

# IMPACT OF AVIATION ON ENVIRONMENT

BY

VANDANA SINGH

(SAP ID-500069892)



GUIDED BY

MRS. YAGBALA KAPIL

ASSISTANT PROFESSOR

INSTITUTE OF MANAGEMENT STUDIES

UNIVERSITY COURSE CAMPUS, GHAZIABAD

A DISSERTATION REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE  
REQUIREMENTS FOR

MBA (AVIATION MANAGEMENT)

OF

CENTRE FOR CONTINUING EDUCATION

UNIVERSITY OF PETROLEUM & ENERGY STUDIES, DEHRADUN

## Acknowledgement

First and above all I would like to thanks Mrs. Yagbala Kapil, for her expertise, help, guidance and patience all through the composition of this report. Without your assist this research would not have been possible.

I have no words to express a deep sense of gratitude to the management of University of Petroleum and Studies, Dehradun for giving me an opportunity to pursue my Dissertation.

I must also thank Mrs. Pooja Bharati, Manager Operations, Airports Authority of India (Jaipur Airport) for her valuable and continuous support.

I also want to thank the staff of Jaipur International Airport to support in acquiring of knowledge related to aviation to complement this report.

Finally I would like to acknowledge with gratitude, the support of my family-my parents, my husband and especially my little son whose time I have given to the research.



Vandana Singh

Residential Address-

8 Officers' Enclave

Opposite Bodhi International School

Jodhpur-342001

Mobile: 8619279137

E-mail: vs.vandana2@gmail.com

Date: Jan 18, 2020

Place: Jaipur



## INSTITUTE OF MANAGEMENT STUDIES

### Declaration by the Guide

This is to certify that the Ms. Vandana Singh, a student of MBA-Aviation Management, SAP ID 500069892 of UPES has successfully completed this dissertation report on “Impact of aviation on Environment” under my supervision.

Further, I certify that the work is based on the investigation made, data collected and analyzed by her and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfillment for the award of degree of MBA.

Signature

**Yagbala Kapil**

**Assistant Professor Dept. Management**  
INSTITUTE OF MANAGEMENT STUDIES, GHAZIABAD  
UNIVERSITY COURSES CAMPUS  
NH-24, ADHYATMIK NAGAR, GHAZIABAD  
9871887906(M)  
+0120 -498 0000 (Off)  
Toll Free: 1800 102 1214  
[www.imsuc.ac.in](http://www.imsuc.ac.in)

Date:

16/01/2020

Place:

GHAZIABAD



## **Contents**

<b>Acknowledgement</b>	<b>ii</b>
<b>Table of Contents</b>	<b>iv-v</b>
<b>List of Figures</b>	<b>vi</b>
<b>List of Tables</b>	<b>vii</b>
<b>Abstract</b>	<b>viii</b>
<b>Chapter 1-Introduction</b>	
<i>1.1 Overview</i>	<i>1</i>
<i>1.2 Purpose of Study</i>	<i>3</i>
<b>Chapter 2-Literature Review</b>	
<i>2.1 Overview</i>	<i>4</i>
<i>2.2 Environmental Impact Assessment</i>	<i>4</i>
<i>2.3 Regulations</i>	<i>12</i>
<i>2.4 Mitigation Approach at Broad Level</i>	<i>14</i>
<b>Chapter 3-Research Design, Methodology and Plan</b>	
<i>3.1 Mitigation Procedures</i>	<i>15</i>
<i>3.2 Role of Indian Aviation on Environment</i>	<i>19</i>
<i>3.3 India's Achievement for Green Aviation</i>	<i>23</i>
<i>3.4 Environmental Measure Taken at Jaipur Airport</i>	<i>25</i>
<i>3.5 Research Design</i>	<i>33</i>
<i>3.6 Analysis and Interpretation of Results</i>	<i>34</i>
<b>Chapter 4- Conclusion and Scope for Future Work</b>	<b>36</b>
<b>Bibliography</b>	<b>39</b>
<b>Appendix-A</b>	
<i>(i) Questionnaire for air traveler</i>	<i>40</i>

<i>(ii) Questionnaire for Airline</i>	41
<i>(iii) Questionnaire for Airport Operator</i>	42
<b>Appendix-B</b>	
<i>(i) Format for Annual Carbon Footprint Data (Airport Operators)</i>	43
<i>(ii) Format for Annual Carbon Footprint Data (Airline Operators)</i>	44
<i>(iii) Format or Monthly Mean and Annual Mean Values</i>	45
<b>Appendix-C</b>	
<i>Imposition of Penalties-Guidelines regarding offence/violation</i>	46

## List of Figures

Figure 1 Aviation and Environment (Source-Annual Report of MoCA).....	2
Figure 2 Impact Predictions (Source-Module of IAA) .....	5
Figure 3 Greenhouse Effects (Source-ICAO Environment Report).....	6
Figure 4 Aviation Growth Comparison (Source-IATA data) .....	20
Figure 5 Green Airports (Source-4 Years of Achievements MoCA) .....	24
Figure 6 Solar Plant Install at Jaipur Airport .....	26
Figure 7 Sewerage Treatment Plant Installed at Jaipur Airport .....	27
Figure 8 Inner View of STP at Jaipur Airport.....	28
Figure 9 Environmental Mapping Machine Used at Jaipur Airport .....	29
Figure 10 Plastic Bottle Crushing Machine Installed at Jaipur Airport.....	32
Figure 11 Key Drivers for Emission Reduction in Aviation.....	36

## List of Tables

Table 1 Ambient Air Pollutant measured near Terminal Building	30
Table 2 Ambient Noise Monitoring Data	31

## Abstract

Transportation is a fundamental supporter of the wellbeing and prosperity of the country's economy. Inside the transportation division, business avionics has advanced into the quickest, most secure, and most broad transportation mode in minimal over a century. The world economy benefits significantly from the capacity to move individuals and items everywhere throughout the globe - rapidly and securely.

Airports, with the offices and administrations they give, are considered as one the most significant pieces of the foundation required for the standard activity of aircrafts. Airports impressively add to nearby economy and employment. However, together with the financial advantages they offer, natural expenses and effects are the indivisible consequences of the activity of air terminals.

Flying influences the earth from numerous points of view: individuals living close to air terminals are presented to clamor from airplane; streams, waterways, and wetlands might be presented to toxins released in tempest water overflow from air terminals; and flying machine motors emanate poisons to the air.

Environmental change requests quick activity and the aircraft business aren't excluding. Several solutions are available in addressing the environmental impact caused by airports. This ranges from adopting new procedures and technology to imposing caps.

In this composition, the principle worries of ecological maintainability raised by activity of air terminals will be discussed and the significance of commitment of networks (coordination between airport management and stakeholders) just as compelling obstruction of government as a feature of the arrangement arranging process for air terminals supportability will be talked about. The requirement of regulations and policies related to environmental sustainability of airports both at national and international level will be also discussed at broad level.

The principle environmental burdens and mitigation techniques used by the airport operator, stakeholders, and local authorities at Jaipur International Airport will be the discussed.



## Chapter 1: Introduction

### 1.1 Overview

The aviation sector has developed at an amazingly quick rate and it looks as though future development might be significantly quicker. Avionics has the most noteworthy development pace of all methods of transport. But there has been no critical discussion about the natural effect this development has had, or about the effect that it will have. There has all the earmarks of being across the board acknowledgment – not least inside government – that rising interest for air travel will precede. Flight development will have genuine ramifications for the earth as far as contamination at neighborhood and worldwide levels, and furthermore in connection to land use getting ready for (example, more terminals and runways).

The natural effect of aeronautics is wide-extending and significant at the neighborhood, provincial and worldwide levels, with most consideration concentrating on clamor (nearby) and environmental change (worldwide). These effects are extreme, and on the grounds that development rates in aeronautics are so incredible mechanical advancement can't stay aware of the development sought after. Utilization counterbalances innovative addition.

In the near future air travel is anticipated to develop significantly therefore, air terminal improvement and extension tasks will probably turn out to be progressively significant. A potential test to the finishing of these activities is network concern with respect to air terminal ecological effects.

Air terminal tasks include a scope of exercises that influence the earth, including

- The activity of airplanes;
- The activity of air terminal and traveler vehicles, and air terminal ground administration hardware (GSE);
- Cleaning and upkeep of airplanes, GSE, and engine vehicles;
- Deicing and hostile to icing of airplanes and landing strips;
- Powering and fuel stockpiling of airplanes and vehicles;
- Air terminal office activities and upkeep; and
- Development.

Green Transport is another idea—an activity to support reasonable monetary advancement without giving up the neighborhood and worldwide condition. Cautious arranging and thoughtful plan are key components in accomplishing Green Transport so as to make it conceivable to diminish land use, particularly ranch land, increment vitality productivity through operational enhancements and decrease hurtful poisons by improved vitality valuing and socially capable financial evaluation of choices.



**Figure 1 Aviation and Environment (Source-Annual Report of MoCA)**

The idea of Greening the flying venture at the same moment can be best connected to decrease of outflow level in the climate, nearest to the point of accomplishing close to carbon lack of bias. Recently, there is a developing concern and acknowledgment on air security in one hand ecological wellbeing on the other.

A few arrangements are accessible in tending to the ecological effect brought about via air terminals. This reaches from receiving new strategies and innovation to forcing tops. One of the powerful measures is Air Traffic Management. It builds the proficiency in the utilization of fuel and utilization of air terminal, which eventually decreases GHG emanations and can relieve clamor outflows.

Growth of air terminals ought to be empowered for the monetary and social advantages they give. In any case, such development ought to be a green development wherein increment in limit isn't accomplished at the expense of negative effects on nature.

## 1.2 Purpose of the Study

This research plans to extensively investigate the current and the future patterns in the avionics business, the logical agreement on its natural effects, and promising emanation relief measures. This writing survey intends to portray major administrative and mechanical issues in the worldwide flight area just as explicitly in the Indian setting to set out the establishment for future research and educated strategy mediation in India.

The issue:

- What are the essential natural issues related with the activity of air terminals?
- What are the arrangements accessible in tending to those natural issues?
- How can the administration balance air terminal development and the earth?
- Describe the natural prerequisites and procedures related with working an open use air terminal.
- To identify the role of all stakeholders and airport management in environment management.
- To know the role of technological advancement at airport for the sake of environment.

The standard ecological weights and moderation systems utilized by every one of the partners at Jaipur International Airports will be talked about.

