Help on Advanced QRA-Modules:

Watch Demo on YouTube

1. Dispersion https://youtu.be/Ov56DCsqXkI
2. Explosion https://youtu.be/bj-hrYyh1Mo
3. Fire https://youtu.be/13O1J7PFnBY
4. Risk Assessment https://youtu.be/NVswC5uKp10

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1. Introduction: Risk comes from French word *rischiare* meaning run into danger i.e. **chance or possibility** of danger and of exposure to **damage consequence.** So Risk has two parameters:

i. **The Chance, Probability, Frequency or Likely hood** of the occurrence of an accident.
ii. **The Damage consequences to life and property**

HAMS-GPS short for **"Hazard management Systems and General Programs in Safety"**, EHS-Software provides comprehensive Solutions in all areas of EHS (Environment, Health and Safety). HAMS-GPS has 2-Sets of Software Modules as under:

i. **Advanced EHS-Modules,**
ii. **Standard EHS-Modules.**

1.1 Sources of Mathematical Models used in HAMS-GPS Software Packages:

i. "World Bank Technical Paper-55, Techniques for Assessing Industrial Hazards"
ii. "Chemical Process Quantitative Risk Analysis", American Institute of Chemical Engineers, Centre for Chemical Process Safety.
iii. "Manual of Emergency Preparedness for Chemical Hazards", MOEF.
iv. "Chemical Process Safety Fundamentals with Applications". By Daniel A. Crowl & Joseph F. Louvar
v. "Process Safety Analysis-An introduction, by Bob Skeleton.
vi. Major Industrial Hazards. By John Withers.
vii. Process Safety Fundamentals. By Frank P. Lees.
viii. Guide lines for Process Equipment Reliability data with data Tables. By American institute of chemical engineers.
ix. Specific rules, regulations and guidelines on Seismic studies and oil/gas exploration.
x. International Standards/codes of practices of on storage and handling of relevant Petroleum Products and other bulk hazardous chemicals involved that have potential for major hazard scenario development.
xi. Meteorological data for the specific site is obtained from Internet.

1.2 Comparison between Advanced and Standard Software Packages:

Advantage No.	Advantages of HAMS-GPS Software Package	Standard HAMS-GPS Software Package
1.	Advanced Package is a single module taking you from Input Data to Final QRA-Results without any data transfer!	The standard package that has several modules requiring Manual data transfer from one module to another.
2.	Advanced Package is extremely user friendly and does not need advanced knowledge of QRA	The Standard Package requires advanced knowledge of HSE and QRA.
3.	The Advanced Package enables in a single stretch of button clicks all simulations from Chemical Storages and Properties through Scenario Development, SMOD, Scenario Simulations for all types of Dispersions, Fires, Explosions leading to Risk Assessment results including FAR, FN-Relation, ISO-Risk and ALARP in one go.	The standard module requires multiple manual data entry and multiple simulations for each module separately, resulting in lot of Manual Unit conversion of Data from one Simulation in to a different Unit for another Module and so on.
4.	The Advanced Package Enables scale plotting of all Graphic outputs on Auto Cad Files, on Graphic Files and also on Blank sheets as per user defined scale and Wind orientation.	The standard package does not have this scale plotting facility. It gives fixed scale graphs in vertical position only, with no reference to wind direction
5.	The Advanced Package under Risk Assessment option includes built in computation of Risk based Investigation (RBI) Matrix.	RBI-matrix is available in Standard package only as a separate module and has toi be run after manual data entry by taking the data from other simulations only.
6.	The Advanced Package ALARP diagram has Scale adjustment facility so you can see each scenario distinctly from other closely positioned scenarios, a facility unique for any ALAP Software available.	The Standard ALARP Module gives a fixed scale ALARP and closely falling scenarios all get overlapped making difficult to read.
7	The Advanced Package is specially designed for Commercial EHS-management.	The Standard Package is specially designed for EHS-Research work

2. HAMS-GPS have also Advanced EHS-Training Modules in the following Formats:

i. **EHS-E-Reading Books available on our Website and Demo Modules containing first 16-Slides ids free to down load. The Full E-Reading is Licensed per Month,**
ii. **EHS-Audiovisual Modules available on CD/DVD provide comprehensive research based Training,**
iii. **We also provide SKYPE based Internet EHS-Training on a wide ranging Topics,**

iv. We also Custom Build EHS-Training Modules in select languages and on Topics Specific to your Industry.

3. Stepwise Details of HAMS-GPS Advanced EHS-Software Package:

Risk Assessment involves determination of the two Risk parameters namely:

i. **Risk-Frequency of Occurrence,**
ii. **Damage Consequences to Life and Property.**

Quantitative Risk Assessment (QRA) involves Quantification of these two Risk parameters of Chance and Severity of damage consequence. In other words, **QRA is Pre-creating potential Maximum Credible Scenarios (MCLS) also Called Maximum Credible Accident Scenario (MCAS) from a given facility. "Maximum Credible" refers to the Worst Scenario from one facility failure like main Pipeline, Storage, Reactor etc.**

4. Installation of HAMS-GPS Software: Both Advanced and Standard Modules are Run from a Single Main Menu Drive and therefore installation Is common for both standard Package and Advanced Package. (See HAMS-GPS EHS-Software installation procedure). On successful installation The Red **"HAMS-GPS EHS-Software"** Icon as shown appears on the Desk Top:

Note: Tool Tips are available for many Dialog items and try to hold curser on the Icon at right and see ToolTip popping. There are several ToolTips on Buttons, Text Boxes, List Boxes etc. Always try to hold Curser at places for ToolTip help.

