operational discontinuities, inconsistencies and differing rules and procedures. Alignment of airspace classifications can help to achieve this goal. It would also facilitate the introduction

and better utilization of data link communications, improved flight plan processing systems, and advanced airspace management coordination tools and message exchange capabilities, leading to progressively more flexible and dynamic management of airspace. Airspace classifications should be harmonized intra-regionally and, where possible, across several regions.

"1.31 Air transport and most business aircraft operations should be contained within airspace within which positive air traffic control services are provided to all aircraft (i.e. Class A, B, C or D).

"1.32 ATM provided in various airspace volumes should be based on the ICAO airspace classification system as defined in Annex 11 — Air Traffic Services (i.e. Class A to G), and those classifications should be implemented on the basis of a safety assessment, taking into account the volume of nature of the air traffic."

10.12 AAI is planning to declare airspace above 29,000 feet as Class 'A' airspace and harmonise airspace above 25,000 feet for alignment of 'Upper Airspace' as an agreed division level of classification as expected by this GPI.

Airspace Management in India

10.13 There are three categories of airspace in India namely (i) civilian airspace, (ii) 'restricted airspace' for defence use and (iii) 'prohibited airspace' like airspace of Rashtrapati Bhavan where flights, whether civil or defence are not permitted. Airports are categorised as civil aerodromes, defence aerodromes and defence aerodromes with civil enclave.

10.14 Ministry of Civil Aviation manages the airspace for civil aviation and provides air traffic services through AAI for flights in civil airspace and operating at the civil aerodromes. Indian Air Force manages restricted airspace for all defence aviation and provides air traffic services for flights operating through it. However, air traffic services at the defence aerodrome are provided by the respective defence wing e.g. Indian Navy provides air traffic services at Goa airport, which belongs to them but clearance to operate a civilian flight to Goa (AOR No.) comes through Indian Air Force.

10.15 Defence authorities use restricted airspace for their own flights and exercises and are not required to inform the civilian side about the movement or timings of their flights, except while passing through the civilian airspace. Civilian flights are required to use only civil airspace and are not permitted to use defence airspace on regular basis, except on specific clearance from IAF/MOD. Avoidance of the defence airspace requires deviation of civilian flights from the preferred tracks and not only leads to increase in fuel consumption affecting the economics of flight but also results in considerable delays especially in view of substantial increase in civilian traffic.

10.16 Civil aviation has grown considerably all over the world. During last three years, there has been an unprecedented growth of civil aviation in India, which is likely to grow at the same rate in coming few years. Further, India is in the centre

of flights from Asia-Pacific region to Europe. As per the present estimates of ICAO, aviation in the Asia-Pacific region is growing and likely to grow further at the fastest rate in the world. All these flights pass through India. The density of civil aircraft in airspace for aviation is also growing accordingly.

10.17 The increase in air traffic density results in considerable delays to flights and it is necessary to improve our airspace management system.

10.18 Most countries have already systems in place for Flexible Use of Airspace for optimum use of airspace by Civil and Military purposes. In India also, some initiatives have been taken both by the Indian Air Force and the Civil Aviation authorities to bring about effective civil-military coordination leading to flexible use of airspace.

10.19 This Committee deliberated on this problem and also had discussions with IAF's representatives and the AAI. The Committee had drafted the following recommendations:

i) The concept of flexible use of airspace should be accepted as the underline basis for optimizing the use of Indian airspace for meeting the needs of both military and civil aviation.

ii) The restricted airspace for Defence would continue with the defence. However, the flexible use of airspace concept would imply that the size of airspace would vary on as required basis. For example, when the presently restricted airspace is not required for defence purposes, it could be made available to Civil Aviation and reciprocally if Defence needs, for limited period is larger, then the civil authorities could make additional airspace available for such requirements. Standard Operating Procedures (SOPs) for managing these changes would be worked out jointly.

iii) As a first step, upper airspace above 25,000 feet could be released for civil traffic in the presently defined restricted/ danger airspace. Of course, the Defence requirements would have a priority of not only increasing their height requirements but also expanding the restricted airspace, whenever required. To divert the planned civilian traffic and not to cause undue hardship to passengers, a notice of at least 24 hours would need to be given. The normal defence air traffic would continue to use the upper airspace above 25,000 feet along with the civilian air traffic as at present.

10.20 The Committee also was of the view that while all defence airspace may continue to remain with defence authorities, it was noted that many of the restricted/ danger areas as specified in Aeronautical Information Publication (AIP), India are not being used for many years e.g. Tilpat Range. MOD/IAF may, therefore, consider a review of all restricted/danger areas mentioned in AIP and present restrictions may be reconsidered.

10.21 Both IAF and MOD were informed about the draft recommendations to solicit their views, which were received vide their letters 12th September, 2007 and 20th November, 2007 respectively.

10.22 Both broadly agreed with the recommendations. The concept of flexible use of airspace was accepted as the underline basis for optimising the use of Indian airspace for meeting the needs of both military and civil aviation. MOD in their letter have stated with the concept of Flexible Use of Airspace being implemented, it is recommended that this aspect be coordinated by the Jointly Manned Area Control Centers as proposed by the IAF in the Service Paper on FUA, rather than giving a blanket clearance.

10.23 It has also been informed that IAF is in the process of reviewing its Restricted and Danger Areas, wherein, the requirement of the available airspace vis-à-vis its utility is under review. Depending on the out come of the study, suitable action would be taken.

10.24 Their reservation was essentially with regard to release of airspace above 25,000 feet for civil use. The matter was considered afresh by the Committee. All civil airspace above 29,000 feet is now available only to aircraft which are compliant with RVSM requirements and the crew are trained for operating in such an environment. The non-RVSM compliant aircraft or the crew not trained for the environment is required to operate below 29,000 feet in the civilian airspace. The release of airspace above 25,000 feet for civilian use was suggested to cater for the cruise phase for all aircraft, whether RVSM compliant or not and alignment of Upper airspace as stated above at paras 10.11 & 10.12. However, taking into consideration the defence requirements, the recommendation is being modified to the extent of 29,000 feet.

Recommendations

10.25 The concept of FUA should be accepted as underline basis for optimising the use of Indian airspace for meeting the needs of the both military and civil aviation for the country, which has been accepted by MOD and IAF.

10.26 Government should constitute a high-level committee for common use of Indian airspace and workout procedures for implementation of flexible use of airspace.

10.27 The restricted airspace for Defence may at present continue with the defence. However, the flexible use of airspace concept would imply that the size of airspace would vary on as required basis. For example, when the presently restricted airspace is not required for defence purposes, it could be made available to Civil Aviation and reciprocally if Defence needs, for limited period is larger, then the civil authorities could make additional airspace available for such requirements. Standard Operating Procedures (SOPs) for managing these changes would be worked out jointly and approved by the high level Committee.

10.28 As a first step, upper airspace above 29,000 feet could be released for civil traffic in the presently defined restricted/danger airspace. The Defence requirements would have a priority of not only increasing their height requirements but also expanding the restricted airspace, whenever required.

10.29 To divert the planned civilian traffic and not to cause undue hardship to passengers, a notice of at least 24 hours would need to be given. The normal defence air traffic would continue to use the upper airspace above 29,000 feet along with the civilian air traffic as at present.

10.30 IAF should review Restricted and Danger Areas expeditiously and suitable action be taken.

10.31 Efforts should be made for synchronisation of the ATM procedures for civil and military airspace which will lead for seamless sky and seamless transition from one sector to another sector.

10.32 Efforts also should be made to provide a seamless sky through standardisation of CNS facilities to meet both military and civil requirements.

CHAPTER – 11

Aviation Weather Services (AWS)

Introduction

11.1 Weather plays an important role for safe operations of aircraft. Pilots are required to obtain information about the enroute weather, prevailing and forecasted weather at destination and alternate airports to ensure safe operation of aircraft. Aircraft are not permitted to take-off unless the prevailing/ forecasted weather permits for safe operation of the aircraft. Accurate and timely weather information becomes critical during monsoon and fog conditions. Weather information like upper air wind data is also needed to work out fuel requirements and flight planning purposes.

11.2 In accordance with Article 28 of the Chicago Convention, 1944, Contracting States are obliged for the supply of Metrological Information and to ensure that aviation metrological services are provided in accordance with the International Standards and Recommended Practices (SARPs) stipulated in Annex 3 of the Convention. India being a signatory to Chicago Convention is obliged to follow these SARPs. Indian Metrological Department (IMD) is the "designated authority" in India to provide aviation metrological services and also to ensure that the metrological services are provided, to meet ICAO SARPs.

11.3 Terms of reference of Ajay Prasad Committee required specifically to examine/review and assess the "Weather Work Stations" and their compliance with the standards and recommended practices stipulated by ICAO. As the basic exercise of the committee is to formulate next generation futuristic Air Navigation Services Master Plan, it has not only assessed the present work station for their compliance but also examined future IMD plans. Further, the Committee has also examined the provision of meteorological services by defence authorities as many civil flights operate to/from defence airports.

ICAO's Global Plan Initiative (GPI) of Meteorological Systems

11.4 Global Plan Initiative (GPI) deals with the Meteorological Systems, with an ***objective*** to improve the availability of meteorological information to support a seamless global air traffic management system and describes the ***strategy*** as follows:

> "Immediate access to real-time, global operational meteorological (OPMET) information is required to assist ATM in tactical decision making for aircraft surveillance, air traffic flow management and flexible/dynamic aircraft routing which will contribute to the optimization of the use of airspace. Such stringent requirements will imply that most meteorological systems should be automated and that meteorological service for international air navigation be provided in an integrated and comprehensive manner through global systems such as World Area Forecast System (WAFS), the international airways volcano watch (IAVW) and the ICAO tropical cyclone warning system.

"Enhancement to WAFS, IAVW and the ICAO tropical cyclone warning system to improve the accuracy, timeliness and usefulness of the forecasts issued will be required to facilitate the optimization of the use of airspace.

"Increasing use of data-link to downlink and uplink meteorological information (through such systems as D-ATIS and D-VOLMET) will assist in the automatic sequencing of aircraft on approach and will contribute to the maximization of capacity. Developments of automated ground based meteorological systems in support of operations in the terminal area will provide OPMET information, (such as automated low-level wind shear alerts) and automated runway wake vortex reports. OPMET information from the automated systems will also assist in the timely provision of forecasts and warnings of hazardous weather phenomena. These forecasts and warnings, together with automated OPMET information, will contribute to maximizing runway capacity"

India Meteorological Department (IMD)

11.5 India Meteorological Department, under the Ministry of Earth Sciences is entrusted with the responsibility to provide meteorological information to all sectors including aviation. Accordingly, IMD was requested to provide their views to assist the Committee in formulation of India's Future Air Navigation Services – Master Plan. A detailed presentation was given by Director General, IMD of their set-up, the present scenario and their future plans.

