Item No. 02

BEFORE THE NATIONAL GREEN TRIBUNAL
CENTRAL ZONE BENCH, BHOPAL
(Through Video Conferencing)

Original Application No. 31/2021 (CZ)
I.A. No. 14/2021

Vijay Singh Applicant(s)

Versus

State of Rajasthan & Ors. Respondent(s)

Date of hearing: **22.12.2021**

Date of uploading : 24.12.2021

CORAM: HON'BLE MR. JUSTICE SHEO KUMAR SINGH, JUDICIAL MEMBER
HON'BLE DR. ARUN KUMAR VERMA, EXPERT MEMBER

For Applicant(s): Mr. Manoj Awasthi, Adv.

For Respondent(s) : Mr. Yadvendra Yadav, Adv.

ORDER

1. The present application has been filed with the prayer to cancel the permission/NOC granted in favour of the respondent no. 6 & other industries of birck klins, by restoring environment of the area, with direction to respondent no. 6 to restore/restitute environment of the area i.e. village Nadaura, Gram Panchayat Silawat, District Dholpur, Rajasthan by removing entire structure of bricks kiln situated at Khasra nos. shown in application.

2. The matter was taken up by this Tribunal on 03.06.2021 and a committee was constituted in the following manner :

"13. *Accordingly, we direct CPCB to constitute*

a Committee of five experts to suggest ways and means, if any, by which sustenance of brick kilns activities may be viable. It will be open to CPCB to nominate in-house or other Experts. The CPCB may also explore viability of PNG as replacement of coal and other best practices in terms of fuel used, at other places. It will be open to the brick kilns owners/associations to give any other suggestions or alternatives for consideration, by CPCB in spirit of collaboration with a view to find a solution within a reasonable time. The CPCB may constitute an expert committee with the consultation of Member Secretary, State Pollution Control Board within three weeks which may give its report within six weeks thereafter. Further report may be furnished in the matter for the year 2019 & 2020 on the following points :

i. *Estimation of Existing Pollution Load w.r.t PM2.5*
ii. *Estimation of Assimilative Carrying Capacity w.r.t PM_{10}*
iii. *Estimation of Supportive Carrying Capacity w.r.t PM_{10}*

14. The committee may also submit the suggestions so that the freedom of trade, business and right to life, with regard to fresh air and unpolluted water should be balanced. The report may be furnished in the matter before the next date i.e. ***06th September, 2021*** *by email at ngtczbbho-mp@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF.*"

3. In compliance thereof, the Joint Committee submitted the report, which is as follows :

"The expert committee held its 05 virtual meetings on 30.6.2021, 29.7.2021, 4.8.2021, 10.8.2021 and 19.8.2021. As per the discussion held during meetings; field surveys and monitoring was executed by the office of RSPCB and based on the available monitoring data, estimation of the pollution load,

assimilative & supportive carrying capacity was estimated. The details of the meetings held and the task carried out are given below:

Date of the meeting	**Discussion Points & Tasks**
June 30, 2021	The committee was in the opinion to collect few preliminary data related to brick kilns & ambient air monitoring in Rajakhera and Dholpur regions along with collecting data of brick kilns monitoring conducted earlier. 1. Collection of the brick kiln related data for Rajakhera & Dholpur district viz. No. Of brick kilns, their technology (FCBTK/Zig-Zag etc.), Fuel types used and daily consumption, operational schedule, production capacity, status & validity of CTE, CTO, GPS location, stack details. 2. 24 hour AAQM for PM_{10} & $PM_{2.5}$ at six Rajakhera and nearby locations. 3. Collection of AOD data of Rajakhera and Dholpur districts. 4. Discussion with GAIL, India regarding the PNG gas feasibility & availability.
July 29, 2021	Based on the information furnished by CPCB & RSPCB; a detailed discussion on the Ambient Air Quality Monitoring, Aerosol Optical Density, Source emission monitoring of Brick kiln data and brick kiln establishment in the Rajakhera, Dholpur was held. Further, it was opined by Dr S K Goyal, Chief Scientist, NEERI, Delhi that based on the available information of the area; a sensitivity analysis may be carried out considering combination of fuel type, meteorological condition etc.
August 4, 2021	Dr S K Goyal, Chief Scientist, NEERI, Delhi explained the outcome of the sensitivity analysis carried out considering the worst conditions viz. uni-directional wind & low wind speed. The impact of the operation of brick kilns on the ambient air quality and the average distance where minimal ground level concentration observed was discussed. As the calculation was based on the average top diameter of the chimney i.e. 0.9 m; it was decided by the committee to consider the diameter and velocity of the flue gases where is was monitored. Dr Goyal was requested to

	re-calculate the same by considering modified data set of velocity, diameter, temperature etc and consider variable wind directions for the sensitivity analysis. The committee was in the opinion that assessment of the carrying capacity of the area merely based on the 24 hourly ambient Air Quality Standard for PM_{10} i.e. 100µg/m^3 will not provide the clear picture on the environmental carrying capacity where background concentration of the PM_{10} is already high. Rather contribution of PM in the ambient air due to operation of the brick kilns needs to be taken in consideration.
August 10, 2021	The outcome of the sensitivity analysis carried out considering the variable wind directions with revised data set viz. Flue gas velocity & diameter of the chimney at the monitoring portholes was discussed. The outcome suggests that for a particular wind direction, all the brick kilns (103) will not be contributing PM to the ambient air towards Rajakhera; only few falling in a particular direction will contributes Contribution of single brick kiln operation showed very less contribution towards Rajakhera. The committee discussed in detail the structure of the chimney and its exit velocity in light of natural draft. It was informed by RSPCB official (as per the discussion with chimney designer) that 12ft diameter is provided at base and this diameter decrease by 4.5 inches every 5 feet and the top diameter is maintained about 35 inches. Secondly, the life of a chimney is considered as 25 years whereas the settling chamber is replaced after about every 10 years. In light of the variable diameter of the chimney along its height and non availability of exit velocity, committee opined to consider the available monitoring porthole data for further analysis. Dr Goyal explained the concept of environmental carrying capacity and its assimilation capacity in detail. He suggested that to make sustainable development, the supportive capacity needs to be based on the interventions that may results in

	accommodation of the new industrial activities viz. converting FCBTK in Zigzag or changing fuel from coal to gas etc.
August 19, 2021	The committee had discussions on the variation in theoretical air quantity v/s the monitored air quantity. It was observed that for a high draft zig-zag kiln producing 30000 bricks/day, 1,40,920 m^3 and 2,01,314 m^3 of air/day is required for SEC of 0.91 MJ/kg and 1.3 MJ/kg, respectively. Whereas, the corresponding air requirement as calculated from monitored field data of the 08 FCBTK (coal+husk) based operational brick kilns at Aligarh, UP is 18,31,248 m^3/day. This variation may be due to the following conditions: • Theoretical air calculated considering High draft zig-zag kilns whereas monitored values are of FCBTK natural draft kilns. • Theoretical air was calculated at 17% excess air; whereas monitored kilns were having average 18.4% O_2 in flue gas. • The flue gas velocity was monitored during the fuel charging period only; whereas, average 30-45mins non-charging period also comes between chargings. This may result in variation in velocity. • The stack diameter is not uniform throughout the length; diameter at bottom/base is about 4m whereas at top it reduce upto 1m. In such non-uniform natural draft stack, monitoring height may also play an important role. The committee opined that as CPCB has recently carried out source emission monitoring of brick kilns of Aligarh with available methodology; the monitoring results may be considered for the assessment of the pollution load, carrying capacity and supportive capacity. However, above points may be considered in further monitoring.

Copies of the Minutes of Meetings are enclosed as **Annexure-III**.

2.0 Status of the Brick kilns

The matter is related to the air pollution due to the brick kilns operational in the Rajakhera village, Dholpur. The

Rajakhera village is located at 26.894696° North latitude, 78.170710° East longitude; at about 8kms aerial distance from River Chambal. Agra city in North and Dholpur in South-West direction are situated at aerial distance of about 35 kms from the village Rajakhera.

The field survey of the brick kilns established in Rajakhera was conducted by Rajasthan State Pollution Control Board (RSPCB). None of the brick kiln was found operational during the field survey due to the ongoing rainy season. The status of brick kilns w.r.t. status of operation, Consent to Operate, Fuel use is as tabulated below:

Village	**No. Of brick kilns**	**Type**	**Fuel**	**CTO validity**
Rajakhera	**103** (Operational-96, Closed-04, Proposed-02 & Under construction - 1)	FCBTK (102) Zig-Zag (1)	Coal (7) Husk (77) Husk + coal (16) Not applicable (03)	Valid-27 Expired-17 Pending-02 Without CTO-57

The field survey revealed that out of 103 brick kilns established within 11kms radial distance from Rajakhera block, only one brick kiln is utilizing Zig-Zag technology and rest all are of Fixed Chimney Bull's Trench Kiln (FCBTK) technology. The major fuel used is Husk (Agro-residue). A huge number of brick kilns i.e. **57** out of 103 are running without Consent to Operate.

The detailed survey report is enclosed as **Annexure-IV.**

2.1 Status of Ambient Air Quality

The 24-hour Ambient Air Quality monitoring of the Rajakhera village and nearby area for PM_{10} & $PM_{2.5}$ was conducted for 02 consecutive days during 7-10th July 2021 by the RSPCB officials at following 06 locations falling within 10 kms radial distance from Rajakhera village:

Location no.	**Monitoring Location Detail**	**Latitude**	**Longitude**
1.	House of Shri Pappu Parashar, Village - Jarah, Tehsil - Rajakhera, Dholpur	26.836488	78.106443

2.	House of Shri Ram Awtar, Village - Bichola, Tehsil - Rajakhera, Dholpur	26.888841	78.169695
3.	House of Shri Shrikant Singh Parmar, Village - Beech Ka Pura, Tehsil - Rajakhera, Dholpur	26.895823	78.060479
4.	House of Shri Sitaram, Village - Teerajpur, Tehsil - Rajakhera, Dholpur	26.901212	78.099852
5.	House of Shri Mangal Jain, Village - Mithawali, Tehsil - Rajakhera, Dholpur	26.874526	78.092203
6.	House of Shri Bachan Singh, Village - Gangoliyapura, Tehsil - Rajakhera, Dholpur	26.891838	78.12891

During the monitoring period i.e. 7-10th July 2021, none of the brick kiln was found to be operational. Rain event was recorded on 8.7.2021 at Dholpur but not at the monitoring site i.e. Rajakhera. The monitoring days were observed sunny with high wind velocity. The soil condition of the monitoring area was loose type. The monitoring results are as tabulated below:

