

Analysis of Air, Water and Noise of International Airport, Bhopal

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ABSTRACT

Rise in pollution level at the air port and its perimeter can cause serious health effects for not only working staff of the airport but also people living near by the airport. The aim of this study is to assess the level of the pollution primarily air, water and noise in indoor as well as in outdoor atmosphere at Raja Bhoj Airport Bhopal. This study has been carried out by monitoring the Raja Bhoj Airport Bhopal for 24 Hours from 10 July, 2017 to 11 July, 2017 with the help of Central Pollution Control Board, Bhopal. Samples have been taken for indoor air quality, outdoor air quality, and water quality and noise level from the sensitive zones of Raja Bhoj Airport Bhopal. It is found in the study that pollution level are in the permissible limits except noise in apron area of Raja Bhoj Airport Bhopal and also the level of $PM_{2.5}$ is above the limit of permissible in indoor air quality monitoring.

Keywords : Airport, CPCB, Monitoring

I. INTRODUCTION

The air port is playing a key role in the development of the city as well as in the state, but with the development airport is also contribute in the environmental pollutions majorly air, water and noise. Yearly there is a significant increment in the air traffic causes rise in pollution level which greatly affects the peoples living around the perimeter of the airport. The fuels burning in the aircraft release particle into the air are the major source of air pollution [1]. Over the last decade the aviation industry has undergone rapid growth and this is predicted to continue for the upcoming future at 5–7% per annum (Airbus Industries, 1997. Global market forces 1997–2016. Airbus Industries, Blagnac, France) [2]. Exposure to environmental pollution from Schiphol airport was studied for aircraft noise, air pollution, and odour and radar installations around the airport. These were selected on the basis of a screening exercise combined with consultations with local stakeholders and expert groups [3]. Currently the regulatory standards for aerosol such as PM_{10} and $PM_{2.5}$ in ambient environments in India are 100 and 60 $\mu\text{g}/\text{m}^3$ respectively. Researchers have studied air pollution status and correlated it with environmental, human and plants health impacts [4]. Air

pollution have mainly four types of pollutants and these are PM_{10} , $PM_{2.5}$, NO_2 and SO_2 these pollutants have different types health effects and these are explain as following

PM_{10} :- These are the respirable suspended particles of size 10 micron, can penetrate and lodge deep inside the lungs. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer.

$PM_{2.5}$:- The size of these particles are 2.5 micron, these can causes asthma, respiratory inflammation, jeopardizes lung functions and even promotes cancers.

NO_2 :- Irritation to the skin, eyes and throat, cough etc.

SO_2 :- Lung disorders and shortness of breath.

The problem of aircraft noise disturbance involves a complex interaction of a number of physical biological, psychological and sociological processes [5]. Health effects of Air Pollution and Noise Pollution exposure to aircraft noise will affect the health status of the population living around the airport in terms of annoyance, sleep disturbance, cardiovascular diseases and reduced performance. It is unlikely that local air

pollution levels will cause respiratory effects or cancer [6].

II. MATERIALS AND METHODS

i. Study Area

Bhopal, the Capital city of Madhya Pradesh popularly known as ‘City of Lakes’ and It's one of India’s greenest and cleanest cities Figure (1). Bhopal has witnessed the world’s worst industrial disaster in December 1984 due to release of Methyl Isocyanides gas from Union Carbide India Ltd storage tank The capital city ‘Bhopal’ is situated between latitude 23°07' to 23°34' N and



Figure 1. Raja International Airport

longitude 77°10' to 77°30' E with an average elevation of 527 m (1729 ft.) above sea level. The weather in Bhopal is temperate with hot summers (April-June) and cool winters (November-February). The minimum and maximum temperature reported of city Bhopal is 9°C and 44°C respectively. Bhopal encompasses an area of 463 sq. km with 85 municipal wards. The population of Bhopal Municipal Corporation as per census 2011 is 23, 71,061. Raja Bhoj Airport is ISO 14001:2004 certified airport of the Madhya Pradesh. It is the second busiest airport in Madhya Pradesh after Devi Ahilyabai Holkar Airport in Indore. Total numbers of flight movement as on date of monitoring (i.e. 10/07/2017 and 11/07/2017) are 26 on each day and total average passengers travelled per day in month of June are 2,019. Average No of passenger movements per month of new terminal building are 65000. In 2013, Raja Bhoj Airport becomes the first airport in the state to use solar power for running its utility grid system. 100-kilowatt solar power plant was made operational in June 2013, with plans to install a 2 megawatt solar power plant at the airport in the future. The information are collected from

