CHAPTER 5

METHODOLOGY

5.1 GENERAL

The general methodology of the present study consists of four parts. In the first, a Gaussian plume dispersion model was developed based on Gaussian plume concept (Figure 5.1). The second part consists of collection of data on emission inventory parameters and meteorological parameters. In the third part the model was used to predict hourly, daily and monthly maximum concentrations of criteria pollutants for the three different seasons. The fourth part contains validation of the Gaussian plume model with the observed data. One month for each season is taken as representative months and the studies were carried out for the months of February (winter), May (summer) and October (monsoon) for five years (1997-2001).

The major Air polluting are identified and stack emission data (including the emission rates of each of pollutants SO₂, NOₓ, SPM, from each stack) available with TNPCB were collected. These data are processed and formatted as required source data for industrial point source emissions for input to the model for all 46 stacks with in the study area. The meteorological data on wind speed, wind direction, temperature, relative humidity, cloud cover, cloud height, solar insolation, mixing height were obtained from IMD processed and formatted as required meteorological input data. The ambient air quality data for the criteria pollutants (SO₂, NOₓ, SPM) at Manali stations for the three seasons namely winter (February), summer (May), monsoon (October) for the year 2000 were collected from TNPCB.
Figure 5.1 General Flow Diagram
5.2 ABOUT THE MODEL

The model we have developed for the estimation of plume concentration at a given distance from the source of emission of pollutants such as suspended particulate matter (SPM), Sulphur-di-oxide (SO$_2$), Nitrogen oxide (NOx) from industries.

The various elements of the model are,

- Emission inventory
- Meteorology
- Atmospheric stability
- Plume rise equations
- Dispersion coefficients
- Mixing height

The parameter such as emission inventory are obtained from the industries and stored in files, which are loaded when required by the user. The meteorological data was obtained from the Indian Meteorological Department and are also stored in files, which can be loaded when required.

The various methods available for the determination of stability are:

- Pasquilli Method
- Turner Method
- Wind fluctuation method
- Temperature Profile Method
The Concentrations are computed for rural as well as urban regions as desired by the user. Briggs equation for urban and rural regions for large distances and Pasquilli Gifford equation for short distances of receptor from the source are used. Buoyancy flux parameters are also computed using the Briggs equation. The other factors that are considered in the determination of concentrations by the dispersion of plume emitted by the various stacks are namely:

- Terrain characteristics
- Building Wake
- Urban Heat Island Effect
- Coastal Sites
- Dispersion coefficients
- Multiple point stacks

5.3 INPUTS TO THE MODEL

Inputs to the model are set of options selected by the user, consists of source parameters, meteorological data, and receptor information and these are explained below:

a. Source emission data
   - coordinates of the point source in meters
   - emission rate g/s
   - stack height in meters
   - exit temperature in kelvin
   - exit gas velocity m/s
   - stack diameter in meters
b. **Meteorological data**  
- wind speed in km/hr  
- wind direction  
- ambient temperature  
- stability class  

c. **Receptor data**  
- Location of receptor  

### 5.4 ADVANTAGES OF THE MODEL

- The model developed is more user friendly and understandable.  
- Options are varied and the various concentrations can be calculated with ease.  
- Any relevant parameter can be changed when running the model and the concentrations can be recalculated.  
- Inputs can be modified and saved in different files and loaded when necessary.  
- The Graph for the different concentrations can be viewed immediately and compared for better numerical evaluation.  
- Files can be saved and loaded with ease, which is an advantage when dealing with voluminous data.  

### 5.5 SALIENT FEATURES OF THE MODEL

- Object Oriented Programming has really enhanced the software.  
- Data hiding, Encapsulation and Abstraction are the salient features available in the present software.
• File handling has made the handling of voluminous data much easier by saving and loading files at will.

• Graphical representation of the result helps the readability of the result and gives a better picture of the dispersion concentrations.

• The variation of concentration with various parameters such as Stability, Wind Speed and Source strength are available.

5.6 DETAILED METHODOLOGY

The detailed methodology followed is shown in the flow chart in Appendix 1. The steps followed can be summarised as follows:

Step 1: Start the program.
Step 2: Initialize the variables.
Step 3: Display the main screen.
Step 4: Accept the user’s choice.
Step 5: IF choice = 1 GOTO Step 11
Step 6: Else IF choice = 2 GOTO Step 14
Step 7: Else IF choice = 3 GOTO Step 18
Step 8: Else IF choice = 4 GOTO Step 20
Step 9: Else IF choice = 5 goto Step 23
Step 10: Else terminate the program.
Step 11: IF user wants to open file load Standard data file.
Step 12: Else accept standard data from the user.
Step 13: GOTO Step 3
Step 14: IF user wants to open a file load Hourly data file.
Step 15: Else accept data from the user.
Step 16: GOTO Step 3
Step 17: Calculate various concentrations.
Step 18: Display the output data.
Step 19: GOTO step 3
Step 20: Accept the variable to be modified.
Step 21: Accept the hour if necessary and the new data.
Step 22: GOTO Step 3
Step 23: IF user wants to open file load it in the buffer.
Step 24: Else IF user wants to save file transfer it to hard disk
Step 25: Else IF user wishes draw graphs
Step 26: Else IF user wishes to recalculate concentration GOTO Step 17
Step 27: Else GOTO step 3