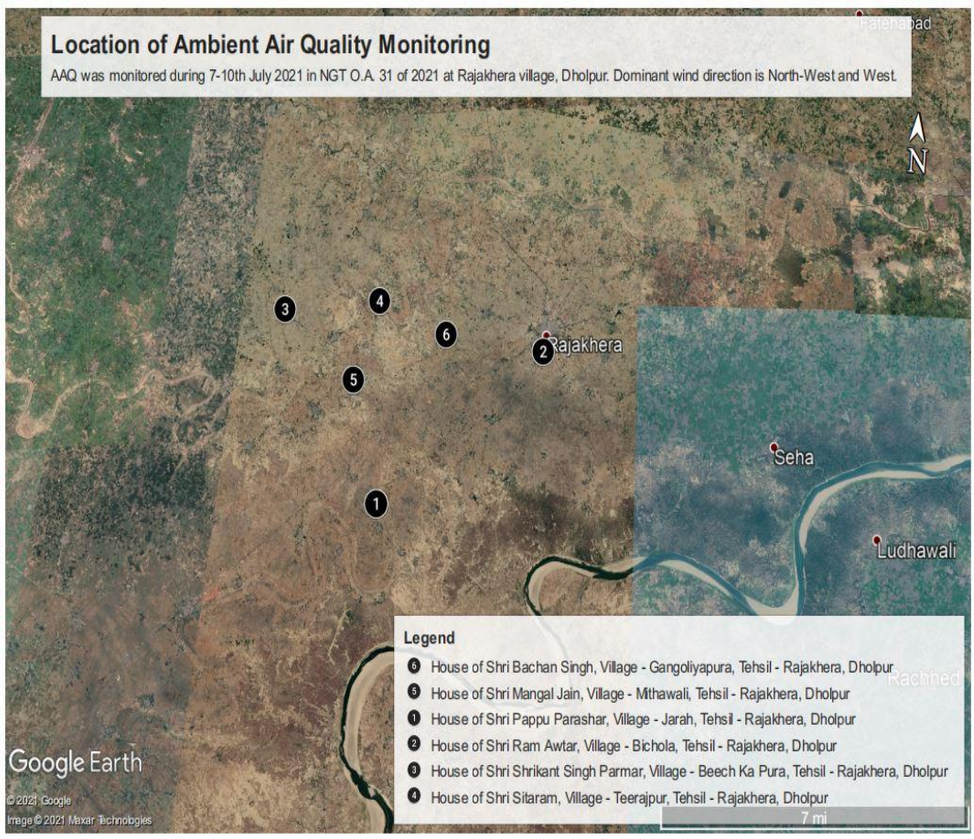
Location no.	**Date of monitoring**	**PM_{10}**	**$PM_{2.5}$**	**Remarks**
1	7.7.2021	309	124	Land preparation & seeding of Kharif crop was ongoing.
	8.7.2021	117	58	
2	7.7.2021	200	92	No major air polluting activity viz. Garbage burning, land preparation etc. was observed
	8.7.2021	254	118	
3	9.7.2021	109	55	Land leveling work was ongoing on 9.7.2021.
	10.7.2021	72	34	
4	9.7.2021	99	48	No major air polluting activity viz. Garbage burning, land preparation etc. was observed
	10.7.2021	75	33	
5	7.7.2021	317	137	Land preparation & seeding of Kharif crop was ongoing.
	8.7.2021	279	133	
6	9.7.2021	155	76	No major air polluting activity viz. Garbage burning, land preparation etc. was observed
	10.7.2021	77	37	

The location no. 02 was in the Rajakhera village, whereas location no. 4 & 6 were in the upwind direction. At these three locations; no major air polluting activity viz. Garbage burning, land preparation etc. was observed. These monitoring locations showed an increasing trend in downwind direction.

Location no.	Distance from Rajakhera town	Date of monitoring	PM_{10}	$PM_{2.5}$
4	7kms	9.7.2021	99	48
		10.7.2021	75	33
6	4kms	9.7.2021	155	76
		10.7.2021	77	37
2	0 kms	7.7.2021	200	92
		8.7.2021	254	118

The Ambient Air Monitoring reports are enclosed as **Annexure-V.**

The Google Earth map showing the AAQM station locations is given below:



The committee considered $PM_{2.5}$ data derived from satellite Aerosol Optical Data (AOD). The data has been provided by Prof (Dr) Sagnik Dey, Project Co-ordinator of "Satellite based near real time monitoring of $PM_{2.5}$ at National Scale for Air Quality Management" IIT Delhi. The data for Dholpur & Rajakhera for the year 2019 & 2020 is given below:

City/Tehsil	2019			2020		
	Min	Max	Avg	Min	Max	Avg
Rajakhera (GPS location 26.8968,78.1705)	38.55	154.16	80	27.22	214.26	91
Dholpur (GPS location 26.6968,77.8925)	35.45	145.33	75	22.38	121.46	62

The data reveal that the annual average $PM_{2.5}$ concentration at Rajakhera & Dholpur was exceeding the annual standard (as given under NAAQS, 2009) of 40µg/m^3 for both the years i.e. 2019 & 2020. The probable reason of higher values of $PM_{2.5}$ at Rajakhera may be various anthropogenic activities like industrial activities, developmental activities, agricultural activities, use of biomass in the rural setting, contribution of crustal particulate matters due to loose soil characteristics, and others.

2.2 Estimation of daily pollution load from single brick kiln

Source emission monitoring was not performed as the brick kilns of Rajakhera block were non-operational due to ongoing rainy season; Considering this, the source emission monitoring data of FCBTK based kilns operating on coal & husk at Aligarh (Uttar Pradesh) was considered. Copy of the data set is enclosed as **Annexure-VI.** This monitoring was carried out by CPCB in June 2021. Based on this data, daily pollution load from single brick kiln was estimated. The calculated PM emission load with 17% O_2 correction for single brick kiln is **0.705 Tons/day.**

The detailed information is given as below:

Sr. No.	Parameter	Value
1.	Type of Fuel Used	Coal + Husk
2.	Monitored at Port Hole Height , m	3.0
3.	Internal diameter of Stack, m	3.0
4.	Flue Gas Velocity, m/s	3.0
5.	Ambient Temp., K	311
6.	Flue Gas Temp., K	350
7.	Actual PM Concentration, mg/Nm^3	273
8.	Corrected PM Concentration at 17% O_2, mg/Nm^3	420

9.	Normalized Flow Volume at 25°C, (Nm^3/day)	16,77,818
10.	Actual PM Emission Load, kg/day	458
11.	Corrected PM Emission Load at 17% O_2, kg/day	**705**

3.0 Estimation of Existing Pollution Load w.r.t $PM_{2.5}$

For the estimation of the pollution load w.r.t. $PM_{2.5}$; total area in which brick kilns are operational, mixing height of the area and $PM_{2.5}$ concentration for the particular months were considered. For $PM_{2.5}$ data, Aerosol Optical Density (AOD) data was considered.

- Total area **(a)** : **380 km²** (All the 103 brick kilns operational in the radial distance of 11 kms from the centre of Rajakhera village)

- Average atmospheric mixing height during a particular month in km **(b)** : As there is meteorological station nearby district-wise meteorological information available online for2015 at https://urbanemissions.info/blog-pieces/india-meterology-bydistrict/ was considered for monthly mixing height. The mixing height was considered same for 2019 & 2020 due to unavailability of the yearly meteorological data. The meteorological data is as tabulated below:

Month	% Frequency of Mixing height in different ranges					Weighted mixing height in KMs
	<100	100-500	500-1000	1000-2000	>2000	
Considered Average height, m	50	300	750	1500	2000	
Jan	66.12	15.45	13.17	5.24	0	0.257
Feb	63.69	13.095	9.52	12.5	1.19	0.354
Mar	58.1989	11.69	8.1989	17.6075	4.3	0.476
Apr	55	10.13	4.166	9.72	20.97	0.654
May	51.47	11.55	3.22	4.3	29.43	0.738
Jun	36.94	17.638	5.13	10	30.277	0.865
Jul	20.43	31.45	12.5	25.67	9.94	0.782
Aug	32.25	30.24	12.7	24.59	0.134	0.574
Sep	55.55	12.777	4.86	17.91	8.88	0.549

Oct	63.3	9.94	3.897	17.069	5.779	0.462
Nov	68.75	11.66	8.33	9.86	1.38	0.307
Dec	68.41	15.32	13.84	2.419	0	0.220
Source: https://urbanemissions.info/blog-pieces/india-meterology-bydistrict/						

- Total volume of Air in the area of concern during a particular month in KM^3 **(C)** : **a x b**

- Average $PM_{2.5}$ concentration for a particular month in kg/km^3 **(d):**

For understanding the ratio of AOD data to CAAQMS data, $PM_{2.5}$ values of 06 cities for the year 2019 were analysed for the ratio of CAAQMS to AOD. The ratio is tabulated below:

S.NO.	City	CAAQMS/AOD ratio of 2019
1.	Jhind	1.08
2.	Bhiwani	1.12
3.	Agra	0.96
4.	Muzaffarnagar	1.07
5.	Sonipat	0.994
6.	Bulandsahar	0.998

As the average ratio is **nearly 1** and in the case of unavailability of the ambient air quality data of the Rajakhera village; AOD data was considered for the calculation.

The AOD derived $PM_{2.5}$ values for the year 2019 & 2020 are as tabulated below:

Month	$PM_{2.5}$ Values ($\mu g/m^3$)	
	2019	2020
January	154	152
February	95	122
March	60	54
April	61	51
May	64	62
June	53	44

July	43	33
August	39	27
September	39	59
October	80	114
November	126	165
December	150	214

Therefore, Total estimated pollution load of $PM_{2.5}$ **(X) = c x d**

Month	**$PM_{2.5}$ Pollution load (MT/Month)**	
	2019	**2020**
January	15	15
February	13	16
March	11	10
April	15	13
May	18	18
June	17	14
July	13	10
August	8	6
September	8	12
October	14	20
November	15	19
December	13	18

3.1 Estimation of total assimilative capacity w.r.t. PM_{10}

Total volume of Air in the district during a particular month in km^3 **(c)**

Particulate Matter (PM_{10}) concentration in ambient air as per NAAQ standard, 2009: 100µg/m^3 i.e. **100 Kg/Km^3** (Ref. Air Quality Index/NAAQ Standards)

Therefore, total assimilative capacity w.r.t. PM_{10} in ambient air of the area during a particular month (**y**): **C x 100 = y** Kgs

2019 & 2020	
Month	**Total Assimilative Capacity in MT**
January	10
February	13
March	18
April	25
May	28
June	33
July	30
August	22
September	21
October	18
November	12
December	8

3.2 Estimation of total supportive capacity based on PM_{10}

Total Supportive Capacity **(z)** = Total Assimilative Capacity **(y)**
(-) Total Estimated Load (PM_{10}) **(x)**

As for the estimation of the pollution load, Aerosol Optical Density (AOD) data of $PM_{2.5}$ was considered. The $PM_{2.5}$ values have been extrapolated to $PM_{10.}$ The month-wise ratio of PM_{10} to $PM_{2.5}$ for the year 2019 & 2020 was calculated based on the nearest manual Ambient Air Quality Monitoring station i.e. Agra city (35 kms from Rajakhera village). The monitoring data for April & May 2020 were not available due to non-operation of manual station during COVID restriction. For these 02 months, average annual ratio was considered which is 1.57.

The estimated total supportive capacity for the year 2019 is

2019					
Month	**Pollution load in MT $PM_{2.5}$**	**Monthly factor of $PM_{10}/PM_{2.5}$**	**Pollution load in MT w.r.t. PM_{10} (x)**	**Total Assimilative capacity in MT w.r.t. PM_{10} (y)**	**Total Supportive capacity in MT w.r.t. PM_{10} (z)**
January	15	1.4	21	10	-11

February	13	1.34	17.42	13	-4.42
March	11	1.93	21.23	18	-3.23
April	15	2.63	39.45	25	-14.45
May	18	2.63	47.34	28	-19.34
June	17	2.86	48.62	33	-15.62
July	13	1.68	21.84	30	8.16
August	8	1.28	10.24	22	11.76
September	8	1.32	10.56	21	10.44
October	14	1.37	19.18	18	-1.18
November	15	1.18	17.7	12	-5.7
December	13	1.2	15.6	8	-7.6

The estimated total supportive capacity for the year 2020 is

2020					
Month	**Pollution load in MT $PM_{2.5}$**	**Monthly factor of $PM_{10}/PM_{2.5}$**	**Pollution load in MT w.r.t. PM_{10} (x)**	**Total Assimilative capacity in MT w.r.t. PM_{10} (y)**	**Total Supportive capacity in MT w.r.t. PM_{10} (z)**
January	15	1.23	18.45	10	-8.45
February	16	1.46	23.36	13	-10.36
March	10	1.62	16.2	18	1.8
April	13	1.57	20.41	25	4.59
May	18	1.57	28.26	28	-0.26
June	14	2.56	35.84	33	-2.84
July	10	1.81	18.1	30	11.9
August	6	1.24	7.44	22	14.56
September	12	1.59	19.08	21	1.92
October	20	1.65	33	18	-15
November	19	1.3	24.7	12	-12.7
December	18	1.26	22.68	8	-14.68

The above analysis indicates that some supportive capacity may be available during the monsoon months, i.e. July, August & September.

3.3 Assessment of restriction of brick kiln operation w.r.t. total Supportive capacity available

Based on the above estimation of pollution load, total assimilative & supportive capacity of the Rajakhera block, decision on restriction of brick kiln operation may be planned to sustain the supportive capacity available. For this the factor of pollution load i.e. **0.705 Tons/day/brick kiln** (Corrected PM emission load at 17% O_2) has been considered.

