International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com ‖ Volume 1 - Issue 5 ‖ June 2016 ‖ PP.01-07

AIR DISPERSION MODELING FOR EMERGENCY RESPONSE AND RESTORATION

Vishnu V
(Department of Production Engineering, Govt. Engineering College, Thrissur-680009, India)

ABSTRACT: With the growing demand for petroleum products, the companies are pushed forward to increase their capacities. This leads to a situation where there are more chances of occurrences to an undesirable event like a gas leakage or Bleve resulting in loss of lives and properties. In order to effectively plan for these we need a Quantative approach for risk evaluation. The paper describes a case of considering a LPG leakage from a storage tank and its dispersion modelling using CAMEO, ALOHA, MARPLOT soft wares resulting in providing an effective simulation of the case. This results in proving the selected method is highly appreciated for use during an emergency situation for quick response and restoration. The case presented in this paper can be applied for modeling anywhere in a situation of gas leakage or related emergencies. This provides a suitable tool to prevent further chaos in such emergencies

KEYWORDS - Air dispersion modelling, ALOHA, CAMEO, Emergency response, MARPLOT

1. INTRODUCTION

The process of Air dispersion modeling is the mathematical simulation of how air pollutants disperse or spread in ambient air. It is done with the help of computer software to solve complex algorithms arising out from various scenarios. The process takes into account various parameters to be considered during solving a particular case. These models are helpful in predicting the amount of a particular pollutant under consideration is under safe level or is required to provide an emergency response for the same. They can also be employed to predict the future concentrations under specific scenarios. The technical literature on air pollution dispersion is quite extensive and dates back to the 1930s and earlier. One of the early air pollutant plume dispersion equations was derived by Bosanquet and Pearson [1]. During the late 1960s, the Air Pollution Control Office of the U.S. EPA initiated research projects that would lead to the development of models for the use by urban and transportation planners [2]. The case explained here takes into account a pinhole leak in a LPG storage sphere caused due to some unknown factors. The chemical properties of pollutant under consideration is extracted from CAMEO software and the information is passed onto ALOHA software to make required dispersion model. The ALOHA makes a well-defined model taking into account various parameters like meteorological data, chemical property, location details and so on. This model is then represented in MARPLOT, which clearly shows the exact location of the incident and the nature of dispersion observed. This will help in efficiently planning for emergency response and restoration purpose during undesirable events. Thus the method proves highly valuable and effective for future planning during any further emergencies elsewhere.

2. AIR DISPERSION MODELING

The process of air dispersion modeling are being used by emergency responders and safety management personnel for emergency planning to respond and restore during an accidental chemical release. The nature of these models may vary according to the algorithm and mathematical relations used. Any model considered should include various details for processing like the meteorological data, type of chemical under consideration, source properties, emission or release parameters, terrain under concern, location related data.The modern science of air pollution modelling began in the 1920’s when military scientists in England tried to estimate the dispersion of toxic chemical agents released in the battlefield under various conditions[3]. This early research is summarized in the groundbreaking textbook by Sutton (1953).The textbooks by Pasquill (1974) and Stern (1976) review much of the research and theory up until the mid-1970[4]. However it requires precise information and in depth knowledge to make a model at that time. With the advent of information technology it became much easier to clearly identify the model and to build them by just entering the parameters considered.

2.1 MODELING METHODOLOGY

The model is drawn taking into account various parameters. The process we employ here is termed as Computer Aided Management of Emergency Operation (CAMEO). It is shown in Fig 2.1. The whole process is integrated with various software packages for emergency rescue and restoration operations. The process involves gathering of data while modeling a particular situation. In our paper we are discussing a case of LPG leakage from a sphere storage tank and modeling the same using CAMEO software and related ones.