## Chapter 2: Literature Review

*“...an unquestioning attitude toward future growth in air travel, and an acceptance that the projected demand for additional facilities and service must be met is incompatible with the aims of sustainable development...”*

*Royal Commission on Environmental Pollution 18th Report,  
'Transport and the Environment', October 1994.*

### 2.1 Overview

Aviation is one of the quickest developing areas of the worldwide economy. It expends significant measures of petroleum derivatives and adds to the developing issues of ozone harming substance outflows and environmental change. Its effect on environmental change is more significant than its proportionate duty regarding ozone harming substance outflows and is exacerbated by the effects of water fume, contrails and cirrus cloud development.

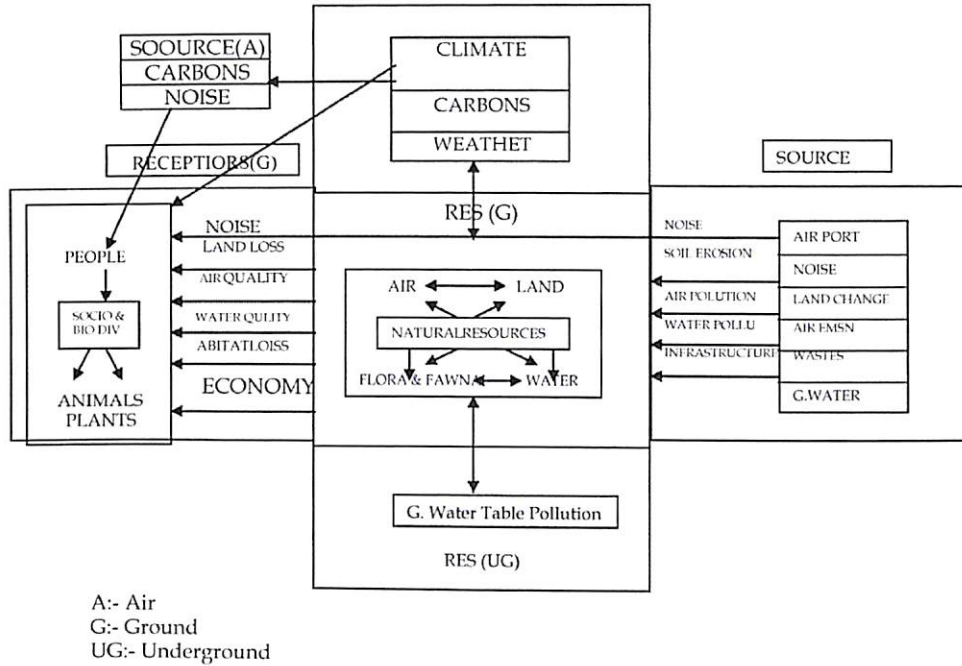
Numerous flying figures concur that worldwide traveler request will keep on increment consistently throughout the following barely any decades. The expanding difficulty of adjusting ecological contacts with these activities is a significant impediment to the reasonable development of the aeronautics business. These natural effects incorporate, yet are not constrained to, network commotion introduction, neighborhood air quality around the air terminal terminal-territory, and atmospheric effects.

Flying is answerable for 1-2 percent of anthropogenic ozone depleting substance discharges yet these gases are infused at moderately significant levels in the climate and have a radiative driving effect of 3. This implies the emanations are roughly multiple times more harming as far as environmental change than if they had been produced at ground level. Flying is relied upon to represent up to 15 percent of the whole commitment to environmental change by 2050.

### 2.2 Environmental Impact Assessment

The ecological, social and monetary effects of the aeronautics business incorporate those from air ship themselves and from air terminals and their supporting

framework, for example, upkeep and adjusting of the airplane, cargo dispersion and terminal offices, for example, shopping centers.



**Figure 2 Impact Predictions (Source-Module of IAA)**

### 2.2.1 Emissions

The anthropogenic negative impacts on the Earth's atmosphere are one of the most significant natural issues the flight business has faced. Emissions from air ship, both at ground level and at elevation, can offer ascent to various negative consequences for air quality, atmosphere and the ozone layer.

Air terminal emanations influencing neighborhood air quality originate from both versatile and stationary sources, including the accompanying:

- Aircrafts.
- Engine vehicles (e.g., autos and transports for air terminal tasks, and traveler, representative, and rental organization vehicles).



- Ground administration hardware (GSE) (e.g., air ship pulls, things and belt loaders, generators, yard cutters, snow furrows, loaders, tractors, cooling units, and freight moving gear).
- Stationary sources (e.g., boilers, space warmers, crisis generators, incinerators, fire preparing offices, air ship motor testing offices, painting tasks, and dissolvable degreasers).

The aeronautics area is one of the primary producers of ozone harming substances (GHG). Common avionics outflows, including household and worldwide flights, represent about 2.5% of worldwide GHG emanations. In the event that the aeronautics division was a nation, it would be the seventh greatest polluter on the planet.

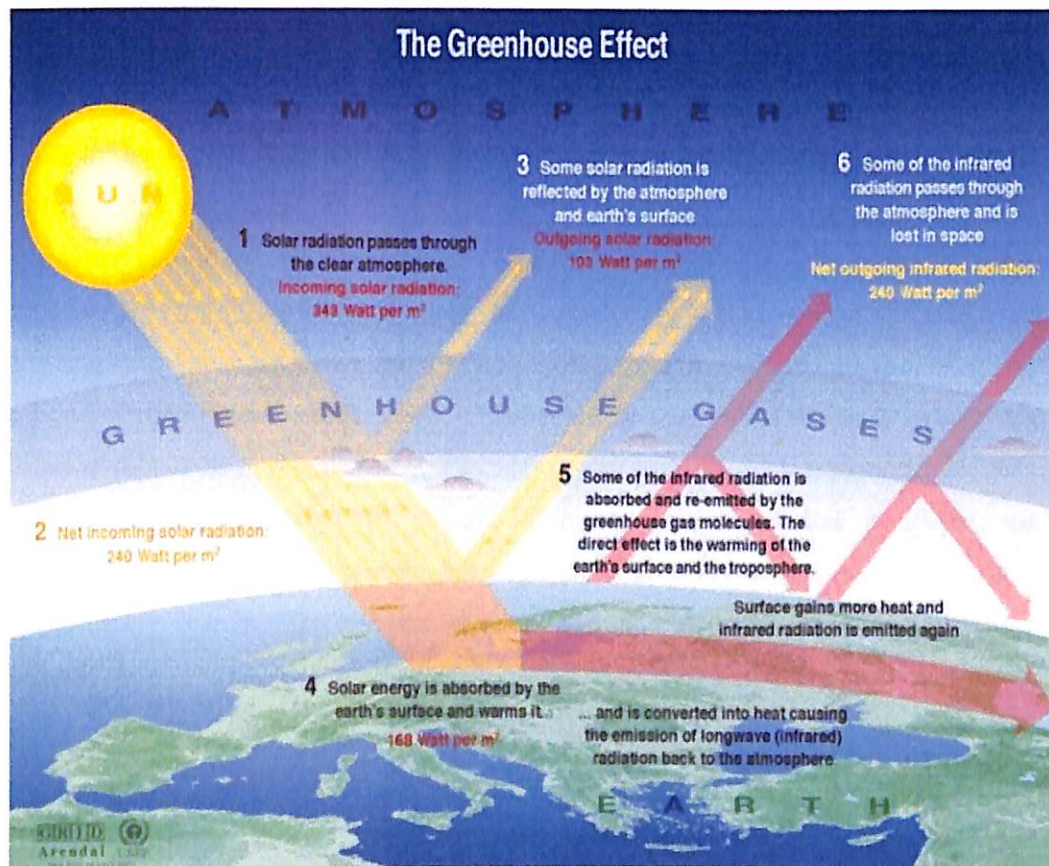


Figure 3 Greenhouse Effects (Source-ICAO Environment Report)

Following are the principal aviation pollutants-

✓ Carbon Dioxide

CO<sub>2</sub> influences the climate legitimately and relying upon the centralizations of particles it influences the capacity of the earth to assimilate active radiation discharged by the world's surface and lower air. Aeronautics is liable for 2 percent of all out anthropogenic CO<sub>2</sub> emanations. As far as global warming this is of incredible worry as CO<sub>2</sub> can live in the climate for a long time. The CO<sub>2</sub> produced via air ship is blended in with CO<sub>2</sub> from different sources; be that as it may, as stream air plane have just been in administration in the course of the most recent 50 years, CO<sub>2</sub> fixations from airplane alone are difficult to evaluate.

✓ Nitrogen Oxides

NO<sub>x</sub> is a typical term used to allude to three types of oxides of nitrogen: nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O) an ozone harming substance which aggregates in the air with other ozone depleting substances prompting an ascent in the world's temperature after some time. NO<sub>2</sub> is a solid oxidizing specialist that responds noticeable all around to shape destructive nitric corrosive, just as poisonous natural nitrates. It likewise assumes a significant job in the climatic responses that produce ground-level ozone or photochemical brown haze. Aside from lightning, airplanes are liable for all NO<sub>x</sub> emanations at 8-15km heights. NO<sub>x</sub> can respond with different substances noticeable all around to frame acids which are stored as downpour, haze, day off (affidavit) or dry particles (dry statement). It tends to be conveyed by wind for many kilometers causing Trans boundary air contamination effects, for example, corrosive downpour harm to material, structures and authentic landmarks, and the acidification and eutrophication of lakes and streams.

✓ Ozone

O<sub>3</sub> is an ozone harming substance framed because of photograph concoction responses among NO<sub>x</sub> and the environment. O<sub>3</sub>, the majority of which lives in the stratosphere, shields the planet against sun powered bright radiation. It can apply a significant impact on the world's vitality spending plan of the climate controlling how much hurtful ultra-violet radiation arrives at the surface. In the stratosphere,

NO<sub>x</sub> can prompt ozone exhaustion by as much as 3 percent (VCÖ, 1997). At lower levels, in the troposphere and tropopause (lower than 9 km height), O<sub>3</sub> can be unsafe to people (respiratory issues) and plants through decreased yield and different side effects. Tropospheric ozone impacts from flying machine alone, be that as it may, are difficult to appraise as there will be significant fixations from different wellsprings of NO<sub>x</sub>, for example, city traffic.

✓ Methane

Notwithstanding expanding tropospheric ozone focuses, aircrafts NO<sub>x</sub> discharges in a roundabout way decline the grouping of methane, which is additionally an ozone harming substance. CH<sub>4</sub> decreases will in general cool the outside of the earth yet not by a similar degree as the warming capability of different GHGs.