the questionnaires submitted by the Raja Bhoj Airport management to Central Pollution Control Board, Bhopal as dated 17 July, 2017. The project work has been carried out with the help of Central Pollution Control Board, Bhopal is based on monitoring of Raja Bhoj Airport, Bhopal for duration of 24 hours as on date regarding indoor air quality, ambient air quality, noise and waste water treatment to which samples are taken for indoor and Ambient air quality at three different locations in which two are indoors and one is outdoor and to monitoring noise we have taken samples from four different locations, afterward for waste water sampling, one sample have taken from final Outlet of STP plant. Also assess for the solid waste management, E-Waste and Bio-Medical waste Management/Handling. For Air quality and Noise monitoring, stations installation we have selected most sensitive zones of the airport and these are

1. Departure Area
2. Arrival Area
3. VIP Parking Area
4. Apron Area

a. Indoor Air Quality Monitoring

1. Departure or Check in Area (Indoor)
2. Arrival Area (Indoor)

b. Ambient Air Quality Monitoring

1. VIP Parking Area (Outdoor)

c. Noise Monitoring

1. Departure Area or Check in Area
2. Arrival Point
3. Apron Area [The airport apron is the area of an airport where aircraft are parked, unloaded or loaded, refuelled, or boarded]
4. VIP Parking Area

d. Sewage treatment plant

1. One sample from final Outlet of STP plant

ii. Sampling

TABLE: 1

Total Samples Collected					
Sample Collected for Air Quality Monitoring					
S. No	Type of Sample	Duration of Sampling	Sample Interval	samples Collected from each Location	Total Samples Collected
1.	Gaseous Samples	24 Hours	4 Hours	6 Samples	18 Samples

2.	PM ₁₀ Filter Paper	24 Hours	8 Hours	3 Samples	9 Samples
3.	PM _{2.5} Filter Paper	24 Hours	24 Hour	1 Sample	3 Samples
Sample Collected for Noise Monitoring					
S. No	Type of Sample	Duratio n of Sampli ng	Sample Frequen cy	Total Locations of Sampling	
4.	Noise Monitori ng	24 Hours	Hourly	04 Locations	
Sample Collected for Waste Water					
S. No	Type of Sample	Duratio n of Sampli ng	Sample Interval	Total Locatio ns of Samplin g	Total Samp les Colle cted
5.	Final outlet of STP Sample	Grab Samplin g	Grab Sampling	01 Sample	01 Sample

Table 1 : shows the total no of samples collected during the monitoring of Air Quality, Noise and Water Quality.

III. ANALYSIS

In this study, especially Air quality (Indoor and Outdoor) with parameters such as PM_{2.5}, PM₁₀, air toxic gases as NO_x, SO₂, Noise for parameters as L₅₀, L₉₀, L_{min}, L_{max} and L_{eq} and Water quality parameters like pH, BOD, COD, Suspended Solids and oil and grease were analysed. For air quality assessment Outdoor and Indoor air is drawn through a size-selective inlet of the dust sampler Envirotech APM-460 NL with attached assembly of Gas sampler Envirotech APM 411 TE and BGI PQ200, Particulate Sampler. And for Noise Monitoring at different locations of airport HD2110L Spectrum Analyser, Integrating Sound Level Meter are used to collect the samples. The collected samples were analysed for various parameters in CPCB Laboratory Bhopal by using standard methods prescribed by Central Pollution Control Board, India and originally described by American Public Health Association (1977) in Laboratory of Central Pollution Control Board Bhopal [7]. PM₁₀ and PM_{2.5} were analysed by gravimetric method. PM₁₀ particles drawn through glass micro fibre filter at a flow rate of 0.5 m³/min and on 8-hourly basis for 24 hours. PM_{2.5} are drawn through glass fibre filter paper at a flow rate of 10-20 LPM continue for 24 hours. Gaseous pollutant NO_x was analysed by Jacob & Hochheiser method. SO₂ were analysed by West & Geake method. The analysis included Six parameters to be tested for Indoor Air Quality and Ambient Air Quality, these are as following:-

