Case Study of Communication Systems of Raja Bhoj Airport, Bhopal

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Abstract- **This paper presents an overview of various aeronautical communication systems and linkage between Primary and Secondary systems. It also describes the purposes, characteristics, and operational facts of both existing and requirements of future aeronautical systems.**

Keywords: **NAVAIDS, ILS, DVOR, DME, RADAR, Communication system.**

I. INTRODUCTION

In 1972, the Government of India constituted the International Airports Authority of India (IAAI) to manage the nation's international airports and constituted the National Airports Authority (NAA) in 1986 to look after domestic airports. In 1994, GoI notified Airports Authority of India Act. Thus in 1995 both these organizations were merged to form a Statutory Body called Airports Authority of India (AAI) under Act of Parliament

The Airports Authority of India (AAI) is under the Ministry of Civil Aviation it is responsible for creating, upgrading, maintaining and managing civil aviation infrastructure in India. It manages a approximately of 129 Airports, which includes 18 International Airports, 7 Customs Airports, 78 Domestic Airports and 26 Civil enclaves at Military Airfields. It also provides Air traffic management (ATM) services over Indian airspace and surrounding ocean areas. AAI covers all major air-routes over Indian landmass via 29 Radar installations at 11 locations along with 700VOR/DVOR installations co-located with Distance Measuring Equipment (DME). 52 runways are provided with Instrument landing system (ILS) installations with Night Landing Facilities at most of these airports and Automatic Message Switching System at 15 Airports.

Responsibilities of AAI include following:-

1) Design, Development, Operation and Maintenance of international, domestic airports and civil enclaves.
2) Control and Management of the Indian airspace extending beyond the territorial limits of the country, as accepted by ICAO.
3) Construction, Modification and Management of *passenger terminals, runways, aprons, taxiway etc.*
4) Development and Management of cargo terminals at international and domestic airports.
5) Provision of Communication and Navigation aids, viz. ILS, DVOR, DME, Radar etc.

Besides above, AAI has also been involved in providing training personals for operation, maintenance & management of airports and various consultancy projects with *Libya, Algeria, Yemen, Maldives, Nauru, Afghanistan, etc*

This paper mainly briefs about data communications and other facilities of Airport under AAI located and functioning at Bhopal in state of Madhya Pradesh, India.

ABOUT RAJA BHOJ AIRPORT, BHOPAL

Raja Bhoj Airport (IATA: BHO, ICAO: VABP) is named after the 10th century Parmar dynasty king 'Raja Bhoj' and is primary airport located in Gandhi Nagar area, which lies 15 km North-west of Bhopal city centre on National Highway 12 (NH-12). It is Madhya Pradesh 2nd busiest airport after Devi Ahilya Bai Holkar Airport in Indore. It is constructed in 400 acres of land and the length of its runway strip is 2,744 metres (9,003 ft), making it possible for larger aircraft to land at Bhopal. The terminal building is built over an area of 26,936 square metres (289,940 sq ft) and has 14 check-in counters, 04 immigration counters for departures and 06 immigration counters for arrival. It also has two customs counters, each for arrival and departure, and six X-ray machines for security.

In 2013, the Raja Bhoj airport became the first airport in the Madhya Pradesh to launch 100-kilowatt solar power plant for running its Grid system. It also plans to install a 2 megawatt solar power plant at the airport in the future.

Figure 1: Bhopal Airport

1) COMPONENTS OF AIRPORT COMMUNICATIONS

The airport communications of is executed through Air Traffic Management (ATM) and depends on Communication[1], Navigation[2] and Surveillance infrastructure.

1.1. NAVIGATION

In the early days, voyages were accomplished by the navigators through the knowledge of terrain or movements of sun, stars and winds. As the time progressed, some instruments such as *Compass, Chronometer, theodolite, etc*. In 20th century, electronics also entered in the aviation field, direction finders and other navigational-aids (NAVAIDS) enabled the navigators to obtain fixes using electronics aids only. Thus navigations aid in determining the position of an aircraft over earth's surface and guiding its progress from one place to another.