✓ Sulphur Dioxide

Sulfur in the fuel is oxidized when consumed to shape SO<sub>2</sub>, an acidic, drab gas. It can respond with water to frame contrails and might be kept as sulfate (H<sub>2</sub>SO<sub>4</sub>) or corrosive downpour. SO<sub>2</sub> at ground level can cause human wellbeing effects, for example, respiratory issues, lung ailment and impeded capacity, asthma impacts, just as influencing plants and making harm structures.

✓ Carbon Monoxide

CO is caused through burning and will in general be delivered when aircrafts are on the ground. Contingent upon the fixation and presentation genuine human medical issues can be experienced.

✓ Volatile organic compounds

VOCs incorporate a wide range of synthetic concoctions, a considerable lot of which are connected to human medical issues. These mixes incorporate hydrocarbons, for example, ethane, isoprene, benzene and toluene and are the aftereffect of un-burnt or in part consumed fuel. Whatever as benzene are connected to expanding danger of grown-up leukemia and others can possibly cause an Earth-wide temperature boost when they respond in the air to frame ozone.

✓ Cirrus cloud, water vapors (H<sub>2</sub>O) and contrails

Cirrus mists are meager and wispy significant level mists normally found at statures more noteworthy than 6km. They are made out of ice gems shaped from the freezing



of super-cooled water beads. Water fume is an ozone depleting substance and is framed as a side-effect of the ignition of lamp oil and at high elevation gathers to shape meager cloud trails (contrails) in the sky. Contrails spread about 0.1 percent of the world's surface on an every year found the middle value of premise, with bigger provincial qualities.

### 2.2.2 Noise Issue

Commotion isn't simply disturbance. It harms wellbeing, it reduces altogether from the personal satisfaction, it stops nearby inhabitants making the most of their nurseries or essentially getting a charge out of harmony and calm, it harms natural life, it harms the learning capacity of schoolchildren and it costs a lot of cash through the expenses of clamor relief and commotion decrease. Aviation noise is a genuine worry around all air terminals and under flight ways despite the appropriation of calmer aircraft and motor innovation.

Clamor, which can be characterized as any undesirable sound, can cause significant negative impacts on people's health and their physical, mental and social prosperity and nature of life. Since the rise of the aeronautics business, air ship commotion has been one of the most significant wellsprings of inordinate commotion created by human exercises. Two wellsprings of aircrafts clamor are the motors, which incorporate two significant sorts of fly and cylinder motors, and the airplane outline. In the perspective on the way that air ship delivers more commotion during take-off and landing, air terminals are viewed as significant supporters of the issue of over the top clamor, and from a network's viewpoint, one of the most clear natural issues of air terminal exercises is clamor pollution. In option, clamor created by ground get to frameworks in the air terminal landside region adds to the previously existing issue of extreme clamor in air terminals.

Noise is estimated on the Decibel "A" Scale normally communicated as dB (A). The scale is utilized by general wellbeing and ecological wellbeing authorities as far as possible or makes suggestions about limits that ought not to be surpassed. A cutoff of 55dB (A) is viewed as one which ought not be surpassed to secure undisturbed rest and sound levels above 70dB (A) deliver typical discourse correspondence.

The World Health Organization 1993 archive, "Network Noise" (WHO, 1993) audits the global logical proof on the impacts of clamor. These include:

- Hearing weakness
- Pain
- Perceived uproar and inconvenience
- Interference with correspondence and discourse observation
- Sleep unsettling influence
- Psycho physiological responses during rest (remembering impacts for pulse, finger beat, breathe)
- Stress
- Cardiovascular impacts
- Psycho endocrine impacts
- Startle reflex and arranging reaction
- Effects on physical wellbeing (counting sickness, cerebral pain, crabbiness, unsteadiness, pugnacity, decrease in sexual drive, uneasiness, anxiety, a sleeping disorder, unusual sleepiness and loss of hunger)
- Mental issue
- Task execution and efficiency
- Deficits in perusing procurement among kids
- Effects on social conduct (e.g. readiness to help other people).

### 2.2.3 Waste and Land Utilization

Land use via air terminal, waste and ground clog is among the issues which need consideration of controllers just as air terminal experts so as to lessen the effects on condition and public activity. Land take alludes to usage of land via air terminals to assemble and working air terminal related exercises. Through viable operational methods and expanding the limit picks up the requirement for extra land for building new runways and offices will be maintained a strategic distance from.

Air terminal waste alludes to the waste created by an air terminal's activity. Such waste can be produced by travelers, landing strip tasks and support exercises, and those brought about by development and demolition. The less the burn through

created via air terminal over a particular time is, the better and increasingly proficient waste administration endeavors of air terminals have been. Needless to make reference to that a portion of the exercises of air terminals, for example, air ship and runway deicing and hostile to icing, fuel stockpiling and refueling, flying machine and vehicle cleaning and upkeep, and development may bring about the release of contaminations to contiguous water bodies and therefore trigger oceanic life and human health.

Solid waste generation, in air terminal improvement is in three phases to be specific, site readiness, development and activity. The sorts of waste, which are created, can be ordered into 4 classes to be specific, development or destruction squander; city squander, i.e., biodegradable and recyclable waste; unsafe waste and E-squander.

Air terminals produce a huge amount of squanders from a wide assortment of sources including:

- In-flight squanders
- Scrap squanders
- Oils and dissolvable, parts from flying machine support
- Catering squanders
- Domestic and office squanders
- Textile, plastic, elastic and metal from airplane renovation

#### 2.2.4 Biological Environment

Air terminal activities may cause change in nearby environments, compromise endangered species, and upset developments and rearing examples of neighborhood natural life. Air terminals are situated inside an assortment of settings (both urban and provincial), which bolster territories and types of their own, some of which will have direct communication with those situated on the air terminal and the other way around. Some neighborhoods likewise are assigned for their temperament preservation esteem. The natural condition of the air terminal ought to consequently be viewed as an indispensable part of the more extensive scene scale environmental system.

### 2.2.5 Socio-economic Environment

Air terminal improvement may regularly require migration of the neighborhood network, which, now and again causes ethnic, social, inborn or strict clashes with nearby individuals. Industrialization and modernization may change the social customs of the nearby network. To contemplate the financial parts of individuals in the investigation zone around proposed air terminal, gauge information on socioeconomics, land utilized examples, water assets for horticultural and mechanical use, human settlements, wellbeing status of the networks, framework offices and monetary conditions in the current and migrated zone, social and archeological resources inside the task region ought to be indexed and exhibited.

## 2.3 Regulations

Regulatory compliance is important to the operator of any facility, but particularly in the area of environmental law. Airport operators are required to follow numerous laws, regulations, and policies, which can be confusing. However, the consequences of failing to comply with environmental law can range from delayed construction projects to criminal charges.

### 2.3.1 International

- ✓ The Kyoto Protocol from 1997 connected to the United Nations Framework Convention on Climate Change (UNFCCC) plans to balance out ozone depleting substances in the environment and recognizes in its lawful ties among created and creating countries. While household aeronautics emanations are incorporated into national outflow inventories and decrease targets, article 2.2 of the Kyoto Protocol expresses that discharge restrictions from universal flying will be sought after through the International Civil Aviation Organization (ICAO).
- ✓ The United Nations (UN) made the International Civil Aviation Organization (ICAO) in 1945 to administer guidelines for flight around the world. ICAO's ecological efforts were initially separated between the Committee on Aircraft Engine Emissions and the Committee on Aircraft Noise, yet these boards were all the while supplanted in 1983 by the development of the Committee on Aviation Environmental Protection (CAEP).

- ✓ The operational and geographic effect related with air terminal improvement is secured by strategy drives (the two systems and enactment) at worldwide, territorial and national levels. The International Civil Aviation Organization (ICAO), which supervises the level and bearing of exertion associated with tending to the natural effect of the part, likewise manages the outflows from air ships.
- ✓ Starting at 2013, CAEP comprises of 23 member countries and 16 observers speaking to different countries and authoritative bodies that have an enthusiasm for its work, such as the International Coordinating Council of Aerospace Industries Associations (ICCAIA), the International Air Transport Association (IATA), and the United Countries Framework Convention on Climate Change (UNFCCC). The committee was built up "to aid the further improvement of Standards, Recommended Practices and Procedures (SARPs) or potentially direction material airplane clamor and motor outflows".
- ✓ ICAO's environmental goals-
  - To limit or reduce the number of people affected by significant aircraft noise.
  - To limit or reduce the impact of aviation emissions on local air quality.
  - To limit or reduce the impact of aviation GHG emissions on the global climate.

### 2.3.2 Indian

- ✓ The Ministry of Civil Aviation is liable for the plan of national approaches and projects for advancement and guideline of common flying. The Directorate General of Civil Aviation (DGCA) is an appended association of the service and manages all parts of guideline and implementation for common aeronautics in India. As to issues, the DGCA sees its duty in "keeping a beware of airplane commotion and motor emanations as per ICAO Annex 16 and working together with the ecological experts in this issue, whenever required".
- ✓ In 2009, the DGCA has set up an Aviation Environmental Unit that tries to address ecological issues from Indian flying and give arrangements and direction with respect to inquiries of eco-friendliness improvement, CO2 decrease or commotion reduction. Besides, it has suggested that other flying partners, for example, air terminal specialists, carriers or air route specialist organizations

ought to make ecological units inside their associations moreover. In its natural roundabout from April 2011, the DGCA ordered carriers to submit fuel utilization information on a month to month premise, which will serve to develop a CO<sub>2</sub> discharge stock. It is to be noticed that, data on the earth units set up by various aircrafts and air terminals isn't yet accessible in the open space.

- ✓ Another significant administrative foundation in Indian aviation is the Airports Authority of India. AAI deals with an aggregate of 137 air terminals which incorporate 23 International air terminals (3 Civil Enclaves), 10 Custom Airports (4 Civil Enclaves) and 104 Domestic air terminals (23 Civil Enclaves). AAI gives air route benefits over 2.8 million square nautical miles of air space. In this way, the AAI can impact a wide scope of flying machine exercises and subsequently should be considered cautiously for potential arrangement mediations.
- ✓ The Ministry of Civil Aviation, Government of India is focused on comprehensive and feasible development of the common flight part in the nation while relieving its negative effects on condition simultaneously. Ministry drafts a white paper on National Green Aviation Policy dated 19-Feb-2019. This White Paper sets out a key structure to address the major ecological difficulties of the flying business. It understands the key natural issues of the part and underscores the Government's methodology towards condition assurance.

## 2.4 Approaches to Mitigation Procedures for Environmental Impacts at Broad Level

- ✓ Improved scientific knowledge and coordinated displaying.
- ✓ New air ship advances.
- ✓ Feasible elective avionics fuel.
- ✓ Air traffic management modernization and operational enhancements.
- ✓ Approaches, natural norms and market based measures.