1. Respirable Suspended Particulate Matter [RSPM] (PM₁₀)
2. Respirable Suspended Particulate Matter [RSPM] (PM_{2.5})
3. Sulphur dioxide [SO₂]
4. Nitrogen Oxides [NO₂]
5. Temperature
6. Humidity

Sample taken from the final outlet of sewage treatment plant for analysis of which following parameters are assessed:-

1. pH
2. Total suspended solids
3. BOD 3 days 27^oC
4. COD
5. Oil and Grease

IV. RESULTS AND DISCUSSIONS

TABLE: 2

Indoor Air Quality Monitoring 10-11, July 2017 Location- Departure or Check in Area						
Param eter→	SO₂ (µg/ m³)	NO_x (µg/ m³)	PM_{2.5} (µg/ m³)	PM₁₀ (µg/ m³)	Temp eratur e (Aver age)	Humidi ty (Averag e)
Conce ntrati on Range	2.42	13.7 2	25.8 0	24.5 5	25.77 ^o C	57.37 %
Stand ards	80	100	15	50	-	-

Table 2. shows the results of samples collected from the Raja Bhoj Airport Bhopal for the Indoor Air Quality at location Departure or Check in area.

So far in India there are no Indoor Air Quality guidelines; hence all the indoor air quality results for this Thesis work are compared with international norms such as ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) and other available recognised international standards like OSHA (The Occupational Safety and Health Administration), American Conference of Industrial Hygienists (ACGIH) and World Health Organisation [8]. As it clear from Table: 2 that all the results of pollutants obtained from the samples of indoor air quality collected from Departure or Check in area are below the permissible limits except PM_{2.5} which is above the permissible limits.

Indoor Air Quality Monitoring Departure or Check in Area

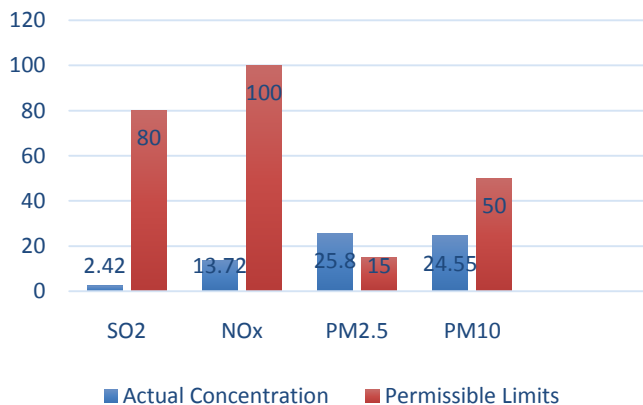


Figure 2. Indoor Air Quality at Departure or Check in Area

TABLE: 3

Indoor Air Quality Monitoring 10-11, July 2017 Location- Arrival Area						
Parameter→	SO ₂ (µg/ m ³)	NO _x (µg/ m ³)	PM _{2.5} (µg/ m ³)	PM ₁₀ (µg/ m ³)	Temper ature (Ave rage)	Humidity (Average)
Concentration Range	2.09	23.45	20.39	18.03	24.36°C	60.25 %
Standards	80	100	15	50	-	-

Table: 3 Depicts the results of Indoor Air Quality at location Arrival Area of Raja Bhoj Airport. Indoor air quality found at arrival area is also much below the permissible limits expect PM_{2.5} which is above the permissible limits.

Indoor Air Quality Monitoring Arrival Area

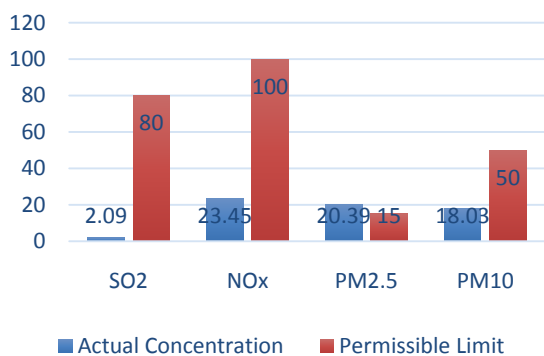


Figure 3. Indoor Air Qualities at Arrival Area

a. Ambient Air Quality Monitoring

TABLE: 4

Ambient Air Quality Monitoring 10-11, July 2017 Location- VIP Parking Area					
Parameter→	SO ₂	NO _x	PM _{2.5}	PM ₁₀	Remarks
Concentration Range	2.96	18.96	37.45	66.96	Cloudy and Rainy atmosphere
Standards as per CPCB	80	80	60	100	

Note- All values of concentrations are in µg/m³ of air

Table: 4 presented the results of Ambient Air Quality at location VIP Parking area at Raja Bhoj Airport Bhopal, Which are compared with the standards provided by the Central Pollution Control Board. It is found that the pollutants present in Outdoor Air are below the permissible limits.

