HAZARD EVALUATION USING ALOHA TOOL IN STORAGE AREA OF AN OIL REFINERY

Praveen Patel[1], Nagendra Sohani[2]

[1]PhD Scholar, Mechanical Engineering Department, Suresh Gyan Vihar University, Rajasthan, India
[2]Associate Professor, Mechanical Engineering Department, IET, DAVV University, M.P., India

Abstract

During accident process equipment, storage area and associated accessories can release hazardous material very quickly and insignificant quantity to spread out in dangerous cloud throughout the plant site and local communities. Areal location of Hazardous Atmosphere (ALOHA) is a software design specially in responding to hazardous material releases. Aloha models assess key hazards such as toxicity, flammability, thermal radiation and explosion over pressure related to chemical releases in the event of either fire or explosion. This paper covers actual damage distances due to flammable liquids and gases of oil refinery stored in finished product section in different pressure vessels. Catastrophic rupture of the individual product has been described in imaging worst scenario and damage distances for heat loads has been calculated. The output of ALOHA Tool provide the worst case scenario consequences results on plant and nearby local community and summarizes the useful fact for onsite emergency plan of oil refinery.

Key Words: Heat Load distances, Hazard Evaluation, Impact Assessment, Onsite Emergency Plan.

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1. INTRODUCTION

A few examples are rapture of process vessel by runway reaction, rupture of pipeline containing hazardous material at high pressure and rupture of tank containing hazardous material stored above its boiling point. Toxic release and dispersion model are an important part of consequence modeling and three steps in consequence assessment are observed essential as given below:

1. Identifying the release incident
2. Developing the source model to describe how material is release and the rate of release.
3. Estimating the downwind concentration of the hazardous material for the impact assessment on hazardous characteristics such as flammability, toxicity and reactivity
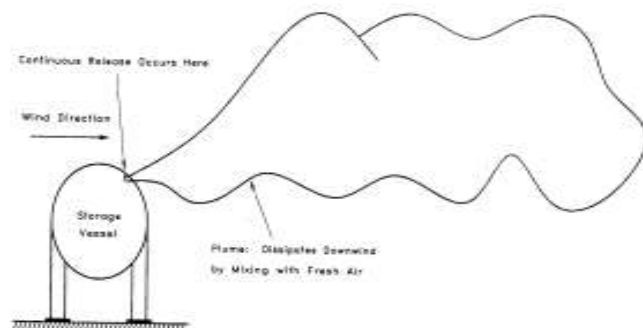
Figure 1.1 Characteristic plume formed by a continuous release of material
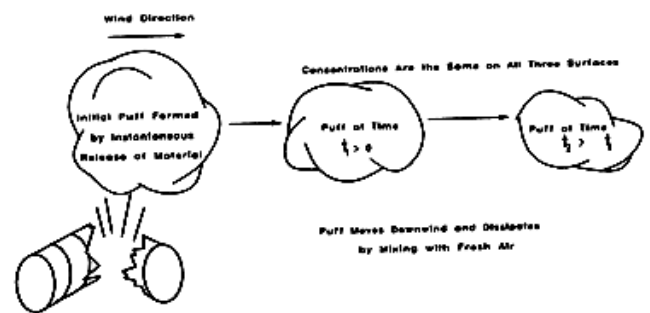
Figure 1.2 Puff formed by near instantaneous release of material.

2 HAZARDS EVALUATION MODEL

Areal location of Hazardous Atmosphere (ALOHA) is a software design specially in responding to hazardous material releases. Aloha models assess key hazards such as toxicity, flammability, thermal radiation and explosion over pressure related to chemical releases in the event of either fire or explosion. Aloha chemical library content information on physical and chemical properties of approximately 1000 common hazardous chemicals. Its computation represents a balance between accuracy and speed.

2.1 INPUT DATA FOR ALOHA MODEL

2.1.1 Describe the location and time
The following steps are needed to incorporate for describing time and place of the scenario:
1. Start aloha
2. Select location from the site menu data

3. If the plant is single stories surrounding mostly by open fields then select single stories building and unsheathes surrounding as shown in figure.
4. Select date and time from the site data menu as shown in figure below:

2.1.2 Hazardous Material Information:

As we built the scenario we need to specify the hazardous material that is being release. The simple steps for the selection of chemical is shown in figure 2.1
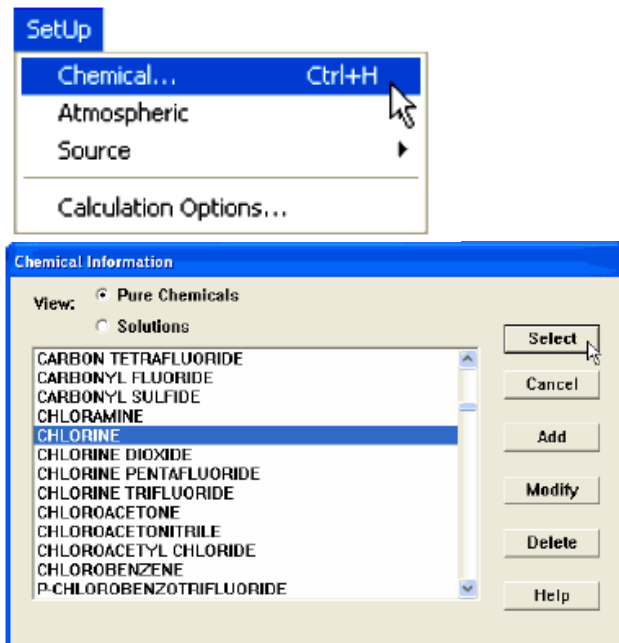

Figure 2.1 Menu bar for site data and Chemical Information.

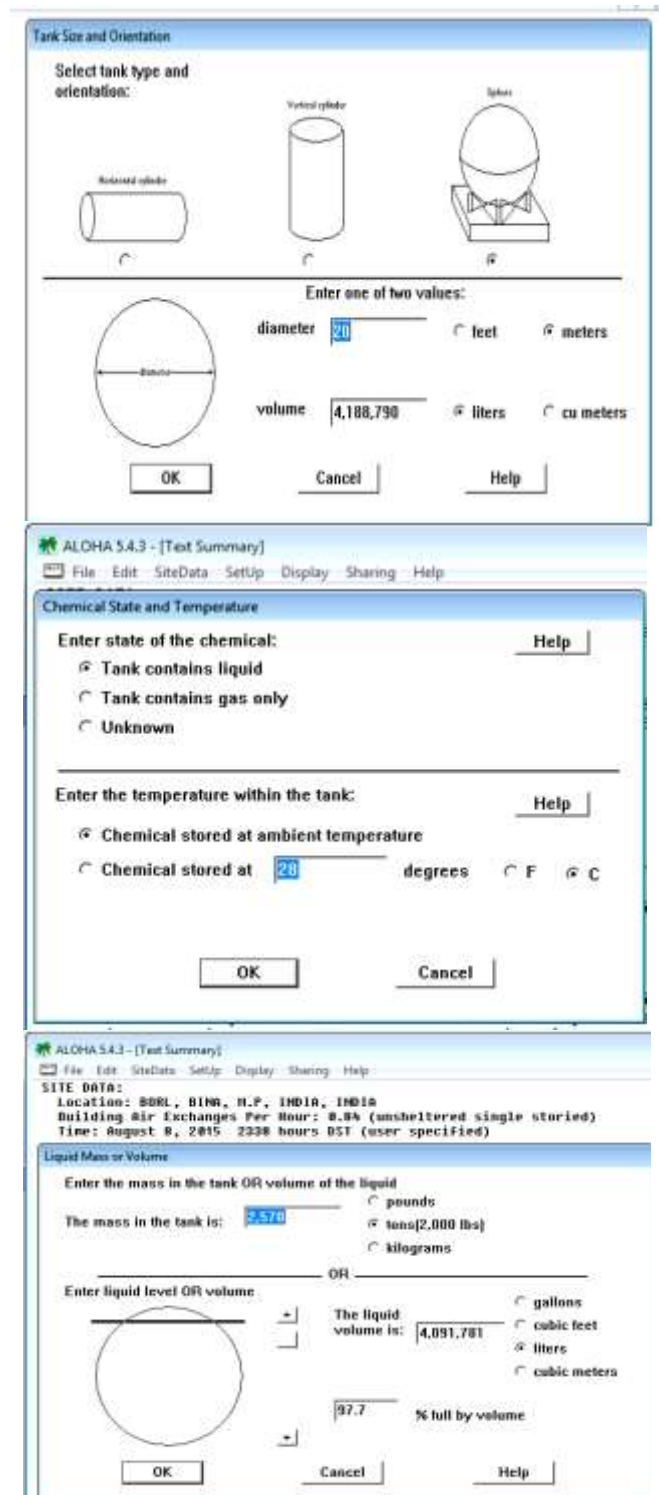**2.1.3 Describe weather information:**

We need to enter the weather information in aloha for accuracy in assessment. The following information one has to provide for weather consideration
1. Wind speed.
2. The exact ground roughness the measure of unevenness of the terrain over which hazardous material is passing.
3. Cloud cover: select cloud cover, partial cloudy or clear as dialog box.
4. Air Temperature: specify the air temperature in the air temperature block.
5. Based on above information on wind speed, cloud cover and Humidity aloha automatically select atmospheric stability class used in dispersion modeling.