The year-wise assessment for restriction of brick kiln operation w.r.t. supportive carrying capacity is as tabulated below:

2019		**Particulates contribution of single brick kiln in Tons/day**	**No. of brick kilns operation needs to be restricted w.r.t. the supportive capacity available**
Month	**Supportive capacity available in MT w.r.t. PM_{10}**		
January	-11	**0.705**	-16
February	-4.42		- 6
March	-3.23		- 5
April	-14.45		- 20
May	-19.34		**- 27**
June	-15.62		- 22
July	8.16		+12
August	11.76		+17
September	10.44		+15
October	-1.18		- 2
November	-5.7		- 8
December	-7.6		- 11

2020		**Particulates contribution of single brick kiln in Tons/day**	**No. of brick kilns operation needs to be restricted w.r.t. the supportive capacity available**
Month	**Supportive capacity available in MT w.r.t. PM_{10}**		
January	-8.45	**0.705**	-12
February	-10.36		-15
March	1.8		+3
April	4.59		+7

May	-0.26		0
June	-2.84		-4
July	11.9		+17
August	14.56		+21
September	1.92		+3
October	-15		**-21**
November	-12.7		-18
December	-14.68		-21

NOTE:

i. *The numerical value with (-) symbol indicates the number of brick kilns whose operation needs to be restricted.*

ii. *The numerical value with (+) symbol indicates the number of brick kilns that can be allowed other then the operational ones.*

Perusal of above table indicated that brick kilns may be allowed to operate during monsoon period (during July-September), if convenient to brick kiln manufacturers.

4.0 Sensitivity Analysis: Prediction of Cumulative Impact of all the Existing Brick Kilns

The committee made an effort to predict the cumulative impact of all the 103 brick Kilns in Rajakhera Block on the Air Quality of Rajakhera Village

1.0 Introduction

Cumulative impact of all the 103 brick kilns presently operating in the Rajakhera Block has been predicted using widely accepted air quality model (AERMOD) under certain critical meteorological conditions (represented by uni-directional flow with low wind) and with assumption that all the brick kilns are of same capacity and similar amount of emissions are released from all the stacks.

The air quality model requires inputs with respect to stack details with flue gas characteristic, and meteorological data (like wind speed, wind direction, relative humidity, ambient temperature etc.) which predicts the resultant air quality in the region/places (receptor) of interest.

The details of model input data with respect to emission sources, meteorological data and predicted resultant air quality in the Rajakhera village is given in the following sections.

2.0 Details of Brick Kilns and Meteorology

2.1 Distribution of Brick Kilns in the Rajakhera Block

At present, there are total 103 brick kilns in the Rajakhera Block. Distribution of all the brick kilns is depicted in **Fig. 1**. These kilns are further divided in three clusters as C1, C2 & C3 based on their location in different directions with respect to Rajakhera village. Cluster C1 (North-West Sector) has most number of brick kilns 62, whereas Cluster C2 (West-South West Sector) has 21 and Cluster C3 has 20 brick kilns. These kilns are located within about 11 km radius from the center of Rajakhera village.

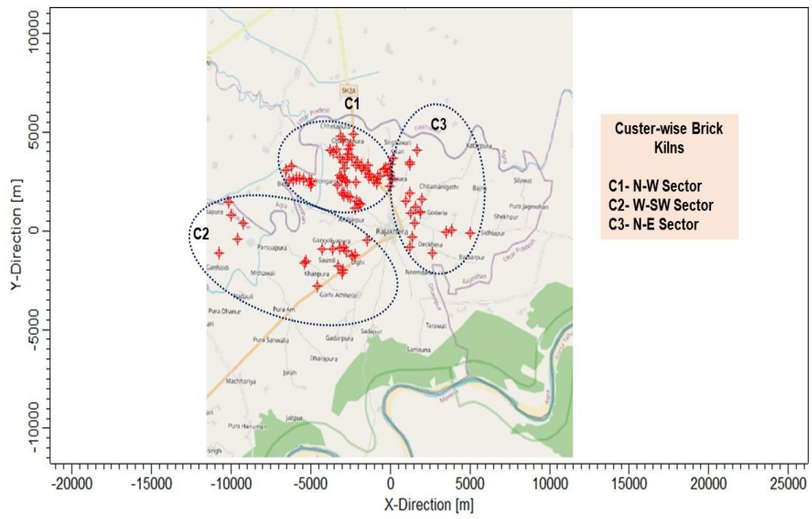


Fig. 1: Distribution of 103 Brick Kilns in the Rajakhera Block, Dholpur District

2.2 Stack and Likely Emission details of Brick Kilns

At present all the brick kilns are non-operational. In the absence of actual field data of the brick kilns in the Rajakhera Block, stack emission data of similar type of brick kilns (FCBTK) located in Aligarh district has been considered. Aligarh is aerially about 110 km from Rajakhera village. Stack monitoring in the brick kilns was done during June 2021 by the team of CPCB. Stack monitoring data of 8 brick kilns is considered and average values are used for the present analysis. Stack monitoring was done at an average height of about 3 meters from the ground, where portholes are provided in the brick kiln stack. The flue gas exit velocity observed at that level has been calculated at the top of the stack by

following the standard procedure. Details of stack and flue gas characteristics considered in the air quality modeling are given in **Table 1.** Two emission scenarios are considered taking actual PM concentration and PM level corrected to 17% O_2 levels.

Table 1: Details of Stack and Flue Gas Characteristics used as Model Input Parameters (based on Actual Data Monitored for 8 Brick Kilns at Aligarh)

Sr. No.	Parameter	Value
	Type of Fuel Used	Coal + Husk
A.	**Monitored at Port Hole Height (3.0 m)**	
1.	Diameter of Stack, m	3.0
2.	Flue Gas Velocity, m/s	3.0
3.	Flue Gas Temp., K	350
4.	Actual PM Concentration, mg/Nm^3	273
5.	Corrected PM Concentration at 17% O_2, mg/Nm^3	420
6.	Normalized Flow Volume at 25°C, (Nm^3/day)	16,77,818
B.	**Calculated/Expected at the Stack Top (30.0 m) and used in Modeling Exercise**	
1.	Top Diameter (m)	1.0
2.	Exit Flue Gas Velocity (m/s) (corresponding to top diameter)	27.0
3.	Exit Flue Gas Temperature (K)	350
4.	Stack Height, (m)	30
5.	Actual PM Emission Load, kg/day	458
6.	Corrected PM Emission Load at 17% O_2, kg/day	705
7.	Actual PM Emission Rate, g/s	5.30
8.	Corrected PM Emission Rate at 17% O_2, g/s	8.16
9.	Daily Operational Schedule	24 hrs Continuous
10.	Total Number of Brick Kilns in Rajakhera block	103

2.3 Meteorological Data

Region specific meteorological data was not available for Rajakhera Block/ Dholpur district, therefore, hourly surface meteorological data collected from the continuous ambient air quality monitoring station (CAAQMS) located at Sanjay Palace, Agra has been used. Agra is about 35 km from Rajakhera village. As most of brick kiln are expected to operate from November-December onwards, typical meteorological data for the month of December is considered.

The meteorological pre-processor, AERMET has been setup and run for one day. The meteorological parameters used in the AERMET are wind speed, wind direction, relative humidity, ambient temperature, solar radiation, atmospheric pressure and precipitation. In addition to that, upper air estimator, an in-built feature of AERMOD, is used to estimate the upper air profile of meteorological parameters.

To present the worst case scenario (uni-direction wind flow with low wind speed), the collected meteorological data has been assumed into three uni-directional directions and one with the wind direction spread equally in all the 8 directions. Wind rose for 4 meteorological scenarios are shown in **Fig. 2**. The uni-directions are selected with a view to consider brick kilns in the upwind direction of Rajakhera village.

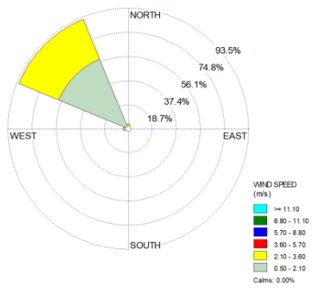
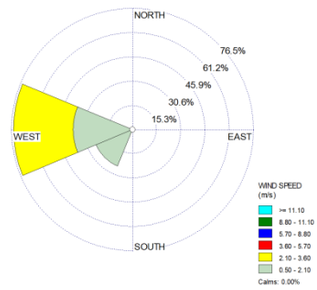
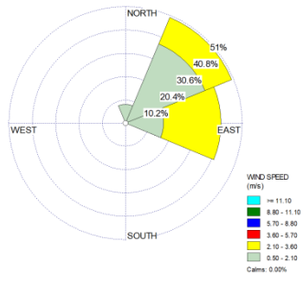
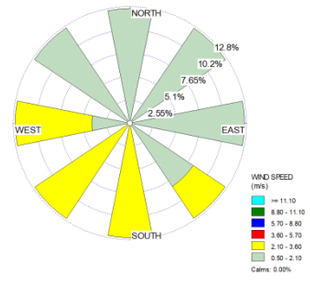
	
Scenario 1- NW Sector	Scenario 2- W-SW Sector
Dominant Wind Speed- 0.50-2.10 m/s	Dominant Wind Speed- 0.50-2.10 m/s
	
Scenario 3- N-E Sector	Scenario 4- All Directions
Dominant Wind Speed- 0.50-2.10 m/s	Dominant Wind Speed- 0.50-2.10 m/s

Fig. 2: Assumed Unidirectional Wind-rose under Different Meteorological Scenarios (Applicable for all 103 BrickKilns)

3.0 Prediction of Impact due to 103 Brick Kiln Emissions on Rajakhera Village

3.1 Modeling Domain keeping Rajakhera Village as Receptor

Air quality modelling has been carried out to predict the likely impact of all the 103 brick kilns operation on the ambient air quality of Rajakhera village. The receptor grid is defined for an area of 11 km x 11 km with Rajakhera village as Centre and grid cell size of 0.5 km x 0.5 km, as shown in **Fig. 3**. Total 2025 receptor points are defined to capture the impact of emission from brick kiln stacks.

Further, 17 discrete receptor points are chosen within 2 km x 2 km region and in all the directions of the Rajakhera village area to predict the PM pollutant concentrations emitted from the brick kiln stacks. The discrete receptor locations are shown in **Figs. 4.**

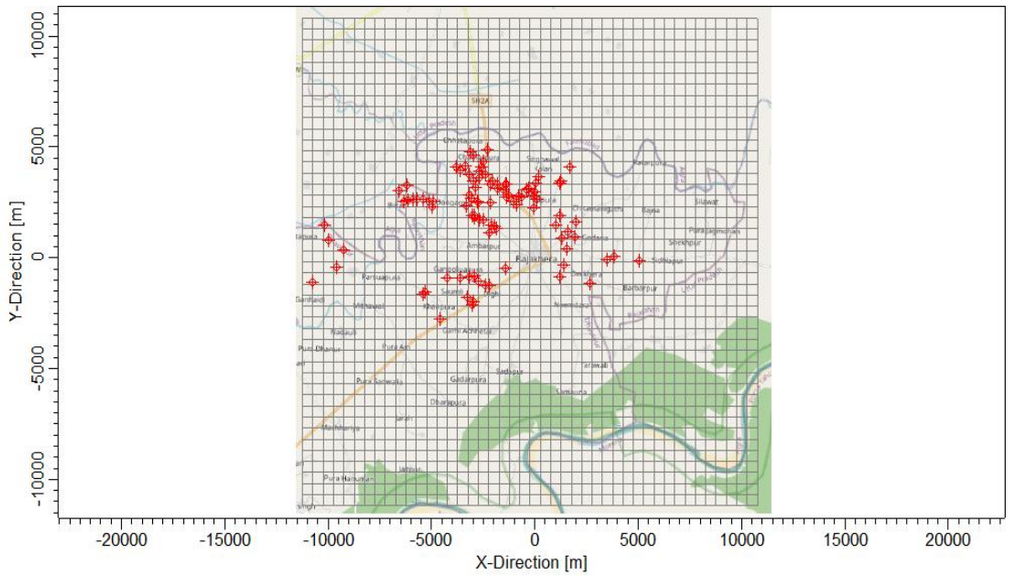


Fig. 3: Receptor Grid Points within 11 km x 11 km area keeping Rajakhera Village as the centre

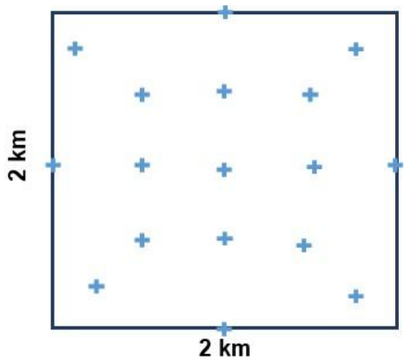


Fig. 4: Discrete Receptor Points for Rajakhera Village

(8 directions with 500 m interval + Centre)

3.2 Air Quality Modelling

Air quality model, AERMOD is used to predict the pollutant concentration emitted from multiple stacks as described in previous sections. The model is setup and run

using input data of sources, emissions and meteorology. The model is setup keeping Rajakhera village as centre of modelling domain (11 km x 11 km) using actual UTM

coordinate system which is converted to local coordinates for better understanding. Individual stacks are defined in the model and grouped altogether to predict the cumulative impact at Receptor Points under different meteorological and emission scenarios.