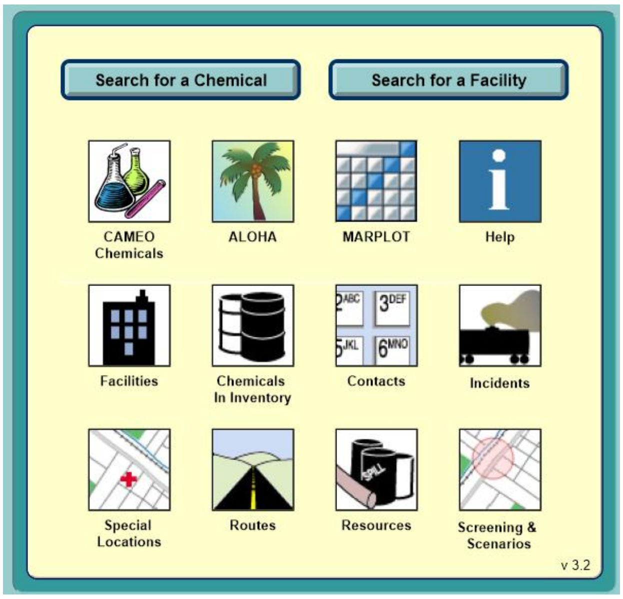

Fig 2.1: CAMEO software overview

2.2 SOFTWARE PACKAGES OR TOOLS USED

While modelling the case scenario, we come across the use of various software packages for the same. These packages are being dealt in this section of the paper. Firstly, the case involved is studied carefully and the location is noted down. The exact coordinates of the place is found using either Google map, Google earth or by using the MARPLOT software that has been incorporated in the system. The next step is to use the Hazmat weather station to take all the required meteorology details for processing at the time of incident. Then all the values required about the chemical LPG is taken from CAMEO Chemicals software and is fed into ALOHA system. The details about the location of the incident like the Latitude, Longitude, Altitude or MSL etc. is taken and recorded. The details are then fed into the ALOHA software for preparing the dispersion model. Also, several other details are fed into ALOHA system and finally we arrive at the required air dispersion model. Now this so formed model is then integrated with the MARPLOT software, which provides a clear idea by showing the pattern of chemical dispersion with the help of Google map. This helps the emergency responders and rescue team to plan accordingly to suppress the chemical release and thereby avoiding the threat. Thus the process proves to be highly important for safety personals.

2.2.1 HAZMAT WEATHER STATION

One of the software and equipment that has been used for modeling is the Hazmat weather station. This is nothing but a meteorological data extractor which provides a real time view of weather of a particular area. In our paper we use this weather station in order to get details about the weather data likeOutside temperature, Humidity, Dew point, Wind speed, Wind direction, Pressure, Average wind speed, Peak wind speed and much more. This software helps in inputting the required atmospheric details into the ALOHA system for dispersion modeling. The simple overview of Hazmat weather station is shown in Fig 2.2. There are so many applications for the weather station like EMS, fire & rescue training, firefighting, wind surfing, ski patrol, sky diving, military, critical response, drop & landing zone safety, expeditionary flight operations, hazmat response, sniper training & operations, unmanned aerial vehicles, air quality monitoring, asphalt placement, spray applications, search and rescue (SAR) services, motor sports, drag racing, shooting sports, archery, scientific expeditions and so on. In our paper we use this equipment and related software to provide meteorological data [5].