Main Menu: Both Software Packages are Run from the same Main Menu. To open the Main Menu, Click on this HAMS-GPS Icon. You will find a Welcome display follow by the Main Menu Drive as under:

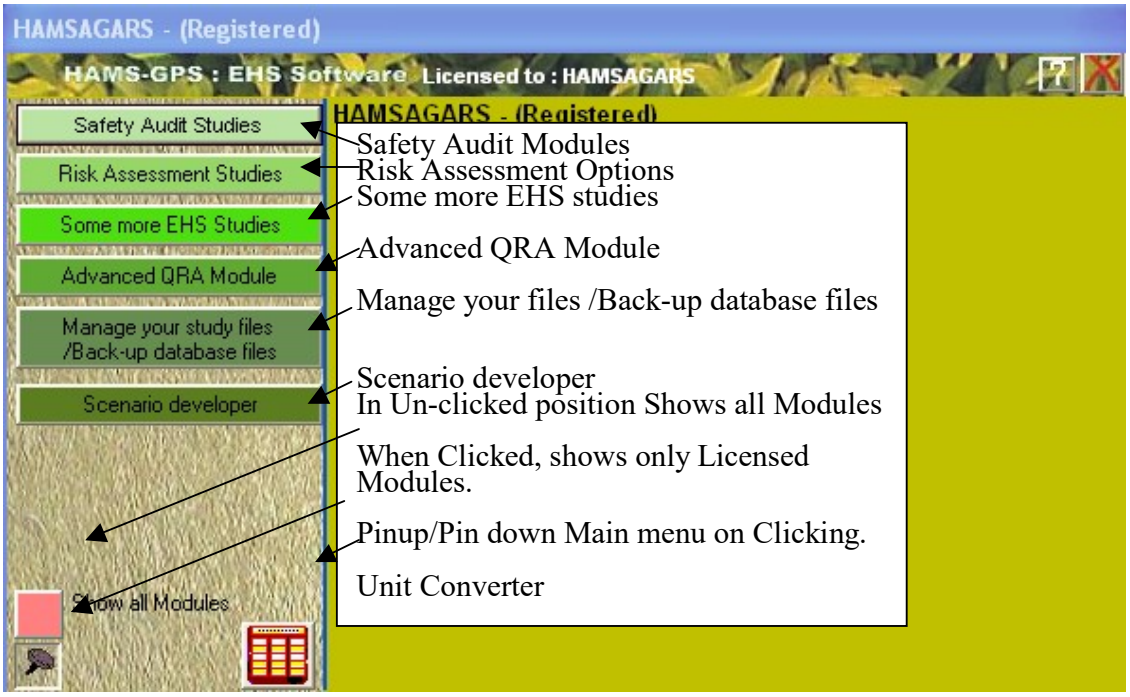


Fig-1: HAMS-GPS Main Menu Drive with curser pointing to [Risk Assessment Studies] option (Curser Position on each option changes its colour from Green to Yellow. Arrows against Text in white Text Box show various options available.

The Main menu drive contains several List Box buttons that open in to list of options available in each button. These and other options available are depicted in the above diagram of Main menu drive with bolder fonts and arrow marks for easy understanding. You can click on each option List Box button and see the dropdown list showing options available in each List Box. Each time you click an option button, the [Home] button which when clicked, the opened List box closes and full Main menu drive displayed again as Home state of Main menu drive.

5. Repair HAMS-GPS Module:

Note: In case Main Menu does not open, it may be Blocked for some reason. Nothing to Worry! In that case, you need to Repair the Software by opening Start Button->Click on All Programs->Open directory on [Hams-Gps Safety Software]-> You will find [Hamsrepair] icon. Double click you will get Repair dialog as shown below. Click on the [Please click to repair HAMS-GPS Module] button. The Module gets repaired and the Main menu gats opened!

6. Creating data base of chemicals for physical, chemical properties and storage conditions:

Before you start Risk Assessment study, you need your storage conditions and their chemical and physical and toxicity, flammability properties stored in the database and develop scenarios for Risk Assessment.

For this purpose you click on the Scenario developer List Box button and you will find the following view of Database management and Scenario developer:

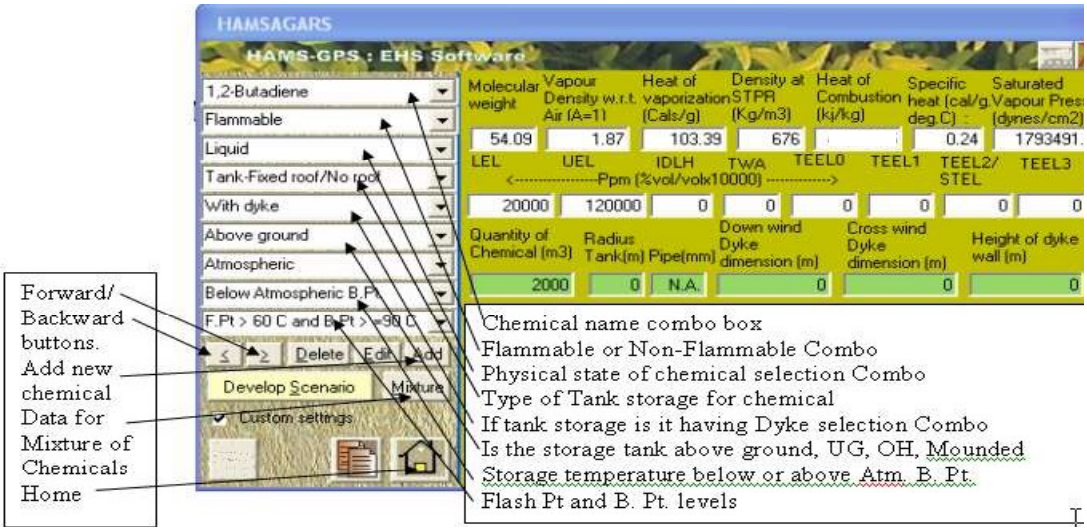


Fig-2: Scenario developer and Chemical Database Management view.

