SAMPLE REPORT

Example Industrial Facility

Indore Region, Madhya Pradesh, India

1-Hour SO_2 Modeling Report

Prepared by	DSTechnoverse, Indore
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Example Industrial Facility

1-Hour SO_2 Modeling Report

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1.0 Introduction

1.1 Executive Summary

This document summarizes the results of a sulfur dioxide (SO_2) air quality modeling analysis for the Example Industrial Facility (the Facility), located in the Indore region of Madhya Pradesh. The analysis was developed to evaluate whether emissions from the Facility cause or significantly contribute to modeled exceedances of the 1-hour SO_2 benchmark in an area that also contains the Example Power Station (the Power Station), the dominant SO_2 source in the area. This analysis considers emissions from both facilities together with ambient background levels.

This analysis shows:

- Emissions from the Facility do not cause or significantly contribute (no more than 0.39% of the total concentration) to any modeled exceedance of the benchmark.
- The highest offsite impact attributed to Facility sources alone, including background, is 131.8 µg/m³, about 33% below the 196.5 µg/m³ benchmark.
- Facility impacts are highest within 1–2 km of the property boundary and decrease with distance. At 5–8 km south-south-west, in the direction of the Power Station, impacts fall to levels close to ambient background.
- The Facility and the Power Station are about 14 km apart. Facility emissions therefore have no significant effect on concentrations near the Power Station.
- The highest combined impact from the Power Station, the Facility and background is 203.91 µg/m³. The Facility accounts for 0.31 µg/m³ (about 0.15%) of this value.
- Based on these results, the Facility should be excluded from any nonattainment boundary that results from the designation process.

1.2 Background

Area designation reviews for the 1-hour SO_2 standard are typically based on dispersion modeling of the largest nearby emitter. In this sample scenario, an initial regional assessment modeled only the Power Station and treated the Facility as part of the monitored background. A reviewing authority questioned whether background monitoring data could adequately represent concentration gradients created by the Facility, and proposed a large study area covering both sources.

The work in this report extends the earlier assessment by explicitly modeling Facility sources alongside the Power Station and by refining several inputs. The methodology was set out in a modeling protocol provided to the regulatory authority before the analysis began (see Appendix B).

1.3 Overview of Analysis

The analysis follows the approach of the earlier regional assessment, with the following refinements:

No.	Refinement
1	All modeling used AERMOD regulatory default options (see Section 2.0).
2	Hourly varying exit velocity was used for the Power Station, based on concurrent heat input, instead of a constant full-load value (see Section 2.1.2).
3	Building downwash was included for both the Facility and the Power Station.
4	Meteorological data were reprocessed with the current version of AERMET (see Section 2.4).
5	Facility sources were modeled at permitted rates, except the two boilers, which used representative maximum hourly rates (see Section 2.1.1).
6	One comprehensive receptor grid covered the area around both facilities (see Section 2.2).

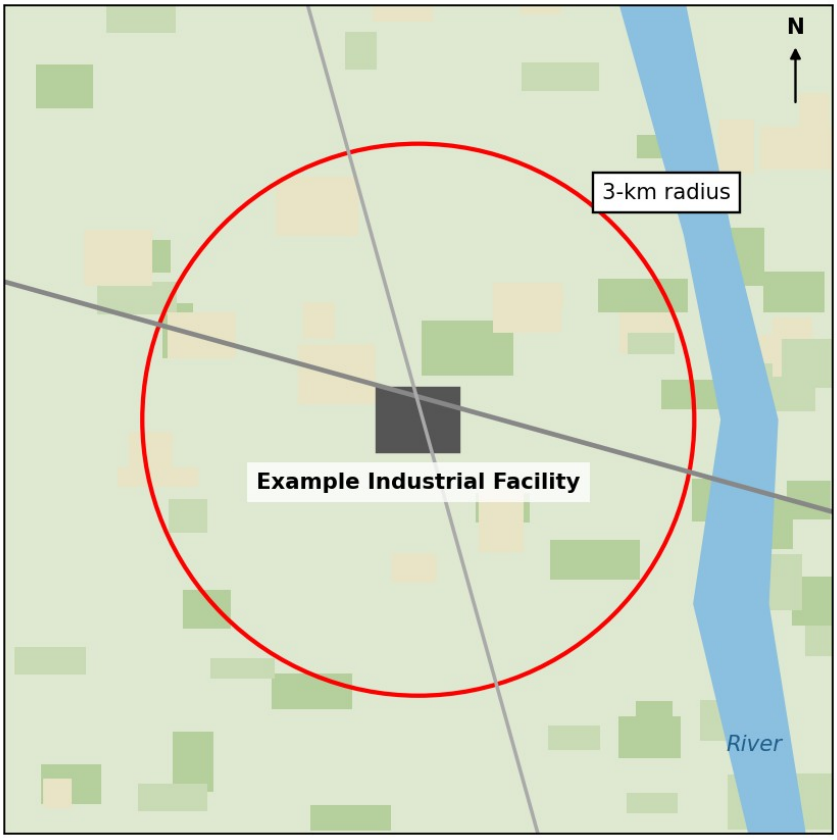
No.	Refinement
7	Ambient background was updated with recent monitoring data and combined with modeled values by season and hour of day (see Section 2.5).