Ambient Air Quality Monitoring VIP Parking Area

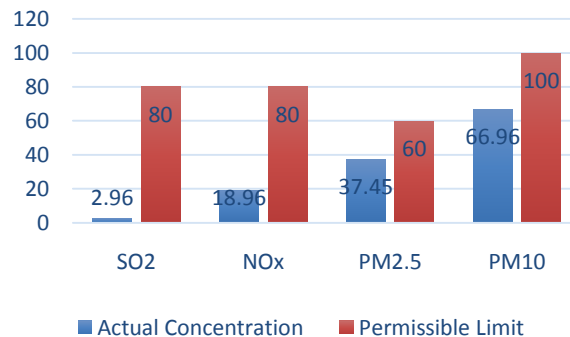


Figure: 4 Ambient Air Qualities at VIP Parking Area

b. Noise Monitoring

The Noise level monitoring was carried out on 10.07.2017 to 11.07.2017 at four locations e.g. Departure Area or Check in Area, Arrival Point, Apron Area [The airport apron is the area of an airport where aircraft are parked, unloaded or loaded, refueled, or boarded] and VIP Parking Area.

TABLE: 5

Location	Noise Monitoring 10-11/07/2017					Leq dB(A) (Average)	Per missi ble Li mit
	L ₅₀	L ₉₀	L _{min}	L _{max}	Leq dB(A)		
Departur e Area or Check in Area							
Time ↓							
11:15 AM to 12:15 AM	55 .1	52 .3	50.6	69.6	57.6	Day Time - 67.11	Day Tim e- 75
12:40 PM to 01:40 PM	61 .2	58	56.5	76.0	69.0		
01:45 PM to 02:45 PM	72 .1	71 .5	70.8	75.2	72.1		
02:55 PM to 03:55 PM	72 .1	71 .3	70.4	73.6	72.1		
04:00 PM to 05:00 PM	72 .2	71 .4	69.1	81.2	72.2		
05:30 PM to 06:30 PM	72 .1	70 .5	60.7	76.9	72.9		
07:15 PM to 08:15 PM	70 .5	63 .4	58.1	78.0	70.4		
09:00 PM to 10:00 PM	70 .7	70	69.0	77.0	71.1		
06:30 AM to 07:30 AM	61 .5	58 .9	57.2	81.6	63.6		
08:00 AM to 09:00 AM	58 .5	56 .8	54.8	70.2	59.2		
09:30 AM to 10:30 AM	57 .5	55 .9	53.6	72.1	58.1		
10:00 PM to 11:00 PM	69 .7	69	67.4	77.3	69.9		
11:00 PM to 12:00 AM	69 .7	69	68.3	70.9	69.7		
12:30 AM to 01:30 AM	69 .6	68 .9	68.3	71.7	69.5		

Table 5 shows the results of at location Departure or Check in Area of Raja Bhoj Airport Bhopal. The value observed of Average L equivalent dB (A) at location Departure or Check in area in Day Time (i.e. 06:00 am to 10:00 pm) is 67.11 dB(A) and in Night Time (i.e. 10:00 pm to 06:00 am) is 69.7 dB(A), both of the values are below the permissible standard limits. During day time Noise monitoring L_{max} was found 81.6 and L_{min} was found 50.6 and during night time L_{max} was found 77.3 and L_{min} was found 67.4.