Tool Tips are available for all controls, which are visible on holding the curser on the required control.

Carefully study these options.

6.1 Large Number of Chemical data is Preset:

If you open first combo on Chemical Name, you will find series of chemicals. You can type first alphabet of the chemical you want, the combo list position moves to chemicals beginning with that alphabet. This helps in rapid selection and also to check whether your chemical is available.

Open each List box one by one and see the options for selection in each List Box. All common Chemical and Physical data are entered and checked by the user. You need to enter only Specific Data on Storage of Chemical like Dyke Dimensions etc. and you can run the Module.

7. Adding New Chemical: To add a new chemical click on the [Add] button when a blank form appears as below:

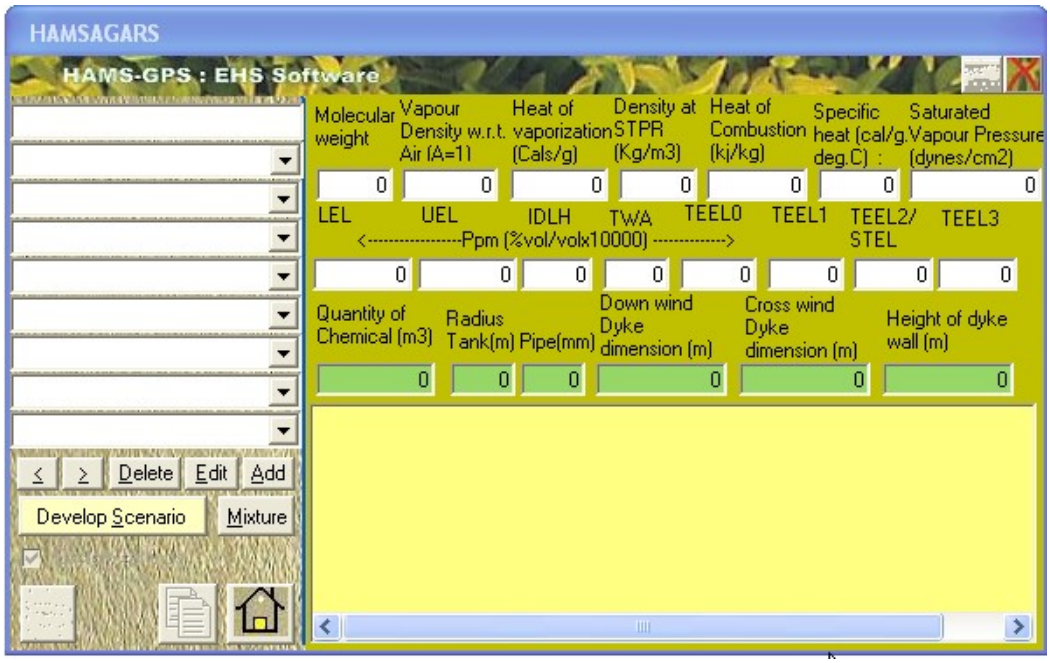


Fig-3: Menu for adding a new chemical.

Click on the first Combo box and write the Name of new chemical you wish to add to the Chemical database with a suffix if same chemical already exists. Then open each combo one by one from top to bottom and select property as appropriate for your new chemical stored at your unit.

After finishing all the combo boxes, go to property text boxes on the RHS of the Combo Boxes and fill up each property for your new chemical. Note there are 3-Rows of Text Boxes for your chemical data entry. The first 2-Rows are in white colour and require only standard data on Physical and Chemical properties of your chemical. The 3rd Row of Text Boxes in Green Colour, require specific data on Storage of the Chemical. These may be entered keeping note of the Units mentioned for each data.

Here Note: TEEL means Temporary Emergency Exposure Limits in ppm. You will find these for your chemical from web site. **TEEL0 is Safe level, TEEL1 is mild action, TEEL2 is no irreversible effect and TEEL3 is life threatening and irreversible health effect.**

Appendix-1 gives TEEL Values of some common chemicals.

7.1 Data Entry for Mixtures of Chemicals: Many times you have Mixtures of Chemicals and data for these are not available. There is a **[Mixture]** Button right of **[Develop Scenario]** Button. Click this and you get a Dialog Box as under:

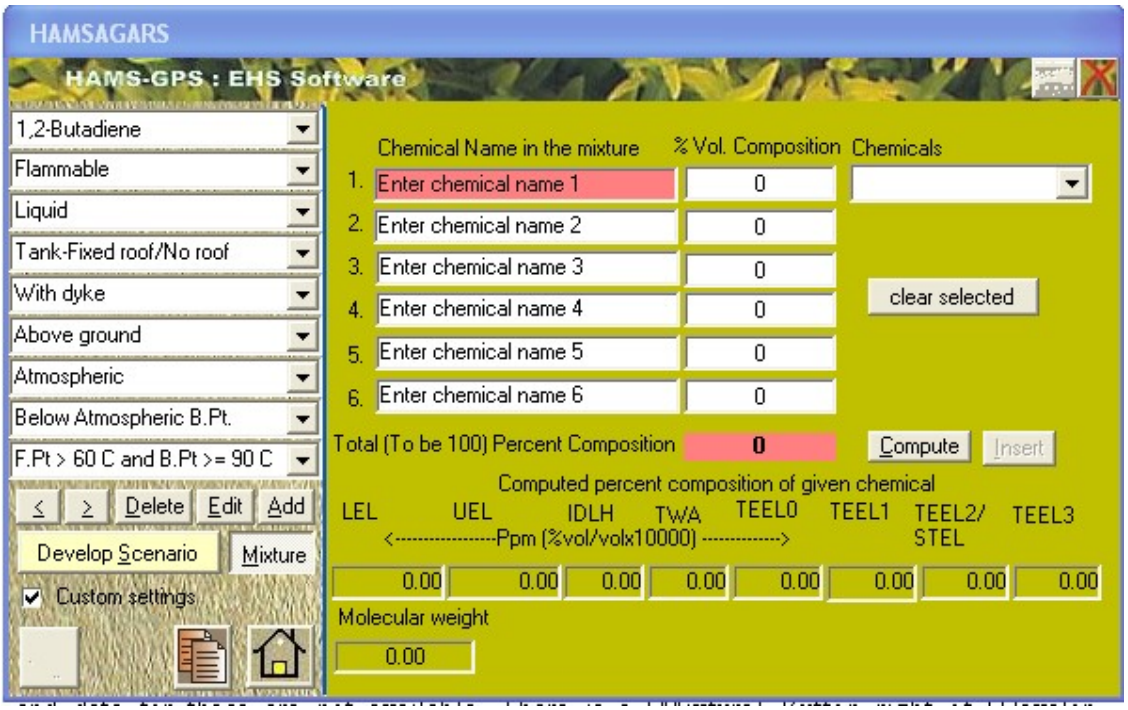


Fig.-3.1: Generating Chemi8cal data for Mixtures of Chemicals.

This Dialog Box allows for up to a Maximum of 6-Chemicals in a Mixture. You have to Open the Combo Box on RH-Top Corner where you will fine several Chemicals and Select the First Chemical if available in the List and Chemical Name and or for Chemicals not available in the Combo Box, manually Enter Chemical Name and %-Volume in the Mixture and Mol. Wt. Repeat for all the chemicals in the Mixture and the total % by Volume must be exactly 100. Then click **[Compute]** Button and you get all the required Chemical Data. Then Press **[Insert]** Button which gets activated and the data for the Mixture gets entered in the corresponding Edit Boxes of Chemical Data.

The Blue Text boxes are specific Storage conditions for a specific storage for your QRA study.

If you select an existing chemical from data base, then you will have to enter the Blue Text boxes for specific storage conditions which are not put for most chemicals as these differ from case to case.

8. Edit Existing Chemical Data: To Edit any existing Chemical data, Click on **[Edit]** Button when all Name and next 2-Combo Box Data remains and the rest become Blank. **To start Editing, you must reselect Chemical Name from the first top Combo Box. Then only the Editing process can start.** Then open other Combo Boxes and select appropriate item from each Combo Box.

9. Creating Scenarios:

Once you have selected a chemical or created data for a new chemical then you click on the [Scenario Developer] button when the scenarios you need to simulate for your QRA study get displayed in the Yellow box as shown below:

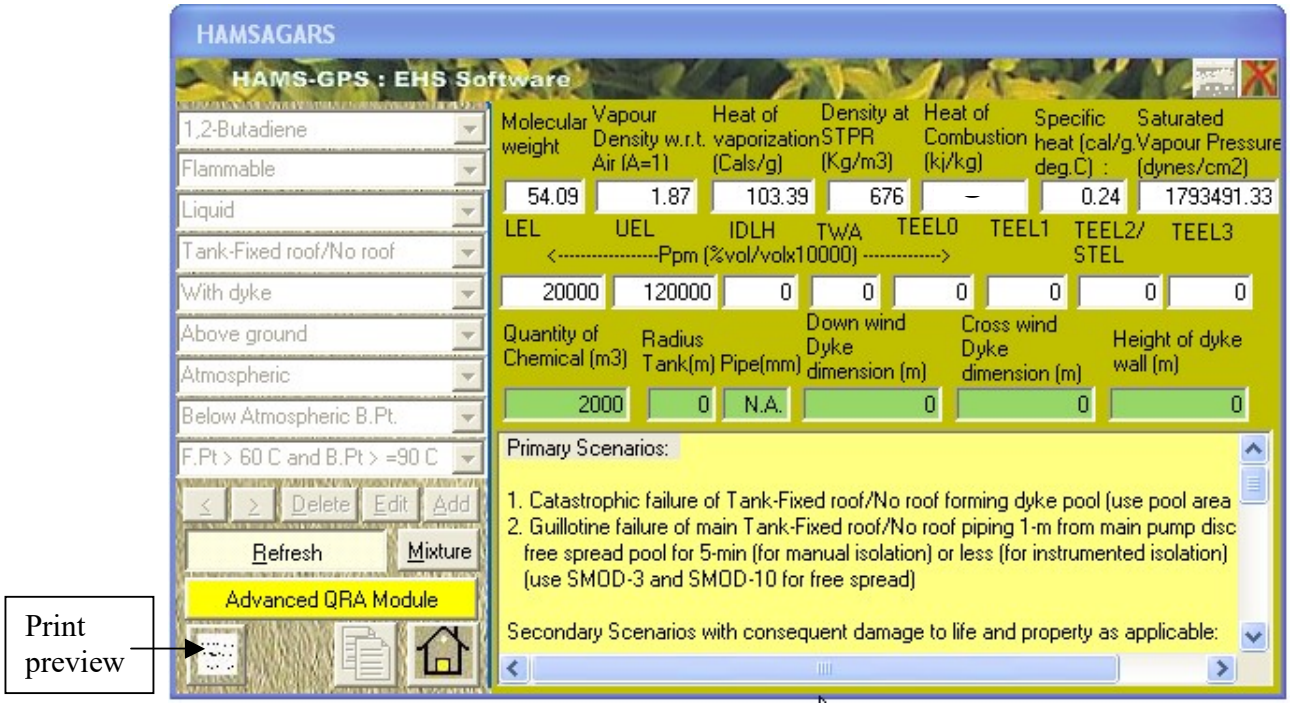


Fig-4: Scenarios for QRA study for your selected Chemical.