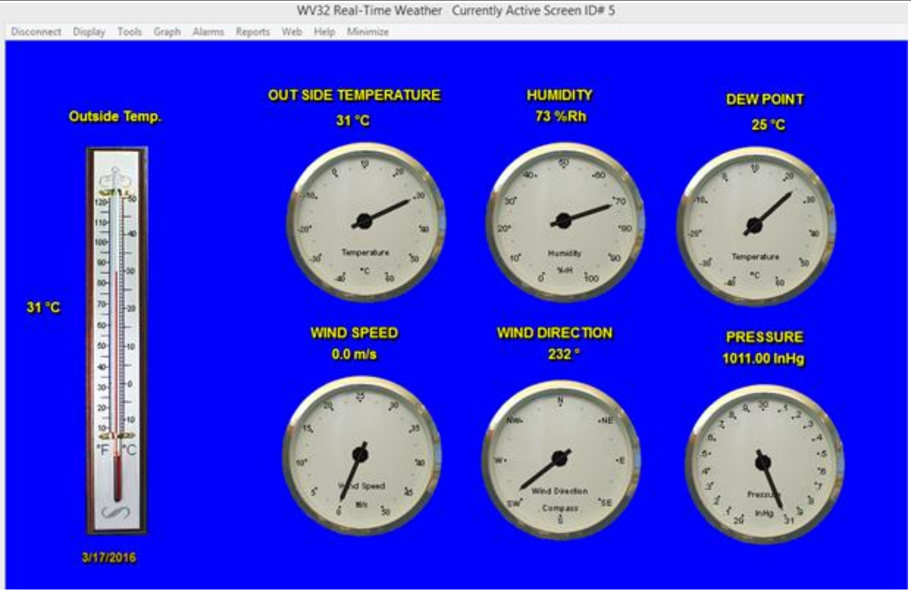

Fig 2.2: Hazmat weather information real time overview

2.2.2 CAMEO CHEMICALS SOFTWARE SUITE

This software is highly useful to obtain the complete details of a chemical under our consideration. The software has an extensive chemical database with critical response information for thousands of chemicals. There are two primary types of datasheets in the database: chemical datasheets and UN/NA datasheets. Chemical datasheets provide physical properties, health hazards, information about air and water hazards, and recommendations for firefighting, first aid, and spill response. UN/NA datasheets provide response information from the Emergency Response Guidebook and shipping information from the Hazardous Materials Table. The Fig 2.3 shows the overview of CAMEO Chemicals software database [6].

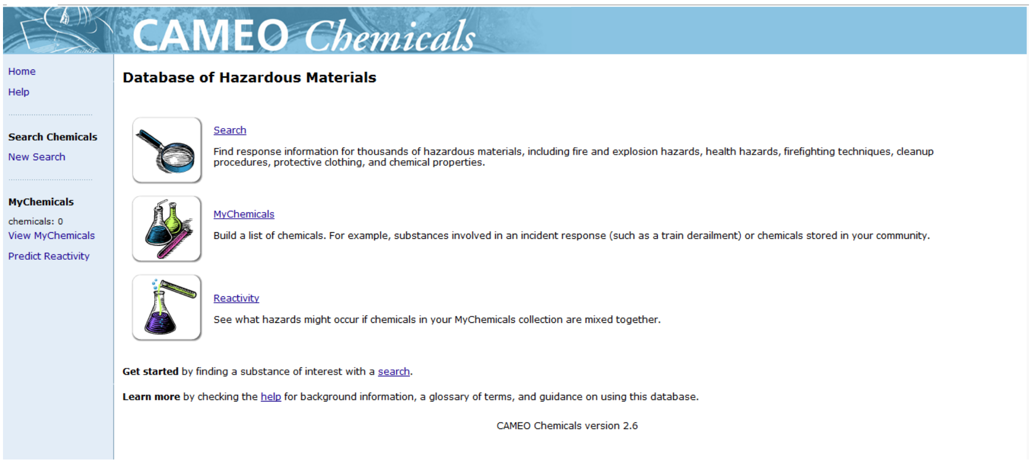

Fig 2.3: CAMEO Chemicals database overview

2.2.3 ALOHA MODELING SOFTWARE

TheAreal Locations of Hazardous Atmospheres(ALOHA) software uses all the information gathered from weather station and chemical database. It also requires the exact condition for case under consideration.ALOHA allows the user to estimate the downwind dispersion of a chemical cloud based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release. It can estimate threat zones associated with several types of hazardous chemical releases, including toxic gas clouds, fires, and explosions. This model can be represented using MARPLOT software for more understanding [7]. Fig 2.4 shows the ALOHA modeling software home screen where the parameters are to be fed in order to get the model.