The cumulative impact of all the 103 brick kilns has been predicted under 4 meteorological scenarios (3 uni-directions and multiple directions) for 2 emission scenarios (actual and corrected PM emissions). The air quality modelling results are presented in the following sub-sections.

3.2.1 Cumulative Impact of 103 Brick Kilns for Actual PM Emission Scenario (458 kg/day)

24-hourly predicted PM Concentration Isopleths for actual PM emission scenario (458 kg/d or 5.30 g/s) considering different wind flow conditions is presented through **Figs. 5-8**, respectively for N-W sector, W-SW sector, N-E sector and multiple directions.

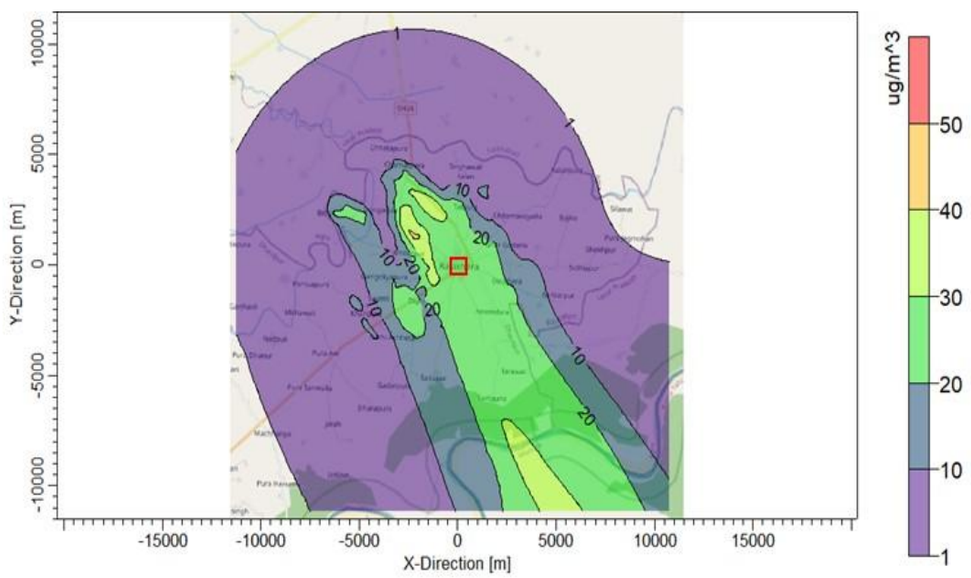


Fig. 5: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in North-West Sector in the Study Area

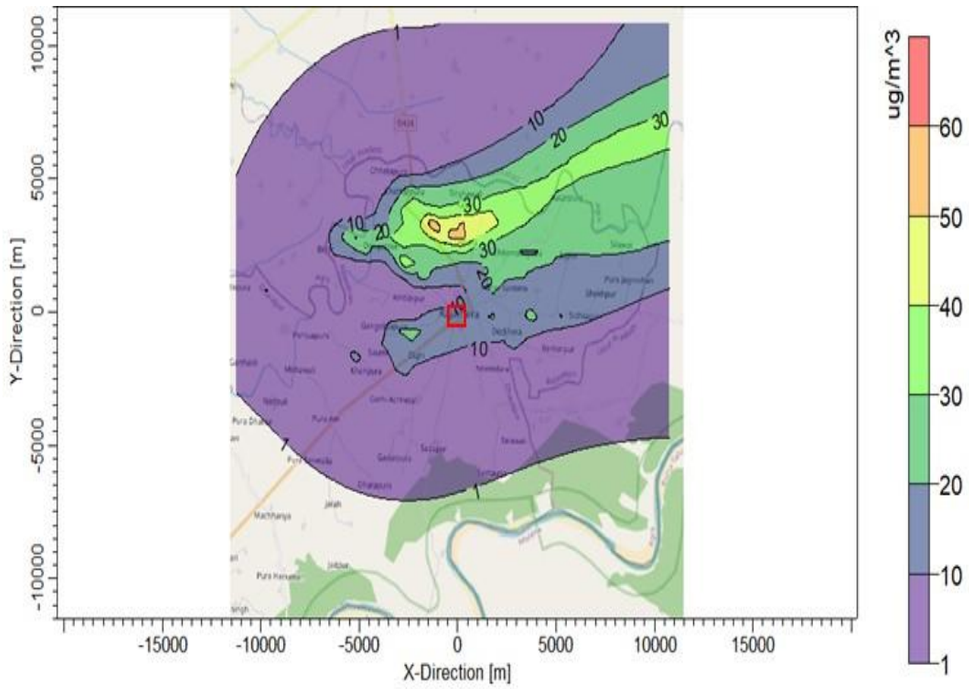


Fig. 6: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in West-South West Sector in the Study Area

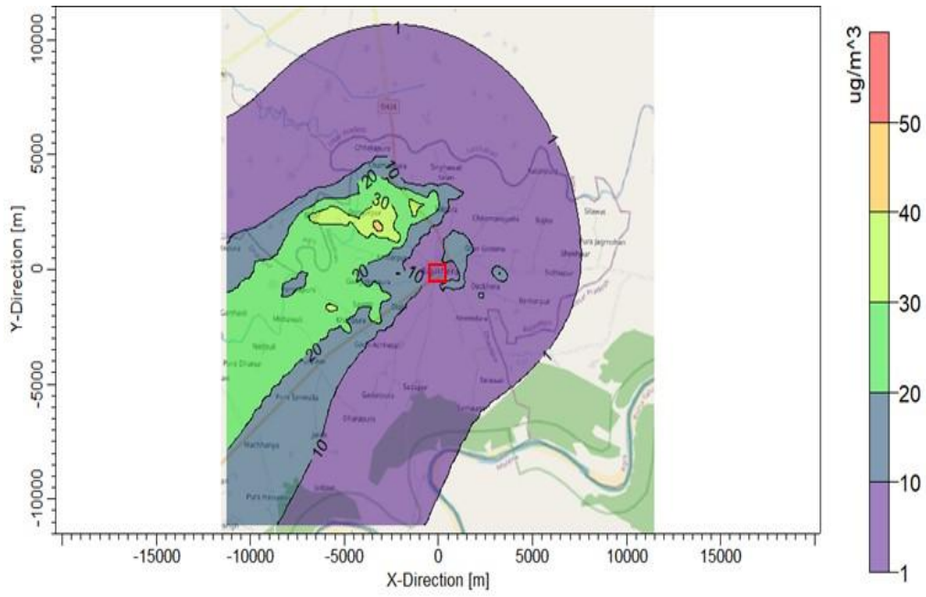


Fig. 7: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in North-East Sector in the Study Area

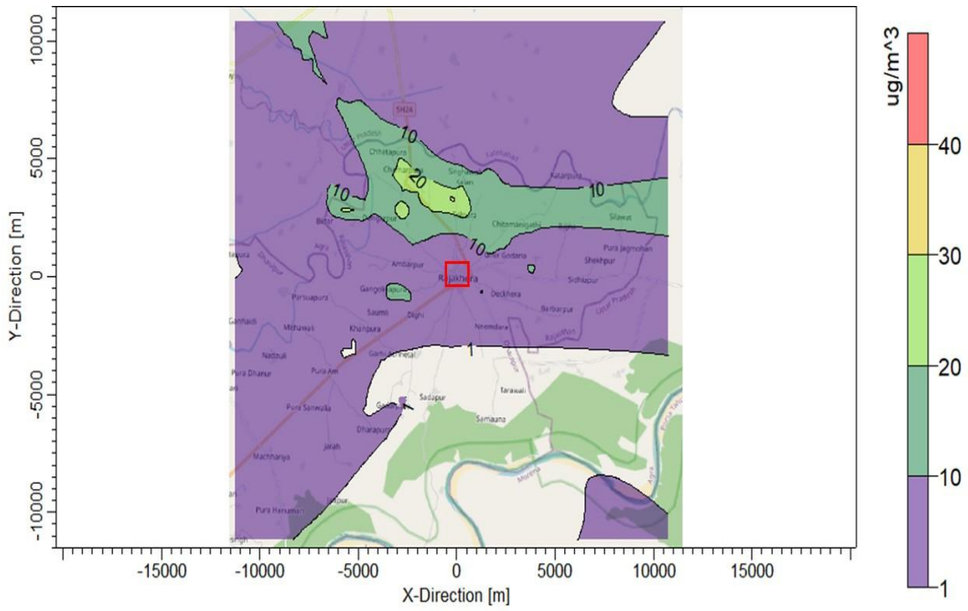


Fig. 8: Predicted PM Concentrations from All Brick Kilns (103) with Wind equally distributed in All Directions in the Study Area

3.2.2 Cumulative Impact of 103 Brick Kilns for Corrected PM Emission Scenario (705 kg/d)

Similarly, 24-hourly predicted PM concentration isopleths for corrected PM emission scenario (705 kg/d or 8.16 g/s) considering different wind flow conditions is presented through **Figs. 9-12**, respectively for N-W sector, W-SW sector, N-E sector and multiple directions.

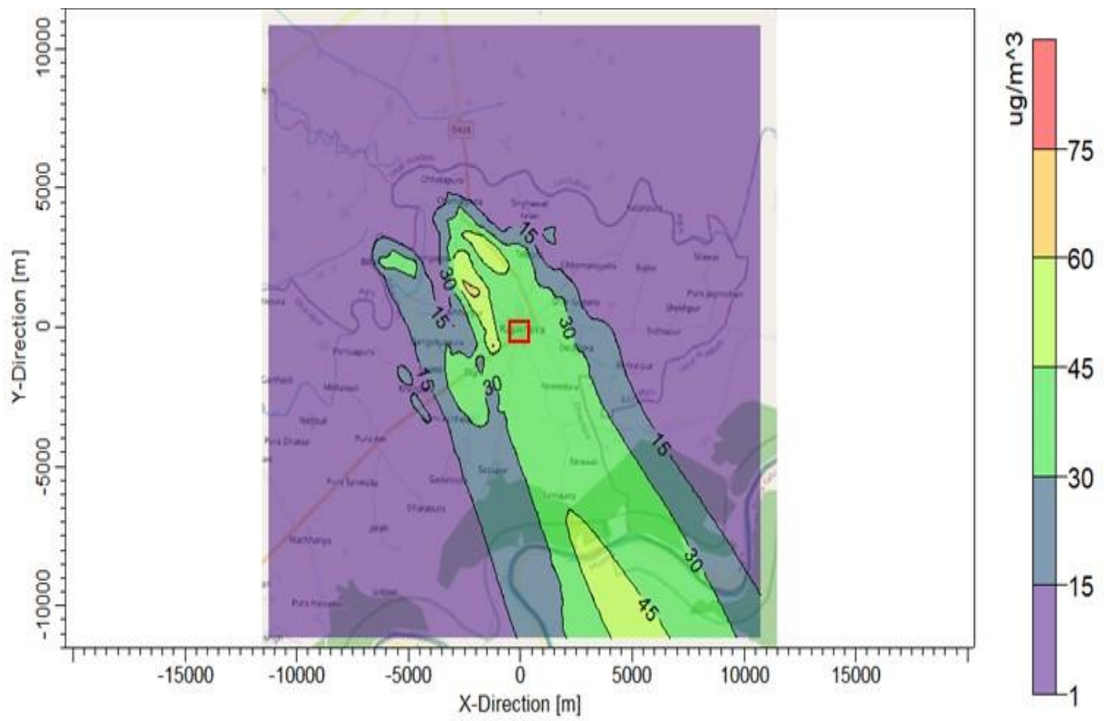


Fig. 9: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in North-West Sector in the Study Area