11.6 It was informed that IMD caters to the needs of aviation through

- Four Metrological Watch Offices (MWOs) functioning at major international airports at Delhi, Mumbai, Chennai and Kolkata;
- 18 Aerodrome Meteorological Offices (AMOs), these include above four MWOs;
- 51 Aeronautical Meteorological Stations (AMSs); and
- Specialised Regional Meteorological Centre at New Delhi is also acting as Tropical Cyclone Advisory Centre (TCAC) of ICAO.

11.7 Four MWOs at major international airports (at Delhi, Mumbai, Chennai and Kolkata) maintain a continuous watch of meteorological conditions over their respective Flight Information Regions (FIRs). Kolkata MWO is also responsible for Guwahati FIR. These four MWOs prepare Significant Met Reports (SIGMETs) for hazardous enroute weather phenomena, such as, thunderstorm, tropical cyclones, turbulence, volcanic ashes etc. which may affect the safety of aircraft operation and exchanges SIGMETs with other MWOs in the region situated within 1100 nautical miles from the boundaries of its own FIR. MWOs also supply their own SIGMETs as well as SIGMETs received from other MWOs to their associated air traffic services units. It also supplies information received on pre-eruptive volcanic activity, a volcanic eruption and volcanic ash cloud to its associated Flight Information Centre and Area Control Centre.

11.8 AMOs maintain continuous watch over the meteorological conditions over the local aerodromes as well as over other aerodromes served by their associated Aerodrome Meteorological Stations. They prepare forecasts, warnings and other relevant information for flights operating from their aerodromes and their associated AMSs.

11.9 AMSs mainly supply current weather observations and their forecasting needs are met by the associated AMO.

11.10 TCAC, New Delhi monitors the development of tropical cyclones in its area of responsibility and issues advisories regarding the position of the cyclone center, its direction and speed of the movement, central pressure and maximum surface wind near the surface to the concerned MWOs. Advisories are also issued to World Area Forecast Centre, International OPMET data banks and other TCACs whose areas of responsibility may be affected.

11.11 It was also informed that Ministry of Earth Sciences had constituted an expert committee on “Meteorological Services at Airports” with the following terms of reference and objective.

- To arrive at a methodology for upgrading the meteorological facilities for aviation to make it more professional and tailor-made to user specific requirements.
- To keep in pace with the rapid aviation growth, changing technologies and operational requirements.
- To make specific standard configurations of met services at all airports with direct access to information to the airport managers/ATCs/ Pilots/ Airlines etc.
- To identify the requirements for development of special features using IT tools, improved product delivery and service.

11.12 The expert committee on Met Services identified following as Major Issues/ Thrust Areas for Modernisation and Standardisation of aviation meteorological services were:

a) Improving Observational and Communicational aids with interactive analytical and dissemination tools;

b) Introduction of improved forecasting/now-casting aids;

c) Introduction of state-of-art web based product delivery systems to the user agencies;

d) Uniformity in aviation Meteorological Office set-up as per their category, including manpower, basic infrastructure and amenities;

e) Training and Accreditation of Meteorologists; and

f) Establishment of a National Aviation Meteorological Centre.

11.13 Further, the expert committee gave 37 recommendations which are at various stages of implementation. Few of the recommendations require inter-ministerial consultation with ministries of defence and finance. These recommendations are:

- All the Defence airports which are catering to civilian flights should also be standardised and be given all the observational and communication facilities at par with the civil airports.

- Integration of IAF/Navy communication with IMD system at Defence airports from where civilian flights operate and would be operating.

- IMD should ensure standardization and optimization of the manpower at the existing and future airports as per the classification, by the recruitment of qualified and suitably trained manpower.

11.14 IMD was also requested to intimate their specific comments in respect of ICAO's GPI of Meteorological Systems. IMD intimated as follows:

a) *Automatic systems for acquisition, processing, dissemination and display in real time of meteorological parameters affecting landing and take-off*:

This is ***partially*** implemented at present. Automatic acquisition, processing and display in real time of meteorological parameters at various ATC locations is available at all the four Meteorological Watch Offices (MWO) but dissemination on AFTN is assisted through IMD's Automatic Message Switching Systems (AMSS). At other airports, there are Current Weather Instruments Systems (CWIS), Distant Indicating Wind Equipments (DIWE) etc. for remote data acquisition and display.

IMD would modernise aviation meteorological services at airports during the 11th Five Year Plan. Work has already started at three runway locations of Mumbai airport for the installation of Integrated Automatic Aviation Meteorological Systems (IAAMS) for the Automatic acquisition, processing, dissemination and display in real time of meteorological parameters. Supply orders have been placed for the installation of IAAMS at seven more airports with a target date of December 2007. IMD informed that equipments have arrived and work at Mumbai would be completed in February, 2008. The work at Delhi for Runway 27 and Hyderabad would be completed by March 2008 as all cables etc. have been laid. In addition procurement action has started for the IAAMS at 20 non-metro airports with the completion target date of March 2009. IMD has planned to provide such IAAMS at all 50 airports where ILS has been planned by AAI. IMD has also planned to install Terminal Doppler Weather Radar (TDWR), Wind Profilers, Anemometer array for wind shear detection and alert system as pilot projects at few selected airports in the 11th Five Year Plan.

b) Ministry of Earth Sciences informed in January, 2008 that the Cabinet has approved modernisation of observation and forecast facilities of IMD (Phase-I) at an estimated cost of Rs.920 crores to be implemented during first two years. Under this, the following equipments are to be installed at various airports:

Name of Equipment	Total Number	Estimated Cost
Airport Instrument System	26	Rs. 98 crores
Wind Profiler	4	Rs. 14.79 crores
Pilot Briefing System	15	Rs. 3.38 crores

Ministry of Earth Sciences further informed that apart from the equipments, there are many types of equipment which would also be used by IMD for forecasting purposes like

- Doppler Weather Radars (13 nos.);
- Automatic Weather Stations (550 nos.);
- Upper Air Instruments (Radio Sonde & Radio Wind – 25 nos.);
- Central Information Processing System;
- Lightening Detectors

c) All the meteorological instruments are located as per the ICAO regulations and WMO specified exposure conditions. The averaging period and reporting criteria for various parameters are as per ICAO Annex 3. The weather messages like METARs, TAFs, SIGMETs, Tropical Cyclone Advisories etc. are disseminated to other international airports, International OPMET Data Banks and WAFC through SADIS Gateway, Singapore, as per Air Navigation Plan (Doc. 9673 – Vol-II FASID 2006) and latest ROBEX Handbook (2007). The four AMSSs located at Delhi, Mumbai, Chennai and Kolkata also act as ICAO recognized National OPMET Data Banks for the automatic retrieval of aviation meteorological messages from any AFTN station.

d) The World Area Forecast System (WAFS) is fully implemented in India. The World Area Forecast Centre (WAFC) London data is received at Regional Telecom. Hub, IMD, New Delhi and this raw data is distributed to four AMSSs through IMD's Wide Area Network. At each of these AMSS, the data are processed and products like SIGWX charts, Wind and Temperature forecasts for different flight levels are generated using BUFR and GRIB decoders. These are further disseminated to other national airports through email, FTP or Fax on Demand servers.

e) A Tropical Cyclone Advisory Centre (TCAC) is operational at IMD, New Delhi to monitor the development of tropical cyclones in its area of responsibility, using geostationary and polar orbiting satellite data, radar data and other meteorological information. The centre issues Tropical Cyclone Advisories concerning the position of cyclone centre, its direction and speed of movement, central pressure and maximum surface wind near the centre to other MWOs and Regional OPMET Data Banks (RODBs) in its area of responsibility and as per ANP and ROBEX Handbook.

f) Presently, the meteorological information is being displayed by four MWOs at all desired ATC locations at Delhi, Mumbai, Chennai and Kolkata. At most of the other airports, meteorological information is displayed in Meteorological Briefing Room and ATC Tower only. At Mumbai and Kolkata, Meteorological information is broadcasted through VOLMET. The METAR / SPECI and TAFs of important airports are available on websites of Chennai, Mumbai and Delhi. IMD has also operationalised an on-line web based aviation products delivery system for the benefit of airlines operators w.e.f. 01/06/07. IMD has also planned to install Pilot Briefing Systems at fifteen airports by March 2009.

g) The use of data-link to downlink and uplink meteorological data through ADS-B, D-ATIS, CPDLC etc. has not started in India. Aircraft observations and reports are not being received and India is totally non compliant to Annex 3 - Chapter 5 in this regard. This aircraft sensed data can give vital information like wind shear and turbulence. This data will also improve Numerical Weather Prediction for upper winds and temperatures and can be used for any wake vortex monitoring system for optimizing the aircraft separations. This data will be passed on to World Area Forecast Centre (WAFC) through Regional Telecom Hub, New Delhi of WMO's Global Telecom System and also through AFTN/AHMS systems via SADIS Gateway, Singapore. Availability of this data will improve the WAFC's products like Wind/Temp forecasts and enroute Significant Weather information etc required for the safety of aviation services.

h) The exchange of aviation meteorological messages is the responsibility of AAI. However, IMD is using its communication network for the exchange of digital data received through WAFC because AFTN is not capable of handling digital data. AFTN is outdated character code based network and is being phased out globally by other digital networks. AAI should also upgrade its Information Technology infrastructure to support digital data exchange.

11.15 IMD informed that following additional points are essential and need consideration for the modernisation of Meteorological services at the airports:

i. There should be close and regular interaction between IMD and AAI for the seamless integration of Met and AAI systems.

ii. Additional office space should be provided to IMD in the ATC units of airports for the installation and operation of additional equipments being installed by IMD.

iii. AAI should provide basic infrastructure facilities like laying of power and signal cables, provision of essential power supply at various runway locations for the field meteorological instruments like CWIS, Ceilometers, Transmissometers etc. (*AAI may provide these services on chargeable basis.*)

11.16 Met Department had also raised some administrative issues, which have been referred to AAI for necessary action.

11.17 The synchronisation of upgrading plans of IMD and AAI was discussed with Director General, IMD. AAI has been able to upgrade their equipment at various airports in a comparatively faster manner than the matching meteorological equipment by IMD, which has created an unbalance.

11.18 AAI had informed during their presentation that they have installed 43 ILS at 37 airports and 7 more ILS equipment are under installation. IMD provides matching RVR equipment, which provides continuous and automatic visual range of runway to the Air Traffic Controllers to be passed on to taking-off or landing aircraft. At present, only 17 RVR equipments are installed and IMD plans to provide RVR equipment for rest of the airports up to 2012 i.e. by the end of 11th Five Year Plan. At airports where RVR equipment is not available manual readings of RVR is taken by IMD officers, whenever visibility falls below 2000 meters. These manual readings are appropriate for flight planning purposes, but cannot be considered adequate for actual landings as RVR is directly related to the minimum height to which the aircraft is permitted to descend during landing. Such gaps in the equipment configuration are not safe and require immediate remedial measures.