Further detail is given in Section 2. All model input and output files are listed in Appendix C.

1.4 Facility Description and Location

The Facility is located in a rural area on the north-east side of the nearest town, in the northern part of the study area. It is a manufacturing plant whose SO_2 sources are two coal and biomass fired boilers, a process furnace, a thermal oxidiser and a standby diesel generator. Additional detail on these sources is given in Section 2.1.1. The Facility location is shown in Figure 1-1.

Figure 1-1 Location of the Example Industrial Facility



2.0 Model Application and Options

AERMOD (current regulatory version) was used for the analysis. AERMOD is the preferred model for short-range transport and can account for the source types and dispersion environment at and around the Facility and the Power Station, including sources subject to building downwash and flat or gently elevated terrain.

AERMOD was applied with all regulatory default options. Procedures were consistent with applicable guidance, including the technical assistance document for 1-hour SO_2 designations modeling and the associated clarification memoranda on combining modeled and monitored concentrations. All stacks were modeled at their actual physical height. The Building Profile Input Program (BPIP-PRIME) was used to incorporate downwash for all stacks. Figure 2-1 shows the Facility stacks and buildings included in the BPIP analysis.

2.1 Source Data

2.1.1 Example Industrial Facility

The primary SO_2 sources and buildings of the Facility are shown in Figure 2-1, and stack parameters and emission rates are summarized in Table 2-1.

A hybrid approach was used for emissions. A conservative constant, representative maximum hourly rate was used for Boilers 1 and 2, and all other sources were modeled at maximum permitted rates. The representative maximum rates were derived from a statistical evaluation of hourly continuous monitoring data for the three-year period, then applied to every hour of the modeled period. About 99.4% of actual hourly boiler emissions fell below these modeled rates, and the remainder were atypical operating periods. Because the standard is based on the 99th percentile, this approach gives a conservative depiction of modeled concentrations.

Exhaust parameters were taken from the operating permit and verified by the Facility.