To see the Print Preview click on the **[Print Preview]** button when the Scenarios may be seen in full page and also get printed as shown below:

9.1 Displaying Scenarios Developed:

HAMS-GPS : Scenario Developer

Licensed to : HAMSAGARS

Date : Sunday, August 22, 2010

Data entered

Name of Chemical : 1,2-Butadiene

Nature of Chemical : Flammable

Physical state of Chemical : Liquid

Equipment handling chemical : Tank-Fixed roof/No roof

Dyke option : With dyke

Location of equipment : Above ground

Working pressure : Atmospheric

Working temperature : Below Atmospheric B.Pt.

Boiling point and Flash point : F.Pt > 60 C and B.Pt > =90 C

Primary Scenarios:

1. Catastrophic failure of Tank-Fixed roof/No roof forming dyke pool (use pool area module)
2. Guillotine failure of main Tank-Fixed roof/No roof piping 1-m from main pump discharge forming free spread pool for 5-min (for manual isolation) or less (for instrumented isolation) (use SMOD-3 and SMOD-10 for free spread)

Secondary Scenarios with consequent damage to life and property as applicable:

1. Tank-Fixed roof/No roof dyke Pool evaporation dispersion under D&F stability (Smod-7 and dispersion modules)
2. Main Pipe leak free spread Pool evaporation dispersion under D&F stability (Smod-7 and Dispersion modules)
3. Tank-Fixed roof/No roof dyke pool fire (Fire module)
4. Main Pipe leak free spread Pool fire (Fire module)
5. Main Pipe leak Jet fire (Fire module)
6. Tank-Fixed roof/No roof catastrophic failure liquid dyke Pool evaporation delayed edge ignition leading to Flashfire scenario (Use Explosion module)
7. Tank-Fixed roof/No roof catastrophic failure liquid dyke Pool evaporation delayed internal ignition leading to Explosion scenario (Use Explosion module)
8. Tank-Fixed roof/No roof engulfed by fire resulting in overpressurization and tanker bursting causing BLEVE

Frequency of Primary Scenarios:

1. For Scenario-1 on Tank-Fixed roof/No roof rupture use Frequency-Magnitude module
2. For Scenario-2 use Pipeline failure frequency module

Frequency of Secondary Scenarios:

1. For Scenario-1 use frequency of Tank-Fixed roof/No roof rupture as done above
2. For Scenario-2 Pipeline failure frequency
3. For Scenario-3, 4 and 5 use Event Tree using Pipeline failure frequency and chances of ignition

Note: Above scenarios for 100% failure provide only MCLS/MCAS for QRA study.
However As per "World Bank techincal paper - 55" Credible scenarios also require 20% failure for Hazard study.

To close the Scenario developer, Clock on [Home] icon.

10. Opening Advanced QRA Module:

After returning to Main Menu by Clicking on [Home] icon, Click on the [Risk Assessment Studies] List Box button to open options there under as shown below. **Note:** More options for Risk Assessment are available on the next Option Button titled **[Other interrelated Study]:**

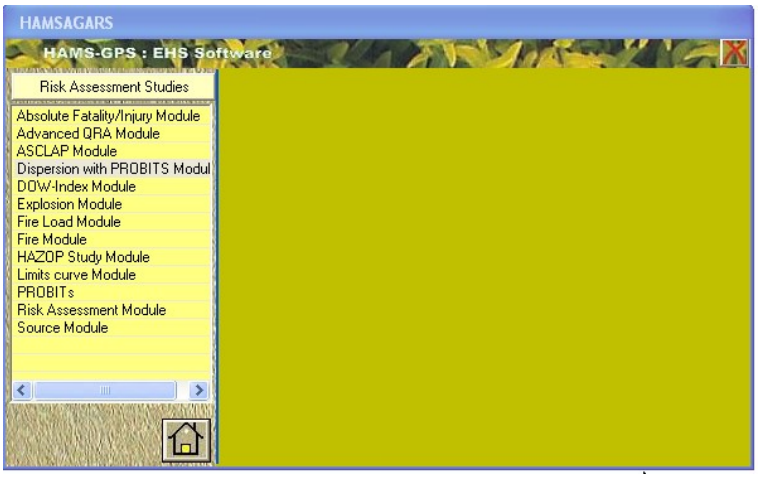


Fig-5: HAMS-GPS Main Menu Drive with [Risk Assessment Studies] option open.

To go back to main menu simply click on the **[Home]** icon:

To start QRA-Study, click on [Advanced QRA-Module] option from list box of [Risk Assessment Studies], when the following "Select Organization" Dialog appears:

Fig-6: Select Organization Dialog box

You can either select an existing organization or create a new organization. For first time use, a MyCo and Test Organizations are provided.
To create a new organization click on [New Orgn.] button or press [Alt][N] and Enter name of Organization under text box "Name of Organization" then Click in the Organization List box blank area. **(This is very Important to complete creation of new organization. By mistake do not click again on [Add New Organization] button. If you do so there will be problem and you will have to exit.)** The name of new organization disappears from **"Name of**

Organization" text box and appears in the name of **"Organization List box"**. Now you should select the organization from List box and the name of Organization selected appears in the **"Name of Organization"** text box.