2.1.4 Describing the release :

We need to set the source for specific scenario and the important information need to provide are given below:
1. If source is observed in storage tank a tank size and orientation dialogue box appears.
2. If hazardous material stored in horizontal tank or in a vertical tank or in a sphere the dimension need to provide in aloha as shown in figure 2.2
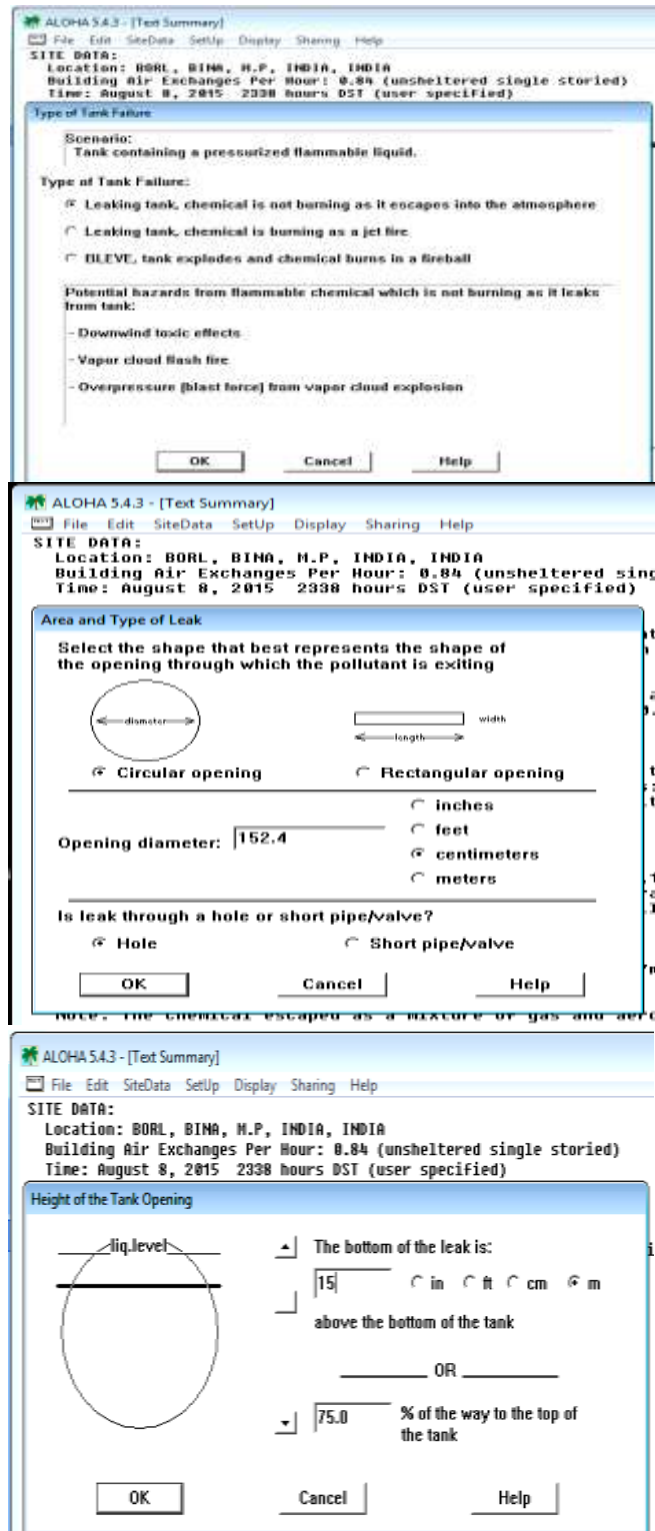
2.2 OUTPUT DATA OF THE ALOHA MODEL