Figure 2-1 Facility Sources and Buildings

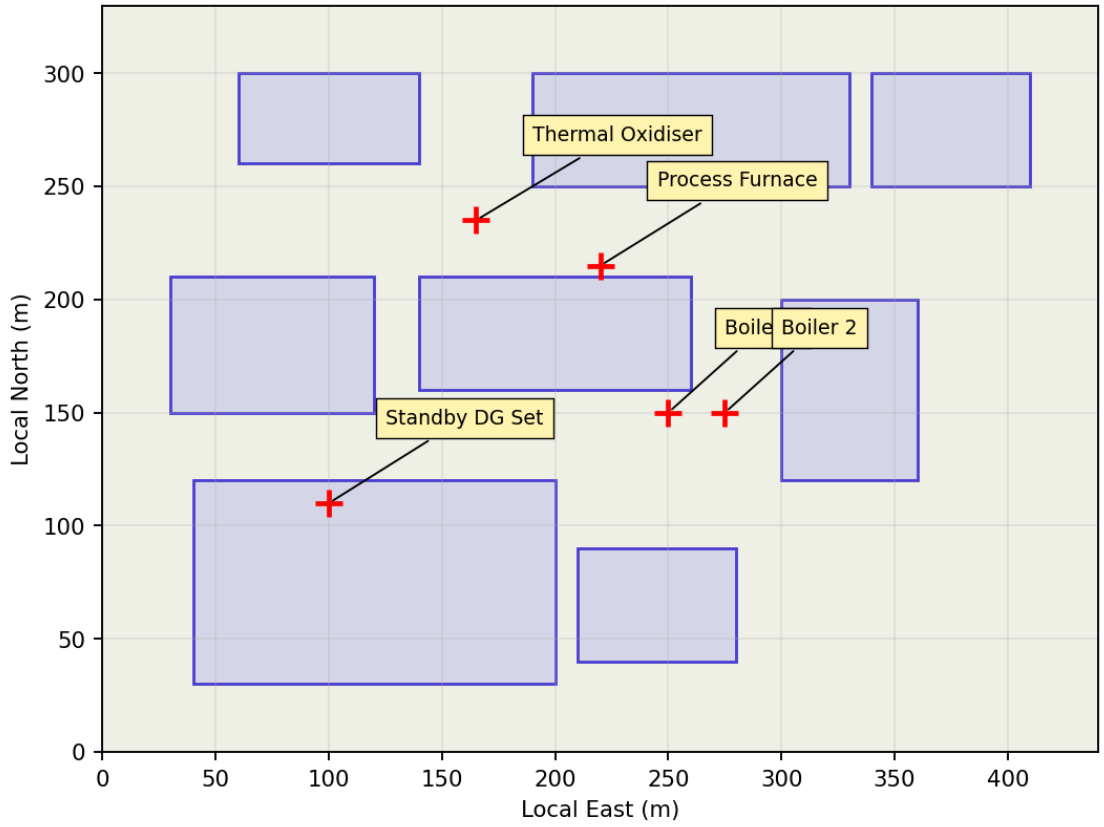


Table 2-1 Stack Parameters and Emission Rates – Example Industrial Facility

Parameter	Boiler 1	Boiler 2	Process Furnace	Thermal Oxidiser	Standby DG Set
Stack ID	01-A	02-A	03-A	04-A	05-A
Base Elevation (m)	548.2	548.0	548.1	548.4	548.0
Stack Height (m)	60.0	60.0	35.0	28.0	12.0
Stack Diameter (m)	2.8	2.8	1.6	0.9	0.4
Exhaust Velocity (m/s)	24.0	24.0	11.5	9.8	18.2
Exhaust Temperature (K)	438	438	395	410	560
SO_2 Emission Rate (g/s)	14.2	12.9	2.1	0.6	0.3
Emission Basis	Max. actual	Max. actual	Permitted	Permitted	Permitted

2.1.2 Example Power Station

The earlier regional assessment modeled the Power Station using three years of actual hourly emissions together with a constant exit flow rate and temperature based on full load. Because stack flow and temperature are typically lower at part load, this likely understated impacts.

To address this, hourly exit velocity was developed for this analysis. Direct hourly flow measurements were not available, but hourly heat input was available from continuous monitoring reports. Hourly exit velocity was computed as the full-load exit velocity multiplied by the ratio of actual hourly heat input to maximum heat input. The full-load exit temperature was not adjusted, because significant variation with load is not expected. Physical stack parameters and full-load values are summarized in Table 2-2.

Table 2-2 Stack Parameters and Emission Rates – Power Station Main Stack

Parameter	Main Boiler Stack
Base Elevation (m)	562.0
Stack Height (m)	150.0
Stack Diameter (m)	7.6
Exhaust Velocity (m/s)	Varied hourly
Exhaust Temperature (K)	346
SO_2 Emission Rate (g/s)	Varied hourly