11.19 The dissemination of aviation meteorological information through web services was discussed with Director (Aviation), IMD. He informed that at present only WMO, Chennai is hosting a web site for aviation and WMOs at Delhi, Mumbai and Kolkata are also in process of hosting similar web sites. The information on the web site contains weather data downloaded from World Area Forecast System, which is upgraded by adding SIGMETs of all the four WMOs. He agreed to the suggestion that there should be a national web site containing complete aviation weather information of India.

Meteorological Services at Defence Airports

11.20 Several defence airports are being used by civil aircraft, which is increasing day-by-day due to considerable growth of civil aviation. Similarly, defence aircraft also use civilian airports. Defence authorities have their own set-up for meteorological observations and weather forecasting and there is a need for

standardisation across the country of these meteorological services at defence and civil airports.

11.21 A meeting was held with Assistant Chief of Air Staff (Meteorology), IAF with a view to understand their system. He informed that as of now there is no structured system of communication between IMD and IAF to exchange aviation meteorological data. This results into non-availability of weather information of IAF airfields to civilian forecasters and similarly non-availability of weather information of civil aerodromes to IAF forecasters. The airline operators are, therefore, forced to directly contact IAF meteorologists to obtain the weather of destination defence airfields.

11.22 Regarding the meteorological equipment at defence airfields, ACAS (Met) informed that as of date, meteorological observation systems at majority of military airfields in the country is not as per ICAO specifications. Indian Air Force on its part has initiated measures to install Automatic Weather Stations at all Air Force airfields and these are expected to be operational by April 2008. It was also informed that Air Force is in the process of procuring 11 Doppler Weather Radars (DWRs), which will be deployed across India.

11.23 During another discussion with Air Traffic Services Directorate of IAF, it was informed that IAF is upgrading its facilities at many airfields, which include installation of Category II ILS. It is understood that RVR equipment compatible with Category II ILS would also be installed as a part of the project.

Airline Practices

11.24 All airlines, prior to a flight, are required to obtain prevailing and forecasted weather at destination and alternate airports to ensure that the weather at the estimated time of arrival is higher than the minima requirements of the flight. Airlines also require upper air wind & temperature data, which is used for calculating the fuel requirements and flight planning purposes.

11.25 Airlines normally obtain Meteorological Reports (METARs) of prevailing weather at the airports, Terminal Area Forecasts (TAFs) and enroute weather from IMD office at departure airport. Sometimes, the weather information of destination and alternate airports is not readily available at the departure airport. Such situation regularly happens when the flight from the departure airport has to take-off before the watch is opened at the destination airport. Further, there is no structured system through which IMD can obtain weather information of defence airfields. Similarly, it is difficult to obtain the information of civilian airports from defence airfields. Airlines, therefore, have a system to obtain the destination weather directly from the airports either through telephones or through their own staff posted at the airports.

11.26 Enroute data of upper air wind & temperature data provided to airlines by IMD is through charts, which cannot be used directly by electronic flight planning software. Most private airlines are using electronic software for flight planning through service providers, who obtain digital enroute data, METARs and TAFs from World Area Forecast System (WAFC). However, these international service providers for flight planning are also not able to obtain information about many domestic airports. The basic reason is that IMD disseminates weather information to WAFC for only 12 airports used for international scheduled airlines either for regular use or as alternate airports. Digital data in respect of other Indian airports, even though available is not disseminated by IMD.

Discussions and Recommendations

Revenue and Budget Allocation of IMD

11.27 Air Navigation Service Provider (ANSP) meets its responsibility for the provision of Aviation Weather Services by dissemination of aviation weather reports and forecasts prepared primarily by the Meteorological Service (MS) of respective States. This necessitates that MS is able to provide aviation weather information in accordance with the needs of ANSP. In India, function of ANSP is performed by AAI and function of MS is performed by IMD.

11.28 Prior to the formation of National Airports Authority in 1986, DGCA used to charge aircraft operators for providing air traffic services, aeronautical communications and navigational aids and **meteorological services** and revenue so generated was debited to Consolidated Funds of India. There was no difficulty as both DGCA and IMD were Central Government Offices. Their wok culture and general service conditions were the same. Most of the issues/ difficulties could be resolved at the airport level and others were resolved at Headquarters level.

11.29 The National Airports Authority Act, 1985 authorised the Airport Authority to charge the aircraft operator for the above services including the charges for the meteorological services provided by IMD. Later on in 1995, with the amalgamation of the National Airports Authority and the International Airports Authority, the power was transferred to Airports Authority of India (AAI).

11.30 With the formation of National Airports Authority there was a change in service conditions and small issues like office accommodation, electricity charges, maintenance charges of residential accommodation etc., which did not pose any problems earlier, arose at many stations but could not be resolved as AAI started levying commercial charges. Thereafter, IMD also started asking for payments of the meteorological services. The charges collected by National Airport Authority in respect of meteorological services were never reimbursed to IMD.

11.31 For reimbursement of cost of Meteorological services provided by IMD for aviation, a committee was constituted by Ministry of Civil Aviation in 1997.

It submitted its report in 2002 and in July 2006, an MOU was signed between IMD and AAI on cost reimbursement.

11.32 IMD has not been able to synchronise its plans for aviation with AAI. One of the reasons for the gaps is that IMD being Government Office, procurement of equipment may still be possible subject to budget allocation but creation of manpower is a very cumbersome and difficult process. AAI being a PSU is not only able to procure their equipment but also create posts to man their equipment. IMD, therefore, lags behind AAI in synchronising the plans.

11.33 Cabinet has approved modernisation of observation and forecast facilities of IMD (Phase-I) at an estimated cost of Rs.920 crores to be implemented during first two years. ***The budget allocation is about ten times its earlier budget and it needs to be ensured that it is fully utilised.***

11.34 A simple budget allocation by the Government or a reimbursement by AAI for meteorological services may not be a complete solution. ***Ministry of Earth Sciences should review the policy on providing Aviation Weather Services, which synchronises the requirements of AAI, coordinates with IAF Met for seamless bi-directional flow of Met Data and also meets the requirements of airlines.***

11.35 ***To meet the above objective, it is recommended that a Standing Committee under the Ministry of Earth Sciences may be constituted having members from Ministries of Civil Aviation and Defence, IMD, AAI, IAF, DGCA and scheduled airlines to meet the operational requirements.***

The Organisation

11.36 The weather at an airport is a result of prevailing weather in large area surrounding the airport and for forecasting prevailing weather over even larger area need to be analysed. Further, aircraft operates from one airport to another airport and requires enroute weather information for its safe operation. Aviation Weather Services (AWS) require collection of meteorological data in real-time from large number of observatories, neighbouring countries and other Global centres, which is subsequently processed by Super Computers using numerical weather prediction (NWP) models. In addition, Satellite Division and National Climate Centre of IMD also provide significant inputs for aviation activities. Products so generated are also disseminated through IMD's communication network. AWS, therefore, cannot be provided only by providing stand alone equipments at the airports and only IMD can provide such service.

11.37 IMD has a large setup and aviation division is small part of it, which at present in no condition to cope up with the needs of civil aviation with an unprecedented growth. AWS is not only required to meet the needs of the airports but also the needs of both domestic and international airlines, which are growing considerably. ***It would be most appropriate to establish a separate National Aviation***

Meteorological Centre (NAMC) under IMD to meet aviation weather requirements of all stakeholders.

11.38 ***IMD should ensure standardisation and optimisation of the manpower at the existing and future airports as per the classification, by the recruitment of qualified and suitable trained manpower.***

11.39 ***Periodic refresher training to the officers/staff involved in aviation weather service should be arranged to keep abreast of advancement in latest forecasting techniques and instrumentation.***

11.40 ***IMD should arrange periodic training abroad and field trips to foreign airports to understand their management and service delivery systems.***

Collection and Dissemination of Aviation Weather Data

11.41 The objective for future aviation weather requirement should be to achieve immediate access to real-time, global operational meteorological (OPMET) information.

11.42 To achieve the above objective, it would be necessary that meteorological systems should be automated and that meteorological service for international air navigation be provided in an integrated and comprehensive manner.

11.43 Sources of aviation-relevant data for strategic and tactical decision making with respect to aircraft routes and flow management (Automatic Weather Observing Systems, Doppler Weather Radars, Weather satellites, Wind Profilers, etc.) should be introduced. Improved weather data content and enhanced displays will allow controllers to make better tactical control decisions and provide more accurate information to pilots.

11.44 Few examples of the meteorological systems required to be installed for providing automated weather services are as follows:

- Airports should have
  - Digital Current Weather Instrument System (DCWIS) for measuring wind direction & speed, temperature, atmospheric pressure etc.;
  - Laser Ceilometers for measuring cloud heights; and
  - Transmissiometers for assessing RVR (Runway Visual Range) at runways and runway ends depending upon the category of ILS.
  - GPS Based equipments to identify visibility land mark, night visibility landmark masts to be erected, wherever is required and polar diagrams shall be updated periodically.
- A network of Doppler Weather Radars should be established providing cover to the all airports in country to detect thunderstorms and clear air turbulence.

- Terminal Doppler Weather Radar/Anemometer array, wind profilers should be installed at airports to detect low wind sheer.

11.45 ***These devices should be integrated systems with facilities for automatic acquisition, processing, real-time display and dissemination of met information to various user terminals as per ICAO and WMO requirements.***

11.46 ***All the defence airports catering to regular civilian flights should also be standardised as per ICAO requirements with all the observational and communication facilities at par with civil airports.***

11.47 ***Provision of web-based meteorological briefing system may be made to enable user agencies to have direct access to weather information, including weather information of defence airports where civilian flights operate on regular basis.***

Miscellaneous Recommendations

11.48 Periodic upgradation of the climatology of all the civilian airports, including defence manned airports every five years and digitization of the current weather data on real-time basis.

11.49 In addition to AFTN channels, all airports met office should have modern communication facility to assimilate satellite imageries, radars imageries, NWP products, AIREPs, routine observations and forecast etc. into briefing systems using IT based technologies like Automatic Self Briefing System (ASBS) and Web-based briefing system with built-in redundancy. The AFTN channels also needs up-gradation to handle the digital data in the requisite format.

11.50 All the four MWOs should have automatic plotters and analyser, which would facilitate the forecasters to assess and prognosticate the current synoptic situation through a forecaster workstation. It should be capable of handling and integrating synoptic & asynoptic observations including reception of WAFC and NWP products and other soft computing.

11.51 A strong R&D support should be given for aviation metrology, and a centre dedicated for operational research in aviation metrology may be considered. The user agencies should be encouraged to sponsor fellowships at institutes and universities to encourage research in aviation meteorology and to attract best talents in aviation metrological services.

CHAPTER – 12

Master Plan and Recommendations

12.1 The Committee examined the various CNS/ATM plans of the AAI with a view to identify the gaps which need to be filled for requirements of a modern Air Traffic Managements System. The basis of the CNS plan should be to meet the needs of the public, the stakeholders and the requirements of Air Traffic Management system rather than to plan for CNS infrastructure and then administer air traffic control (ATC) on that basis. The objectives of the ATM system including the operational concepts, should be spelled out clearly and then the required the CNS infrastructure should be planned accordingly.