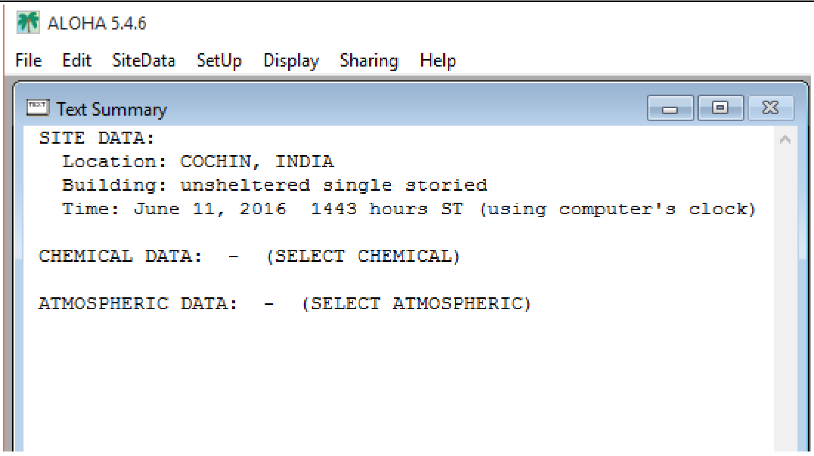

Fig 2.4: ALOHA modeling software home screen

2.2.4 MARPLOT MAPPING SOFTWARE

TheMapping Application for Response, Planning, and Local Operational Tasks (MARPLOT) software is used in our paper to clearly mark and recognize the area for emergency response and restoration. Users can add to the information shown on the map by drawing their own objects (such as chemical facilities, schools, or response assets) or by importing layers of objects already created by other sources. Map objects can be linked to records in ALOHA, in order to store additional information about these locations. Additionally, the areas contaminated by potential or actual chemical release scenarios can be displayed on the maps to determine potential impacts and is helpful in decision making regarding the degree of hazard posed by chemical release [8].

3. OBSERVATIONS AND SIMULATION

The main observation regarding the incident we considered happens to be the atmospheric data at the time frame of incident. This is given in Table 3.1. These values are used by ALOHA to simulate the dispersion model. The project considers a 20 minutes time frame weather data of the incident i.e., from 10:07 to 10:27 hour.