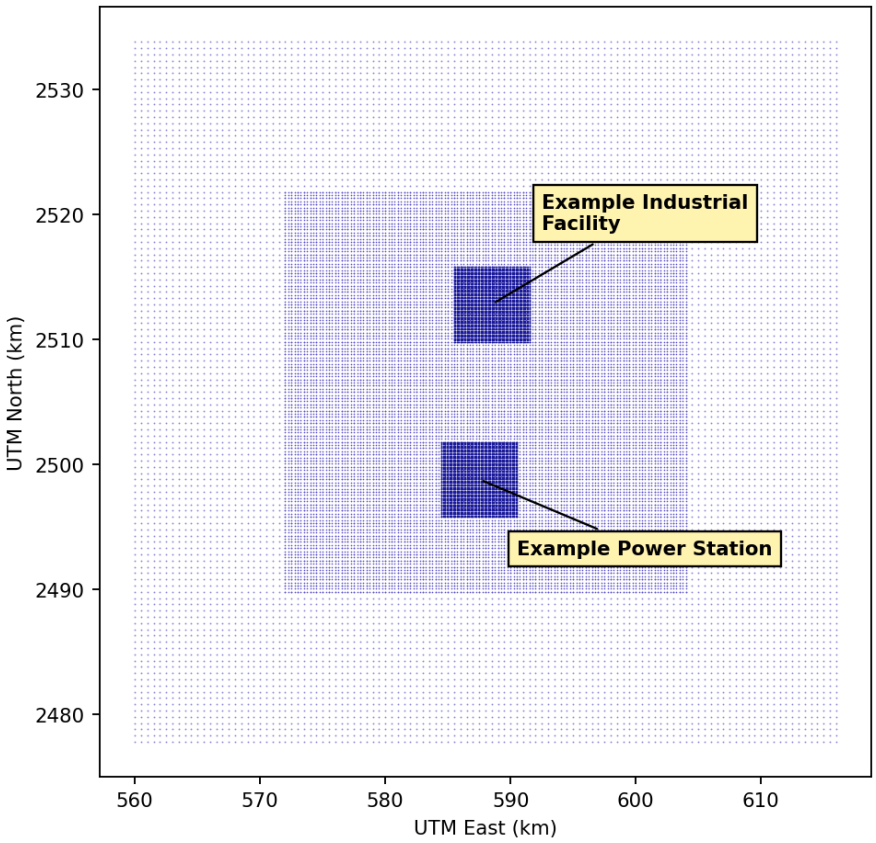
2.2 Receptor Grid

A single comprehensive receptor grid was used around the Facility and the Power Station. It extends a minimum of 20 km in all directions from each facility, with the following spacing:

- 25 m spacing along each facility's ambient air boundary;
- 100 m spacing beyond the boundary out to 3–5 km, depending on direction;
- 250 m spacing for a further 4–8 km;
- 500 m spacing for a further 5 km; and
- 250 m spacing in the central corridor between the two facilities.

The receptor grid is shown in Figure 2-2. It was sufficient to capture the maximum impacts of each facility as well as the combined impacts. Coordinates use the UTM system (WGS84 datum, Zone 43N). AERMAP was used to compute terrain elevations and hill heights from 1 arc-second elevation data, with a domain large enough to include all terrain features that exceed a 10% slope from any receptor.

Figure 2-2 AERMOD Receptor Grid



2.3 Dispersion Environment

AERMOD was applied in rural mode, given that land use within 3 km of each facility is predominantly agricultural, forest and open land. Urban land types made up less than 5% of the area, well below the 50% threshold for urban dispersion coefficients.

2.4 Meteorological Data for Modeling

Three consecutive years of hourly surface observations from the regional airport station were used, together with concurrent upper-air soundings. The data were processed with the current versions of AERMET and AERMINUTE, and surface characteristics were derived with AERSURFACE for 30-degree sectors. A comparison with data processed by the previous AERMET version showed no meaningful differences. The wind rose is shown in Figure 2-4; winds are predominantly from the south-west, with a secondary mode from the north-east.

2.5 Background Monitoring Data

Ambient monitoring data are used to represent the contribution of non-modeled sources. The earlier assessment used a monitor in a regional city about 40 km north of the Facility (Figure 2-3). That monitor is in a more urban setting than the Facility and Power Station, and prevailing southerly flow can carry emissions from both facilities toward it. It is therefore likely to be conservative as a background for the study area, with some double-counting of emissions.