Objectives of CNS/ATM Systems Plan

12.2 In the present scenario when the aircraft are being significantly delayed due to considerable increase in air traffic, a public perception is growing that Indian "skies are not safe due to reported near misses" and various failures of equipments. The objectives, therefore, must address the safety issues and significant delays. An ATC delay of more than five minutes should be considered as significant and accordingly the capacity to handle the air traffic should be determined. Once a capacity is analysed scientifically, the system should not be overloaded. Central Air Traffic Flow management should be in place to ensure that any anticipated overload is appropriately handled without compromising safety issues.

12.3 The main objectives should be in harmony with the Global and Regional Plans of ICAO:

i) To maintain and enhance safety levels in the face of higher traffic densities.

ii) To provide ATC capacity to handle to air traffic that would meet the forecasted demand without significant delays.

iii) To enable all airspace users to operate efficiently while accommodating both civil and military operators' needs.

iv) To provide the required ATM services in a cost-effective manner.

v) To provide interoperability with adjacent airspaces.

vi) To adopt ICAO standards, specifications and functionalities that will standardise the ATM environment.

12.4 The Master Plan has been considered in three following parts:

Near Term/Immediate

The Plan is based on **what we have today** and involves application of procedures, processes and capabilities. It identifies potential gaps to be filled immediately. Time frame should be not more than 2 years.

Medium Term

The Medium Term Plan is based on **what we know today** and involves emerging procedures, processes and capabilities. It identifies gap requirements and action to be planned to implement the same. Time frame should be 11th Five Year Plan i.e. up to year 2012.

Long Term

It is **based on concepts** and involves new procedures and requirements based on Research.

NEAR-TERM / IMMEDIATE PLAN

Streamlining of Air Traffic Procedures

12.5 The present CNS/ATM infrastructure is not adequate to handle even the present air traffic requirements and would not be able to cater for significant growth of air traffic. Building up of infrastructure always takes time. The only way left for immediate results is to enhance the capacity by making the procedures more efficient. This exercise is difficult because we get used to procedures, which were followed when the traffic density was light. There is always a reluctance to change the existing procedures and it needs serious commitment of the management to review them and make them more efficient. It is a continuous exercise for attaining excellence.

12.6 The example of Delhi and Mumbai shows that the handling capacity of both airports considerably increased after some procedural changes were introduced without any significant augmentation of infrastructure.

12.7 At Delhi airport to meet IAF air defence requirements, Khola Committee recommendations regarding air traffic procedures were implemented in 2003, which introduced delays. The recommendations related to creation of a safe zone of at least 20 NM around Delhi airport, which required to following:

- Deviation from the straight path during landing and take-off is not permitted. This requirement does not permit short vectoring of the aircraft by Radar Controllers, which was resorted many times to expedite the landings. Similarly, during take-off as the change of headings are permitted only after crossing the safe zone, procedure during simultaneous use of runways require staggering of take-offs, reducing the capacity considerably.

- Procedure of visual landings is not permitted, which allows closer spacing of aircraft as the pilots can see the aircraft in front and is used on all congested

runways of the world. Instrument procedures always stipulate minimum spacing, which cannot be reduced below a certain limit.

- Holding over Terminal VORs ('DPN') is not permitted and now radar procedures and other VORs are being used, which also results in delay.

12.8 ***Relaxation of these procedures would help to reduce delays at Delhi airport, AAI management and Ministry of Civil Aviation should pursue the case for such relaxation vigorously with the Competent authority.***

12.9 The aerodrome operators were of the view that there was scope to improve Air Traffic Services and considered it possible to significantly increase the capacity of runways by following proper procedures. To substantiate their views Excel charts were provided which reflected total movements of arrivals and departures in each hour of the day at Gatwick airport, which has a single runway. The charts show the total movements could reach up to 50 per hour.

12.10 The present system followed in India for radar separation between the aircraft at the time of landing is about 6-8 NM, which creates a gap of 2-3 minutes between the landings i.e. only 20 landings in an hour. The gap of 3 minutes is adequate to let an aircraft enter the runway and take-off, which can immediately enhance the movements to 40 per hour.

12.11 The ICAO Doc. 4444, which deals with the procedures for Air Traffic Management and is a Bible on the subject permits a normal radar separation of 5.0 NM between the aircraft and can be reduced to 3.0 NM when radar capabilities permit. The radars installed at Delhi and Mumbai have excellent capability and if a separation of 3 NM is used then the capacity can be enhanced considerably. It may not be out of place to mention that Doc.4444 even permits a separation up to 2.5 NM between succeeding aircraft which are established on the same final approach track within 10 NM provided certain conditions are met.

12.12 ***AAI should immediately review air traffic procedures being followed at various airports, especially at Metro airports and initiate action to increase the capacity the air traffic which could be handled through revised procedures. AAI should take this as a continuous exercise and strive to achieve optimisation of the procedures.***

Performance Based Procedures

12.13 Worldwide RNP approaches are being used to increase airspace capacity in dense traffic areas. It is possible to segregate conflicting airport approaches with the help of such procedures, which increases the arrival capacity by 50% at an airport. It also improves traffic predictability and safety considerably.

12.14 Similarly, RNP Missed approaches and RNP Departure paths can be easily segregated on converging runways (as of Delhi airport), which would result in enhanced capacity at the airports.

12.15 The new generation aircraft are capable to move on any defined path and use of 'Constant Descent Path' right from top of descent coupled with RNP options can be used for closely spaced parallel approaches to considerably increase the capacity.

12.16 Such special procedures are being actively supported by FAA for nation-wide implementation programme. FAA under the umbrella of ICAO had recently carried out workshops in India and there was an overwhelming response to it from the airlines, AAI and DGCA.

12.17 AAI has entered into a contract with MITRE for developing these procedures for Mumbai and Delhi and to build in-house capability for other airports.

12.18 ***AAI should implement these RNAV and RNP procedures at Mumbai and Delhi as soon as they are finalised by MITRE***.

12.19 The near-term/immediate plan also envisages the CNS/ATM infrastructure to be enhanced. The detailed discussions are in the respective chapters dealing with the subject.

Communication Systems

12.20 ***Voice Communication*** is one of the primary requirements for providing air traffic control services. Conventionally there are two types of radios used for the purpose, one working on VHF frequencies, which is line-of-sight communication and has a range of about 200 NM at 30,000 feet and the other HF frequencies, which has a longer range but the weather affects the communication considerably. VHF radios are used in the continental airspace and limited use of HF radios is for oceanic region. The detailed discussions are in Chapter 5 and the specific requirements and recommendations relating to Near-term/Immediate Master Plan are reproduced below.

12.21 ***AAI plan to complete VHF coverage throughout the continental airspace at a height of 20,000 feet and above should be implemented on priority but not later than the new targeted date of May 2008.*** (Reference paragraph 5.20)

12.22 ***AAI, in order to meet international standards of ICAO, should provide VHF coverage in the Area Control Centres, which have been declared as Class 'D' airspace by AAI and are required to provide VHF coverage to all IFR & VFR flights operating there in.*** (Reference paragraph 5.21)

12.23 As stated above coverage of VHF radios is limited to line-of-sight operations. The extension of coverage is provided through remote operations of VHF radios, which requires a link to operate the remote equipment to transmit/receive voice communication to/from the equipment. An operation of such equipment is known as Remote Controlled Air Ground (RCAG) VHF, the reliability of which is dependent on link used for the purpose. AAI plans to connect 80 airports shortly through Dedicated Satellite Communication Network (DSCN), which has an excellent reliability and RCAG VHF equipments can be operated through it.

12.24 ***AAI should use the Dedicated Satellite Communication Network for operating RCAG VHF equipments.*** (Reference paragraph 5.31)

12.25 ***Digital - Automatic Terminal Information Service (D-ATIS)*** enables data link equipped aircraft to send a request to the Air Traffic Service provider to automatically obtain terminal information like weather information, which runways are active, available approaches, and any other information required by the pilots, such as important NOTAMs. The D-ATIS implementation relieves the ATCO of repetitive task of recording material for transmission. Further, the data link enables the flight crew to access the information during any phase of flight mitigates the risk of misunderstanding and transcription errors.

12.26 ***The Committee is of the opinion that AAI should upgrade the ATIS facility to D-ATIS facility having both Voice and Data Link capabilities at the earliest as the equipment bought has a capability to provide the same.*** (Reference paragraph 5.42)

12.27 ***Data Link Services*** like pre-departure clearance, oceanic clearance, D-ATIS, automatic position reporting, etc can bring immediate efficiency benefits to the provision of Air Traffic Services (ATS). AAI is already using Controller Pilot Data Link Communication (CPDLC) messages for oceanic clearances.

12.28 ATM Directorates requires that Data Link for clearance delivery should be implemented at Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Ahmedabad and Calicut airports. AAI has informed that the DATALINK for clearance delivery for Mumbai and Delhi airports was part of automation upgradation project, which is delayed due additional requirements and the revised PDC is August 2008.

12.29 ***AAI should provide Data Link application for departure clearances at Mumbai and Delhi as per their plan with PDC of August 2008.*** (Reference paragraph 5.43)

12.30 **ATS Inter-facility Data Communication (AIDC)** permits exchange of information through a data link. ATM Directorate requires that this facility to be provided in all ACCs and ATC units to be implemented at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Bangalore, Ahmedabad, Varanasi, and Nagpur. AAI informed

that AIDC for Mumbai and Delhi airports is also a part of automation upgradation project for which the revised PDC is August 2008.

12.31 ***AAI should provide AIDC to communicate with all ATS units for Mumbai and Delhi as per their plan with PDC of August, 2008.*** (Reference paragraph 5.44)

12.32 Primary means of Communication in Oceanic airspace is through CPDLC with FANS-1/A equipped aircraft and the secondary means is through HF Radio at Mumbai, Kolkata, Chennai Oceanic control centres. The major difficulty is being reported for Mumbai HF radio.

12.33 ***It would be appropriate to conduct detailed studies of the difficulties faced by pilots operating in the Mumbai FIR and take appropriate action to rectify the transmission/reception on HF 'MWARA' frequencies for international operations in the region.*** (Reference paragraph 5.50)

Navigation Systems

12.34 The new generation aircraft are able to navigate more accurately through Inertial systems on board and are able to monitor their performance with the help of aircraft Flight Management Systems (FMS). It is, therefore, possible to design ATS route demanding accurate navigation, like RNP-10, RNP-1, which would considerably reduce the width of the ATS routes and permit addition of more routes resulting in enhanced capacity of the airspace. ICAO Annex 11, which stipulates SARPs for Air Traffic Services recommends at Para 2.7.2 that for the en-route phase of flight, RNP types RNP-1, RNP-4, RNP-10, RNP-12.6 and RNP-20 should be implemented as soon as practicable.