Select MyCo and the MyCo appears in the **"Name of Organization"** Text box. Then click on **[Open QRA]** Button or click **[Alt][O]** when the following **"Quantitative Risk Assessment"** dialog box appears as shown below:

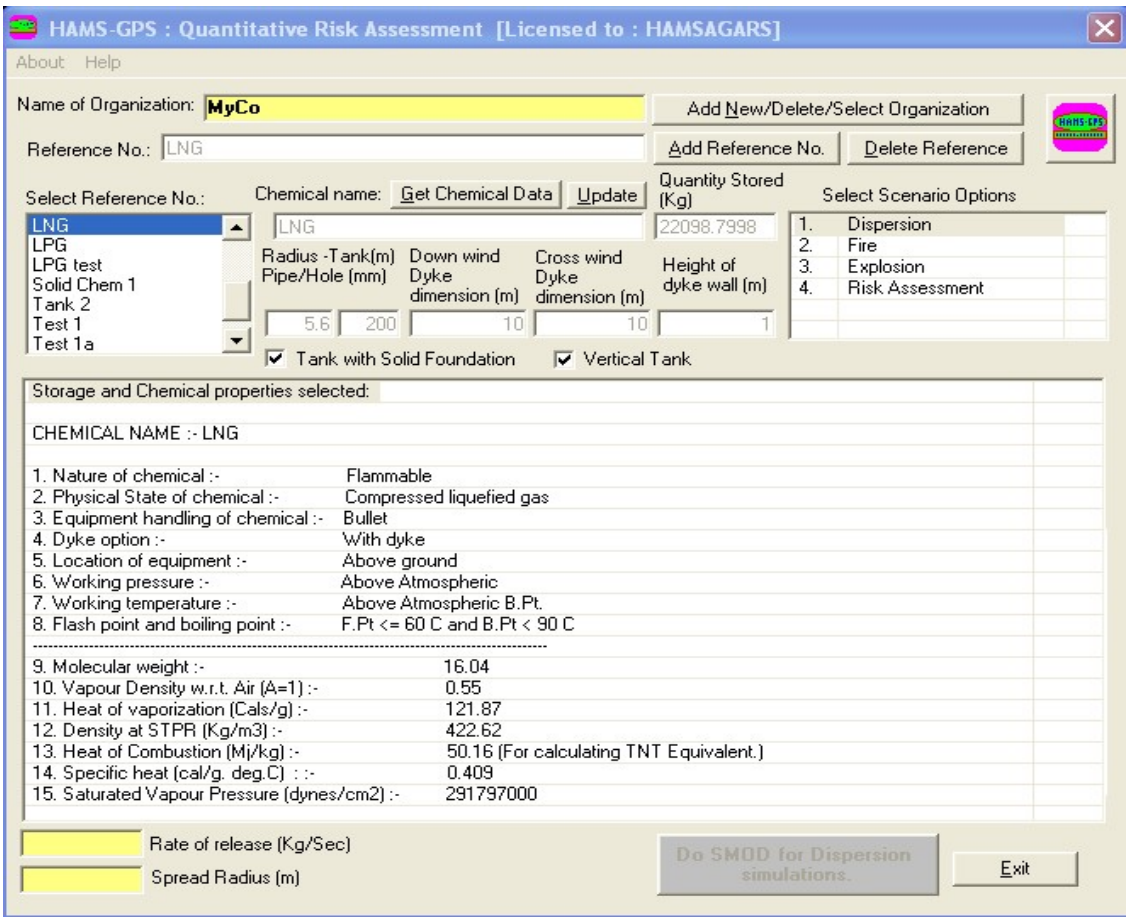


Fig-7: Risk Assessment Simulation dialog with Reference NLG Tank added.

You will find few Chemicals already added in the **"Select Reference No.:"** box. You can just click on any of these chemicals and the chemical name appears in the Reference No. Text Box along with all data from the Chemical Database of **[Scenario Developer]** option on the Main Menu.

11. Adding new Chemical to the "Select Reference No.:" box: Click **[Add Reference No.]** button when focus moves to **"Reference No"** Text box. Type Reference No. in the Reference No. Text Box. The Reference No. should be normally the name of the Chemical for QRA study. If there are different capacity

storage facilities, Chemical name may be suffixed by a word to identify the storage of the Chemical. So you can have as many References for one chemical for the QRA-Project. After Entering the Chemical name with identifying suffix, click inside the **"Select Reference No."** Box **(IMP: Click in empty space of the Box and not on any listed Item).**

12. Getting Chemical Data: To get storage data of the Chemical in the Text Boxes, click on **[Get Chemical data]** button. **"Select Chemical"** Dialog Box appears with **"Select Chemical Name"** Combo Box as shown below:

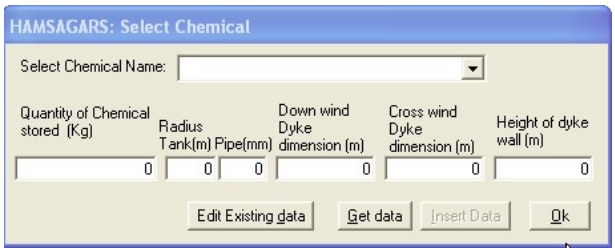


Fig-8: Select Chemical dialog box.

Select your Chemical from the Combo Box (Type first Alphabet of your Chemical to go to the Chemicals starting with the Alphabet) and then search further by curser down operation, your Chemical and Click. The Chemical Storage data appears in the Text Boxes below. Click on [Insert Data] button and the data for the selected chemical gets inserted in the QRA Dialog Box. Then Click **[Exit]** button on the **"Select Chemical"** Dialog Box to close this Dialog Box.

There can be number of references in the "Select Reference No." List box as you go on creating Reference No. of new QRA Projects.