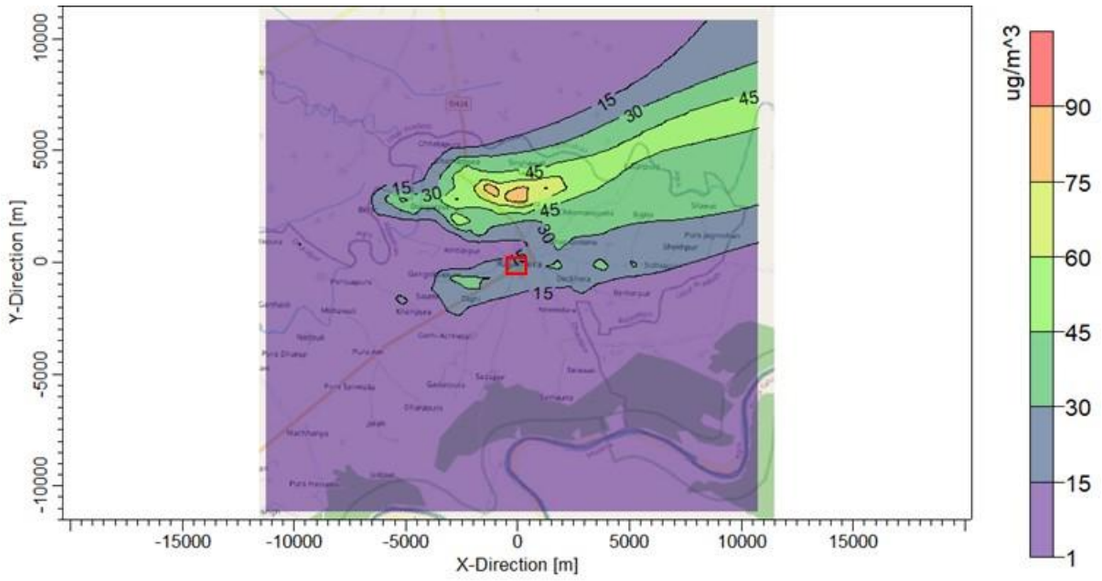


Fig. 10: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in West-South West Sector in the Study Area

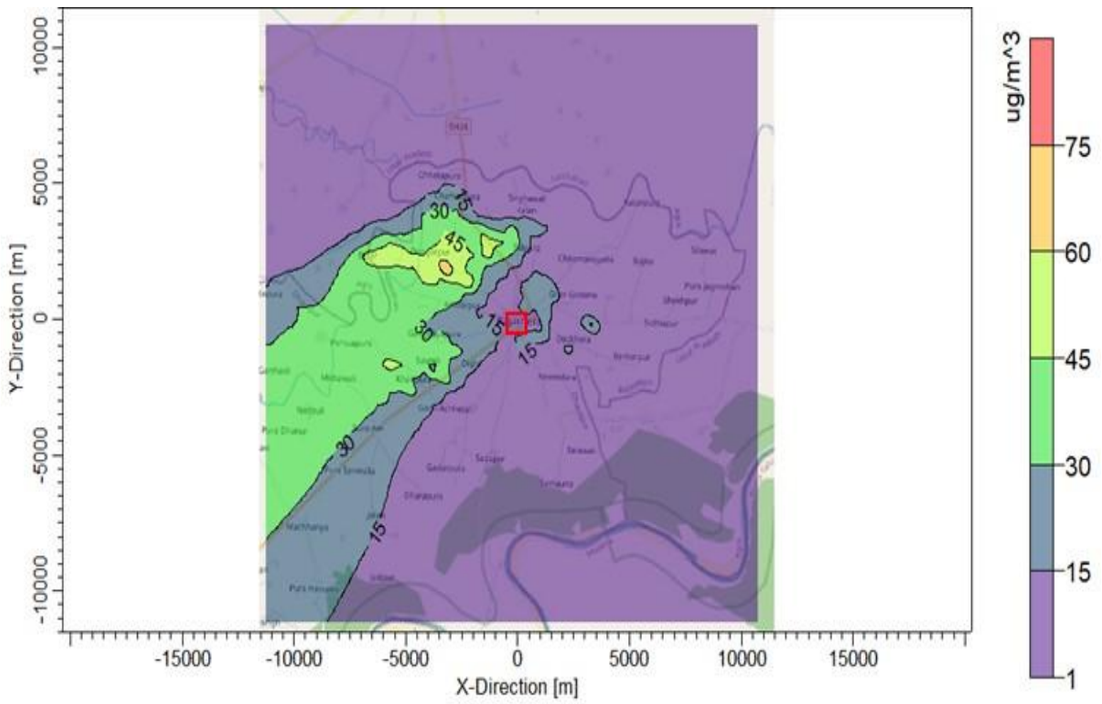


Fig. 11: Predicted PM Concentrations from All Brick Kilns (103) with Dominant Wind in North-East Sector in the Study Area

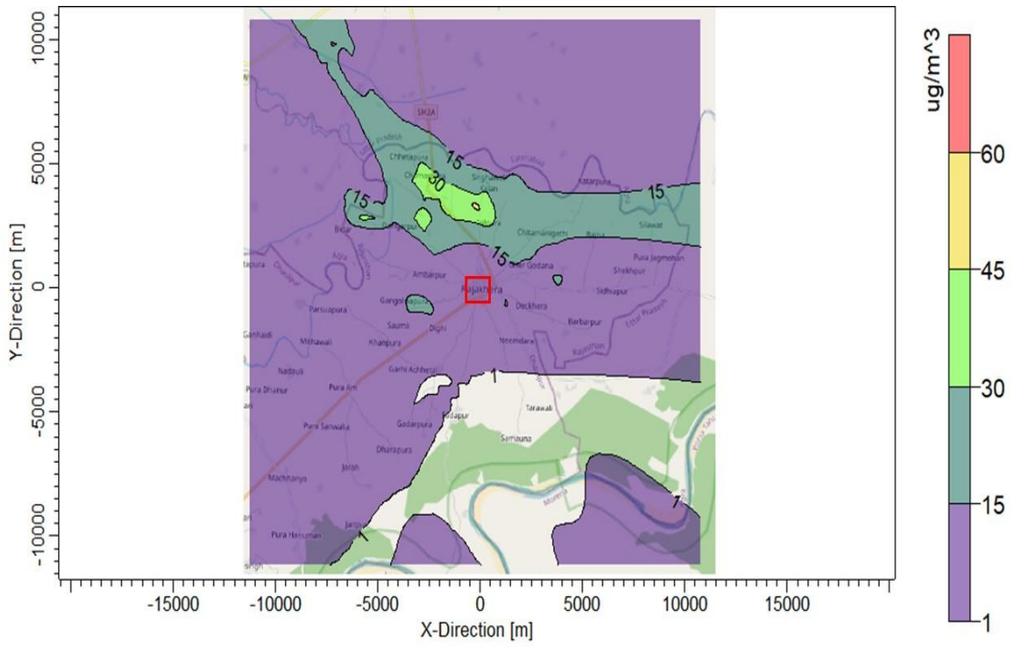


Fig. 12: Predicted PM Concentrations from All Brick Kilns (103) with Wind equally distributed in All Directions in the Study Area

3.3 Predicted PM Concentration Levels at Rajakhera Village

3.3.1 Cumulative Impact of 103 Brick Kilns

24 hourly predicted PM concentrations levels in Rajakhera Village under 2 emission and 4 meteorological scenarios (as observed in isopleths) are summarized in **Table 2**. Further, for better understanding predicted PM levels (minimum, maximum and average values) at discrete receptor points of Rajakhera village are included.

Depending upon the predominant wind direction, the brick kilns in the upwind direction of the village will have more impact on the air quality of the village. *Maximum impact is predicted under the worst meteorological condition (wind from N-W direction) to be 24 µg/m³ for actual emission scenario and 36 µg/m³ for combustion corrected emission scenario.*

Table 2: Predicted 24 hourly PM Concentrations Levels in Rajakhera Village for Different Emission and Met Scenario

Sr. No.	PM Emissions / Meteorological Scenario	No. of Brick Kilns likely to impact	PM Conc. Range based on Isopleths (µg/m³)	PM Conc. (µg/m³)		
				Min.	Max.	Avg.
1.	**Actual Emission Scenario (458 kg/d or 5.30 g/s)**					
a.	North-West (N-W) Sector	62	20-30	23	24	**24**
b.	West-South West (W-SW) Sector	21	10-20	9	18	**13**

Sr. No.	PM Emissions / Meteorological Scenario	No. of Brick Kilns likely to impact	PM Conc. Range based on Isopleths (µg/m³)	PM Conc. (µg/m³)		
				Min.	Max.	Avg.
c.	North-East (N-E) Sector	20	1-10	9	10	**9**
d.	All Directions	103	1-10	3	5	**4**
2.	**Corrected Emission Scenario (705 kg/d or 8.16 g/s)**					
a.	North-West (N-W) Sector	62	30-45	35	37	**36**
b.	West-South West (W-SW) Sector	21	15-30	13	28	**20**
c.	North-East (N-E) Sector	20	1-15	14	16	**15**
d.	All Directions	103	1-15	5	8	**6**

3.3.2 Impact of Single Brick Kiln

Further, impact of a single brick kiln is predicted under the similar situation/scenario. It is predicted that 24 hourly PM concentration from single brick would be about 2.32 µg/m³ and 3.62 µg/m³ for actual and corrected PM emissions scenario at a distance of 500 m from the brick kiln. The predicted PM levels at different distances are summarized in **Table 3**.

Table 3: Predicted 24 hourly PM Concentration from Single Brick Kiln at different Downwind Distances

Distance in Downwind Direction	PM Concentrations (µg/m³)			
	Actual Emission Scenario (458 kg/d or 5.30 g/s)		Corrected Emission Scenario (705 kg/d or 8.16 g/s)	
	N-W Sector Wind Flow	All Directions Wind Flow	N-W Sector Wind Flow	All Directions Wind Flow
500 m	2.32	0.01	3.62	0.02
1 km	1.28	001	3.18	002
1.5 km	0.99	0.01	2.10	0.02
2 km	0.84	0.01	1.37	0.01
2.5 km	0.59	0.01	1.13	0.01
3 km	0.47	0.01	1.06	0.01
5 km	0.40	0.00	0.66	0.01
10 km	0.36	0.00	0.56	0.00

Limitation: *In the absence of actual stack emission data for the brick kilns and meteorological data of the Rajakhera Block, similar/corresponding data for the nearby brick kilns in Aligarh region and met data of Agra has been used in the air quality modeling. Therefore, the air quality prediction results should be treated as indicative values. It is recommended that this exercise need to be updated for the brick kilns of Rajakhera block adopting "Guidelines on Methodologies for Source Emission Monitoring" published by CPCB and actual meteorological data for the Rajakhera region.*

Based on the supportive capacity estimation and the sensitivity analysis outcomes; regulatory authority may take decision on the month-wise restriction on the operation of the brick kilns situated on the upwind direction i.e. North, North-West considering the distance from the Rajakhera village.