2.2.1 Display menu: The display menu will provide the information on source strength for the particular scenario as shown in figure 2.3
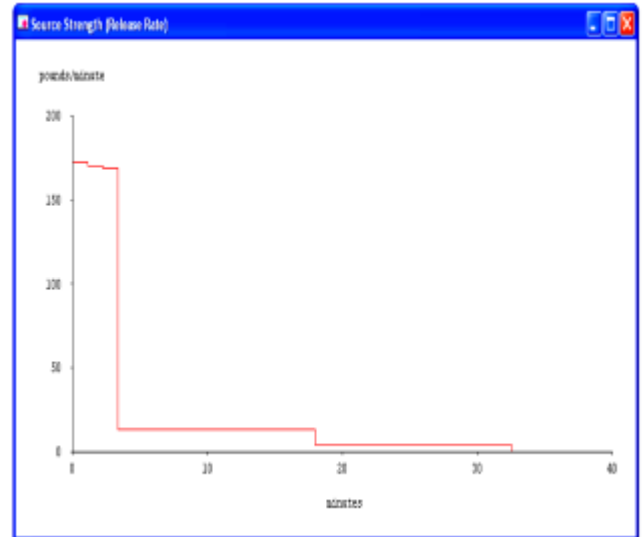

Figure 2.3 Menu bar for Source Strength (Release Rate)

2.2.2 Text summary: The text summary provides the text information on site data, chemical data, atmospheric data and source strength on a single click. The information use to estimate the threat zone of the plant site and local communities

Figure 2.4 Menu bar for Text Summary

2.2.3 Checking the Calculation and display Options settings

1. Select the calculation options from the calculation options as from setup menu.
2. Select the display option from the display menu and choose threat zone from display menu. Provide acute exposure guideline level (AEGL) for toxic level 1, level 2 and level 3 in toxic level of concern dialog box as shown in figure

Figure 2.2 Input information on sources strength of butane gas.

3. Hazardous chemical state and stored temperature need to provide in tank content liquid option.
4. The volume of the chemical need to specify in liquid
5. The area and type of leak need to provide in Aloha as shown in figure 2.2
6. The liquid level play an important role during release of hazardous material and shall be provide in height of the tank opening dialog box
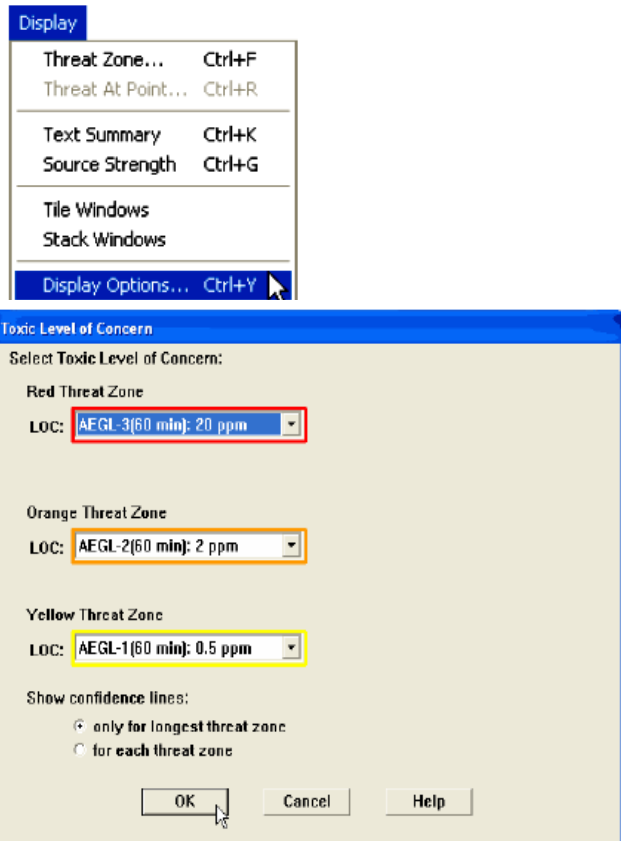
Figure 2.5 Menu bar for Display & Toxic Level of Concern.