Two approaches are commonly used to add monitored background. The first adds the monitored design value to the modeled design value, which is conservative. The second combines monitored concentrations by season and hour of day with modeled hourly results inside AERMOD, and the design concentration is then taken from the combined series. This analysis used the second approach with three recent years of monitor data. Design concentrations are given in Table 2-3 and seasonal hour-of-day values in Table 2-4.

Figure 2-3 Location of SO_2 Monitor

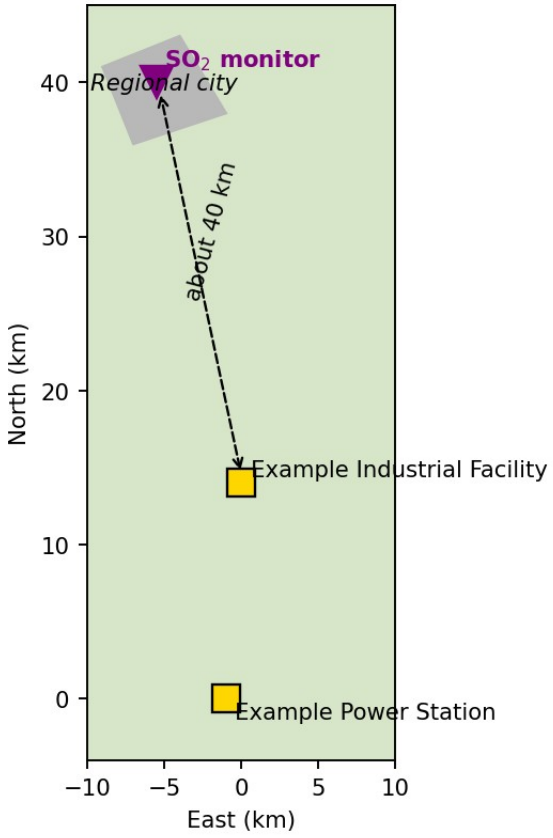


Figure 2-4 Regional Wind Rose (3-year period)