5.0 Recommendations

5.1 General Recommendations

The particulate matter emissions from brick kiln stacks are primarily due to incomplete combustion of coal or biomass fuels, leading to formation of black colored soot particles, which form majority of the particulate matter in the stack emissions. Coal contains about 15-35% volatile matter, which is lower chain of hydrocarbons. This volatile matter gets released within seconds of firing the coal in the kiln. For combustion of this volatile matter, both primary air (from below the coal) and secondary air (above the coal) are required in appropriate proportion and quantity. If the air is not provided for combustion, part of this released volatile matter does not get burned or gets only partially burnt, which gives release to unburnt hydrocarbons (HC) and Carbon monoxide (CO). The unburnt hydrocarbons, once cooled to about below 600^{o}C, get condensed and form soot particles. This is an irreversible reaction and soot once formed, cannot be combusted. If the soot formation could be prevented or substantially reduced, the particulate matter emissions from brick kilns can be substantially reduced. Reduction in soot formation also means reduction in coal consumption.

The conversion from FCBTK to zig-zag technology helps in improving the combustion by providing better mixing of fuel and air and longer high temperature zone to burn off the volatile matter resulting in the reduction of particulate matter emissions. The results from various previous monitoring studies show significant reduction in particulate matter emissions in stack gases in zig-zag kilns as compared to FCBTK:

In this regard, specific opinion/suggestion with a road map regarding sustenance operation of brick kilns to make viable in Rajakhera block are as under:

(A) IMMEDIATE MEASURES (0-1 years for implementation)

1. As an immediate measure to reduce emission of particulate matter from stack, path length of flue gases may be increased so that most of SPM may settle due to action of gravity. As it will also bring down the temperature of the flue gases, an induced fan will need to be installed before stack. Path length may be increased by zig-zag setting of the bricks in FCBTK or by diverting the flue gases to a long nala (channel/path) before entering into the stack. This nala will be connected to stack at the other end.

2. It is observed that pollution level during rainy season is almost negligible and keeping this in mind, brick kilns may be allowed to operate during rainy season (July to September) also if they have proper shed arrangements and willing to do so. Shed will also be helpful in reducing the fugitive dust emissions and fuel requirement. Shed will also reduce heat losses which will increase the thermal efficiency of the kiln.

3. Rajasthan State Pollution Control Board must fix the length and width of the kiln. It will restrict the enormously high production of bricks (more than 50,000 bricks per day) as in practice by most of the Brick kiln operators. This will results in lower emission load and improvement in carrying capacity.

4. Brick kilns manufacturers association may be asked to conduct innovative studies to meet the emission norms for the present FCBTK type brick kilns by adopting fueling firing mechanism, modifying the path length of flue gas flow, installing appropriate pollution control system (like wet scrubber system) before the flue gas exit the chimney. This may be tried for different types of fuels being used in the kilns.

(B) SHORT TERM MEASURES (within 3 years)

The above immediate measures can effectively control the SPM level up to 20%, however, these are not the adequate/permanent methods to control the emission of finer particulate matter (PM_{10} and $PM_{2.5}$) which are escaped from stack due to high temperature of flue gas. Therefore, following short term measures are recommended and must be implemented (within 3 years) for further reduction in the stack emissions.

1. Conversion of FCBTK kilns to zig-zag kilns.
2. Installation of a proper air pollution control device like wet scrubber for control of PM_{10}, $PM_{2.5}$ and greenhouse gases emission due to burning of coal is suggested. Wet scrubber is the most trusted, proven, efficient and sustainable technology for control of particulate matter and scrubbing of greenhouse gases. This device can be helpful to reduce SPM below 50 mg/Nm^3.

Suitability of Wet Scrubber Technology

During firing of green bricks in zig-zag fired induced draft brick kilns a significant concentration of moisture is carried away by the flue gas. Since the temperature of flue gases in the stack of kilns is generally between 50-100^oC, which result in condensation of moisture in flue gases and at times it is required to be drained from the bottom of the ID fan which otherwise affects performance of the fan efficiency besides corrosion of fan. The flue gas also contains SO_2 due to sulphur in coal. In view of this, the wet scrubber would be the suitable option as air pollution control device which can simultaneously remove particulate matter and gaseous pollutant like SO_2.

It is also brought out that the chimney in induced draft brick kiln is either installed in the central island or along the outer trench wall of the kiln i.e. outside the kiln. Whereas the installation of air pollution control device would be easy with the chimney outside the kiln, installation of APCD in the central island is expected to pose several problems and would require an innovative design solution. The water used for

scrubbing of gases would be required to be neutralized using alkaline material, which can further be recirculated or can be used in preparing clay mix for brick moulding. However, before its adoption at wider scale, the basic design parameters are required to be confirmed/checked and suitability of the system be assessed by demonstrating at two or three locations.

(C) MID-TERM MEASURES (3-10 years)

Following mid-term measures are recommended for further improvement in the brick industry using high draught technology for implementation in next 3-10 years depending on the need, infrastructure availability and expenditure involved:

1. The use of internal fuel is recommended which is a well proven technology to control particulate matter and gaseous emissions from brick kiln. It can reduce or exempt the use of external fuel demand for firing of bricks. Materials like agricultural residues, fly ash, rice husk, mustard husk, cow dung, reject coal, coconut fiber or any other non-hazardous material can be used as internal fuel. Use of Agro-residue as internal fuel can also reduce clay consumption by 30-40% and reduce gaseous emission. Agriculture residue as an internal fuel can be recommended after a proper scientific and technical study. Although use of coal as an internal fuel is a well-established technology in other countries. However, in India, it is in a very primitive stage and requires detailed study. Use of internal fuel in zig-zag kilns especially when APCDs are in place, should be promoted. Further, use of internal fuel is not possible in all regions because the characteristics of brick earth is different in all over the country and having mixing problems due to low bonding capacity of the brick earth. The other main constraints in implementation of this technology are mechanized and electricity powered extruders, pug mills, power connection, huge investment etc.

2. Agriculture residue can be used in zig-zag brick kilns as external fuel only after converting to briquettes for the reduction in particulate matter and gaseous

emissions from flue gas. Although its use depends on the availability of materials and briquettes making plant nearby.

3. Manufacturing of Resource Efficient Bricks (REBs) products such as perforated bricks, hollow bricks and blocks. These products save fuel up to 30 % resulting reduction in pollutants emission up to 30 %. REBs also reduce clay up to 50 % for their manufacturing apart from saving of other resources during use as walling unit in buildings. Although this is possible only after mechanization of brick kiln. Bureau of Energy Efficiency (BEE) is supporting REBs technology and launching a special "E3" mark to promote the manufacturing and marketing of the REBs.

4. Use of auto coal/fuel feeding system to standardize the firing practice at optimum level.

5. The introduction of mechanization process for the molding of clay bricks is suggested. This proves largely beneficial especially in the case of mixing internal fuel with clay as the manual mixing of internal fuel is hazardous for the health of the workers who are involved in the process.

6. Use of fly as (minimum 25%) in clay brick should be made mandatory to save soil and fuel.

(D) LONG TERM MEASURES (After 10 years)

After 10 years, based on need to shift/upgrade on to the new technology like tunnel kin, Hoffman kiln or any other new technology based on cheaper fuel like solar power or natural gas (PNG/CNG), long term measures can be implemented to reduce emission of particulate matter to negligible level. Although there are many environmental advantages of shifting to new technology like gas based kiln/tunnel kiln, but the implementation of these measures depends on the availability of infrastructure and willing of brick kilns for huge investment for change of technology which is not possible in today's scenario. After 10 years, there

may be possibility of availability of cheaper fuel and infrastructures required for adopting gas based technology. The major constraints in use of natural gas in existing zig-zag kiln are as under:

1. All the kilns will have to modify either to Hoffman Kiln or a Tunnel kiln. Both these technologies are comparatively less efficient than the existing kilns.

2. **Viability of PNG:**

- The combustible mixture of natural gas and air does not ignite if the mixture is leaner than 5% and richer than 15% of the fuel-air ratio required for ignition. This narrow inflammability range makes PNG one of the safest fuel. *(Source: GAIL India, Ltd).* However, bricks kilns require it in very large volume. Expert man power is required to handle it and work has to be carried out according to strict schedules and parameters. To keep such high level of disciple, looks very difficult in bricks kilns.

- The pricing of PNG is another issue. To make a comparison, the coal, having GCV of about 6000 Kcal/kg, is available at a price of about 11000 per MT whereas, currently the PNG (GCV 11500kcal/kg) cost at Agra for industrial use is Rs. 45/SCM (rate effective from 7.4.2021), it will mean an increased cost of burning.

  Brick kiln operator need to make modifications in plant & arrange for internal pipeline from downstream of meter till the gas consumption points which requires addition expenditure. This shall increase the cost of manufacturing.
- The technology to use PNG in brick kilns is not available indigenously and has to be imported. Even the equipment with the required safety devices has to be imported.

(E) MEASURES TO CONTROL FUGITIVE DUST EMISSION

Fugitive dust is generated from various processes during brick manufacturing and having bigger particle size which cannot travel beyond a distance of more than 100 meters. The major fugitive dust emission takes place from following steps during brick manufacturing:

i. Clay Excavation, Transportation, and Stacking at the Kiln site
ii. Preparation of Clay by adding internal fuel and water
iii. Manual Moulding of Green bricks
iv. Loading in the Brick Kiln
v. Covering Bricks with Ash in Kiln Rooftop
vi. Fuel Handling (Coal/Agriculture Waste)
vii. Firing of Bricks in High Draught Kiln
viii. Removal of Ash from Kiln Rooftop
ix. Unloading of Fired Bricks
x. Stacking and Delivery of bricks

Following measures are recommended to control the fugitive dust emission from a brick kiln:

1. Coal should preferably be stored under shed with proper ventilation on a pucca platform. Crushing of coal should be done in enclosed equipment/ area to avoid process emissions. The coal size should be between powders to ¾ inch i.e. properly graded coal. This would help in uniform brick quality as the powdered coal ignites immediately on feeding thereby releasing heat to the top layer of brick setting.

2. To control dust emissions due to airborne ash from the top of brick settings, the top ash layer in the preheating zone should be kept covered with sheet.

3. The clay should be prepared at a Centralized location with the use of Backhoe-Loader(JCB) and Mechanized Clay mixing machine which can help in the reduction of dust emissions at clay mixing places.

4. An iron shed should be installed over the kiln which will reduce the fugitive emission from the kiln and also reduce the coal consumption. This will further helpful

in reducing the pollution due to burning of coal and protection of the kiln during rains. Provision of shed over kiln would save at least 20-30 tons of coal every first cycle. Providing shed over the kiln would also improve the ambience of the area and provide shed to the workers working in the kiln.

5. Pavement of approach road within the premises of brick kilns. Water should be sprinkled frequently over roads around brick kiln and over the ash layer before its removal and transfer.

6. A wall of at least 3.0 meters height to be constructed on the sides where land is not available for green belt development to prevent fugitive emissions. Multi-layer green belt to be developed along the periphery of brick kiln.

5.2 Specific Recommendations

Estimation of the pollution load, assimilative & supportive capacity for the Rajakhera block has been carried out. Though, actual stack emission from the brick kilns and meteorological data of the Rajakhera block are not available, yet assessment has been carried out utilizing monitoring data for the brick kilns of Aligarh region which is close to Rajakhera block. Following are the key conclusions/recommendations for sustenance of the brick kiln within the supportive capacity:

i. RSPCB, Regional Office, Bharatpur shall ensure that none of the 57 brick kilns operates without Consent to Operate (CTO).

ii. RSPCB, Regional Office, Bharatpur may take decision on the month-wise restriction on the operation of the brick kilns situated on the upwind direction i.e. North, North-West considering the distance from the Rajakhera village. The impact of individual brick kiln on ambient air quality at the receptor points within the Rajakhera block reduces as the distance from the

receptor point increases. Therefore, any kilns near the periphery of the block may be allowed to operate if these can be relocated at a farther distance.

iii. Regulatory authority viz. RSPCB shall ensure the implementation of the immediate & short term measures of reducing the pollution on priority.

iv. To control the fugitive emission, brick kiln operators may be directed to implement the above recommendation to control the fugitive dust emission.

v. Biomass is available in plenty in Northern India including Rajasthan and should be given preference for controlled combustion with pollution control system, otherwise burning of biomass in open field will have more adverse impact on air quality, as observed in Delhi NCR during Post monsoon & winter months for last few years.

vi. Further, a study on Source Contribution Assessment within 11 km from the Centre of Rajakhera is recommended to assess the actual contribution of brick kilns and other local sources of air pollution in the Rajakhera village. The study should cover sources of air pollution (including the Rajakhera Village itself), air quality monitoring in Rajakhera Village, meteorological data collection, dispersion & receptor modeling with health impact assessment. This will not only help in delineating action plans for the air quality management in the Rajakhera village but will also help in assessing the actual assimilative, supportive and carrying capacity of the Rajakhera village in terms of brick kilns to be permitted in future. Such study should be conducted by Brick Manufacturers Association of Rajakhera Block, under the guidance of the present Expert Committee.