3. In the show confidence line check only for the longest threat zone option and obtain toxic threat zone as shown in figure 2.6.
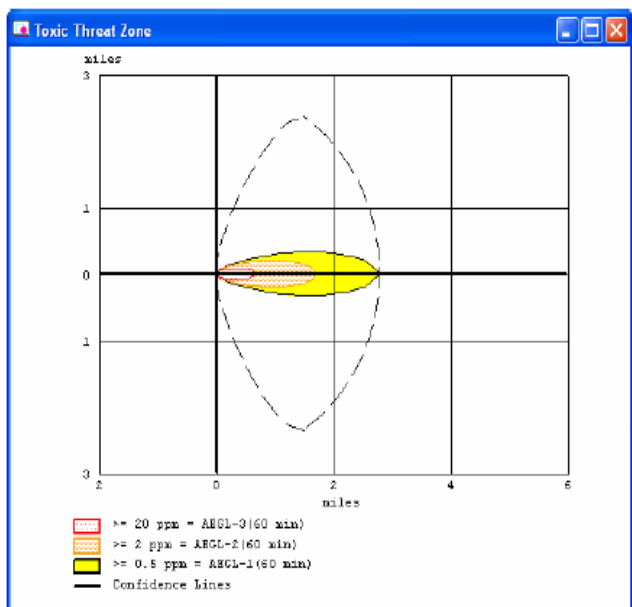

Figure 2.6 Menu bar for Toxic Threat Zone.

4. The red AEGL 3 threat zone observed greatest exposure level and the orange AEGL threat zone predicted medium exposure level. The yellow AEGL threat zone predicted low exposure level of the hazardous material.

2.2.4.Determine the threat levels at specific location :

The ALOHA software is useful to determine the hazardous material concentration at any location in local community form the source of release. The following steps need to incorporate in software.

1. Choose threat at point form the display menu.

2. Click relative coordinates to indicate the specific location in teams of its downwind and cross wind distance from the release point.

3.ALOHA then display the graph of predicted concentration at specific location during the hour after the release begin as shown in figure 2.7
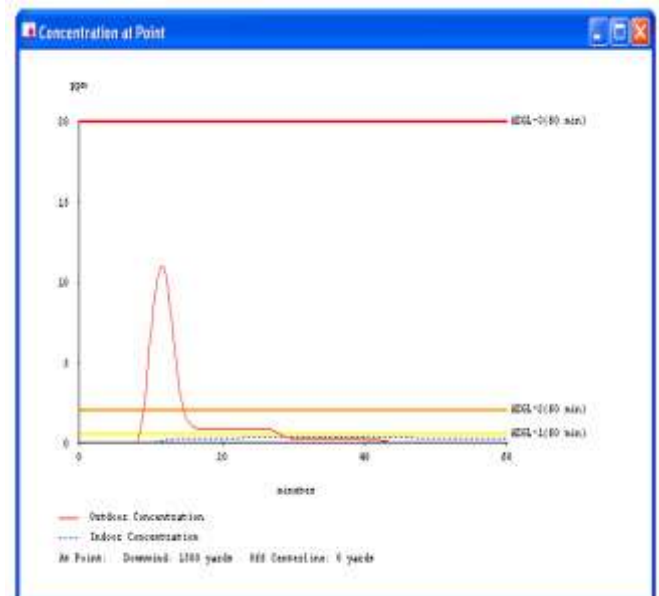

Figure 2.7 Menu bar for Concentration of Point

3. WORST SCENARIO DESCRIPTION

This section covers actual damage distances due to flammable liquids and gases of oil refinery stored in finished product section in different pressure vessels. Catastrophic rupture of the individual product has been described in imaging worst scenario and damage distances for heat loads has been calculated. The damage distances for heat load are divided into following four categories threat zone based on ALOHA software output.

1. Flammable gas dispersion LEL & UEL distances.
2. Radiation distances due to jet fire.
3. Radiation distances due to pool fire.
4. Blast wave pressure impact on plant and local community.