## **Chapter 3: Research Design, Methodology and Plan**

Environment plays a fundamental role in advancement of nation. Perceiving the significance of ecological insurance and supportable improvement, the Ministry of Environment and Forest, Government of India had detailed arrangements and methodology administering the modern and other formative exercises to forestall aimless misuse of regular assets and to advance joining of natural worry in formative undertakings.

Air terminals are consistently looked with the outcomes of both their own and their occupants' over a significant time span ecological activities. Consistence prerequisites require an audit and observing of these conceivably risky tasks, yet in addition those all things considered and temporary workers working on the air terminal too. Directing an ecological review is the suggested strategy for deciding the Airport Operator's general natural liabilities and issues.

India being one of the contracting states of ICAO actualizes the goals on natural approaches and practices embraced by ICAO through Director General of Civil Aviation (DGCA), under Ministry of Civil Aviation, GOI at national level to alleviate the operational effect related with flying at air terminals.

It guarantees that ecological concerns are deliberately incorporated into air transport approach by improving specialized natural norms on commotion and vaporous discharges; progressing long haul innovation enhancements; assessing aerodrome site for giving aeronautical leeway; improving the air traffic the executives and advancing flight wellbeing condition at air terminals.

### **3.1 Mitigation Procedures**

Mitigation measures are the evasion, decrease or cure of critical unfriendly impacts as clarified underneath:

- Avoidance (for example at source through structure),
- Reduction includes reducing the seriousness of an effect,

- Remedy which could incorporate pay acknowledges that there will be unfavorable outcomes yet gives implies by which those results can be moderated or made up for,
- Enhancement or enhancements to nature not identified with a recognized effect, however where there will be a net advantage to the earth,
- Only quantifies that can be executed by the candidate, either straightforwardly or in a roundabout way, for example by means of a legitimate commitment with different gatherings for example, ought to be incorporated,
- All critical unfavorable effect ought to be considered for alleviation and explicit estimates set forward; and consideration ought to be paid to all phases of the advancement, specifically the development organize where there is probably going to be extraordinary potential for disturbance,
- All proposed alleviating measures ought to be fit for implementation,
- Mitigating measures themselves once in a while have conceivably antagonistic effect on different parts of condition, which should also be surveyed as far as essentialness. This needs the co-appointment between different specialists who might be associated with the procedure.

### 3.1.1 Land environment

#### ✓ Foreseen Impacts

The effect of the exercises in the region on the land is to be plainly recognized. A portion of the effect includes:

- Fuel stockpiling and taking care of (conveyance, stockpiling and utilization of fuel for airplane and different vehicles)
- Aircraft and vehicle upkeep,
- Waste internment, spillage, consuming exercises, fly tipping and so on.
- Fire preparing, utilization of surfactants, and so on.

#### ✓ Mitigation Approach

Mitigation measure ought to be unmistakably shown and a portion of these include:

- Transfers of powers during refueling tasks, spill discovery on underground channels, regulation of any surface spillage are to be checked.



- Aircraft upkeep, affectability of the area where exercises are attempted, and control of overflow of potential contaminants, synthetic compounds and so forth are to be appropriately actualized and revealed.
- Proper seepage frameworks, crisis control in case of a significant spill during rainstorm season and so forth are to be accommodated.

### 3.1.2 Water Environment

#### ✓ Foreseen Impacts

The fundamental clients of water incorporate:-

- Aircraft and vehicle washing
- Aircraft consumable water supply
- Catering offices
- Toilets/laundries/cleaning liquids/and other local offices
- Greatest utilization of crisp water is for staying units, having state, residential traffic, Flight providing food.

#### ✓ Mitigation Approach

Measure for moderating the runoff from the scene zone is to course it to water reaping structures for additional utilization in putting out fires activity, cooling plants and forced air systems after treatment. This will likewise energize the ground water table. The runoff from cleared structures like Runways, Taxiways, can be steered through channels to oil partition tanks and sedimentation bowls before being released into water gathering structures. Two lines of water supply - consumable (crisp) and non-consumable (treated); are to be fused in the undertaking plan to serve end clients, properly.

### 3.1.3 Air Environment

#### ✓ Foreseen Impacts

Transient effect on encompassing air quality because of air emanations from various volume sources (from moving source, for example, aircrafts, surface vehicles and point sources, for example, DG Sets are anticipated utilizing significant models. The model info information is the emanations from air ship determined based on ICAO information, discharges from vehicles and outflows from DG Stack.

#### ✓ Mitigation Approach

Mitigation measures for outflows from operational sources as presented by ICAO are as per the following:

- Low fuel/emanation airplane takeoff methods,
- Continuous Descent Approach and low force low drop strategies,
- Design the air terminals to limit flying machine holding and maneuvering times
- Avoid Aircraft lining on the ground,
- Avoiding pointless utilization of air ship assistant force units,
- Taxiing the board (for example towing and single motor taxi),
- Increasing the utilization of open vehicle,
- Encouraging staff to "vehicle share "to utilize progressively maintainable vehicle get to,
- The utilization of electric vehicles or less contaminating energizes (fluid and flammable gas),
- Use less contaminating energizes in air terminal structures,
- Ensure sufficient vehicle support,
- Energy the board in structures and for landing strip frameworks,
- Fugitive discharge controls.

#### 3.1.4 Noise Environment

##### ✓ Foreseen Impacts

Clamor sources related with air terminals are:

- Aircraft clamor - produced via air ship noticeable all around and during departure and landing.
- Ground clamor - ground based exercises due to navigating of air ship, ground running of motors, assistant force units, ground administration vehicles and so forth.

##### ✓ Mitigation Approach

The moderation estimates embraced are a blend of progress in aircraft motor/air outline plan and change in air traffic methodology. Acoustic walled in areas for DG sets, commotion obstructions for ground-run sounds, ear plugs for working faculty are the other relief measures for clamor sway because of ground sources.

New age aircrafts of diminished outflows to air is not ready to work in lion's share of Indian air terminals because of their enormous size and necessity of extra length of runway. Extension and modernization of these air terminals can cause them to work at these landing strips and cut down air outflows at occupied air terminals by de-clogging traffic over them.

The commotion special courses which the airplanes overfly the least populated regions after takeoff and before landing are to be recommended. Late evening flying approach to constrain the quantity of flights and measure of commotion created during this most touchy time is to be defined and determined. Relief measures could likewise incorporate presentation of higher landing charges for uproarious air ship and for late evening arriving in limit cases could be considered.

### 3.1.5 Biological Environment

#### ✓ Foreseen Impacts

In light of the organic species found in the territory, the natural estimation of the species saw in the examination region is as evaluated. This evaluation will help in the improvement of finishing which structures one of the significant alleviation measures.

#### ✓ Mitigation Approach

An organic activity plan can help in the arranging of the finishing exercises of the air terminal territory. Additionally appropriate choice of plant species to maintain a strategic distance from feathered creature settling can help in limiting winged creature strikes in the air terminal zone. Appropriate Landscape the board plans are to be distinguished for the air terminal region.

## 3.2 Role of Indian Aviation on Environment

### 3.2.1 Overview

The Indian air transport segment has demonstrated solid development lately and expected to become quicker in coming years. The Indian residential avionics showcase is as of now the quickest developing household advertises universally (estimated regarding income traveler kilometers). The size of things to come potential development in the Indian residential market is clear from the way that, the

quantity of local voyages attempted in 2017 speaks to only 7.3% of India's absolute population.

## Major Domestic Markets

Million O-D passenger journeys (to, from and within)

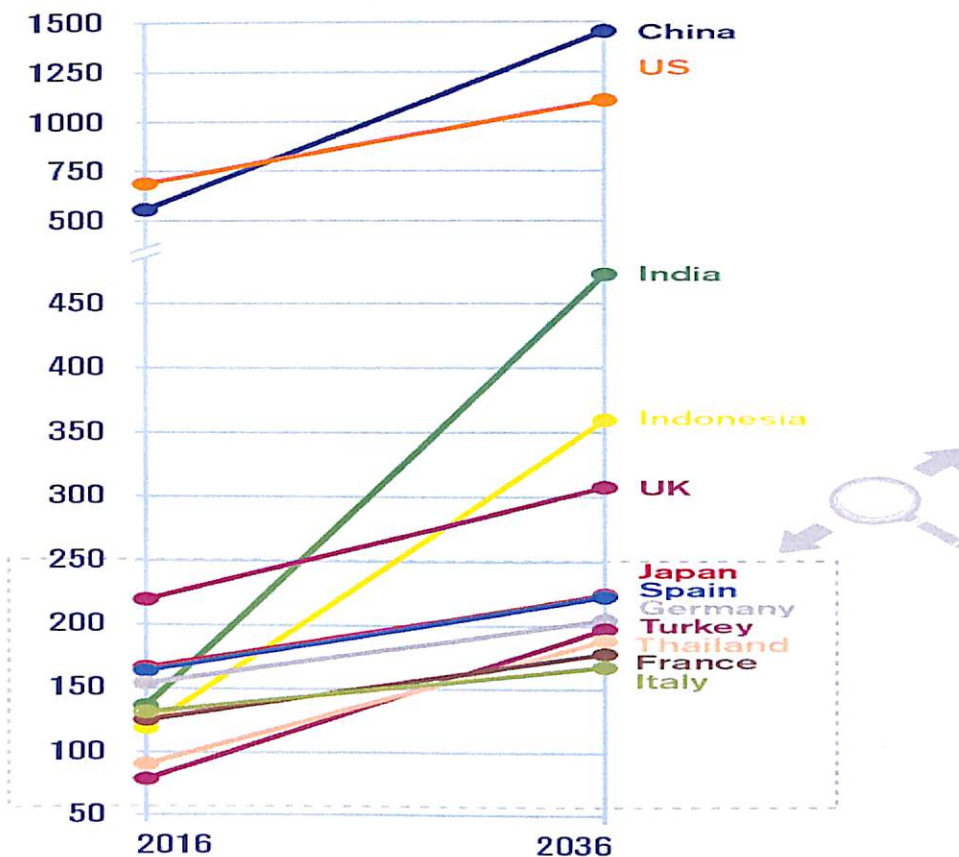


Figure 4 Aviation Growth Comparison (Source-IATA data)

India being one of the fastest growing aviation market, doubled its number of air passenger flew in a year in last 6 years. As per data released by Aviation regulator DGCA, we observed 117 million passengers in 2017, compared to 59 million in 2011. As per the study done by The International Air Transport Association (IATA) in late 2017, we expect the global aviation market to double its size by 2036. At the same time, Indian Aviation is expected to grow almost 4 times, and will be having fastest significant growth in the aviation,

Perceiving the way that Indian flying division would have exponential development, tending to nature and maintainability concerns are significant. To conquer the above expressed concerns and address these issues, the requirement for a Green Civil Aviation Policy has been conceived with a reasonable target of accomplishing supportable development of the common flying.