12.35 ***RNAV & RNP routes significantly enhance the capacity of airspace and should be adopted by AAI for domestic and international routes.*** (Reference paragraphs 6.9 and 8.20)

12.36 As stated above precision approaches can be made through ILS equipment, which provides vertical guidance through the 'glide slope' component of the ILS. Out of about 80 operational airports, 40 only have ILS equipment. However, a near precision approach with vertical guidance known as 'APV Baro VNAV Approach' can be designed to be used by modern aircraft equipped with FMS computers providing constant descent glide-path. This would be the most cost effective and quickest way to enhance safety and efficiency at airports with insufficient or no landing aids and runways with Non-Precision Approaches only.

12.37 ***The Committee, therefore, is of the opinion that AAI should on priority design and provide Approaches with Vertical Guidance for runways not equipped with ILS. Such approaches are close to Cat-* I *ILS and reduce risk of CFIT accidents.*** (Reference paragraph 6.19)

12.38 Global Navigation Satellite Systems (GNSS) provides to the aircraft its position for navigation. The GNSS signal is accurate for en-route navigation but its accuracy does not permit navigating the aircraft for a precision landing. It is possible to enhance the accuracy of the GNSS signal through a Ground Based Augmentation System (GBAS), which permits to land with an accuracy equivalent to ILS Cat-I landing. An ILS Cat-I equipment is required to be installed on each end of the runway, therefore an airport having 3 runways would need 6 ILS Cat-I equipments to be installed to permit a precision landing from any end of the runways. Further, ILS equipment has site requirements at runway ends, which some times are not fulfilled thereby restricting its installation. Single GBAS equipment at an airport is sufficient to cater for all ends of the runway. Airports having two or more than two runways should have a GBAS especially when some end does not meet the site requirements for ILS, as in case of Mumbai airport.

12.39 ***AAI should install GBAS system at Delhi and Mumbai airports.*** (Reference paragraph 6.24)

Surveillance Systems

12.40 Surveillance is essentially performed with the help of radars. The aircraft based Automatic Dependent Surveillance – Broadcast (ADS–B) systems are much cheaper option than radars but require ADS–B equipment on board, which at present many aircraft are not equipped with it. Multilateration equipment also pinpoints the location of aircraft (Reference paragraph 2.28) with the help of Mode S transponder on board the aircraft. It may not be possible to use these ADS–B and Multilateration technology in the near term plan and existing and planned radars are discussed.

12.41 Behrampur radar was installed and is working for about 5 years but could not be declared operational because of the low reliability of the data link between Behrampur and Kolkata.

12.42 ***AAI should use DSCN circuit to operationalise Behrampur radar immediately.*** (Reference paragraph 7.8)

12.43 AAI has planned installation of ten new radars, 3 ASR/MSSR (Primary + Secondary) at Cochin, Amritsar & Bangalore (BIAL) airports and 7 new MSSR (Secondary Radars) to fill up radar gaps at Jodhpur, Bhopal, Porbandar, Bellary, Vizag, Jharsuguda & Katihar/Kishanganj. AAI initially in April 2007 had informed the PDC of all the 10 radars as 2008-09. However, in January 2008 AAI revised the PDC of radars at Cochin and Amritsar to September 2009 and 7 other radars to December 2009. Bangalore radar is under installation with a PDC of March, 2008.

12.44 ***AAI should install all 10 radars on priority as it helps to reduce the spacing of the aircraft and increase the capacity of airspace.*** (Reference paragraph 7.1)

12.45 Installation of independent radars helps in airport terminal areas where traffic density is high as it assists in reducing the spacing between the arriving and departing aircraft. The three planned radars (ASR/MSSR) at Amritsar, Bangalore and Cochin come in this category. Installation, however, requires setup for providing radar approach control from these airports requiring highly trained ATCOs and results in deconsolidation of airspace, which normally should be avoided.

12.46 The other 7 radars are being used for fill up radar gaps for surveillance of Indian airspace. With the installation of these radars almost complete Indian airspace and the ATS routes would be covered at a height of 20,000 feet and above. It would permit radar separations between the aircraft introduced in Indian airspace, which is much lesser than the procedural spacing and thereby enhancing the capacity significantly. These radars, however, can be effectively used only with the networking, otherwise new ACCs would have to be created at these locations, which would result in massive deconsolidation of airspace and should be avoided. With the availability of DSCN, AAI should network all the radars simultaneously. AAI has informed PDC as 2008-09 for Radar networking.

12.47 ***AAI should network all radars in accordance with their planned PDC of 2008-09 and 10 new radars being procured should be commissioned in the network mode permitting them to operate from ACCs at Delhi and Mumbai.*** (Reference paragraph 7.1)

12.48 The ICAO procedures permit separation between the aircraft up to 2.5 NM between succeeding aircraft which are established on the same final approach track within 10 NM provided certain conditions are met. It is essential that such procedures are put in place at Delhi and Mumbai airports. ATM Directorate in their requirements have stated that two and more overlapping Terminal Approach Radars (TAR) i.e. PSR+MSSR should be available at Mumbai and Delhi to support reduced spacing on final approach to 3NM and multiple runway operations to enhance capacity.

12.49 ***As AAI is already in process of procuring 10 new radars, it is appropriate that this requirement of Delhi and Mumbai is also added to the process to expedite procurement of radars for reducing spacing between succeeding aircraft in the final approach track to 3 NM.*** (Reference paragraph 7.2)

12.50 AAI has installed Advanced Surface Movement Guidance and Control Systems (ASMGCS) at Delhi Airport for surveillance and control of all aircraft and ground vehicles in the operational area of the airport and is extremely effective against runway incursions. Similar systems are now being installed at Mumbai, Chennai, Kolkota, Bangalore and Hyderabad. Initially AAI informed the PDC 2008-09 for Mumbai, Chennai & Kolkata but at the end of January, 2008 revised the PDC to September 2009. The PDC for Bangalore and Hyderabad has also been revised from March 2008 to April/May 2008.

12.51 ***AAI should install Advanced Surface Movement Guidance and Control Systems (ASMGCS) as per their plan.*** (Reference paragraph 7.1)

12.52 The trials of ADS-B at Chennai were successful but AAI has informed that during their trails only 10% of the aircraft were equipped with ADS-B equipment. AAI therefore plans to use the ADS-B system after significant improvement in aircraft equipage and maturity of technology. FAA has opened an office for Surveillance and Broadcast Services program in 2005 and ADS-B is one of the crucial components of their Next Gen programme.

12.53 ***The Committee is of the opinion that it would be appropriate for AAI to start planning the ADS-B with extended multilateration infrastructure now rather than wait for regional plans, which are essentially to cater for international traffic.*** (Reference paragraph 7.13)

12.54 ***It may also be appropriate to have ADS-B surveillance system at Port Blair and Agatti as suggested by ATM Directorate.*** (Reference paragraphs 7.2 and 7.15)

ATS Systems

12.55 ***The functional capabilities of ATS support systems such as conflict prediction, detection, advisory and resolution needs to be standardised and should be made available to ATCOs.*** (Reference paragraph 8.23)

Air Traffic Management Automation Tools

12.56. With increasing number of arrivals and departures at congested airports it is not possible to use conventional procedures for safe and efficient handling of the traffic. Automated solutions for handling the air traffic in different phases of flight are readily available today. Surface Multilateration and Surface Management systems are used for aircraft movement at airport ramp area. Terminal Automation augmented with departure management is used for take-off and departure procedures. Integrated automation is being used for coordinated flight trajectories, civil/military strategic flight planning across airspace and 'Medium Term Conflict Detection' tools for en-route phase of the flight. Similar integrated automation for Oceanic surveillance is also available. Arrival Management tools are used for efficiently handling arriving and landing aircraft and thereby increasing airspace capacity.

12.57 Such tools are not available at present even at the busy airports like Mumbai and Delhi, which is big handicap for the air traffic controllers and are forced to handle the traffic manually by gaining the experience.

12.58 Automation capabilities are available today, which increases not only the efficiency and capacity but it also enhances the safety considerably.

12.59 ***AAI should immediately evaluate the existing automation solutions/ technologies and implement them expeditiously with a view to deliver near-term benefits.***

Air Traffic Flow Management (ATFM)

12.60 The objective of ATFM is to ensure an optimum flow of air traffic to or through areas during times when demand exceeds or is expected to exceed the available capacity of the ATC system. An ATFM system should therefore reduce delays to aircraft both in flight and on the ground and prevent system overload. The ATFM system assists ATC in meeting its objectives and achieving the most efficient utilization of available airspace and airport capacity. ATFM should also ensure that safety is not compromised by the development of unacceptable levels of traffic congestion and, at the same time, to ensure that traffic is managed efficiently without unnecessary flow restrictions being applied.

12.61 In an integrated ATM system, real-time flow management tools will be required to assimilate the mass of information and offer flow strategies that take full advantage of changing conditions. Many aircraft have sophisticated FMSs that can adapt to changing situations and will communicate automatically with ground systems; therefore, they will be valuable partners in the flow strategy decision-making process. Comprehensive databases will describe current and projected levels of demand and capacity. Sophisticated models that accurately predict congestion and delay will be used to formulate effective real-time strategies for coping with excess demand. Users will interface with the flow management process in-flight planning to negotiate trajectories that best satisfy their needs while meeting ATM capacity constraints.

12.62 The tactical flow management process that monitors the progress of individual aircraft and intervenes in their flight paths when required to meet ATM constraints (e.g. separation standards) will also make extensive use of automation. When a user determines that a flight plan amendment or update is required, a negotiation process will be established between the aircraft's flight management computer system and the ground-based tactical management process to define a new trajectory that best meets the user's objective and satisfies ATM constraints. Similarly, when the ground-based tactical management process recognises a need to intervene in the cleared flight path of an aircraft, the ATM computer will negotiate with the flight management computer to determine a modification meeting ATM constraints with a minimum deviation from the user's preferred trajectory. These negotiation processes would be a dialogue involving both the pilot and air traffic controller to the extent required to permit them to exercise their management and control responsibilities. In essence, ATS and ATFM will merge into a single, seamless system.

12.63 Annex 11 and ICAO Doc 4444 stipulate that an air traffic flow management (ATFM) service shall be implemented for airspace where traffic demand at times exceeds the defined ATC capacity.

12.64 ***As International Standards of ICAO stipulated in Annex 11, which deals with Air Traffic Services and ICAO Doc 4444, makes it obligatory for India to have Air Traffic Flow Management System, AAI needs to implement AFTM system expeditiously preferably in the Near-Term-Immediate Plan***. (Reference paragraphs 8.24 to 8.27)

MEDIUM TERM PLAN

Performance Based Procedures

12.65 As stated above AAI has entered into a contract with MITRE for developing RNAV and RNP procedures for Mumbai and Delhi and to build in-house capability for other airports. The plans for Mumbai and Delhi are being finalised by MITRE. Plans of few other airports would be developed by AAI under supervision of MITRE as part of building in-house capabilities. As aircraft navigation capabilities are increasing it would be appropriate to include them while preparing these procedures.