1.1.1. Types of Navigations

a) Visual

The navigator `fixes' his position on a map by observing known visible landmarks, such as rivers, railway lines, mountains, coast lines etc. During night, 'Light' beacons from cities and towns can provide information about the position of aircraft however this is possible only under good visibility conditions.

b) Navigation by dead reckoning

In this method the ground 'Position' of an aircraft at any instant is calculated from its previously determined position, the speed of its motion with respect to earth along with the direction of motion (i.e. velocity vector) and the motion time elapsed. For navigation by dead reckoning, direction of motion is provided by magnetic compass and speed by air-speed indicator. Navigation would be straight forward if the medium, in which the aircraft is moving, is stationary. But, while flying, the wind speed and the direction from which it blows affects the aircraft's speed and may also drift the aircraft from the direction to which its nose is pointing. Hence the ground position of an aircraft is determined from the knowledge of its speed.

c) Radio navigation

This method is based on the use of Radio Transmitter, Radio Receiver and propagation of electromagnetic waves to find navigational parameters such as direction, distance etc., required to find the position of the aircraft. The Radio Navigational AIDS provide information to the pilot regarding the position of his/her aircraft in azimuth and/or elevation at any instant of time. Radio communication and navigational AIDS also provide useful information to Air Traffic Control Officers for effective control of air traffic

1.1.2. Navigational AIDS (NAV-AIDS)

The Navigational equipment are scattered throughout the operational area and are centrally monitored and controlled through Remote Control Equipment's. The equipment and support received by an aircraft starting from the take-off at departing aerodrome to touchdown point at destination is known as Navigational AIDS or NAV-AIDS. Various NAV-AIDS are available like DVOR, DME and ILS etc

The function of NAV AIDS are as following:-

1) To provide and maintain Doppler VHF Omni Range (DVOR) for Airport.

In the earlier times, only NAV-AID available was Visual AID. Direction of travel was determined by measuring deviations from the Pole Star or certain pre-determined landmarks. Further development in science produced more accurate and precise device called 'Compass'. Thus, centuries of development brought rapid changes to NAV-AIDS.

Very high frequency (VHF) band is a kind of radio frequencies (from 112 to 118 MHz) developed in the US in 1937 and deployed by 1946. Thus, VOR is the standard air navigational system in the world, used by both commercial and general aviation. There are about 3000 VOR stations around the world and 87 alone in all over India.

VOR (VHF Omni directional Radio) range, is a type of short-range radio navigation system for aircraft, enabling aircraft to determine their position and stay on course by receiving radio signals transmitted by a network of fixed ground radio beacons, with a receiver unit.

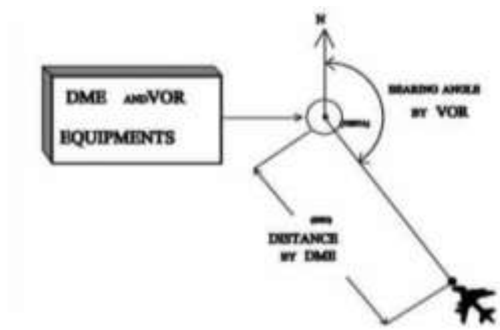

Figure 2: DVOR

2) To provide and maintain Distance Measuring Equipment (DME) co-located with DVOR.
3) To provide and maintain Instrument Landing System (ILS) for runway

An instrument landing system or ILS is a ground-based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting arrays to enables a safe landing during

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[1] Communication refers to the exchange of voice and data information between the pilot and air traffic controllers or flight

[2] Navigation element of CNS/ATM Systems is meant to provide Accurate, Reliable and Seamless Position for determining capability to aircrafts.

instrument meteorological conditions (IMC), such as low ceilings or reduced visibility due to fog, rain, or blowing snow.

An ILS consists of two independent sub-systems, one providing lateral guidance (localizer), the other vertical guidance (glide slope or glide path) to aircraft approaching a runway. A localizer (or LLZ) antenna array is normally located beyond the departure end of the runway and generally consists of several pairs of directional antennas. Two signals are transmitted on one out of 40 ILS channels in the carrier frequency range between 108.10 MHz and 111.95 MHz (with the 100 kHz first decimal digit always odd, so 108.10, 108.15, 108.30, and so on are LLZ frequencies but 108.20, 108.25, 108.40, and so on are not).

One is modulated at 90 Hz, the other at 150 Hz and these are transmitted from separate but co-located antennas. Each antenna transmits a narrow beam, one slightly to the left of the runway centerline, the other to the right.