MoCA alongside the key flight partners directed partner gatherings and planned a team and working gatherings to consider on the prerequisite of a National Green Civil Aviation Policy. The contributions from the individuals from Task power, working gatherings and partners were acquired through gatherings, meetings to generate new ideas and surveys. In view of the reactions got from different partners the White Paper on National Green Civil Aviation Policy has been laid out.

### 3.2.2 Objective of the National Green Aviation Policy

- ✓ To help practical and comprehensive development of the Indian common avionics part and adjust it to ICAO's Vision and Mission.
- ✓ To make Indian aeronautics one of the most asset effective areas without bargaining condition and natural assurance while thinking about the need of water, vitality and fuel protection by actualizing condition amicable measures and so forth.
- ✓ To empower and advance improvement and most extreme utilization of sun based and other sustainable power source in the common flight biological system of India.
- ✓ To guarantee usage of Environmental Management System (EMS) approach crosswise over aeronautics units to give an establishment to improving the joining of natural manageability and administrative necessities into the arranging, basic leadership, endorsements and tasks of Airports, Airlines, Air Navigation Services, Ground Support System and so forth.
- ✓ Enhance the aeronautics frameworks from traditional to cutting edge condition neighborly, asset effective foundation/framework with dependable and practical choices, for example, green structure idea, and so on.

- ✓ To lessen GHG and different vaporous discharges in accordance with national and worldwide structures by thinking about utilization of eco-friendly armadas, propelled air route framework with adaptable utilization of airspace, coordinated A-CDMs, outflow free ground bolster hardware, utilize sustainable power source and other feasible energizes like bio powers and so on.
- ✓ Enhance competency on ecological supportability for all aeronautics experts with committed capacities, jobs and duties in every individual flying units, for example, Airports, Airlines, Air Navigation Services, Ground Support System and so forth.
- ✓ Create a good administrative system for clearances of aeronautics ventures to meet the foreseen development of Indian Civil Aviation, with due consideration to condition supportability.

### 3.2.3 Environmental Challenges for Aviation Stakeholders at Broad Level

- ✓ Impact of environmental change on air terminal and aircraft activity.
- ✓ Increased GHG emission & Air quality concerns, vulnerability as for bio fly fuel.
- ✓ Aircraft commotion and network concern.
- ✓ Land use arranging around air terminals.
- ✓ Connectivity to air terminal so as to lessen the natural impressions.
- ✓ Longer handling time for administrative clearances and endorsements for Airport ventures, which are of national intrigue and brings colossal financial, social and natural advantages.
- ✓ Waste Management and feathered creature danger concerns.

### 3.2.4 Environmental Measures by Airport Operator at Broad Level

- ✓ Green Building improvements, Green/Renewable vitality age and use via air terminals
- ✓ Carbon Neutral Airports and Airport Carbon Accreditations from ACI and Adoption of GHG bookkeeping, carbon balancing and impartiality programs
- ✓ Water the board: Rain water collecting, squander water treatment and reuse via Airports
- ✓ Implementation of Noise the executives programs-ICAO's decent methodology and DGCA prerequisites

- ✓ Low emission advances at Airports-Fixed Electrical Ground Power (FEGP) and Pre Conditioned Air (PCA)
- ✓ Introduction of productive Aircrafts via carriers
- ✓ Adoption of eco-friendliness improvement, operational productivity improvement estimates embraced via Airlines.

### 3.3 India's Achievements for Green Aviation

- ✓ Kochi airport is world's first fully operational solar power airport.
- ✓ AAI received National Excellence Award by Ministry of New and Renewable Energy (MNRE) for use and promotion of solar energy in FY17.
- ✓ AAI was conferred 2 SKOCH BSE Award in FY17 for Chandigarh airport project for environmental protection.
- ✓ Solar Power Plants-AAI is setting up solar power plants for energy generation at different terminals instead of traditional energy source of fuel which is non-exhaustible and furthermore causes pollution. AAI has marked MOU with Solar Corporation of India (SECI) to arrangement the rooftop top solar power plants at different air terminals.

Solar PV Policy- Government has been set the target 146 MWP solar energy across all airports. AAI generated 30.43 MWP till May, 2018.

- ✓ The guidelines of Ministry of Environment and Forests are being trailed by Ministry of Civil Aviation and organizations under its regulatory control towards protection of the environment. Endeavors are made to receive elective alternatives with a Target to decrease carbon footprint explicitly concerning activity in aeronautics division. AAI's Bhubaneswar airport, Kolkata airport, Trivandrum airport, and Varanasi airport have upgraded to Level-2 "Reduction" of the Airport Carbon Accreditation Program.
- ✓ AAI and other agencies under the ministry of civil aviation are conducting energy audits and water audits.
- ✓ The Airports Authority of India has just applied for a Green Rating for Integrated Habitat Assessment (GRIHA) accreditation for the eco-accommodating utilizations of the terminals.

# AIRPORTS GOING GREEN

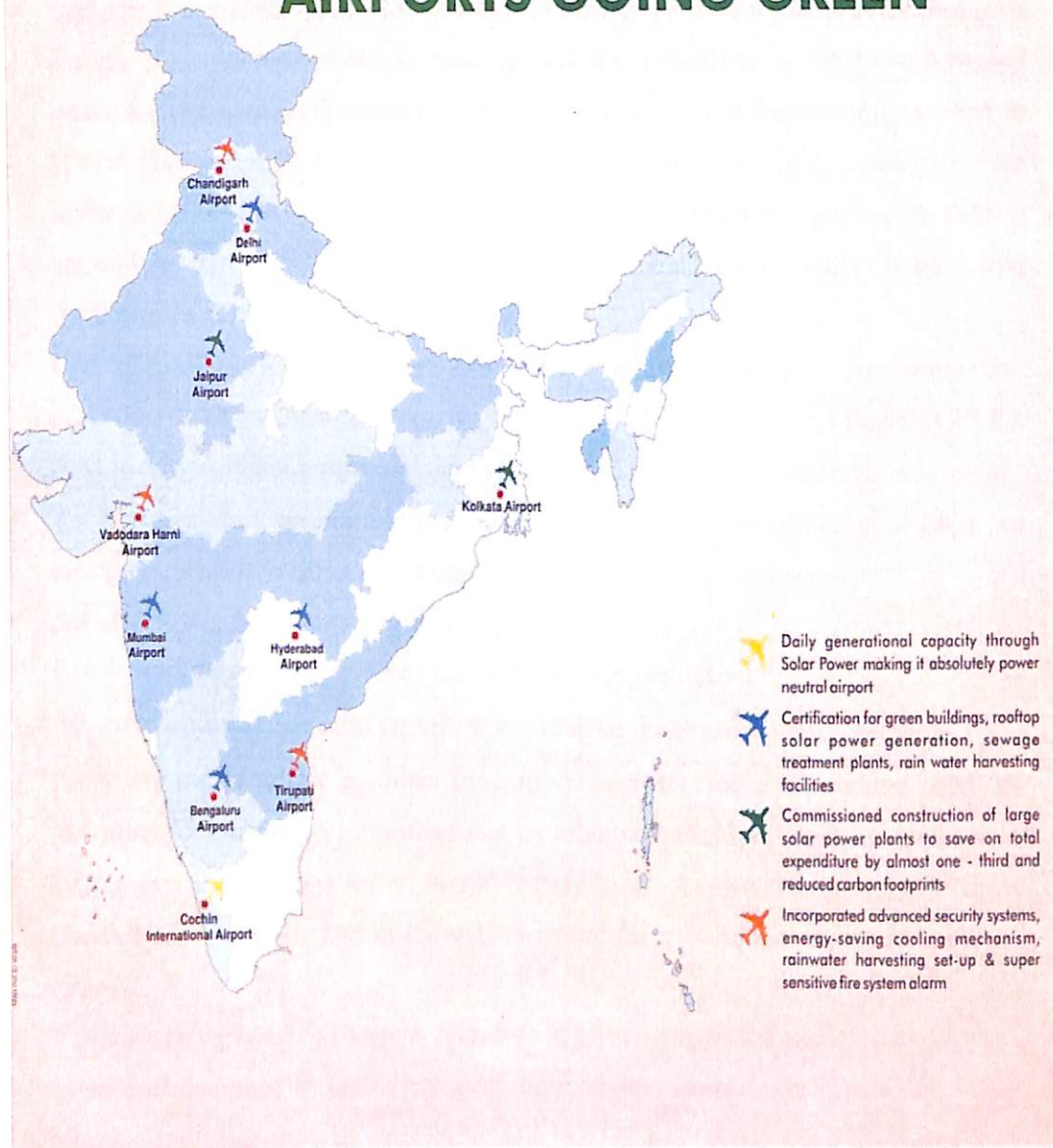


Figure 5 Green Airports (Source-4 Years of Achievements MoCA)