This report is being filed by the Expert Committee through CPCB, for the consideration of Hon'ble National Green Tribunal."

4. During the course of hearing on 03.06.2021 this Tribunal observed as follows :

1. "Freedom of profession, trade and business as guaranteed under the provisions of Constitution of India is to be read with Article 21 of the Constitution of the India which provides that no one shall be deprived of life and liberty except according to the procedure established by Law. Right of fresh and unpolluted air and unpolluted water is also part of the life and any activity by anyone polluting the air and water, directly or indirectly endangering the health of human being is deprivation of life, in violation of provisions as contained in the Constitution of India. If the right to fresh air is not enforced, this will be contrary to the mandate of the Constitution and the Environmental Law, particularly the Principal of Sustainable Development. It is well established that deteriorated Ambient Air Quality in terms of PM 10 and PM 2.5 affects respiratory system, particularly lungs which may make individuals more vulnerable to get other related fatal diseases.

2. The points raised in this application is installation and operation of bricks kiln in the area ignoring the damage of the public health, environment due to the pollution as broadly measured in the area in terms of AQI. Article 51 A(g) of the Constitution of India provides that everyone have to take initiative and protect, improve natural environment. It is stated that, the Air Quality Index of town Rajasthan,

Dholpur is reported to be more than 250 meaning thereby area of Rajakhera is under the air pollution and life of the people of the area is under the great environmental threat. Respondent No. 6 has newly installed bricks kiln in the nearby area of the applicant which is situated at Agriculture land i.e. Khasra Nos. 1213/963 area 0-1873 Hecatare, 1211/964 area 0-2898 Hectare, 1209/962 area 0-1715 hectare, 965 area 0-1012 Hectare total area 6021/25 Square Meter and Shri Bali Singh, Veeran Singh, Roop Singh, Bharat Singh, Phool Singh and Malla Devi W/o Roop Singh of the Khatedar / tenant of the such agriculture land. Huge quantity of toxic elements from bricks kiln causes serious public health by damaging environment, the bricks kiln emits toxic fumes containing suspended particulate matter which in carbon particles and high concentration of carbon monoxides and sulpher oxides which are harmful to eyes, lungs and throat, such air pollutants stunt the mental and physical health of the children. The guidelines issued by the Rajasthan State Pollution Control Board, Jaipur are not being complied with by the industry of the Bricks kiln as well as by the Respondent no. 6 causing damage to the public health property and environment and raising a substantial question relating to environment as well as substantial question of fundamental right of environment which is being curtailed/violated by industrialist of the bricks kiln including Respondent no. 5 by installing and operating bricks kilns with the violation of

provisions of Air (Prevention and Control of Pollution) Act 1981, Provision of Environmental (Protection) Act 1986, Provisions of Water (Prevention and Control of Pollution) Act 1974 as well as the violation of fundamental rights as provided under the Constitution of India.

3. Question for consideration is extending applicability of Graded Response Action Plan (GRAP), applicable to Fixed Chimney Bull Trench Kilns (FCBTK), to other coal fired brick kilns, including those using 'Zig-Zag' technology **in the** Region **during the period, the air quality is 'severe',**having potential for adverse health effects. Further issue that has emerged is the carrying capacity of the air quality in the region to sustain the brick kilns. Associated issue is improving effectiveness of safeguards and the regulatory measures to minimize the impact of air pollution by operation of brick kilns, where such brick kilns are otherwise permissible.

4. Categories of air quality and its adverse health effect can be noticed from following tables extracted from the judgment of the Hon'ble Supreme Court in *Arjun Gopal & Ors. v. UOI & Ors*[1]*:*

Table 1

AQI	***Associated Health Impacts***
Good (0-50)	***Minimal impact.***
Satisfactory (51-100)	***May cause minor breathing discomfort to sensitive people.***
Moderately polluted (101-200)	***May cause breathing discomfort to people with lung disease such as asthma,and discomfort to people with heart disease, children and older adults.***

[1] (2017) 1 SCC 412

Poor (201-300)	***May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.***
Very Poor (301-400)	***May cause respiratory illness to the people on prolonged exposure. Effectmay be more pronounced in people with lung and heart diseases.***
Severe May (401-500)	***May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.***

Table 2

AQI Category, Pollutants and Health Breakpoints								
AQI category (Range)	***PM10 24-hr***	***PM2.5 24-hr***	***NO2 24-hr***	***O3 8-hr***	***CO 8-hr (mg/m^3)***	***SO2 24-hr***	***NH3 24-hr***	***Pb 24-hr***
Good (0-50)	***0-50***	***0-30***	***0-40***	***0-50***	***0-1.0***	***0-40***	***0-200***	***0-0.5***
Satisfactory (51-100)	***51-100***	***31-60***	***41-80***	***51-100***	***1.1-2.0***	***41-80***	***201-400***	***0.5-1.0***
Moderately polluted (101-200)	***101-250***	***61-90***	***81-180***	***101-168***	***2.1-10***	***81-380***	***401-800***	***1.1-2.0***
Poor (201-300)	***251-350***	***91-120***	***181-280***	***169-208***	***10-17***	***381-800***	***801-1200***	***2.1-3.0***
Very poor (301-400)	***351-430***	***121-250***	***281-400***	***209-748****	***17-34***	***801-1600***	***1200-1800***	***3.1-3.5***
Severe (401-500)	***430+***	***250+***	***400+***	***748+****	***34+***	***1600+***	***1800+***	***3.5+***

We are conscious that brick kilns may be necessary. Object of this order is not to stop any legitimate business activity but to enforce the right to breathe fresh air which is right to life. The source apportionment studies, show that brick kilns contribute 5-7% PM. Air pollution Control devices to be installed by the polluting sources including the brick kilns need to comply not only the consent standards but are also the Ambient Air Quality norms and available assimilative capacity of the region. ***If the right to fresh air is not enforced, the consequences of brick kilns beyond carrying capacity of the air quality in the area are disastrous in terms of deaths and air borne diseases. This will be contrary to the mandate of the Constitution and the environmental law, particularly the principle of 'Sustainable Development'. It is well established that deteriorated ambient air quality in terms of PM10 and PM2.5 affects respiratory system particularly, the lungs which may make individuals more vulnerable to get other related***

fatal diseases[2].

5. ***Standards of Ambient Air Quality laid down under Section 17 (g) of the Air Act are required to be followed. If the order has been passed without undertaking any study on status of ambient air quality without any carrying capacity assessment to take the additional load at concerned areas and without any safeguards on 'Precautionary' principle, the same may not be justifiable having regard to the acknowledged adverse impact of operation of the brick kilns on the ambient air quality.*** Reference was made to the Judgements of the Hon'ble Supreme Court in *M.C. Mehta v. Union of India, (1998) 9 SCC 149, M.C. Mehta v. Union of India (2000) 7 SCC 422, M.C. Mehta v. Union of India, (2002) 4 SCC 378, K. Guruprasad Rao v. State of Karnataka, (2012) 12 SCC 736* wherein the Hon'ble Supreme Court directed closure or shifting of brick kiln industries and *M.C. Mehta v. Union of India, (2001) 9 SCC 235* laying down that brick kilns may be allowed to operate after studying the impact on human population and vegetation.

6. Main reason for air pollution by brick kilns is use of coal etc. as fuel. The pollution can be minimized if the fuel which is currently used is considered to be replaced by cleaner fuels like PNG by appropriate modification in design not adding to the PM load. Dealing with the air pollution caused in Morby Industrial Area in Gujarat on account of coal gasifiers in tile manufacturing, the Tribunal directed closing of coal gasifier industries without prejudice to such industries switching over to non-coal gasifiers, PNG or other such technology.

[2] https://airqualitynews.com/2020/08/13/the-link-between-air-pollution-and-covid- 19/http://www.babushahi.com/full-news.php?id=107487

7. Issue of operation of brick kilns may give rise to following questions:

(i) The use of cleaner fuels or any other alternative measures to be used to prevent air pollution.

(ii) Siting and carrying capacity.

8. In view of the fact that there is no carrying capacity of the air quality in region to permit any further addition to PM load by permitting unconditional operation of brick kilns using fuel which adds to PM load and since it may be necessary to consider the issue of utilizing fly ash, we require an expert opinion on following issues:

(a) *how brick kilns can be allowed in without damage to the air quality;*

(b) *conditions subject to which it may be done;*

(c) *number of brick kilns to be allowed and criteria for fixing such numbers.*

9. India, air quality standards are measured in terms of the Air Quality Index (hereinafter "AQI"). The AQI was launched in India on 17-10-2014 by the Ministry of Environment and Forests. According to the press release of the Press information Bureau of the same date, it consists of a comprehensive set of parameters to monitor and asses the air quality. The AQI considers eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb), and based on the levels of these pollutants six categories of AQI ranging from "Good" to *"Severe"* have been prescribed.

10. The adverse effects of these extreme levels of air pollution spare no one — the young, the old, the infirm and even the future generations. A study of the data of the Global

Health Depository of the World Health Organisation reveals that India has the world's highest death rate from chronic respiratory diseases and that about 1.5 million people in India die annually due to indoor and outdoor pollution (see Delhi Wakes up to an Air Pollution Problem it cannot Ignore, 15-2-2015, The New York Times). The Kolkata-based Chittaranjan National Cancer Institute (CNCI), in a study commissioned and handed over to the Central Pollution Control Board, found that key indicators of respiratory health, lung function to palpitation, vision to blood pressure, of children in Delhi, between four and 17 years of age, were worse off than their counterparts elsewhere. It also found that more than 40% of the school children suffer from lung damage (see Landmark Study Lies Buried, 2-4-2015, The Indian Express). We note with apprehension that there are nascent studies that suggest that pollution can lower children's IQ, hurt their test scores and increase the risks of autism, epilepsy, diabetes and even adult-onset diseases like multiple sclerosis (see Holding Your Breath in India, 29-5- 2015, The New York Times).

11. In environmental law, "precautionary principle" is one of the well-recognised principles which is followed to save the environment. It is rightly argued by the petitioners that this principle does not need exact studies/material. The very word *"precautionary"* indicates that such a measure is taken by way of precaution which can be resorted to even in the absence of definite studies. In Vellore Citizens' Welfare Forum *[Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647],* this Court explained the principle in the following manner: (SCC pp. 658 & 660, paras 11 & 14-16)

"11. Some of the salient principles of

"Sustainable Development", as culled out from Brundtland Report and other international documents, are Inter-Generational Equity, Use and Conservation of Natural Resources, Environmental Protection, the Precautionary Principle, Polluter Pays Principle, Obligation to Assist and Cooperate, Eradication of Poverty and Financial Assistance to the developing countries. We are, however, of the view that "the precautionary principle" and "the polluter pays principle" are essential features of "Sustainable Development". The "precautionary principle" — in the context of the municipal law — means:

(i) Environmental measures — by the State Government and the statutory authorities — must anticipate, prevent and attack the causes of environmental degradation.

(ii) **Where there are threats of serious and irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.**

(iii) *The "onus of proof" is on the actor or the developer/industrialist to show that his action is environmentally benign.*

***

14. In view of the abovementioned constitutional and statutory provisions we have no hesitation in holding that the precautionary principle and the polluter pays principle are part of the

environmental law of the country.

15. Even otherwise once these principles are accepted as part of the Customary International Law there would be no difficulty in accepting them as part of the domestic law. It is almost an accepted proposition of law that the rules of Customary International Law which are not contrary to the municipal law shall be deemed to have been incorporated in the domestic law and shall be followed by the courts of law. To support we may refer to H.R. Khanna, J.s' opinion in ADM, Jabalpur v. Shivakant Shukla [ADM, Jabalpur v. Shivakant Shukla, (1976) 2 SCC 521] , Jolly George Varghese case [Jolly George Varghese v. Bank of Cochin, (1980) 2 SCC 360] and Gramophone Co. case [Gramophone Co. of India Ltd. v. Birendra Bahadur Pandey, (1984) 2 SCC 534 : 1984 SCC (Cri) 313].