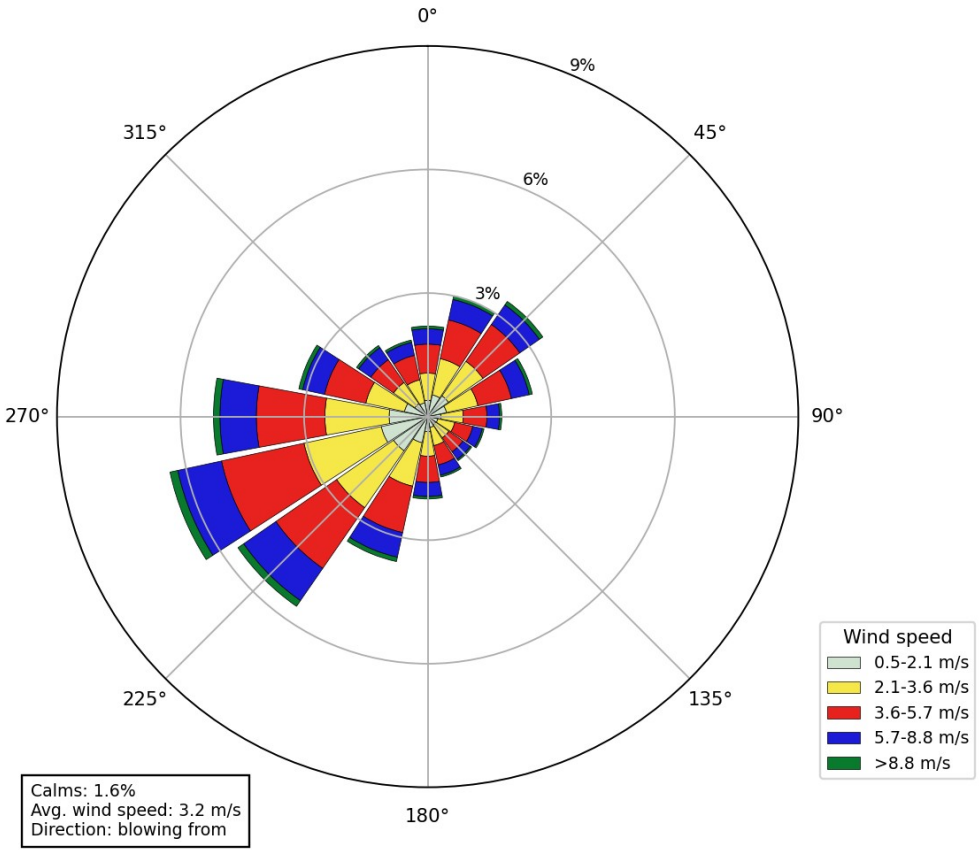


Table 2-3 SO_2 Monitor Design Concentrations (3-year period)

Monitor Year	Valid hours	Capture (%)	99th pct (ppb)	Design conc. (ppb)	Design conc. (µg/m³)
Year 1	8,602	98	11		
Year 2	8,574	98	13	11	28.8
Year 3	8,391	96	10		

Table 2-4 Monitor Season and Hour-of-Day Background Concentrations (ppb)

Hour	Winter	Spring	Summer	Fall
1	2.5	2.6	2.3	2.0
2	2.4	2.5	2.2	1.9
3	2.4	2.5	2.2	1.9
4	2.5	2.6	2.3	2.0
5	2.6	2.7	2.4	2.1
6	2.7	2.8	2.5	2.2
7	3.0	3.1	2.8	2.5
8	3.5	3.6	3.3	3.0
9	4.7	5.6	6.9	4.2
10	5.9	6.8	8.1	6.3
11	5.5	6.4	7.7	5.9
12	5.0	5.9	7.2	5.4
13	4.5	4.6	4.3	4.0
14	4.1	4.2	4.5	3.6
15	3.8	3.9	4.2	3.3
16	3.6	3.7	4.0	3.1
17	3.5	3.6	3.9	3.0
18	3.4	3.5	3.2	2.9
19	3.3	3.4	3.1	2.8
20	3.1	3.2	2.9	2.6
21	2.9	3.0	2.7	2.4
22	2.8	2.9	2.6	2.3
23	2.7	2.8	2.5	2.2
24	2.6	2.7	2.4	2.1

3.0 Modeling Results

AERMOD was applied for the three-year meteorological data set to determine combined 1-hour SO_2 concentrations for the Facility sources and the Power Station main stack. Season and hour-of-day background was included within AERMOD. The design concentration reported is the highest three-year average of the 99th percentile of daily maximum 1-hour concentrations.

Table 3-1 summarizes modeled concentrations and source contributions. In summary:

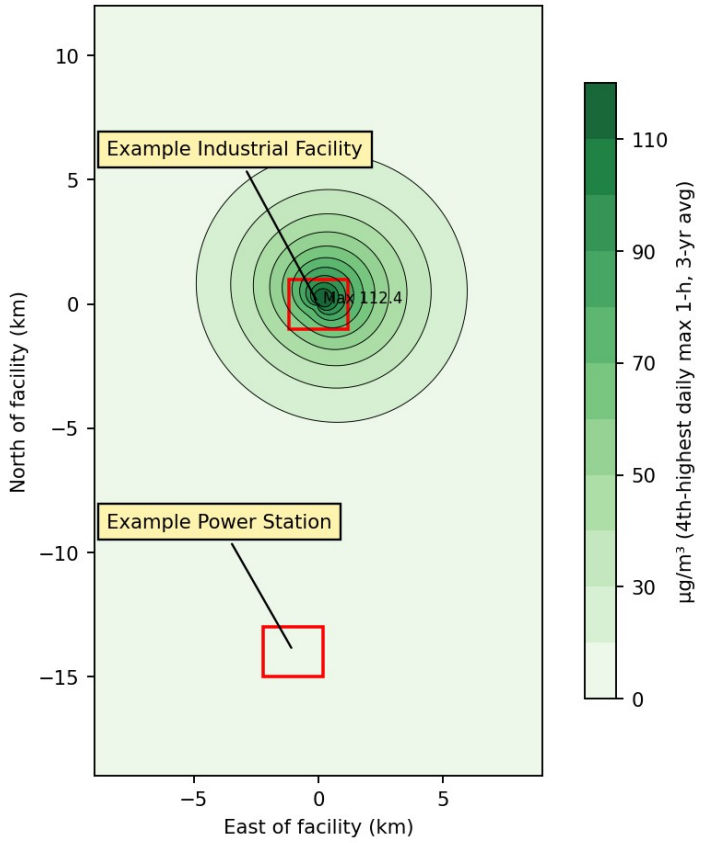
- The overall highest concentration from all sources plus background is 203.91 µg/m³. This exceeds the 196.5 µg/m³ benchmark and is primarily due to the Power Station. The Facility contributes only 0.31 µg/m³ (about 0.15% of the total).
- The highest concentration from all sources where the Facility has a significant impact (at or above 7.9 µg/m³) is 148.70 µg/m³. The Facility contributes 9.30 µg/m³ (6.3%) of this value.
- The highest concentration due to Facility sources alone, plus background, is 131.80 µg/m³. Figure 3-1 shows the isopleths for the Facility alone. Highest values are at the facility boundary, below the benchmark, and drop off significantly with distance. At 5–8 km from the Facility, Facility-only concentrations approach background levels, well short of the Power Station.