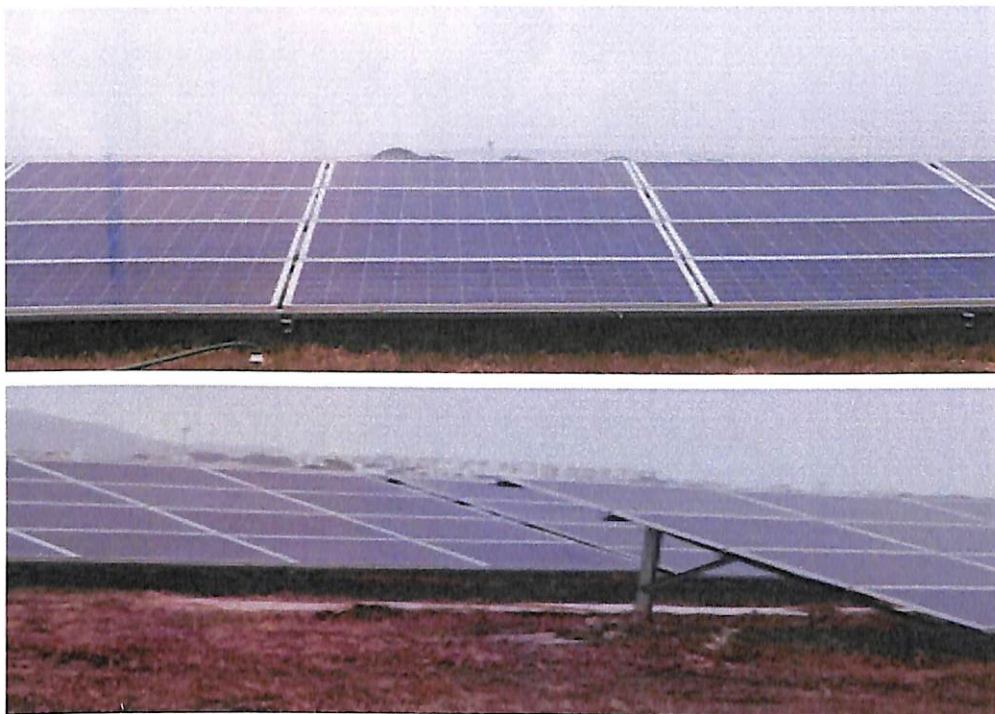


- ✓ Swachh Bharat Mission-Ministry of Civil Aviation and its attached/subordinate organizations are organizing swachhata pakhwada and took up explicit exercises according to definite action plan drawn to achieve the goal of swachhata campaign. Ministry of civil aviation declared the best ministry for its commitment towards swachhata action plan under swachh bharat mission.
- ✓ Sewage Treatment Plants- AAI has set up sewage treatment plants at air terminals for the management of waste transfer and for utilization of the treated reused water for the gardening reason, for flushing in toilets and furthermore utilized in HVAC framework to limit the utilization of new water. Sludge as a last item with water is utilized in planting as manure/compost. Through this procedure AAI is attempting to limit the contamination of characteristic water bodies and furthermore monitor on utilization of water.
- ✓ Use of Acoustic Enclosure type DG sets-To minimize the sound contamination according to the standards set up by the Central Pollution Control Board (CPCB), AAI is only using compact and canopy type DG sets at the air terminals.
- ✓ To decrease dust generation and air contamination at construction sites in air terminals, wheel washing and water sprinklers are being utilized.
- ✓ Automatic organic composter is being installed.
- ✓ Extensive landscaping with horticulture and tree plantation.

#### 3.4 Environmental Measures taken at **Jaipur International Airport**

- ✓ Pollution under check is done by airport operator for the vehicles used for movement within airport premises and by other stakeholders for the vehicles used by the concerned agencies at Jaipur International Airport. Compressed Natural Gas (CNG) is used as fuel in the vehicles used for ground movement at airside at airport.
- ✓ Vehicle entry permit for airport premises is given only to the vehicles which have complete documents including pollution under control certificate at Jaipur International Airport.

- ✓ Solar Panel of capacity 1.8 MW is installed and in application at Jaipur International Airport. This initiative reduced the power consumption charges up to the half of the previous (approximate) and also a very fruitful step for environment. (This data has been taken from AAI electrical, Jaipur International Airport).



**Figure 6 Solar Plant Install at Jaipur Airport**

- ✓ Sewerage Treatment Plant (STP) of capacity 150KLD is installed at Jaipur International Airport. Sewerage water is recycled by STP and used for gardening purpose at airport premises. (Source-AAI Electrical Department, Jaipur International Airport).



**Figure 7 Sewerage Treatment Plant Installed at Jaipur Airport**



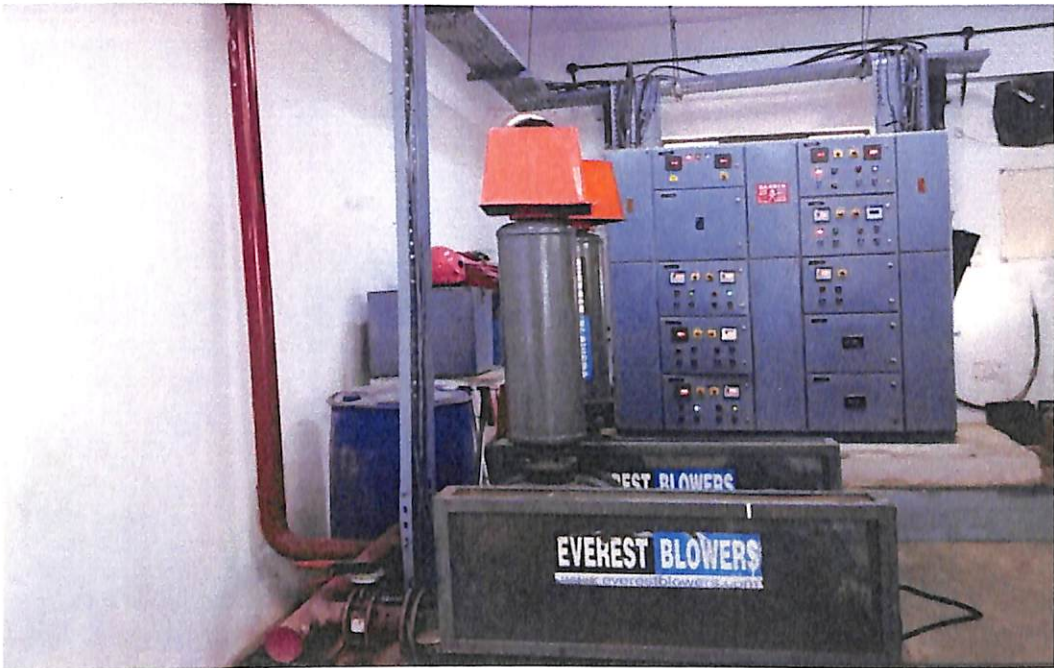


Figure 8 Inner View of STP at Jaipur Airport

- ✓ Garbage disposal is done on regular basis. Dustbins are placed at each required location and garbage has been collected from each location in a closed movable container or in closed vehicle (as applicable) and via garbage hut waste is sent at the designated location by designated local authority.
- ✓ Jaipur International Airport has an Airport Environment Management Committee (AEMC). All the stakeholders of airport (directly or indirectly) are members of this committee. The recent AEMC meeting was held on 19-July-2019 in which issues related to Jaipur Airport regarding environment like garbage control, wild life hazard management and roles of all stakeholders have been discussed.
- ✓ Height of the chimney for the smoke of AC plant is approximate 40 feet.
- ✓ Ambient air quality has been monitored on regular basis on Jaipur International Airport. Environmental mapping machine has been placed three different locations at airport like near runway, near terminal and at city side area of airport.



**Figure 9 Environmental Mapping Machine Used at Jaipur Airport**

Environmental mapping machine measures the air quality in the ambience of airport and compares the values to the parameters given in the Rajasthan Pollution Control Board (RPCB).

S. No.	Parameters	Observed Value ( $\mu\text{g}/\text{m}^3$ )	As per RPCB Norms ( $\mu\text{g}/\text{m}^3$ )
1.	Particulate Matter ( $\text{PM}_{10}$ )	65.60	100
2.	Particulate Matter ( $\text{PM}_{2.5}$ )	31.80	60
3.	Sulphur Dioxide as ( $\text{SO}_2$ )	4.30	80
4.	Oxides of Nitrogen ( $\text{NO}_2$ )	15.30	80
5.	Carbon Monoxide as CO	275.00	2000
6.	Ammonia as ( $\text{NH}_3$ )	8.50	400
7.	Ozone as ( $\text{O}_3$ )	9.70	100
8.	Lead (Pb)	0.02	1.0

**Table 1 Ambient Air Pollutant Terminal Building (Source-Civil Jaipur Airport)**

- ✓ Water quality monitoring has been done on regular basis on Jaipur International Airport on regular basis. For the sampling and analysis of potable/drinking water samples has been collected from the selected locations (bore wells near runway and near terminal building) to test the parameters of pH, color, odor, taste, turbidity, total hardness, Fe, chloride, residual chlorine, fluoride, total alkalinity, TDS, coli form etc.
- ✓ Ambient noise monitoring has been done on regular basis at Jaipur International Airport. Noise level is measured at different locations like near runway, near terminal and at city side area of airport (at both day and night hours). Measured data has been compared to the RPCB norms.



S . N o .	Sampli ng Station	Observed Value [in Db(A)] Day Time		Observed Value [in Db(A)] Night Time	
		Val ue	Standard	Val ue	Standard
1.	Airport Termin al Buildin g	54	75	32	70
2.	Near Runwa y	63		45	
3.	At City side	49		42	

**Table 2 Ambient Noise Monitoring Data (Source-Civil, Jaipur Airport)**

- ✓ Tree plantation program at the city side area of Jaipur Airport has been conducted as a step in the direction green aviation. All stakeholders at airport are invited in it and their suggestions for betterment are also being considered.
- ✓ Jaipur International Airport has been declared as Single Use Plastic Free Airport recently. AAI has taken measures to maintain this status of airport by installed Plastic bottle crushing machines at three locations where maximum passenger movement at airport and also guide concessioners to avoid the single use plastic.



Figure 10 Plastic Bottle Crushing Machine Installed at Jaipur Airport



## 3.5 Research Design

### 3.5.1 Data Sources

- ✓ The approach of this study is primary and secondary data based analysis.
- ✓ The primary data is to be collected via questionnaire. As aviation is a very vast subject and roles of all stake holders are very crucial for it and also for its impact on environment, different questionnaires will be used to seek views, opinions and ideas on aviation and climate change.
- ✓ Three different questionnaires (refer to the Appendix A) have been used during the survey as each individual look at aviation and environment from their own perspective. Following are the types of questionnaire-
  - i. Questionnaire for air traveler
  - ii. Questionnaire for airlines
  - iii. Questionnaire for airport operator.
- ✓ Secondary data is collected from various sources from official websites, books and scholarly journals. Other reports from AAI and ICAO publications and many other institutional are also collected for supporting the literature references. Altogether relevant books, journals and periodicals, research papers, published thesis, articles, financial dailies, websites, are also consulted by the guide for better referencing.

### 3.5.2 Research Methodology

- ✓ The research methodology used is convenient sampling. It is a sort of non-probability sampling where the example is taken from a gathering of individuals simple to contact or to reach. For instance, remaining at a shopping center or a market or an airport as in case of this research and posing individuals to answer inquiries would be a case of a convenience sample.
- ✓ The reasons behind the selection of this methodology are-
  - It is easy and simple to use as very few rules have to be followed.
  - It is inexpensive to collect data by this method.
  - Time consumed is very less.
  - Samples are readily available because the population selected is approachable.

- ✓ Samples have been collected by conducting survey among passengers, employees of airline and employees of airport operator.
- ✓ Samples are selected on random basis but within the defined population that is research area Jaipur International Airport.
- ✓ Survey questions are simple in format and easy to understand so that it is easy for answer to anybody and population selected is not feel pressure on them.
- ✓ It is declared initially that it is not mandatory to show their identity. It is solely their decision. So that they can answer without any hesitation.
- ✓ The printout of questionnaire has been taken and distributed to the randomly selected individual of population and at the different time of day so that all types of data can be collected.
- ✓ Total 90 samples (30 samples for each questionnaire) have been collected for survey purpose.