TABLE: 6

Locatio n	Noise Monitoring 10-11/07/2017					Leq dB(A) (Avera ge)	Per missi ble Lim it
	Arrival Area	L ₅₀	L ₉₀	L _{min}	L _{max}		
Time ↓							
12:30 PM to 01:30 PM	50 .5	49. 7	48.8	76. 8	53 .7	Day Time- 58.35	Day Tim e- 75
01:45 PM to 02:45 PM	53 .9	53. 0	52.1	77. 8	57 .8		
03:00 PM to 04:00 PM	53 .7	52. 9	52.0	66. 8	53 .9		
04:00 PM to 05:00 PM	53 .8	53. 0	52.2	73. 4	55 .2		
05:00 PM to 06:00 PM	53 .7	52. 8	52.0	66. 7	55 .1		
06:00 PM to 07:00 PM	51 .2	53. 6	53.1	72. 6	62 .4		
07:00 PM to 08:00 PM	53 .4	52. 8	50.9	82. 1	63 .1	Night Time- 52.82	Nigh t Tim e- 70
08:00 PM to 09:00 PM	55 .2	53. 0	52.2	78. 6	61 .6		

09:00 PM to 10:00 PM	53.2	52.9	51.9	79.7	62.4		
10:00 PM to 11:00 PM	53.7	49.3	48.1	80.4	60.0		
11:00 PM to 12:00 AM	49.2	48.5	47.2	54.3	49.2		
12:30 AM to 01:30 AM	50.6	49.7	45.6	75.8	51.1		
02:00 AM to 03:00 AM	50.8	49.7	48.1	58.0	51.0		

02:20 PM to 03:20 PM	54.5	52.8	52.0	70.8	55.7		
03:30 PM to 04:30 PM	54.5	53.2	52.5	73.5	55.5		
04:35 PM to 05:35 PM	57.5	53.9	53.6	72.1	58.2		

Not done due to instrument failure

Value observed of Average L equivalent dB (A) at VIP Parking area in Day Time (i.e. 06:00 am to 10:00 pm) is 60.2 dB (A) the value found is below the permissible standard limit. During day time Noise monitoring L_{max} was found 82.6 and L_{min} was found 52.0.

Values are below the permissible standard limits. During day time Noise monitoring L_{max} was found 105.8 and L_{min} was found 43.4 and during night time L_{max} was found 93.8 and L_{min} was found 45.6.

*Value observed of L_{eq} (1 Hour Average) was 77.3 at the time of Landing and take-off Aircraft of Air India and Jet Airways in Day time, it was found above the permissible limit.

** Value observed of L_{eq} (1 Hour Average) was 74.5 at the time of Landing and take-off Aircraft of Air India and Jet Airways in Day time, it was found near the permissible limit.

TABLE: 8

Location	Noise Monitoring 10-11/07/2017					Average L equivalent dB(A)	Permissible Limit
	VIP Parking Area	L_{50}	L_{90}	L_{min}	L_{max}		
Time ↓							
12:00 PM to 01:00 PM	54.5	52.9	52.2	79.7	61.3	Day Time-60.2	Day Time-75
01:15 PM to 02:15 PM	58.4	53.5	52.0	82.6	70.3	Night Time-Not done	Night Time-70

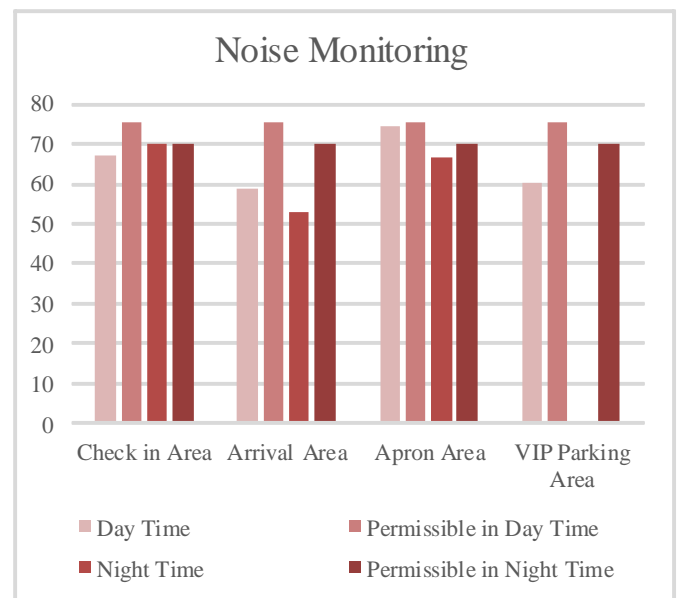


Figure 5 : Noise Level in different area of airport

c. Day-night equivalent noise levels (L_{dn}):-

The day-night average sound level (L_{dn} or DNL) is the average noise level over a 24-hour period. The noise between the hours of 10pm and 7am is artificially increased by 10 dB. This noise is weighted to take into account the decrease in community background noise of 10 dB during this period. The

day night equivalent noise levels of a community can be expressed as [9].