12.66 ***In view of the above, the Committee is of the view that AAI while developing the capability to design Area Navigation (RNAV) and Required Navigation Performance (RNP) procedures should take into account the aircraft capability to achieve sequencing requirements to runways through use of the "required time of arrival" function within the flight management system (FMS) of aircraft.***

12.67 Medium Term Plan also like the near-term-immediate plan, envisages the CNS infrastructure to be enhanced. The detailed discussions are in the respective chapters dealing with the subject.

Communication Systems

12.68 ATM Directorate of AAI has projected their requirements of complete VHF coverage in the Area Control Centres (ACCs) at 10,000 feet and above, overlapping VHF coverage in ACCs to ensure positive control and to permit dynamic sectorisation and VHF networking & retransmission capability to support consolidation/ deconsolidation of sectors. A discussion on the ATM requirements is at paragraphs 5.22 to 5.28 and Committee is of the following view:

12.69 ***AAI should meet the following requirements of ATM Directorate in the continental airspace:***

- ***a) VHF coverage up to 10,000 feet & above in ACCs;***
- ***b) Overlapping VHF coverage in ACCs to ensure positive control and dynamic sectorisation; and***
- ***c) VHF networking to support consolidation of sectors during lean traffic periods and deconsolidation during peak traffic hours***

12.70 Regarding provision of Data Link services the discussion is at paragraphs 5.32 to 5.37 and the Committee is of the following view:

12.71 ***AAI should provide Data-Link Services like pre-departure clearance, automatic position reporting and ATC Clearances.***

12.72 ATM Directorate has projected that data-link for Air Traffic Control –clearance delivery should be implemented at Mumbai, Delhi, Kolkata, Chennai, Hyderabad, Ahmedabad and Calicut. AAI has informed that clearance delivery is part of automation upgradation project for Mumbai and Delhi. For rest of the airports the PDC is August 2009.

12.73 ***AAI should implement clearance delivery (i.e. Pre-Depature Clearance and Departure Clearance) for other major airports like Kolkata, Chennai, Hyderabad, Bangalore, Ahmadabad, Calicut etc.*** (Reference paragraph 5.43)

12.74 ATS Inter-facility Data Communication (***AIDC***) permits exchange of information through a data link. ATM Directorate requires that this facility to be provided in all ACCs and ATC units to be implemented at Mumbai, Delhi, Chennai, Kolkata, Hyderabad, Bangalore, Ahmedabad, Varanasi, and Nagpur.

12.75 AAI has informed that AIDC is part of automation upgradation project for Mumbai and Delhi. AAI also informed that for Chennai and Kolkata AIDC facility has been planned as part of ATS automation modernisation programme to be implemented by September, 2009.

12.76 ***The Committee is of the opinion that it is essential that AAI provides AIDC to communicate with all ACCs and ATS units.*** (Reference paragraph 5.45)

12.77 In Oceanic region the primary means of communication is through CPDLC systems and the time of communication is of the order of 120 seconds, which is not considered adequate for passing emergency messages. Such emergency messages can be passed though broadband IP based systems.

12.78 ***It is, therefore, necessary that AAI should provide IP based telephone service accessible to controllers at all ACCs for coding into the IMARSAT GES ATS abbreviated dialling service for aircrew emergency contact.*** (Reference paragraph 5.51)

12.79 ATN is going to be the basic data connectivity in aviation. It would provide connectivity between Aircraft, Airline, Air Traffic Control, Aviation Weather Services and Flight Information Services through air-to-ground sub-networks of VHF, HF, Mode S and Satellite and also ground-to-ground sub-networks of airlines and ATM. AAI has already provided an ATN gateway at Mumbai for international communication traffic to pass from West to East and vice-a-versa through India.

12.80 ***In view of the above,*** **AAI should immediately upgrade domestic communication connectivity through ATN**. (Reference paragraph 5.54)

Navigation Systems

12.81 ATM Directorate has projected their requirement that all terminal facilities should have VOR/DME. AAI has informed that current requirement will be met after provision of 20 new DVOR/DME under procurement and the target date has been given as 2010.

12.82 ***AAI should provide VOR/DME at all operational airports.*** (Reference paragraph 6.2)

12.83 ISRO has informed that GAGAN would be implemented by 2009 and as such forms a part of Medium Term plan. ***ISRO and AAI should expedite the implementation of GAGAN.*** (Reference paragraph 6.25)

Surveillance Systems

12.84 ATM Directorate has projected their requirements for surveillance systems, the details of which are at paragraph 7.2. The Committee is of the view that following requirements of ATM should be processed by AAI as part of Medium Term Plan:

12.85 ***Overlapping multiple radar cover and back up radars should be available in high density traffic areas to ensure uninterrupted radar service*.**

12.86 ***AAI should provide independent Terminal Area Radars (TAR i.e. Primary +Secondary Radars) at all approach control units where traffic density has reached 50 or more per day.***

12.87 ***The entire control areas should be under radar cover and matching seamless air-ground communication should be available for efficient ATM.***

12.88 ***All radars should be networked to ensure entire continental airspace is covered under radar surveillance and seamless radar separation is achievable.***

12.89 ***Networked radar data should be available at all centres or alternately all centres should be amalgamated at one or two centres with multiple sectors. Dynamic consolidation and deconsolidation of sectors should be facilitated with supporting communication capabilities.***

12.90 India has already conducted trials of ADS-B, which were successful but AAI has decided to defer its implementation due to low equipage by the aircraft. The new generation of aircraft would have these facilities and new generation of aircraft

are being procured by the airlines. Use of ADS-B would become a reality in few years. AAI should implement to have ADS-B at airports with low density of traffic and also increase the airspace coverage to improve the surveillance.

12.91 FAA has a modernised oceanic control system which fully integrates flight & radar data processing, automatically disseminates significant weather information, provides enhanced Conflict Probe, detects aircraft to aircraft & aircraft to airspace conflicts, provides CPDLC, AIDC & ADS-B/C surveillance capabilities and automates numerous manual processes.

12.92 ***AAI may carry out a feasibility study whether a system similar to FAA oceanic system can be provided in oceanic airspace of India.***

LONG TERM PLAN

12.93 The long term plan is based on the concepts which would be used in future. Performance based infrastructure would be used for CNS/ATM systems. At present, a concept of Required Navigation Performance (RNP) is being used for navigation and SARPs are available for Required Communication Performance (RCP). ICAO is developing SARPs for Required Surveillance Performance and is also expected to stipulate SARPs for ATM and finally SARPs for Required Total System Performance (RTSP). The future of CNS/ATM would be planned on basis of RTSP.

12.94 ***AAI should, therefore, plan Navigation in Indian airspace using SARPs of RNP, which is already being used on some routes. Similarly, plans of Communication should be based SARPs of RCP. If the CNS/ATM plans are prepared for providing the Required Performances, a plan would be available to meet the RTSP.***

Communication

12.95 The future of various communication technologies being used at present and the new concepts which would be implemented in future are as follows:

- A shift from Voice Communication to Data Communication is envisaged. At present voice is used through VHF & HF radios and is analogue in nature. In future the digital voice may be used through communication satellite and finally voice may be retained as a back-up when complete data communication is used.

- ACARS technology is being mainly used by the airlines and to some extent by ATS for DATIS and departure clearances. ACARS is an analogue technology and has industry standards, which would be replaced by digital technology using ICAO SARPs. It is unlikely that ACARS would be used in future.

- Similarly, FANS-1/A capability used by the aircraft would be phased out as they use ACARS technology.

- Aeronautical Telecommunication Network (ATN) would replace present AFTN systems, which are character-based communication whereas ATN is digital based communication technology and connects aircraft, ground-based network of airlines and ground-based network of ATS. ATN has a limited bandwidth and may not be able to accommodate all communications of airlines with their aircraft, it may force broadband Internet Protocol (IP) format to be used by airlines in future. However, ATS would continue to use ATN and also have broadband IP.

12.96 ***AAI may keep themselves updated of upcoming technologies and prepare transition plans to merge with ICAO Global CNS/ATM plans.***

Navigation

12.97 The future navigation systems would be essentially based on the Satellite systems providing en-route and precision landing guidance and using enhanced aircraft capability through the Flight Management Systems (FMS) capable of delivering 4-D trajectory.

12.98 ***AAI should design ground part of ATM to integrate effectively with the aircraft equipped with new technology CNS systems and ensure homogeneous, continuous and efficient service to the user from pre-flight to post flight.***

12.99 The ground based navigation equipments like NDB, VOR/DME and ILS may be retained as a back-up for some time before being phased out. GAGAN would play an extremely important role in the future navigation systems.

12.100 ***The Committee is of the opinion that GAGAN project has a national prestige and India should make efforts to commercially exploit its signal for extending this facility to the countries, which fall in the coverage area.*** (Reference paragraph 6.29)

Surveillance

12.101 Surveillance is primarily carried out through radars, which is very expensive. Surveillance in non-radar coverage area is through procedural process of obtaining position reports from the aircraft, which cannot be used in a high density air traffic area as the separations required between the aircraft are much higher than in the radar covered area. The new technologies have not yet matured. Therefore, in near future requirements of radars would increase till cheaper options of surveillance are available.

12.102 The upcoming technologies in surveillance are ADS-B and wide area multilateration and both can be used in combination to provide extended surveillance. These technologies would be much cheaper than radars, with less maintenance requirements and more accuracy and are future surveillance systems.

12.103 At present, for surveillance of oceanic, remote and mountainous regions ADS-C is used for FANS-1/A compliant aircraft, using ACARS technology. After ACARS is phased out, ADS-C would use ATN for data transfer.

12.104 AAI should actively consider implementation of ADS-B and Multilateration in combination to cover the entire Indian airspace as backup of radars.

Air Traffic Management

12.105 In future also, ATM core functions would remain same i.e. Airspace Management, Flow Management, Traffic Management, Separation Management and Aircraft Systems and supported by state-of-the-art technology for CNS and weather systems. These ATM functions, however, would be fully automated to increase capacity, improve safety and efficiency. All core functions and the support systems would be networked configured as System Wide Information Management (SWIM).

12.106 ***AAI should keep the future architecture (SWIM) in view while preparing their long term plans.***

12.107 ***AAI should design ground part of ATM to integrate effectively with the aircraft equipped with new technology CNS systems and ensure homogeneous, continuous and efficient service to the user from pre-flight to post flight.***

Implementation & Review of Master Plan

12.108 This Master Plan like any other plan can be successful only if it is implemented and reviewed from time to time taking into consideration the users and aviation community requirements and advent of new technology.