16. The constitutional and statutory provisions protect a person's right to fresh air, clean water and pollution-free environment, but the source of the right is the inalienable common law right of clean environment. ...”

38. The precautionary principle accepted in the aforesaid judgment was further elaborated in A.P. Pollution Control Board case [A.P. Pollution Control Board v. M.V. Nayudu, (1999) 2 SCC 718] as under: (SCC pp. 732-34, paras 31-35)

> *“31. The “uncertainty” of scientific proof and its changing frontiers from time to time has led to great changes in environmental concepts during the period between the Stockholm Conference of 1972 and*

the Rio Conference of 1992. In Vellore Citizens' Welfare Forum v. Union of India [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] a three-Judge Bench of this Court referred to these changes, to the "precautionary principle" and the new concept of "burden of proof" in environmental matters. Kuldip Singh, J. after referring to the principles evolved in various international conferences and to the concept of "sustainable development", stated that the precautionary principle, the polluter pays principle and the special concept of onus of proof have now emerged and govern the law in our country too, as is clear from Articles 47, 48-A and 51- A(g) of our Constitution and that, in fact, in the various environmental statutes, such as the Water Act, 1974 and other statutes, including the Environment (Protection) Act, 1986, these concepts are already implied. The learned Judge declared that these principles have now become part of our law. The relevant observations in Vellore case [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] in this behalf read as follows: (SCC p. 660, para 14)

> '14. *In view of the abovementioned constitutional and statutory provisions we have no hesitation in holding that the precautionary principle and*

the polluter pays principle are part of the environmental law of the country.'

The Court observed that even otherwise, the above said principles are accepted as part of the customary international law and hence there should be no difficulty in accepting them as part of our domestic law. In fact, on the facts of the case before this Court, it was directed that the authority to be appointed under Section 3(3) of the Environment (Protection) Act, 1986.

'shall implement the "precautionary principle" and the "polluter pays principle"'.

The learned Judges also observed that the new concept which places the burden of proof on the developer or industrialist who is proposing to alter the status quo, has also become part of our environmental law.

32. The Vellore [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] judgment has referred to these principles briefly but, in our view, it is necessary to explain their meaning in more detail, so that courts and tribunals or environmental authorities can properly apply the said principles in the matters which come before them.

33. ***A basic shift in the approach to environmental protection occurred initially between 1972 and 1982. Earlier, the concept was based on the "assimilative capacity" rule as revealed***

from Principle 6 of the Stockholm Declaration of the U.N. Conference on Human Environment, 1972. The said principle assumed that science could provide policy- makers with the information and means necessary to avoid encroaching upon the capacity of the environment to assimilate impacts and it presumed that relevant technical expertise would be available when environmental harm was predicted and there would be sufficient time to act in order to avoid such harm. But in the 11th Principle of the U.N. General Assembly Resolution on World Charter for Nature, 1982, the emphasis shifted to the "precautionary principle", *and this was reiterated in the Rio Conference of 1992 in its Principle 15 which reads as follows:*

> *'Principle 15.—In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack offull scientific certainty shall not be used as a reason for proposing cost-effective measures to prevent environmentaldegradation.'*

34. In regard to the cause for the emergence of this principle, Charmian Barton, in the article earlier referred to in "The Status of the Precautionary Principle in Australia" [(1998) 22 Harvard Environmental Law Review 509 at p. 547] says:

> *'There is nothing to prevent decision-makers from assessing the record and concluding that there is inadequate information on which to reach a determination.If it is not possible to make a decision with "some" confidence,* ***then it makes sense to err on the side of caution and prevent activities that may cause serious or irreversible harm****. An informed decision can be made at a later stage when additional data is*

available or resources permit further research. To ensure that greater caution is taken in environmental management, implementation of the principle through judicial and legislative means is necessary.'

In other words, the inadequacies of science is the real basis that has led to the precautionary principle of 1982. It is based on the theory that it is better to err on the side of caution and prevent environmental harm which may indeed become irreversible.

35. The principle of precaution involves the anticipation of environmental harm and taking measures to avoid it or to choose the least environmentally harmful activity. It is based on scientific uncertainty. Environmental protection should not only aim at protecting health, property and economic interest but also protect the environment for its own sake. Precautionary duties must not only be triggered by the suspicion of concrete danger but also by (justified) concern or risk potential. The precautionary principle was recommended by the UNEP Governing Council (1989). The Bomako Convention also lowered the threshold at which scientific evidence might require action by not referring to "serious" or "irreversible" as adjectives qualifying harm. However, summing up the legal status of the precautionary principle, one commentator characterised the principle as still "evolving" for though it is accepted as part of the international customary law, 'the consequences of its application in any potential situation will be influenced by the circumstances of each case'. (See First Report of Dr. Sreenivasa Rao Pemmaraju — Special Rapporteur, International Law Commission dated 3-4-1998, paras 61 to 72.)"

(emphasis in original)

39. In such cases which pertain to the protection of environment, thrusting of "onus of proof" on the developer/industrialist in Vellore Citizens' Welfare Forum [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] was also elaborated by the Court in the following manner: (A.P. Pollution Control Board case [A.P. Pollution Control Board v. M.V. Nayudu, (1999) 2 SCC 718] , SCC pp. 734-35, paras 36-38)

"36. We shall next elaborate the new concept of burden of proof referred to in Vellore case [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] at p. 658. In that case, Kuldip Singh, J. stated as follows: (SCC p. 658, para 11)

'(iii) The "onus of proof" is on the actor or the developer/industrialist to show that his action is environmentally benign.'

37. It is to be noticed that while the inadequacies of science have led to the "precautionary principle", the said "precautionary principle" in its turn, has led to the special principle of burden of proof in environmental cases where burden as to the absence of injurious effect of the actions proposed, — is placed on those who want to change the status quo (Wynne, "Uncertainty and Environmental Learning: Reconceiving Science and Policy in the Preventive Paradigm" [(1992) 2 Global Environmental Change 111 at p. 123]). This is often termed as a reversal of the burden of proof, because otherwise in environmental cases, those opposing the

change would be compelled to shoulder the evidentiary burden, a procedure which is not fair. Therefore, it is necessary that the ***party attempting to preserve the status quo by maintaining a less polluted state should not carry the burden of proof and the party who wants to alter it, must bear this burden.*** *(See James M. Olson, "Shifting the Burden of Proof: How the Common Law can Safeguard Nature and Promote an Earth Ethic" [(1990) 20 Environmental Law 891 at p. 898] .) (Quoted in "The Status of the Precautionary Principle in Australia" [(1998) 22 Harvard Environmental Law Review 509 at p. 547] at pp. 519, 550.)*

38. The precautionary principle suggests that where there is an identifiable risk of serious or irreversible harm, including, for example, extinction of species, widespread toxic pollution in major threats to essential ecological processes, it may be appropriate to place the burden of proof on the person or entity proposing the activity that is potentially harmful to the environment. (See Report of Dr Sreenivasa Rao Pemmaraju, Special Rapporteur, International Law Commission, dated 3-4-1998, Para 61.)"

(emphasis in original)

41. It may be stressed that in Vellore Citizens' Welfare Forum case [Vellore Citizens' Welfare Forum v. Union of India, (1996) 5 SCC 647] , this Court had banned the tanneries when it was found that they were causing immense damage to the environment. Thus, environment protection, which is a facet of Article 21, was given supremacy over the right to carry on business enshrined

in Article 19(1)(g). We state at the cost of repetition that right to health, which is recognised as a facet of Article 21 of the Constitution and, therefore, is a fundamental right, assumes greater importance. It is not only the petitioners and other applicants who have intervened in support of the petitioners but the issue involves millions of persons living in Delhi and NCR, whose right to health is at stake. However, for the time being, without going into this debate in greater details, our endeavour is to strive at balancing of two rights, namely, right of the petitioners under Article 21 and right of the manufacturers and traders under Article 19(1)(g) of the Constitution.

44. Applying the aforesaid principle, in the first blush it may appear that the aforesaid argument has substantial force in it. However, that would be only one side of the picture as there are two contra-arguments which are sufficient to take the sheen out of the aforesaid plea. First aspect is that the argument of economic hardship is pitched against right to health and life. ***When the Court is called upon to protect the right to life, economic effect of a particular measure for the protection of such right to health will have to give way to this fundamental right. Second factor, which is equally important, is that the economic loss to the State is pitched against the economic loss in the form of cost of treatment for treating the ailments with which people suffer as a result of burning of these crackers. Health hazards in the form of various***

diseases that are the direct result of burning of crackers have already been noted above. It leads to asthma, coughing, bronchitis, retarded nervous system breakdown and even cognitive impairment. Some of the diseases continue on a prolonged basis. Some of these which are caused because of high level of $PM_{2.5}$ are even irreversible. In such cases, patients may have to continue to get the medical treatment for much longer period and even for life*. Though there are no statistics as to what would be the cost for treating such diseases which are as a direct consequence of fireworks on these occasions like Diwali, it can safely be said that this may also be substantial. It may be more than the revenue which is generated from the manufacturers of the crackers. However, we say no more for want of precise statistical data in this behalf."*

Carrying Capacity Concept

Carrying capacity is a facet of sustainable development. It is inherent in 'Precautionary Principle' as well as in 'Inter-generational Equity'. In MC Mehta v. UOI & Ors., (2017) 1 SCC 412

16. ***construction activity in the catchment area of Badkhal were directed to be restricted/regulated to the level of Carrying capacity.*** *It was observed that:-*

"Preventive measures have to be taken keeping in view of the carrying capacity of the ecosystem operating in the environmental surroundings under consideration."

12. *We are conscious that brick kilns may be necessary. Object of this order is not to stop*

any legitimate business activity but to enforce the right to breathe fresh air which is right to file. The source apportionment studies, placed on record, show that brick kilns contribute 5-7% PM. Air pollution Control devices to be installed by the polluting sources including the brick kilns need to comply not only the consent standards but are also the Ambient Air Quality norms and available assimilative capacity of the region. ***If the right to fresh air is not enforced, the consequences of brick kilns beyond carrying capacity of the air quality in the area are disastrous in terms of deaths and air borne diseases. This will be contrary to the mandate of the Constitution and the environmental law, particularly the principle of 'Sustainable Development'. It is well established that deteriorated ambient air quality in terms of PM_{10} and $PM_{2.5}$ affects respiratory system particularly, the lungs which may make individuals more vulnerable to get other related fatal diseases****."*

5. During the course of hearing Learned Counsel for the Central Pollution Control Board has argued that the committee has forwarded certain recommendations with immediate measures, short term measure, mid-term measure and long term measures. The committee has further opined that after 10 years based on need to shift /upgrade on to the new technology like Tunnel kiln, Hoffman Kiln or any other new technology based on cheaper fuel like solar power /natural gas (PNG/CNG) long terms measures can be implemented to reduce emission or particulate matter to negligible level. The combustible mixture of natural gas and air does not ignite if the mixture is leaner than 5 % and richer than 15% of the fuel air ratio required for ignition.

6. Considering all relevant factors submitted by the Joint Committee, we are of the view that short term and long term measures are policy matters, which are to be decided and implemented by the State Authorities, according to the suitability and availability of the energy.

7. A balance between supply and demand of the materials, which are being used for construction activities have to be maintained.

8. In view of above, we are of the view that the recommendations at point no. 5.2 by the Joint Committee should be taken care of and implemented by the State Pollution Control Board considering all relevant factors including negative supportive capacity such that pollution load remains within permissible carrying capacity. So far as the short term and long term measures are concerned, we refer the report of the Joint Committee to the Secretary (Environment), State of Rajasthan for taking appropriate decision in consultation with the Central Pollution Control Board.

O.A. No. 31/2021 (CZ) along with I.A. No. 14/2021 stands **disposed of** accordingly,

Sheo Kumar Singh, JM

Arun Kumar Verma, EM

24th December, 2021
OA No. 31/2021 (CZ)
K