### 3.6 Analysis and Interpretation of Results

- ✓ In this research the interrelations between ecological effect, social discussion and natural correspondence with respect to air terminals, applied to the instance of Jaipur Airport is being inspected. The research questions concentrated on the degree to which genuine natural impacts, and the correspondence about them, are in accordance with one another and whether view of the air terminal's ecological effect are guided by the correspondence system of the air terminal organization itself.
- ✓ After conducting survey by the questionnaire attached, the data collected has been analyzed and compared with the secondary data which have been collected from the different sources.
- ✓ The all possible type of environmental impact of aviation has been studied and analyzed at Jaipur Airport.
- ✓ It can be assessed by the research that environment management at airport shall be the primary concern of all aviation stakeholders.
- ✓ The mitigation techniques for environment management currently used at Jaipur Airport and its effectiveness are has been studied.

- ✓ After analyzing the data it can be interpreted that till now from a consumer's point of view it is not even relevant how climate-intensive their activities are but airport recognizes the issue and continuously improving in the direction of green aviation with respect to impact on environment.
- ✓ It can be assessed that technological advancement in aviation are the primary catalyst for the environment friendly airports.

## Chapter 4: Conclusion and Scope for Future Work

Aeronautics is a mind boggling and essential industry serving the whole world. It supplies gigantic monetary advantages to those nations that grasp it. Its speed and openness are appropriate to present day society as globalization, innovation improvement, and without a moment to spare assembling change the world. To keep up its focal transportation job, aeronautics must guarantee it can alleviate any ecological limitations that outcome from its tasks.

The selection and utilization of new green activities feature the flying business' unmistakable duty in decreasing aeronautics' carbon impression while propelling avionics. Our neighborhood green activities and research endeavors have shown empowering results up to this point, and there are proceeding with endeavors to put resources into clean innovation and push the limits of research for the advancement of elective energizes.

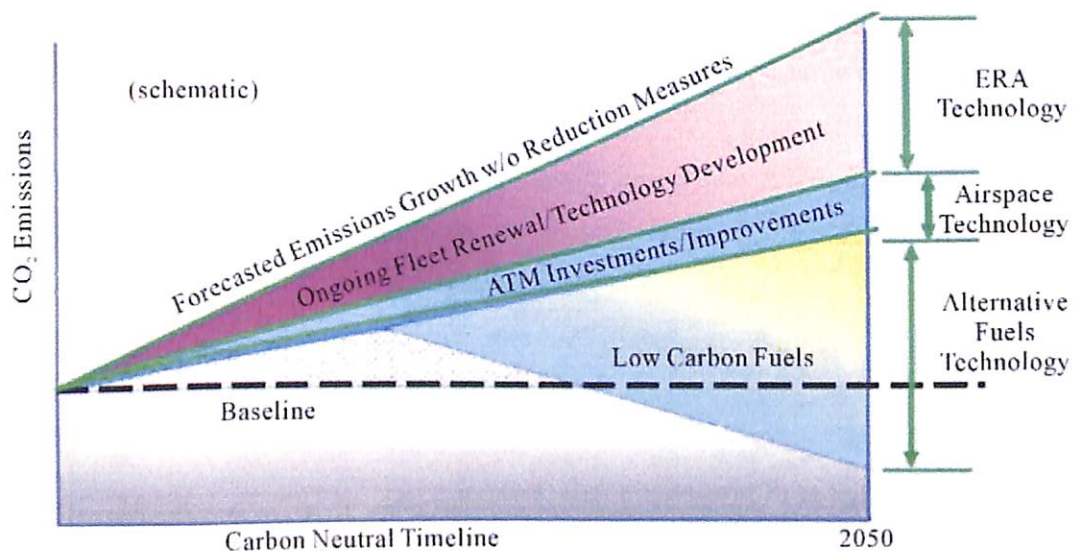


Figure 11 Key Drivers for Emission Reduction in Aviation  
(Source-American Journal of Climate Change, 2012)

Aeronautics puts a high premium on wellbeing, which requests the joining of just demonstrated and actually stable advances to diminish ecological effects. Aircrafts are significant expense and have a long life expectancy, requiring long lead times for new innovations to be broadly joined in the armada. Airframe and motor producers just as carriers should contribute the money to assemble and work flying machine with new advancements for flight to understand the natural and operational advantages. Air terminal foundation requires considerable arranging and development exertion, just as open and monetary help.

To alleviate effect and set objectives need to ceaselessly evaluate difficulties, patterns, and interdependencies in a rigors way. The key drivers towards accomplishing carbon-neutral development to accomplish in such mitigation adventures, just as the related outflow reduction benefits and requiring capital uses are interpreted as-

- Fleet Renewal-Airlines reducing a huge amount of money for fleet renewal which caused a very good percent of reduction in carbon dioxide emission.
- Activities-Improved operational works on, including decreased Auxiliary Power Unit (APU) use, progressively effective flight systems, and weight decrease measures, will accomplish discharges decreases.
- Infrastructure-Full execution of progressively productive ATM and air terminal infrastructure could give an extra discharges reduction internationally, while advantages could be as high in certain areas.
- Motor retrofits and airframe innovation-Modifications to the current armada utilizing current advances (winglets, drag decrease, and so forth.) could accomplish outflows decrease.
- Bio-Fuels-Use of bio-fuels can provide a very big amount of reduction of carbon dioxide but that also with a big investment of industry and Government.
- Green Take-Offs-Green Departures-There is an enormous assortment of how to play out the naturally most invaluable departure. Today, much thought is given to commotion requirements. Airplane taking off are in the section of the flight where they are at their heaviest, implying that they consume most fuel/time. Air-

makes regularly move in a progression of steps isolated by periods of level flight, neither effective nor environ-intellectually cordial.

- Emission based taxes can be imposed to set the accountability of the airlines operator.
- Bio-fuels or electrical vehicles can be used in the airport premises.
- Air routes can be chosen according to the paths which reduce fewer emissions. Although it needs research work, coordination and investment but can be a good step for green aviation.
- Landing fees can contain a noise related component. A decreased landing expense for the activities of calmer airplane can give a motivator to airplane administrators to utilize less boisterous airplane. Higher expenses may likewise be charged for tasks during evening time periods.

The worldwide avionics industry is progressively indicating affectability toward natural concerns and is deciding to put resources into green innovation items. Be that as it may, the costs of such innovation still remain the fundamental issue for obtaining green items. Consistently checks tradeoffs to get pros and cons of different arrangements sets have to be done and then utilize the best science accessible to educate choices.

## Bibliography

- Amit Pandey, Abhoy Kumar & Vandana Singh, *Improvised Airport Operation with technology*, 2019.
- A. N. Sarkar, *Evolving Green Aviation Transport System: A Holistic Approach to Sustainable Green Market Development*, 2012.
- Arushi , Stefan Drews, *Aviation and Environment -A Working Paper*, 2011.
- DGCA Civil Aviation Requirements Section 10 – Aviation Environmental Protection Series ‘B’ Part I Issue, 2015.
- IAAE, *Module-2 Airport Planning, Construction and Environmental*, 2019
- ICAO Annex-16 Volume 1-2-3, *Environmental Protection*.
- John Whitelegg, *AVIATION: the social, economic and environmental impact of flying*, 2000.
- John Whitelegg and Howard Cambridge, *Aviation and Sustainability-A Policy Paper*, 2004.
- Kobe Boussauw and Thomas Vanoutrive, *Flying Green from a Carbon Neutral Airport: The Case of Brussels*, 2019.
- Linda Luther, *Environmental Impacts of Airport Operations, Maintenance, and Expansion*, 2007.
- Maha Mousavi Sameh & Juliana Scavuzzi, *Environmental Sustainability Measures for Airports*, 2016.
- Matthew J. LeVine, “A Framework for Technology Exploration of Aviation Environmental Mitigation Strategies”, 2015.
- Ministry of Civil Aviation (GOI), *48 months of transforming aviation in India (2014-2018)*.
- Ministry of Civil Aviation (GOI), *White paper on National Green Aviation Policy*, 2019.
- Office of The Environment Energy, Federal Aviation Administration, *Aviation Emission, Impacts & Mitigation-A Primer*, 2015.

## Appendix-A

### i. Questionnaire for Air Traveler

This survey is only for research purpose. It will not be used for any type of business strategy.

Name-..... (Optional) Gender-.....

Occupation-..... Age-.....

1. How many times have you travelled by air in a month?  
a. 1-3 times   b. 3-5 times   c. More than 5 times.
2. Do you know aviation have negative impact on environment?  
a. Yes   b. No   c. Do not know
3. Do you consider other mode of transport for shorter distance?  
a. Sometimes   b. Always   c. Never   d. Depends on convenience
4. Are you aware of the plastic free airport status of Jaipur International Airport?  
a. Yes   b. No
5. What type of transport service have you used to come at the airport?  
a. Bus   b. Cab   c. Self vehicle   d. Any other
6. How do you react when any airport staff asks you to help to maintain cleanliness at airport?  
a. Agreed   b. Disagreed   c. Shouting   d. Understanding
7. Are you aware of the fact the increased in flight luggage will increase the fuel consumption of aircraft?  
a. Yes   b. No   c. Do not know
8. Will you consider reducing your unnecessary on board luggage only for the sake of environment?  
a. Always   b. Never   c. Sometimes   d. Often
9. According to you, who are the most responsible for environment at airport?  
a. Airlines   b. Passenger   c. Airport operator   d. All stakeholders
10. Are you voluntarily using dust bins, bottle crusher machines if no one is watching you?  
a. Always   b. Never   c. Sometimes   d. Often



ii. Questionnaire for Airlines

This survey is only for research purpose. It will not be used for any type of business strategy.

Name-..... (Optional) Gender-..... Age-.....

Airlines-..... Designation-.....