12.109 ***It is, therefore, recommended that a Standing Committee should be constituted under the Secretary, Ministry of Civil Aviation for timely implementation of the plan. The Committee should be assisted by an 'Operational Group' having members from AAI, IAF, IMD, DGCA and scheduled airlines.***

CNS/ATM Plan and Organisation

CNS/ATM Planning of AAI

12.110 AAI is entrusted with the responsibility of Air Navigation Services Provider (ANSP) for civil air traffic in India. Air Navigation Services infrastructure is provided through Communication, Navigation and Surveillance/Air Traffic Management (CNS/ATM) systems.

12.111 ATM Plan document provides the objective, strategy and the operational concept for Air Navigation Services. The ATM Plan envisages the CNS infrastructure and other support system. AAI neither has an ATM plan nor a CNS plan approved by their board. The CNS planning wing plans for the procurement of the equipment to be purchased depending upon the difficulties faced while providing Air Traffic Services. The system, therefore, essentially is to fill the gaps. As the planning is to cover the gaps, the plans of AAI would never meet the actual requirements of ATM. The substantial growth in aviation has resulted in wider gaps, increasing the delays to the flights and inconvenience to passengers.

12.112 The Committee has now in February 2008 been informed that AAI has developed a Draft ATM Plan document, which describes CNS infrastructure requirements in detail based on ICAO guidelines. The Plan, however, still needs to be approved by the AAI Board to follow the same.

12.113 The radars are being installed to cover the continental area but as initially these radars are not going to be networked they would operate in isolation to each other. Further, planning resulted in 11 Area Control Centres (ACCs), instead of 4 ACCs one in each FIR, which is the practice followed all over the world. Almost similar is the situation in respect of VHF coverage.

12.114 The present concept is to consolidate the airspace. Air Services Australia has reduced their FIRs from six to two. With the present infrastructure in Australia one is sufficient but two are kept to provide the other as a backup.

12.115 The present ATM concept is a strategic architecture of “System Wide Information Management” (SWIM) and network enabled operation of CNS/ATM system.

12.116 ***AAI should immediately prepare ATM plan which would consolidate airspace from four FIRs to two FIRs with 2 ACCs, one at Delhi and the other at Mumbai. The plan should be an integrated automated ATM system with networked radars and VHFs.***

Organisation of AAI

12.117 Section 12 of the Airports Authority of India Act, 1994 (55 of 1994) which deals with the Functions of the Authority inter-alia states that "It shall be the duty of the Authority to provide air traffic service" and "plan, procure, install and maintain navigational aids, communication equipment, beacons and ground aids at the airports and at such locations as may be considered necessary for safe navigation and operation of aircrafts".

12.118 AAI is an 'Air Navigation Service Provider' (ANSP) for India, which is a distinctly different function than of an 'Aerodrome Operator' also being performed by AAI.

12.119 AAI has essentially four directorates to perform the above functions namely 'ATM Directorate' which deals with provision of Air Traffic Services; 'Aerodrome Planning' dealing with planning of airports and does not deal with ATM planning; 'Communication Directorate' to deal with operational/ maintenance of CNS equipment; and 'Communication Planning' to plan and procure CNS equipment. There is no separate directorate to deal with ATM planning. Recently, a post of Executive Director has been created and filled to deal with planning aspects of ATM.

12.120 In the present scenario of rapidly growing traffic, capacity constraints the need to cut delays and further enhance safety related procedures becomes paramount. This brings into a sharp focus the need for a systematic and well construed ATM planning. ***The present structure of AAI does not clearly demarcate its dual functional responsibility of an 'Aerodrome Operator' and of ANS provider. This issue was debated at length by the Committee and it is our view that the present arrangement needs to be modified to bring the required focus and importance to this critical area.***

12.121 One solution is, of course, what some countries have adopted and that is to create a separate dedicated organisation which takes over the responsibility of an ANSP. There are different model available in the world – ranging from complete privatisation to Government agency which are functioning successfully. In India also, there has been a discussion going on for some time on the need for separating these functions. The Naresh Chandra Committee in its report submitted in 2004, in fact, recommended Corporatisation of ATC functions.

12.122 This Committee notes that recently AAI has commissioned a Study through KPMG to examine various options available for corporatisation of ANS including the question of the financial viability of the new entity as well as the impact on the AAI. This is a welcome step and once the findings of such a study become available, further steps should be taken urgently for putting the recommendations into effect. As this study has not been concluded, this Committee is not aware of the direction in which the findings will emerge.

12.123 ***This Committee recommends that pending any final decision on the findings of the KPMG study, the process of bringing about the necessary organisational changes in AAI be taken up immediately. As a first step, independent directorates for (i) Airspace Management & Procedures and (ii) ATM Strategic Planning & System Development with adequate manpower should be established. The organogram of the AAI should also be suitably modified to bring about unity of control and responsibility in all work related to provision of ANS including planning, acquisition of technology and equipment and O&M aspects.***

Other Recommendations

12.124 The recommendations relating to ANS Planning & Procurement Policy of AAI; Human Resources for ATM & CNS; and Centre of Excellence are at Chapter 9. Recommendations regarding Flexible Use of Airspace and Aviation Weather Services are in their Chapters i.e. Chapter 10 & 11 respectively.

(Satendra Singh) **(Air Marshal (Retd.) Ajit Bhavnani)** **(P. Seth)**

(Ajay Prasad)

Date: 25 February, 2008

No. AV. 25011/5/2005-A
Government of India
Ministry of Civil Aviation

B-Block, Rajiv Gandhi Bhawan,
Safdarjung Airport,
New Delhi, dated the 20th March, 2007

ORDER

1. It has been decided to constitute a Committee under the Chairmanship of Shri Ajay Prasad, former Secretary (CA) for formulating next generation futuristic Air Navigation Services Master Plan.

2. The composition of the Committee will be as under:-

(i)	Shri Ajay Prasad Former Secretary (Civil Aviation)	Chairman
(ii)	Shri Satendra Singh former DGCA	Member
(iii)	Air Marshal (Retd.) Ajit Bhavnani former Vice Chief of Indian Air Force	Member
(iv)	Shri P. Seth Member (Operations) Airports Authority of India	Member

3. The "Terms of Reference" of the Committee are to examine/review the following aspects with a view to formulate next generation futuristic Air Navigation Services Master Plan and make appropriate recommendations thereafter:

(i) Assessment of Air Navigation Services (ANS) in the country based on the requirements specified by ICAO in the Regional Air Navigational Plans.

(ii) Assessment of the weather work stations based on the standards and recommended practices prescribed by ICAO.

(iii) Recommend a futuristic Master Plan of Air Navigation Services based on the latest technologies in the field and the forecast of the future requirements.

(iv) Recommend ways and means of harmonization of ANS in the country with the ANS systems of other countries/regions.

4. The Committee may co-opt experts as per requirement and may invite any group or individual to assist in the work of the Committee.

5. The Committee will be assisted by the Airports Authority of India for all logistics requirement including cost of travel, secretarial service, arranging meeting etc. in connection with the work of the Committee.

6. The Chairman and the Members of the Committee will have honorary positions. They will be reimbursed actual cost incurred in connection with the work of the Committee by Airports Authority of India.

7. The Committee will submit its report within six months from the date of issue of these orders.

-Sd-
(Sandeep Prakash)
Director
Tel: 24616025

1. Shri Ajay Prasad, former Secretary (Civil Aviation), New Delhi.
2. Shri Satendra Singh, former Director General of Civil Aviation, New Delhi.
3. Air Marshal (Retd.) Ajit Bhavnani, former Vice Chief of Indian Air Force, New Delhi
4. Shri P. Seth, Member (Operations), Airports Authority of India, Rajiv Gandhi Bhawan, New Delhi.

Copy to:

Shri K. Ramalingam, Chairman, AAI, New Delhi. It is requested that AAI may provide all the secretarial and logistic support for smooth functioning of this Committee.

Copy for information please:

1. AS&FA, MoCA
2. JS(R), MoCA
3. JS(K), MoCA
4. JS(A), MoCA
5. OSD to Minister (CA)
6. Sr. PPS to Secretary (CA)

GLOSSARY AND ACRONYMS

ACRONYM	Full Form
AAI	Airports Authority of India
ACARS	Aircraft Communications Addressing and Reporting System
ACC	Area Control Centre
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
ADS-X	Automatic Dependent Surveillance - Extended
AFTN	Aeronautical Fixed Telecommunications Network
AIDC	ATS Inter-facility Data Communications
AIP	Aeronautical Information Publication
AMHS	Aeronautical Message Handling System
AMSS	Automatic Message Switching System
ANS	Air Navigation System/Services
ANSP	Air Navigation Service Plan
ASBS	Automatic Self Briefing System
ASDE	Airport Surface Detection Equipment
ASM	Airspace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
APP	Approach Control
ASMGCS	Advanced Surface Movement Guidance and Control Systems
AWBS	Aviation Weather Briefing Service
AWDSS	Aviation Weather Decision Support System
BIAL	Bangalore International Airport Limited
BSNL	Bharat Sanchar Nigam Limited
CAR	Civil Aviation Requirements
CAT	Category
CATC	Civil Aviation Training College
CDA	Constant Descend Angle
CFIT	Controlled Flight Into Terrine

ACRONYM	Full Form
CLNP	Connection Less Network Protocol
CIAL	Cochin International Airport Limited
CM	Conflict Management
CNS	Communications, Navigation, Surveillance
CNS/ATM	Communications Navigation Surveillance /Air Traffic Management
CPDLC	Controller Pilot Data-link Communications
CWIS	Current Weather Instrument Systems
D-ATIS	Digital Automatic Terminal Information Service
DCL	Departure Clearance
DCWIS	Digital Current Weather Instrument System
DGCA	Director General of Civil Aviation
DG, MET	Director General, Metrological
DIAL	Delhi International Airport Limited
DME	Distance Measuring Equipment
DPN	Code of Delhi VOR
DSCN	Dedicated Satellite Communication Network
DVOR	Doppler VHF Omni Range
DVTR	Digital Voice Data Logger
DWR	Doppler Weather Radar
EFB	Electronic Flight Bag
FAA	Federal Aviation Administration (U.S.)
FANS	Future Air Navigation Systems
FDPS	Flight Data Processing Systems
FIC	Flight Information Centre
FIR	Flight Information Region
FIS	Flight Information Services
FMC	Flight Management Computer
FMS	Flight Management System
FUA	Flexible Use of Airspace
GAGAN	GPS Aided GEOS Augmented Navigation
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System (ICAO – Generic)
GPS	Global Positioning System (USA)
GPI	Global Plan Initiative
HIAL	Hyderabad International Airport Limited
HF	High Frequency