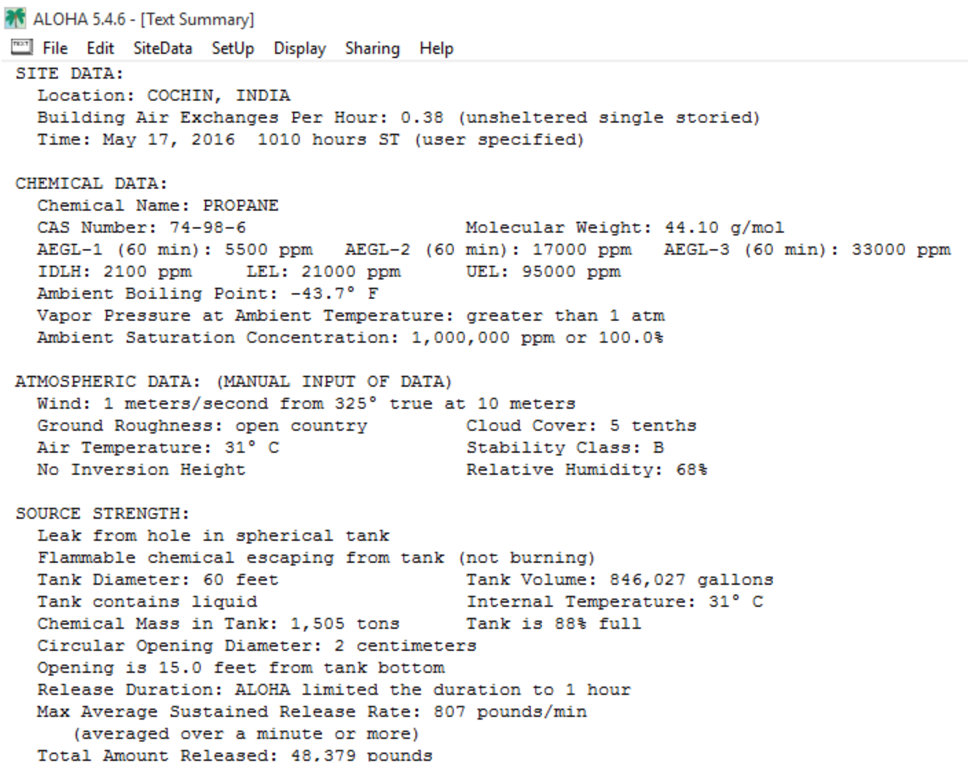

Fig3.1: ALOHA modeling text summary of the incident

Hour	Outside Temp	Wind chill	Dew point	Heat index	Out humidity	Pressure	Wind dir.	Avg. wind speed	Peak wind speed
10:07	33	33	26	41	69	1011.3	231	0.1	0.1
10:08	33	33	26	41	69	1011.3	210	0.1	0.2
10:09	33	33	26	41	68	1011.2	184	0.1	0.2
10:10	33	33	26	41	69	1011.3	238	0.1	0.1
10:11	33	33	26	41	69	1011.3	213	0.1	0.2
10:12	33	33	26	41	69	1011.3	221	0.1	0.2
10:13	33	33	26	41	69	1011.3	203	0.1	0.1
10:14	33	33	26	41	69	1011.3	218	0.1	0.2
10:15	32	33	26	41	69	1011.3	197	0.1	0.1
10:16	32	32	26	41	69	1011.3	216	0.2	0.3
10:17	32	32	26	41	70	1011.3	214	0.1	0.1
10:18	32	32	26	41	69	1011.3	218	0.1	0.2
10:19	32	32	26	41	70	1011.3	248	0.1	0.2
10:20	32	32	26	41	70	1011.3	281	0.1	0.1
10:21	32	32	26	39	69	1011.3	241	0.1	0.2
10:22	32	32	26	41	70	1011.2	204	0.1	0.1
10:23	32	32	26	41	70	1011.3	264	0.1	0.2
10:24	32	32	26	39	70	1011.3	301	0.2	0.4
10:25	32	32	26	39	70	1011.3	212	0.1	0.2
10:26	32	32	26	39	70	1011.2	225	0.2	0.3
10:27	32	32	26	40	71	1011.2	241	0.2	0.3

Table 3.1: Weather data at the time of incident from Hazmat Weather station

The table shows the complete weather data needed for simulating the incident using ALOHA software. Here we take the time frame of the incident for dispersion modeling purpose. This can also be employed to identify and compute extend of chemical release at a time in a day and to proceed for preventing further disaster.