Table 3-1 1-Hour SO_2 Benchmark Analysis Results – Concentrations (µg/m³)

Case	Total conc.(1)	Power Station	Facility	Monitored background	Bench-mark	SIL
Overall maximum	203.91	181.20	0.31	22.40	196.5	7.9
Maximum where Facility significant	148.70	127.10	9.30	12.30	196.5	7.9
Maximum due to Facility alone	131.80	--	112.40	19.40	196.5	7.9

(1) 1-hour SO_2 99th percentile design concentrations.

Figure 3-1 Facility Alone Modeling Results (excludes ambient background)

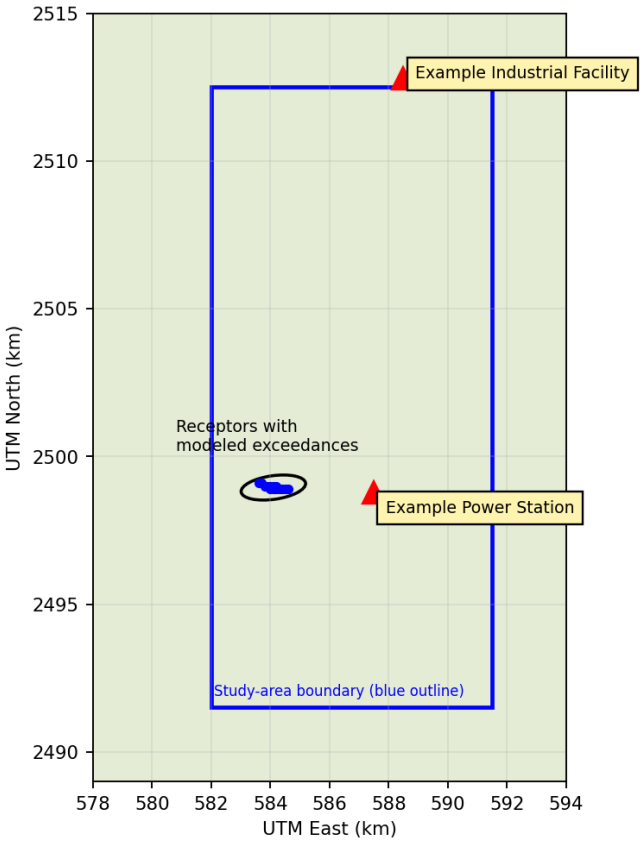


A number of other receptors also exceed the benchmark. Their locations are shown in Figure 3-2 and a summary of the modeled exceedances is given in Table 3-2. The Facility does not contribute significantly to any of them: the maximum Facility contribution to any modeled exceedance is 0.78 µg/m³ (about 0.40% of the benchmark). Figure 3-2 also shows how small the area of modeled exceedances is relative to the study area.