3.1 A storage tank containing naphtha having dimensions as 40meter in diameter and 14meter in height has been undergo a serious damage due to excessive pressure build up with in the tank. A rectangular rupture of dimensions 1.5 x 5.5 m2 at a height of 2meter from the ground level was observed due to malfunction of breather valve. The details on the input and output in ALOHA software performance and results has been summarized in section-4.
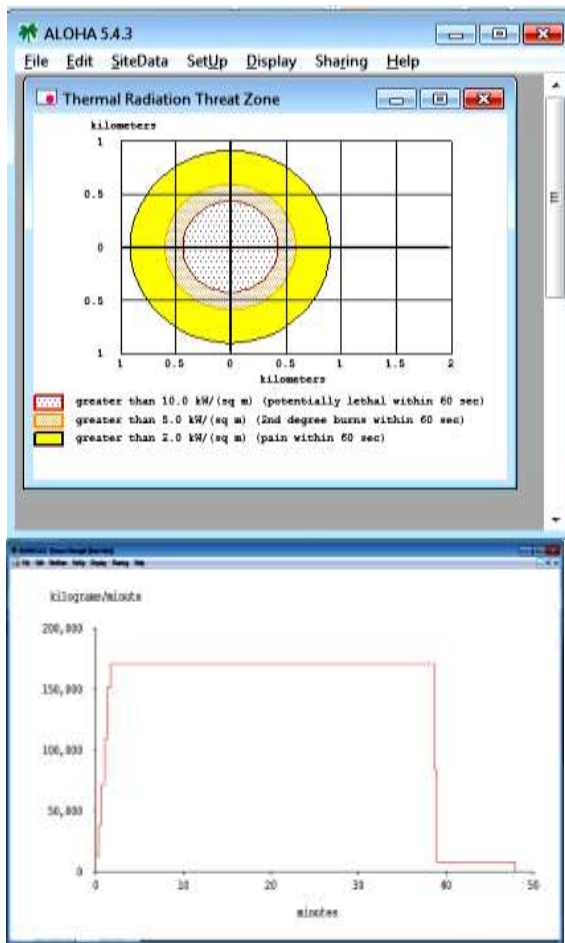
Figure 3.1 Thermal radiation threat zone & burning rate of naphtha tank as ALOHA tool output.
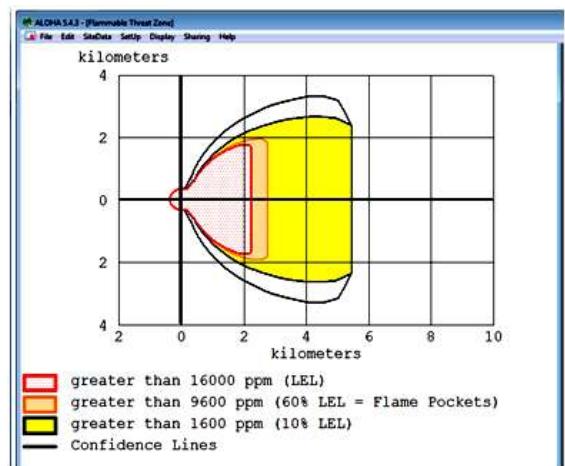
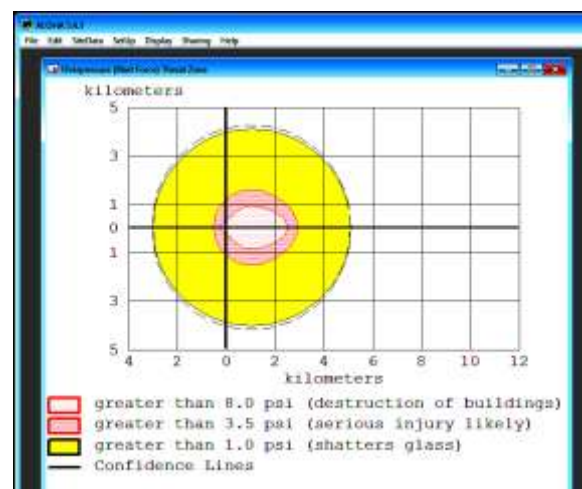3.2 A sphere containing Liquid Petroleum Gas (Butane) having dimensions as 20 meters in diameter has been undergo a serious leakage due to malfunction of drain valve at height of 15 meter above the bottom of the tank. A considerable amount of butane starts leaking from a circular opening of size 152.4 cm. diameters. A huge flammable vapor cloud of butane has been observed at storage area. The consequences parameter such as thermal radiation threat zone, pressure wave generation and vapor cloud area has been calculated with the help of ALOHA software.

Figure 3.2 Flammable threat zones of LPG sphere.