ACRONYM	Full Form
IAAMS	Integrated Automatic Aviation Metrological System
IAF	Indian Air Force
IATA	International Air Transport Association
IAVW	International Airways Volcano Watch
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IMD	India Metrological Department
INS	Inertial Navigation System
INRSS	Indian Regional Satellite System
IT	Information Technology
METAR	Aerodrome Routine Meteorological Report (ICAO)
MIAL	Mumbai International Airport Limited
MOD	Ministry of Defence
MOU	Memorandum of Understanding
MS	Metrological Service
MSAW	Minimum Safe Altitude Warning
MSSR	Mono-Pulse Secondary Surveillance Radar
MTCD	Medium Term Conflict Detection
MTNL	Maha-Nagar Telephone Nigam Limited
MWARA	International HF Frequency.
MWO	Metrological Watch Officer
NAVAID	Navigation Aid
NATS	National Air Traffic Service, UK
NDB	Non-Directional Beacon
NM	Nautical Mile
NOTAM	Notice to Airmen
NWP	Numerical Weather Prediction
OPMET	Global Operational Metrological
O&M	Operation and Maintenance
PAR	Precision Approach Radar
PBN	Performance Based Navigation
PDC	Probable Date of Completion
PSR	Primary Surveillance Radar
RDARA	Domestic HF Frequency

ACRONYM	Full Form
RCAG	Remote Control Air to Ground
RCP	Required Communication Performance
R&D	Research and Development
RNAV	Area Navigation
RNP	Required Navigation Performance
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima
SARPs	Standards and Recommended Practices (ICAO)
SADIS	Satellite Distribution System
SBAS	Space Based Augmentation System
SIGMET/ PRIP	Significant Met Reports/Pilot Report
SESAR	Single European Sky ATM Research
SMR	Surface Movement Radar
SSR	Secondary Surveillance Radar
SOPs	Standard Operating Procedure
TAF	Terminal Area Forecast
TAR	Tower Approach Radar
TCAC	Tropical Cyclone Advisory Center
TCAS	Traffic Alert and Collision Avoidance System
TDOA	Time Difference of Arrival
TDWR	Terminal Doppler Weather Radar
TMA	Terminal Control Area
UHF	Ultra High Frequency
VCCS	Voice Communication Control System
VDL	VHF Data Link
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omni-directional Range
VOLMET	Broadcast Met Information of Terminal Area
VMC	Visual Metrological Conditions
VNAV	Vertical Navigation
VSAT	Very Small Aperture Terminal
WAFC	Weather Area Forecast Center
WAFS	World Area Forecast System
WMO	World Metrological Organization.

LIST OF ORGANISATIONS INVITED BY THE COMMITTEE

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
1.	**Airports Authority of India (AAI)**	Dr. K. Ramalingam, Chairman Shri V.P. Agrawal, Member (P) Shri S.K Kakar, ED (CNS-P) Shri V. Somasundram, GM (ATM) Shri Anurag Sharma, DGM (CNS-P)	Airports Authority of India Rajiv Gandhi Bhavan Safdarjung Airport New Delhi-110003 +91-11-24632930 +91-11-24628818 +91-11-24618279 +91-11-24652648	**11-04-2007 and 7-1-2008**
2.	**Chief of the Scheduled Airlines**	Capt. K. Mohan, V.P. Flight Operation-Admn.)	Jet Airways (India) Limited S.M Centre, Andheri Kurla Road, Andheri (E), Mumbai-400059 +91-22-28520401/1238	**19-04-2007**
		Gp. Capt. C.S. Banga Chief Instructor, AC Performance Training	Sahara Airlines Ltd. A-110, Road No-5, National Highway NH-8 Mahipalpur Extension New Delhi-110037 +91-11-30682936	
		Capt A. K. Govil Executive Director (Airline Operation)	Alliance Air Domestic Arrival Terminal IGI Airport New Delhi-110037 +91-11-25671472 (Tel.)	
		Capt V. Kulkarni Addl.General Manager (Ops.)	Air India Operation Department, Old airport, Santacutz(E), Mumbai-400029 +91-22-26263589 (Tel.)	
		Capt M.S. Chadda, TRE(Airbus) Surveillance Inspector	Kingfisher Airlines Limited,1st floor, Terminal 1A, IGI Airport, New Delhi 110037 +91-11-32544912 / 13	
		Capt. Teghjeet Singh Malhotra Commander Airbus-320	Air Daccan +91-11-25674677 +91-1125674749	

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
3.	**Airport Developers**	Mr. Phillip Cash,Airport Director Mr. Oliver Weiss, Head ASM Mr. A. Kulshreshtha, GM (Air sides) Mr. K.S. Krishnamurthy, Head – Operation	MIAL CSI Airport 2nd Floor, Terminal 1B, Santacurtz (E), Mumbai 400099 +91-22-26156789 (Tel.) DIAL (GMR) Terminal-1B, IGI Airport New Delhi-110037 +91-11-25675226 (Tel.) HIAL (GMR) BIAL 118,Gayatri Lake Front Outer Ring Road, Hebbal Banglore-560024 +91-80-23540000 (Tel.)	**11-05-2007**
4.	**ICAO Experts**	Mr. H.V. Sudershan, Technical Officer, Planning and Coordination Office Mr. Vince Galotti, Chief, ATM Section Air Navigation Bureau,	ICAO 999, University Street Montreal,Quebec, Canada H3C5H7	**16-05-2007**
5.	**Inian Air Force**	AVM D.C. Kumaria, AVSM, VM, VSM, ACAS OPS(Space) Gp Captain V.K. Vij, Director OPS(ATS) Gp Captain A.J.S. Dhillon Director OPS(Navigation) Wg. Cdr S Nagalia JD ATS Wg S Rajkumar JD OPS(Nav)	Indian Air Force Air Headquarters	**18-05-2007**

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
6.	**India Metrological Department (IMD)**	Mr. R.C Bhatia Director General Mr. M.K. Bhatnagar Director, Aviation Service	India Metrological Department	**22-05-2007**
7.	**Indian Space Research Organisation (ISRO)**	Dr. S.V. Kibe, Program Director, SATNAV	Indian Space Research Organization Antriksh Bhavan, New BEL Road, Bangalore – 560094+91-80-23415281 (Tel)	**22-05-2007**
8.	**FAA, USA**	Mr. Randall S. Fiertz, Senior Representatives, South Asia Mr. Ajay Kumar , Civil Aviation Specialist, South Asia	American Embassy, Shanti Path, Chankyapuri New Delhi-110021(India) +91-11-24198403 (Tel.) +91-11-24198403	**23-05-2007**
9.	**NATS**	Mr. Mervyn Harris, Manager International Communications Project and Policy Mr. Nick Webb, Commercial Manager	NATS, London Terminal Control Center, Center place Porters Way West Drayton Middlesex UB7 9AX +44(0) 1895 423705 (Tel.)	**25-05-2007**
10.	**Boeing Company**	Larry Coughlin Managing Director-Indian Operations Commercial Airplanes Mr. Randall S. Fiertz, Senior Representatives, South Asia Mr. Ajay Kumar, Civil Aviation Specialist, South Asia	The Boeing Company 10th Floor, Eros Corporate Tower, Nehru Place New Delhi-110019 +91-11-46566077 (Tel.) FAA American Embassy, Shanti Path, Chankyapuri New Delhi-110021(India) +91-11-24198403 (Tel.) American Embassy, Shanti Path, Chankyapuri New Delhi-110021(India) +91-11-24198299 (Tel)	**13-06-2007**

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
11.	**International Air Transport Association**	Mr. Robert Eagles, Director, Safety, Operation & Infrastructure - Asia Pacific Mr. P.C. Goel, Assistant Director, Safety, Operation & Infrastructure- India	IATA 77 Robinson Road #05.00 Robinson, Singapore 068896 207-208, Kailash Building 26 Kasturba Gandhi Marg, New Delhi-110001. +91-11-41524673(Tel.)	**18-07-2007**
12.	**Airbus**	Celine Baillard, Manager- Flight Management System/ RNP Engineering Captain Dilip Kharkar, Regional Executive Director Flight operations support and Services India Mr. Ajay K. Mehra, Managing Director- South Asia	Airbus S.A.S.1 Round-Point Maurice Bellnte 31707 Blagnac Cedex, France +33(0) 561932725 (Tel.) Airbus S.A.S. +33(0) 561931556 (Tel.) B-387, New Friend Colony New Delhi-110065 +91-11-41627712 (Tel.)	**25-07-2007**
13.	**SITA**	Mr. Akhil Sharma Director, Aircom ATC Services Mr. Devindra Mohan Arora, Associate Director- Flight Operation, South Asia and India Mr. Maneesh Jaikrish Director-Sales & Relationship Management South Asia & India	SITA 1 London Gate, 252-254 Blyth Road, Hayes Middlesex UB3 1BW, UK +44(0) 2087568339 (Tel.) 6, Factory Road Near Safdarjung Hospital Ring road New Delhi-110029 +91-11-26192341 (Tel.) 6, Factory Road Near Safdarjung Hospital Ring road New Delhi-110029 +91-11-26198493 (Tel.)	**14-08-2007**

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
14.	**Lockheed Martin**	Kelly H. Shea Director Business Development - Asia Pacific Region	Lockheed Martin Transportation & Security Solutions 501, Orchard Road #21-02 Wheel Lock Place Singapore 238880 (65)-6738-7533 (Tel.)	**23-08-2007**
		Mr. Daniel Magoon Business Development	Lockheed Martin Transportation & Security Solutions 9231Corporate Boulevard Rockville, MD 20850 301-604-3530 (Tel)	
		R.K Sharma Director and National Deputy	Lockheed Martin Global Inc. Taj Palace Hotel Suite#131Sardar Patel Marg, Diplomatic Enclave, New Delhi-110021 +91-11-6611-6513 (Tel.)	
15.	**DGCA**	Mr. K. Gohain Director General	Directorate General of Civil Aviation, opposite Safdarjung airport , New Delhi-110003 +91-1124620784 (Tel.) +91-11-24627830 (Tel.)	**11-09-2007**
		Mr. J.S. Rawat, Director (Aero Stds)	+91-11-24641435(Tel.)	
16.	**M/s INFO-Electronic System India PVT Ltd**	Dr. H P.S. Ahluwalia, President	M/s INFO-Electronic System India PVT Ltd	**20-09-2007**
		Rear Admiral Gurmit Singh (Rtd.) General Manager	P-18, 1st Floor Green Park Extension, New Delhi +91-11-26197981/2 (Tel.)	
		Mr. Preet I.S. Ahluwalia Manager-Operation	P-18, 1st Floor Green Park Extension, New Delhi	
17.	**Thales-ATM**	Mr. Greg D, Crus Director (Air System Division)	Thales-ATM Statesman House, 12th Floor, B-148, Barakhamba Road New Delhi-110001 +91-11-43531920 (Tel.)	**17-10-2007**
		Mr. Stan Vogels Business Development Director Thales Air Systems		

S. No.	Organisation	Representatives	Address and Telephone Numbers	Date
18.	**Era Corporation**	Mr. Axel Bensh,Regional Director APAC	Era Corporation1881 Campus Commons Dr Suite 101, Reston, VA 20191United States +1 703637 7283 (Tel.)	**30-10-2007**
19.	**IAF (Met)**	Air Vice Marshal Tyagi	IAF	**Nov. 2007**