Table 3-2 Facility Contribution to Modeled Benchmark Exceedances (µg/m³)

X (m)	Y (m)	Maximum design conc. (with background)	Facility contribution
584400.00	2498900.00	203.91	0.31
584300.00	2498900.00	203.60	0.52
584000.00	2499000.00	201.88	0.34
584500.00	2498900.00	201.12	0.31
584200.00	2498900.00	200.74	0.66
583900.00	2499000.00	200.27	0.78
584100.00	2499000.00	199.46	0.35
584100.00	2498900.00	198.70	0.66
584600.00	2498900.00	198.31	0.31
584200.00	2499000.00	197.95	0.33
583800.00	2499000.00	197.52	0.78
583600.00	2499100.00	197.20	0.33
584000.00	2498900.00	196.98	0.78
583700.00	2499100.00	196.77	0.30

Figure 3-2 Receptor Locations of Modeled Benchmark Exceedances



These results demonstrate that the Facility does not contribute significantly to any modeled exceedance, which are all due to the Power Station. The analysis also demonstrates that the Facility itself does not cause any modeled exceedance of the benchmark.

4.0 References

US EPA. User's Guide for the AMS/EPA Regulatory Model (AERMOD). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

US EPA. User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards.

US EPA. User's Guide for the AERMOD Terrain Preprocessor (AERMAP). Office of Air Quality Planning and Standards.

US EPA. SO_2 NAAQS Designations Modeling Technical Assistance Document. Office of Air Quality Planning and Standards.

US EPA. Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 NAAQS (March 1, 2011).

US EPA. Guideline on Air Quality Models, Appendix W to 40 CFR Part 51.

US EPA. Guideline for Determination of Good Engineering Practice Stack Height.

Central Pollution Control Board, India. National Ambient Air Quality Standards.

Appendix A Summary of Regulatory Guidance

This appendix summarizes the main guidance framework used for the sample analysis.

Topic	Summary
Designation basis	Areas are classified as nonattainment, attainment/unclassifiable or unclassifiable based on monitoring or dispersion modeling, together with emissions, meteorology, geography and jurisdictional factors.
Benchmark	The 1-hour SO_2 level is 75 ppb (196.5 µg/m^3), expressed as the three-year average of the 99th percentile of daily maximum 1-hour concentrations.
Model	AERMOD with regulatory default options. Beta options require approval from the reviewing authority before use in regulatory work.
Emissions	Recent actual hourly emissions, or maximum permitted emissions, may be used. Hourly stack parameters are preferred where available.
Nearby sources	Sources that may cause concentration gradients in the area of analysis should be modeled explicitly rather than represented only by monitored background.
Background	Monitored background may be added as a single design value or combined by season and hour of day.

Appendix B Modeling Protocol Submitted to Regulator

DSTechnoverse, Indore

Date: October 2026

To: Air Permits, Sample Regulatory Authority

Subject: Proposed Modeling Methodology for 1-hour SO_2 Area Designation Review

Dear Sir or Madam,

DSTechnoverse proposes to perform additional dispersion modeling to determine the impact, if any, of the Example Industrial Facility on modeled exceedances of the 1-hour SO_2 benchmark predicted near the Example Power Station. The earlier assessment modeled only the Power Station. This letter sets out the methods we propose to apply, which follow the earlier approach with the following changes:

- All modeling will use AERMOD default options.
- Hourly exit flow and temperature estimates will be used for the Power Station.
- Building downwash will be included for both facilities.
- Meteorological data will be reprocessed with the current AERMET version.
- Facility sources will use permitted rates, except the two boilers, which will use representative maximum hourly rates based on the 99th percentile or greater of recent operations.
- One comprehensive receptor grid will cover both facilities, extending at least 20 km from each.
- Background will be updated with recent monitor data and combined by season and hour of day.

We would welcome any comments on these procedures.

Yours sincerely,

Air Quality Specialist, DSTechnoverse

Appendix C Modeling Archive

The archive provided with the report contains the following model files.

File group	Contents
AERMOD input/output	Run files for Facility alone, Power Station alone and the cumulative case
BPIP-PRIME	Building and stack input and output files
AERMAP	Terrain input, receptor elevations and hill heights
AERMET / AERMINUTE	Processed surface and profile meteorological files
Background	Spreadsheet of seasonal hour-of-day calculations
Post-processing	Contribution analysis and exceedance tables