There are hundreds of Chemical data some with storage conditions. For any new chemical or Mixtures of chemicals, not in the database, you have to go to Main Menu and add new chemical and its properties and storage conditions as described earlier above. To go back to "Select Organization" dialog box, click on [Add new/Delete/Select Organization] button on Top of "Risk Assessment Simulation" Dialog.

Here LNG is selected as an example that has data regarding storage, from **"Select Chemical Name"** Combo box. After selecting, click **[Get data]** button. Or click **[Alt][G].** The following data gets displayed in the [Select chemical] dialog box as shown under. If the Program is already run once you will get the Chemical name and Storage data at once on clicking the Chemical in the **"Select Reference No.:"** box as shown in the following dialog box:

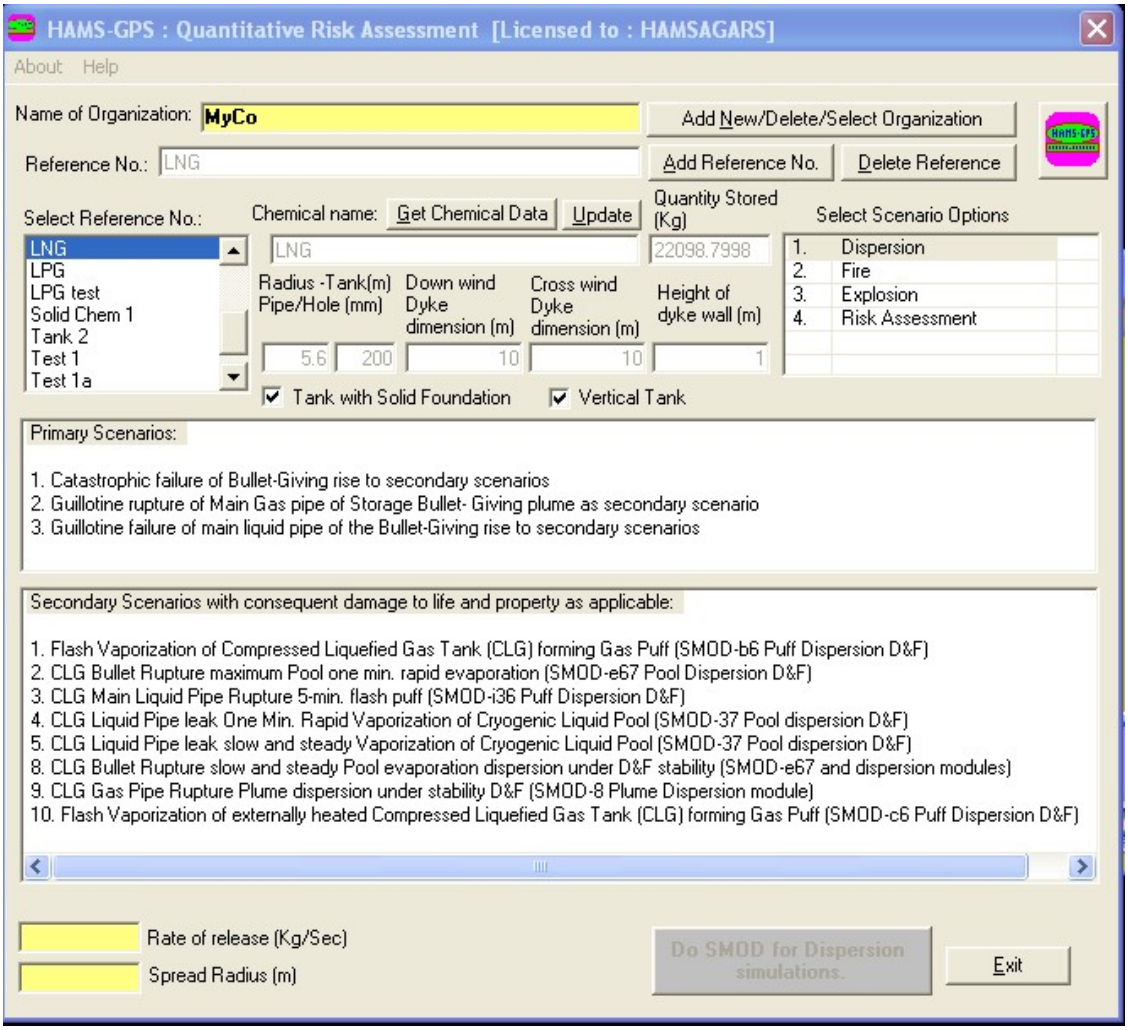


Fig-: 8A: Select Chemical Dialog box with chemical selected.

13. Source Modeling for Dispersion Simulation: Now click**: "Dispersion"** under **"Select Scenario Options"** Box. The Primary and Secondary scenarios for Dispersion get displayed. By Clicking other Scenario Options, the Primary and Secondary Scenarios for these get displayed. **Note: The Primary Scenarios are only for Information and should not be clicked.** Study the different Secondary Scenarios and Select any one Scenario for Source Modeling (SMOD).