$$L_{dn}, \text{dB (A)} = 10 \times \log_{10} \left[\frac{16}{24} (10^{L_d/10}) + \frac{8}{24} (10^{(L_n + 10)/10}) \right]$$

L_d = day-equivalent noise levels (from 6AM – 10PM), dB (A)

L_n = night equivalent noise levels (from 10 PM - 6 AM), dB (A)

The day hours in respect to assessment of noise levels, is fixed from 6 AM – 10 PM (i.e., 16 hrs) and night hours from 10 PM - 6 AM (i.e., 8 hrs). A sound level of 10 dB is added to L_n due to the low ambient sound levels during night for assessing the L_{dn} values.

TABLE: 9

Location	Date	i_d Day Events- (06:00 AM to 10:00 PM)	i_n Night Events- (10:00 PM to 06:00 AM)	L_d	L_n	L_{dn}
Arrival Area	10/07/2017 to 11/07/2017	09	04	58.3	52.8	60.2
Departure Area	10/07/2017 to 11/07/2017	11	03	67.1	69.7	73.8
Apron Area	10/07/2017 to 11/07/2017	08	03	74.1	66.3	74.8
VIP Parking	10/07/2017 to 11/07/2017	05	*Not Done	60.2	*Not Done	60.2

*Not done due to instrument failure.

Table: 9 are presented values of Day-Night Equivalent Noise Levels (L_{dn}) at locations Arrival, Departure, Apron and VIP Parking Area of Raja Bhoj Airport Bhopal. The lowest value found at Arrival Area and the Maximum value of L_{dn} found in Apron area, because this area is the operational area of the airport

where the activities like aeroplane take-off and landing happened.

TABLE: 10

Grab Sampling analysis results of STP-140 KLD Final Outlet Raja Bhoj Airport, Bhopal (Date of sampling-10/07/2017)			
S.No.	Parameters	Final Outlet	Limits (As per Consent)
1.	pH	7.56	Between 5.5-9.0
2.	BOD	12	Not exceed 100
3.	COD	4.0	Not exceed 250
4.	Suspended Solids	11	Not exceed 100
5.	Oil & grease	1.4	Not exceed 10

Note: - All values are mg/l, except pH.

Table: 10 depict the results of water sample collected from the final outlet of STP plant installed at the Raja Bhoj Airport Bhopal. It is found that the water pollutants are much below the permissible limits given in consent.

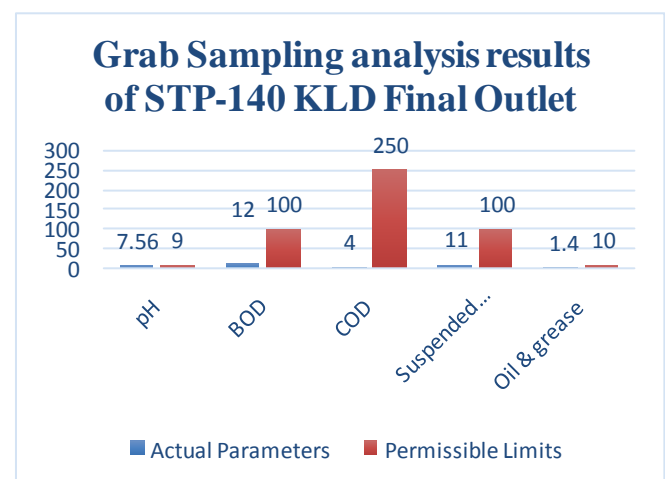


Figure 6. Water quality level

V. CONCLUSION

Results revealed that the level of $PM_{2.5}$ is above the permissible limits for indoor air pollution on both of the monitoring stations at Raja Bhoj Airport Bhopal. The

data of samples collected for outdoor air pollution and water pollution results concluded that all the pollutants parameters are in the range of permissible limits. Samples collected for noise pollution at four different locations are analysed which disclose that at three monitoring stations it is below the permissible limits but in apron area for some short of time noise pollution is above the permissible limits. This is because of operational activities such as flight movements in apron area of Raja Bhoj Airport Bhopal.

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