Figure 3.3 Over pressure threat zones of LPG sphere

3.3 A underground horizontal Cylindrical Tank containing propane having dimension 7x81 m2 observed a leak from hole at 3.0 meter from the bottom of tank. The detail on consequences and impact of hazard has been calculated with the help of ALHOA software. The leakage size in the form of rectangular opening 152 x 12.7 cm2 and propane gas escape in the form of jet fire from the leak.
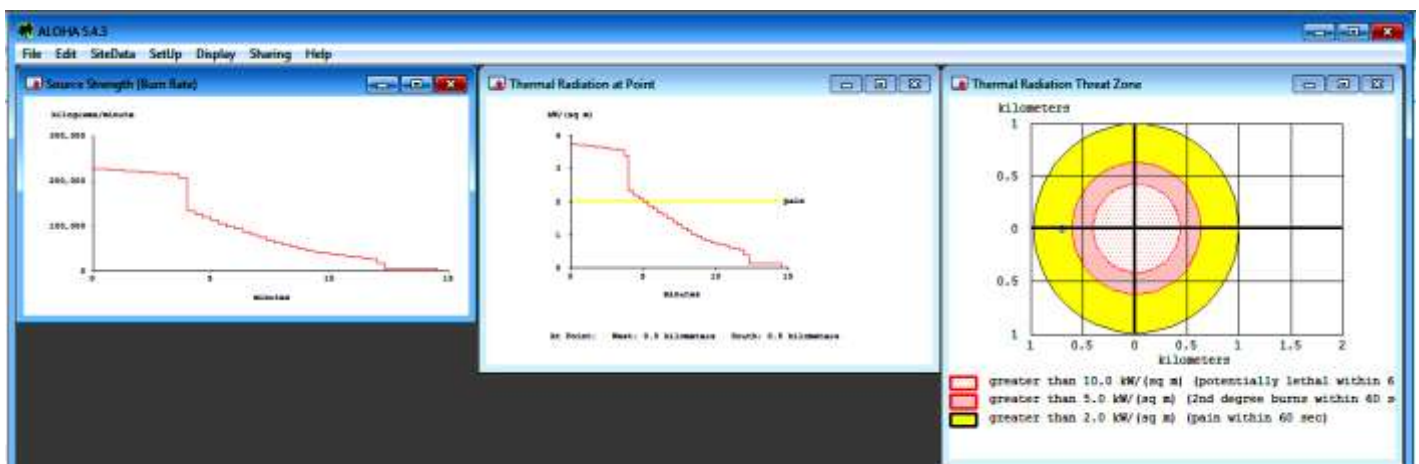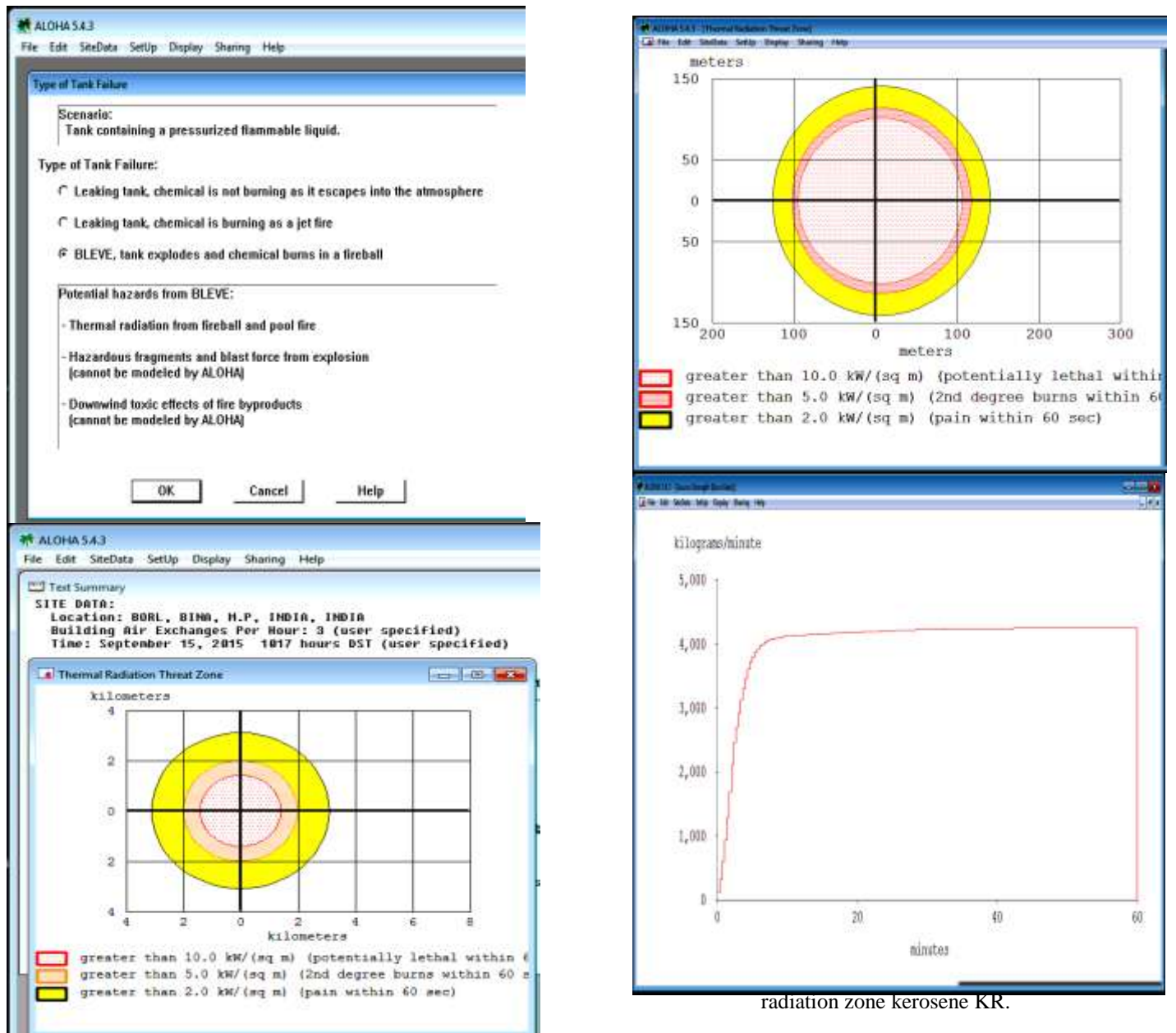