1. Do you think aviation has negative impact on aviation?  
a. Yes      b. No      c. Do not know
2. Is your agency taking any measure for management of environment at airport?  
a. Voluntarily    b. After imposing    c. As convenience
3. What is the recent measure has been taken by your agency in this regard?  
.....
4. Are you voluntarily participating in program held at airport in compliance of guidelines of DGCA/ICAO for environment protection?  
a. Always    b. Never      c. Sometimes    d. Often
5. What was the latest program/activity held at airport in which you have participated?  
.....
6. Have you taken any measure for pollution checks of your ground vehicles?  
a. Yes      b. No      ..... (write down the recent one)
7. Do you voluntarily aware passengers about plastic free status of Jaipur International Airport and ask them to avoid single use plastic?  
a. Yes      b. No
8. Are you as an employee, follow all the rules/guidelines imposed by airport operator for environment protection?  
a. Always    b. Never      c. Sometimes    d. Often
9. Do your airlines have proper waste removal and disposal system for aircraft?  
a. Yes      b. No
10. What type of transport service have you used as daily conveyance to come at the airport?  
a. Bus      b. Cab      c. Self vehicle    d. Office pool

iii. Questionnaire for Airport Operator

This survey is only for research purpose. It will not be used for any type of business strategy.

Name-..... (Optional) Gender-..... Age-.....  
Department-..... Designation-.....

1. Are you taking any measure for environment management at airport?  
a. Voluntarily b. After guidelines c. After incident happened
2. What are the recent measures have you taken at the airport in this regard?  
.....
3. Does your airport have any noise mitigation techniques?  
a. Yes b. No
4. Are you committed to the goals of MoCA regarding environment protection?  
a. Yes b. No
5. Does your airport have proper waste management system?  
a. Efficient b. At initial stage c. Can be improved d. Not managed
6. What is the latest program has been held at your airport in compliance of the guidelines of MoCA for green aviation?  
.....
7. Are you taking measures for pollution checks for vehicle entering at airside?  
a. Yes b. No
8. Do you consider the concerns of all stakeholders regarding management system?  
a. Always b. Never c. Sometimes d. Often
9. Do you make arrangement for inspection of all areas of airport premises for proper compliance of guidelines regarding environment protection?  
a. Yes b. No
10. Are you imposing any fine to the stakeholders on non compliance of guidelines regarding environment protection?  
a. Always b. Never c. Sometimes d. Often

## Appendix-B

### i. Format For Annual Carbon Footprint Data (Airport Operators)

CIVIL AVIATION REQUIREMENTS  
SERIES 'B' PART I

SECTION 10  
5<sup>TH</sup> AUGUST, 2015

Annexure I

**FORMAT FOR ANNUAL CARBON FOOTPRINT DATA (AIRPORT OPERATORS)**

Name of the Airport Operator		
Calendar Year		
Aircraft Movements*	Domestic	
	International	
	Total	
Number of Passengers	Domestic	
	International	
	Total	
Cargo (Tonnes)	Domestic	
	International	
	Total	
Scope 1: Fuel consumed by power generators, airport vehicles/equipment (e.g. GPU) moving inside or outside airport boundary owned by the airport company**  <i>Report fuel quantity &amp; unit (e.g. liters, m<sup>3</sup>, kgs, tonnes)</i>	Petrolfor Generators	
	Petrol for Vehicles/Equipment	
	Dieselfor Generators	
	Diesel for Vehicles/Equipment	
	CNGfor Generators	
	CNG for Vehicles/Equipment	
	LPGfor Generators	
	LPG for Vehicles/Equipment	
	Other	
Scope 2: Total electricity (MWh) purchased for heating, cooling, lighting of terminal building, runways, offices, etc. for all users, including the airport operator's company, third parties, etc.***	Electricity	
Scope 2: Total electricity (MWh) purchased for heating, cooling, lighting of terminal building, runways, etc. only for the airport operator's company	Electricity	
Short description of data collection and quality control methodology (i.e. explain the source of the data, responsible department, checks done, correction process, etc.)		
Authorized person		
Designation		
Telephone number		
Email address		
		Signature                      Date
* Aircraft movement is defined as aircraft take-off or landing at an airport. One arrival and one departure represent two movements.		
** Vehicles, equipment, etc. that are sub-contracted should not be part of the calculations.		
*** One number needs to be reported. In most of the cases this number will be based on the main electricity bills paid by the airport operator for the whole airport consumption.		

ii. Format For Annual Carbon Footprint Data (Airline Operators)

CIVIL AVIATION REQUIREMENTS  
SERIES 'B' PART I

SECTION 10  
5<sup>TH</sup> AUGUST, 2015

Annexure II

**FORMAT FOR ANNUAL CARBON FOOTPRINT DATA (AIRLINE OPERATORS)**

Name of the Airline Operator		
Calendar Year		
Types of aircraft		
Number of Aircraft Movements*	Domestic	
	International	
	Total	
Number of Passengers	Domestic	
	International	
	Total	
Cargo (tonnes)	Domestic	
	International	
	Total	
Revenue Tonne Kilometers (RTK)**	Domestic	
	International	
	Total	
Scope 1: ATF consumed by aircraft engines, APUs, maintenance etc. (tonnes)****	Domestic operations***	
	International operations***	
	Total	
Short description of ATF data collection and quality control methodology (i.e., explain the source of the data, responsible department, checks done, correction process, etc.).		
Authorized person		
Designation		
Telephone number		
Email address		
		Signature
		Date
<p>* Aircraft movement is defined as aircraft take-off or landing at an airport. One arrival and one departure represent two movements.</p> <p>** <math>RTK = \text{Distance} \times \text{Payload}</math>, Where:</p> <ul style="list-style-type: none"> <li>• <b>Distance</b> means the actual distance flown by the aircraft. In case of non-availability of this information, the great circle distance between the aerodrome of departure and the aerodrome of arrival plus an additional fixed factor of 95 km may be used.</li> <li>• <b>Payload</b> means the total mass of revenue-based freight, mail and passengers carried. The number of passengers shall be the number of persons on-board excluding crew members. An aircraft operator may choose to apply either the actual or standard mass for passengers and checked baggage contained in its mass and balance documentation for the relevant flights. Alternatively a default value of 100 kg for each passenger and their checked baggage may be used.</li> </ul> <p>*** Domestic flights are those that depart and arrive in India. International flights are those that depart from India and arrive in another country or those that depart from another country and arrive in India. ATF consumption from flights departing from another country and arriving to another country by an Indian airline (e.g. a flight from Brussels to Toronto) should also be reported as international flights. The airline should state the amount of fuel consumed for domestic and international flights separately. For flights that combine both a domestic and international leg, airlines should report the domestic leg at the domestic operations section and international leg at the international operations section by using a justified methodology. ATF consumption information may be calculated based on the summation of fuel consumption from each individual flight or on other appropriately documented and accepted methodology.</p> <p>**** In case conversion from litres to kgs is required and there is no information on the specific density factor value, then the value of 0.8 kg/litre may be used.</p>		

iii. Format For Monthly Mean And Annual Mean Values (To be Submitted Every 12 Months)

CIVIL AVIATION REQUIREMENTS  
SERIES 'B' PART I

SECTION 10  
5<sup>TH</sup> AUGUST, 2015

Annexure - V

**TABLE 1: MONTHLY MEAN VALUES (TO BE SUBMITTED EVERY 12 MONTHS)**

Airport													
Station Location													
Reporting Period													
Month	NO	NO <sub>2</sub>	NO <sub>x</sub>	CO	O <sub>3</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	HCS	Temp	RH%	WS	WD*
Prevailing (i.e. most common) wind direction should be reported.													

**TABLE 2: ANNUAL MEAN VALUES (TO BE SUBMITTED EVERY 12 MONTHS)**

Airport				
Station Location				
Reporting Period				
Pollutant	Minimum**	Mean**	Maximum**	Data Capture %***
NO				
NO <sub>2</sub>				
NO <sub>x</sub>				
CO				
O <sub>3</sub>				
SO <sub>2</sub>				
PM <sub>10</sub>				
PM <sub>2.5</sub>				
HCS				
Temp				
RH%				
WS				
WD*				
<p>* Prevailing (i.e. most common) wind direction should be reported for the mean, while no minimum or maximum value should be reported for this parameter.</p> <p>** Calculation for minimum, mean and maximum values shall be based on hourly values recorded throughout the entire reporting period.</p> <p>*** <b>Data Capture (%)</b>: This is calculated by dividing the total number of valid measurements (e.g. hourly average values stored by the equipment) by the total possible number of valid measurements (e.g. 8760 hours in one calendar year) and converting the result into a percentage (by multiplying by 100).</p> <p><b>Note:</b> Periods where the equipment is being periodically serviced or calibrated are not taken into account. For example, in a 30-day month (e.g. June), 670 valid hourly measurements are obtained while the analyser calibrated during a 5-hour period at the end of the month and the analyser malfunctioned for a total of 45 hours. In that case, the Data Capture (%) would be <math>670 / (670 + 45) = 93.7\%</math>.</p>				

## Appendix-C

### Imposition of Penalties-Guidelines regarding offence/violation

Annexure-1

#### Imposition of Penalties - guidelines regarding

Sl. No.	Offence/Violation	Penalty in (Rs)
1.	Smoking in public area except where designated smoking chambers or areas are established.	1500
2.	Spitting in airport premises	1000
3.	Misuse of passenger baggage trolley	1000
4.	Using language likely to cause offence/annoyance	2000
5.	Throwing loose papers, plastic cups or glass etc. in airport premises	1000
6.	Non-display of Photo Identity Cards while entering in to or being in the terminal or operational area	1000
7.	Transportation of overloaded airline baggage containers in operational area	1000
8.	Vehicle/ equipment operating without anti-collision light/obstruction inside operational area	2000
9.	Parking of vehicle/ equipment in no parking area on kerb side and city side including approach road within airport premises.	500
10.	Un-authorized entry into terminal building or operational area.	1000
11.	Rash driving/over speeding in operational area	3000
12.	Driving in operational area while being in state of intoxication	5000
13.	Causing public inconvenience, unruly behaviour or creating nuisance in public area	1000
14.	Organizing or taking part in any public assembly, demonstration, dharmas or procession likely to obstruct or interfere with proper use or orderly functioning of airport	5000
15.	Display of banners, flags, posters, emblems or write slogans in or around terminal	5000
16.	Obstruction of authorized persons in the discharge of his or her duties	5000
17.	Dumping garbage in operational area	3000
18.	Vehicle/equipment left unattended in operational area outside designated parking area/hard stand for ground support equipment/vehicles	2500
19.	Vehicle/equipment not following vehicular lanes on Apron	1500
20.	Vehicle/equipment/person obstructing aircraft movement	5000
21.	Crossing/operating vehicle/equipment close to active runway/taxiway without permission	5000
22.	Vehicle/equipment operation in the operational area without permit (ADP)	5000
23.	Damage, display, removal or alter any building structure or other property of AAI whether movable or immovable. Besides penalty action to be taken to recover the loss from the defaulter or insurer organization	5000
24.	Photography and film shooting/ videography at airport without permission	5000
25.	Commercial activities at airport without permission	5000