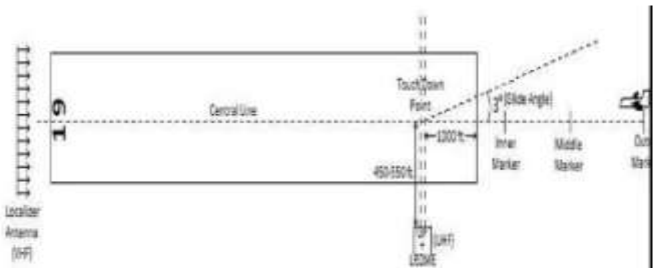

Figure 3: ILS

1.2. RADAR[3]

Radar is basically a means for gathering information about distant objects called "targets" by sending electromagnetic waves at them and analyzing the returns called the "echoes.

1.2.1. CLASSIFICATION OF RADARS

a) Primary RADAR

Also known as Primary Surveillance Radar operation is based on the principle of echolocation. It is a conventional radar sensor that illuminates a large portion of space with an electromagnetic wave and receives back the reflected waves from targets within that space.ie, detect and localize potentially non-cooperative targets. It is specific to the field of air traffic control where it is opposed to the secondary radar which receives additional information from the target's transponder.

A primary radar measurement includes:

- the distance D based on the wave transit time on the path to / from;
- Angle θ based on the position of a directional antenna in azimuth;
- Radial velocity using the Doppler Effect.

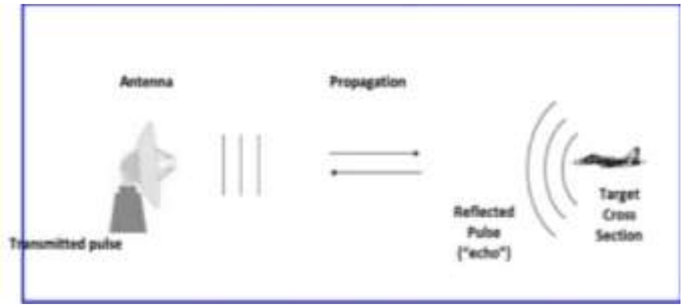

Figure 4: Primary Surveillance RADAR

b) Secondary RADAR

The Secondary RADAR works on a two way communication. *ie, The signals are transmitted from the antenna in the form of pulses*. These pulses are decoded by the target (i.e. the aircraft) and the target replies with another pulse in response to the signal received by the target are sent back to the radar. The transmission power in secondary radar is inversely proportional to the square of the distance travelled by the wave. It has interrogator at the transmitting end and transponder at the receiving end.

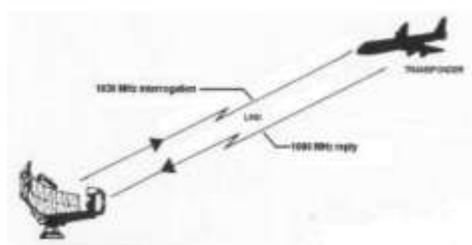

Figure 5: Secondary RADAR communications

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2) Aeronautical Information Service

Aeronautical Information Service (AIS) is responsible for collection, collation, editing and publishing of the aeronautical information for used by all types of aircraft operations.

Since Pilots are primary users of AIS and those engaged in airline operational chart and document producing agencies are Secondary users. Hence main objective of AIS is to provide information, necessary for the safety, regularity, economy and efficiency of air navigation.

II. CONCLUSION

This paper attempts to study the Communication and Surveillance system used at airport and understand the practical visualization and handling of associated equipments.

Generally the Communication system is categorized into two parts (a) air to ground communication and (b) ground to

[3] **Ra**dio **D**etection **A**nd **R**anging

ground communication. This is accomplished mainly through navigational-AIDS, which includes *ILS, DME and DVOR, etc.* This study suggests that feasibility of secondary service in aeronautical spectrum would help in establishing communication with other National and International airports as the frequency usage and system characteristics of aeronautical equipments are well coordinated worldwide. This gives an opportunity of achieving economy of scale for the secondary system manufacturers and service providers. On the other hand, aeronautical systems have stringent protection requirements because they perform safety-of-life operations. This makes the control of interference from the secondary system both difficult and important task. Reliable and sufficient protection of primary users is a key challenge to realize the secondary access to aeronautical spectrum.

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