Figure 3.4 Tile windows for burning rate, thermal radiation zones and thermal radiation at specific location.

Figure 3.5 The radiation threat zone of propane BLEVE.

3.4 A vertical cylindrical tank having 4.2 meter diameter and 8.6 meter in height containing Kerosene KR flammable liquid get rupture with a rectangular opening having dimension 6x243 cm^2. The location of leak is observed 2 meter from the bottom of the tank. Tank containing unpressurized liquid and it burn and forms pool fire at the storage area. The detail on thermal radiation concern and zones are performed by ALOHA software.

radiation zone kerosene KR.

4. RESULT SUMMARY

This section covers the worst case scenario consequences results on plant and nearby local community and summarizes the useful fact for onsite emergency plan of oil refinery. The details on the same are given in Table no.4.1

Table 4.1 Result Summary of Hazard Evaluation

Scenario	Hazardous Material Involved	Leak size	Leak Location form the bottom of the tank	Type of Tank	Threat Modeled	Threat Zone		
						Red	Orange	Yellow
Unpressurized flammable liquid leaking from the tank	Naphtha 17593 m^3 (Petroleum)	152x548 cm^2 Rectangular	6 meter	Vertical Cylindrical tank	Flammability of pool fire	475 meter	625 meter	970 meter
Pressurized liquefied petroleum gas	Butane 4188 m^3	152.4 cm Circular	15 meter	Sphere	Thermal radiation of jet fire	2.3 km	2.8 km	5.5 km.
Pressurized liquefied petroleum gas	Butane 4188 m^3 4188790 lt.	152.4 cm Circular	15 meter	Sphere	Vapour cloud explosion overpressure by detonation	2.3 km	2.8 km	5.5 km.
Pressurized liquefied petroleum gas	Propane 3117245 lt.	152x12.7 cm^2 Rectangular	3 meter	Horizontal cylindrical tank	Flammability	1.4 km.	2.0 km.	3.1 km.
Pressurized liquefied petroleum gas	Propane 3117245 lt.	152x12.7 cm^2 Rectangular	3 meter	Horizontal cylindrical tank	BLEVE thermal radiation	1.4 km.	2.0 km.	3.1 km.
Unpressurized flammable liquid leaking from the tank	Kerosene KR	243x6 cm^2 Rectangular	2 meter	Vertical Cylindrical tank	Flammability of pool fire	106 meter	117 meter	142 meter

5. CONCLUSIONS

We provide the hazard associated with the hazardous material inventories at the storage area of oil refineries. The hazard evaluation done by the computerize tool ALOHA for easy, fast and accurate calculation of heat load distances in the worst scenarios. The worst case scenario are define based on J.M.Tseng et al. (2012) and prepare the suitable configuration of the release of flammable material from the source. The atmospheric condition and stability classes are taken based on pasquill Gifford dispersion model of hazardous substances in to the atmosphere. The threat zones flammability concern of hazardous substances are based pool and jet fire occurrences in the storage area however the over pressure blast force zones of concern are calculated based on vapour cloud explosion by the detonation at the site of storage. The ALOHA simulation graph of heat flux and over pressure concern are prepared with consideration of wind speed, atmospheric stability level and relative humidity for actual dispersion of hazardous substance.

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