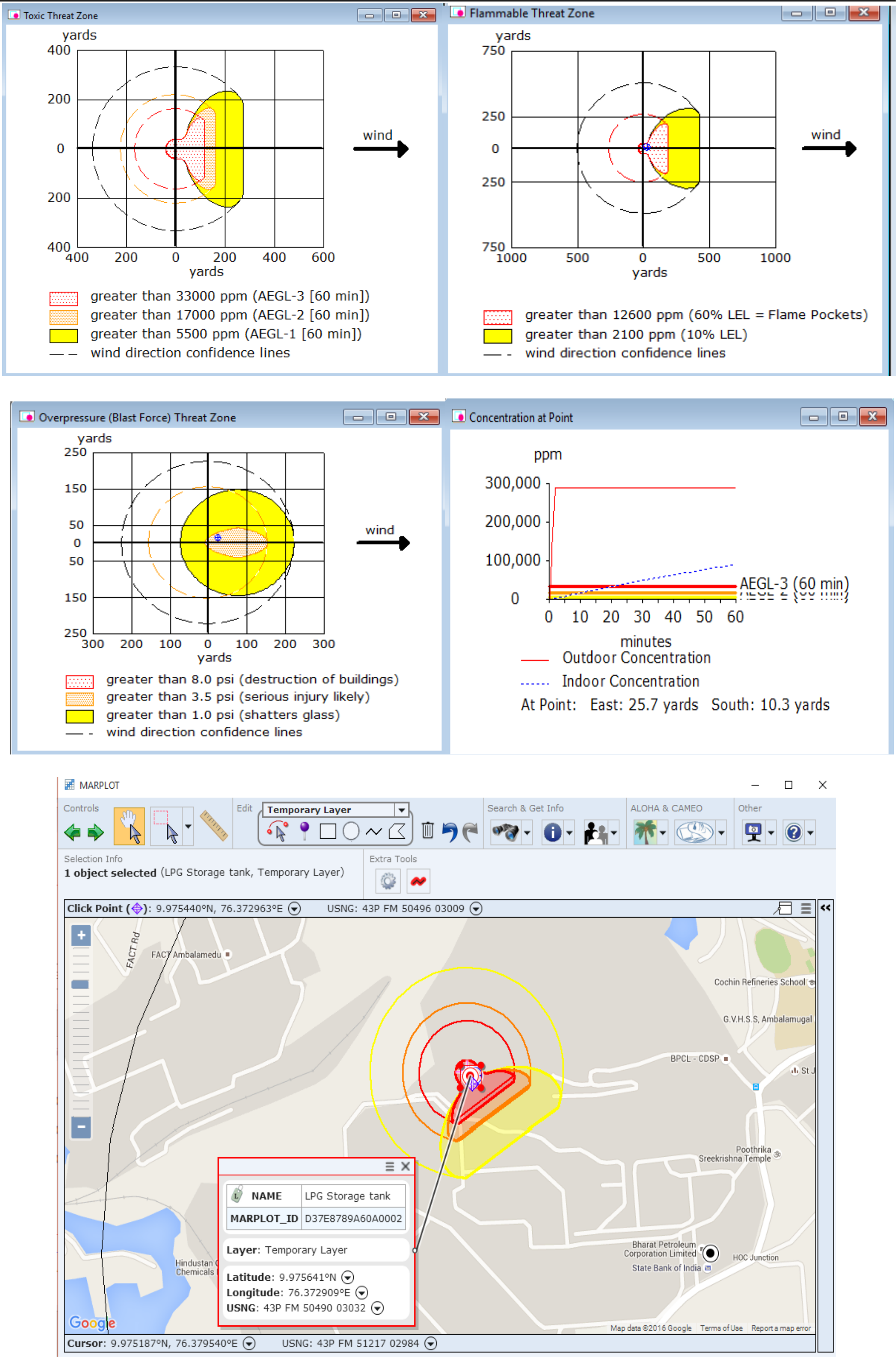

Fig3.2: Dispersion model and its representation in MARPLOT

4. CONCLUSION

The paper describes developing a process plan that would be helpful for emergency response and restoration team during an incident. The paper aims at predicting the risk posed by the scenario by modeling the air dispersion pattern for the chemical release. Also, this will prove to be helpful in determining the rate and direction of chemical release as well as the emergency plan required in order to suppress any chances of danger. The main steps in modeling the scenario is firstly selecting the chemical under consideration. In our case we have considered LPG and the whole details and needed properties of the chemical is then extracted from a software known as CAMEO Chemicals. Where the software provides all the necessary details regarding the chemical. The next step is to study the nature of weather. This is done with the help of an equipment known as a weather station. In our case we use the Hazmat weather station to get all the meteorological details on a regular systematic basis.Next step is to measure details regarding the location, position, dimension, etc. of the leak. Then we take the location details from either Google earth or by using MARPLOT software. Now, the whole data is fed into our ALOHA system where we model the dispersion pattern. The ALOHA software then computes the dispersion model and pattern for the chemical release. Various patterns like vapor cloud formation, BLEVE, toxic gas zone, blast zone, etc. is modeled using the ALOHA software [9]. The final step is to transfer all these model related data into the MARPLOT software where the whole model can be seen in the map. This will help the emergency response team to plan accordingly for suppressing the chemical release and effectively manage the situation.These modeling can be employed in any case where there is a chemical release and thus proves to be highly relevant and useful to prevent undesired events owing to loss of life and properties.

REFERENCES

[1]. Bosanquet, C.H. and Pearson, J.L., "The spread of smoke and gases from chimneys", Trans. Faraday Soc., 32:1249, 1936

[2]. Fensterstock, J.C. et al., "Reduction of air pollution potential through environmental planning", JAPCA, Vol.21, No.7, 1971.

[3]. Barrat, Rod (2001). “Atmospheric Dispersion Modelling” (1st Ed.). Earth scan Publications. ISBN 1-85383-642-7.

[4]. Robert Macdonald,“Theory and objectives of air dispersion modelling”, MME 474A Wind Engineering December 2003.

[5]. HAZMAT Weather Station – Weather Pak, Coastal environmental systems,USA, February 2014

[6]. CAMEO®, NOAA’s National Ocean Service, Office of Response and Restoration, US Dept. of Commerce, September 2015.

[7]. ALOHA®, NOAA’s National Ocean Service, Office of Response and Restoration, US Dept. of Commerce, July 2015

[8]. MARPLOT®, NOAA’s National Ocean Service, Office of Response and Restoration, US Dept. of Commerce , November 2015.

[9]. SHAO Hui, DUAN Guoning,Risk quantitative calculation and ALOHA simulation on the leakage accident of natural gas power plant, 2012 International Symposium on Safety Science and Technology, Procedia Engineering 45 (2012) 352 – 359