13.1 Selecting Secondary Scenarios and start Do SMOD for Dispersion:

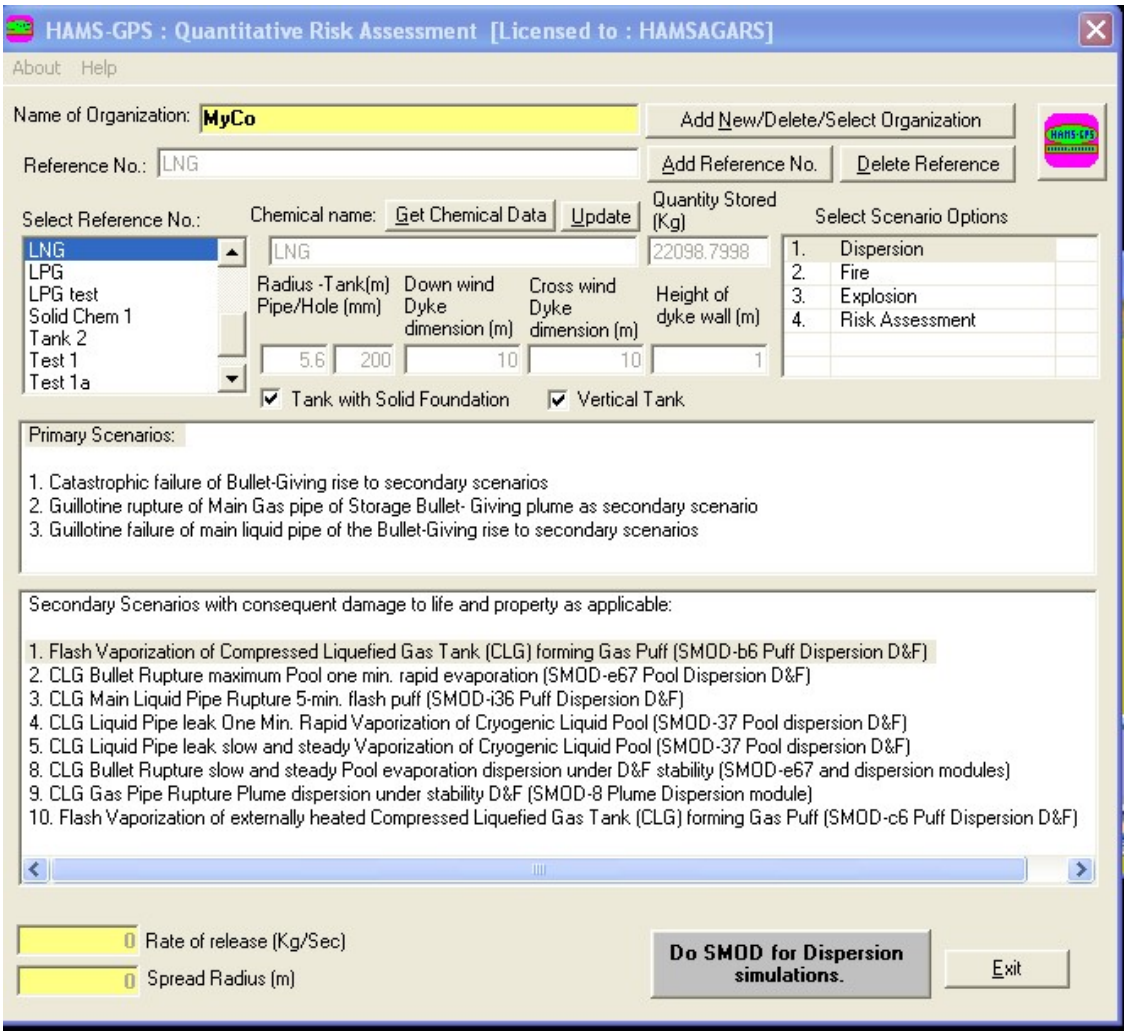


Fig-: 8B: On selecting Secondary scenario, the [Do SMOD] for Dispersion simulation] button gets enabled.

SMOD is quantification of Primary scenario. Now select the first secondary scenario for Flash Vaporization of LNG forming Gas Cloud for Puff dispersion. You will find the **[Do SMOD for dispersion simulation]** button at the LHS bottom gets enabled. Click this button. **"Some more Data Required"** Dialog opens.

13.2 Selecting Some more Data required:

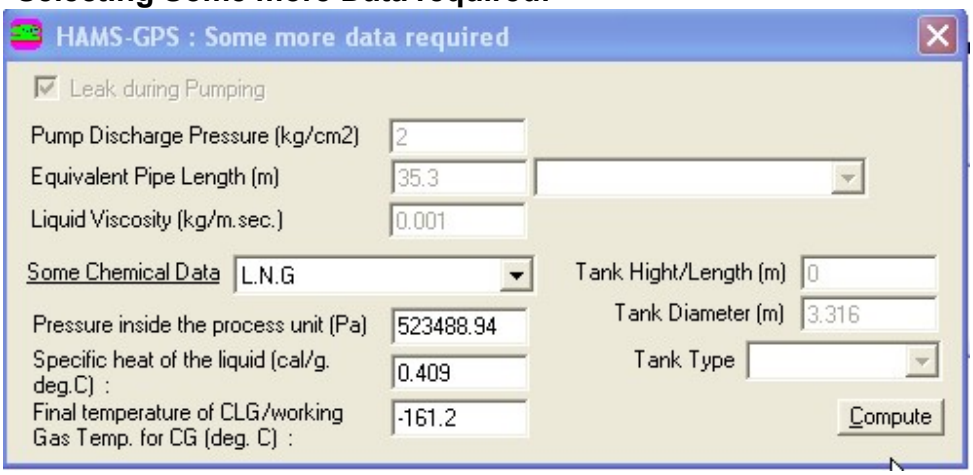


Fig-9: "Some more data required" dialog box.

In this Dialog Box, there is **"Some Chemical Data"** Combo Box select LNG. Other required data is already taken by the software. If the required Chemical is not in the **"Some Chemical Data"** Combo Box, you will have to manually enter all the required data of the Chemical that is neither displayed nor can be found in the **"Some Chemical Data"** Combo Box. Click **[Compute]** Button on the **"Some more data required"** Dialog Box. The dialog Closes. Now the **[Do SMOD for Dispersion simulation]** Button has changed to **[Start Dispersion simulations / Redo SMOD]** button and Click on this renamed Button.

13.3 SMOD Results:

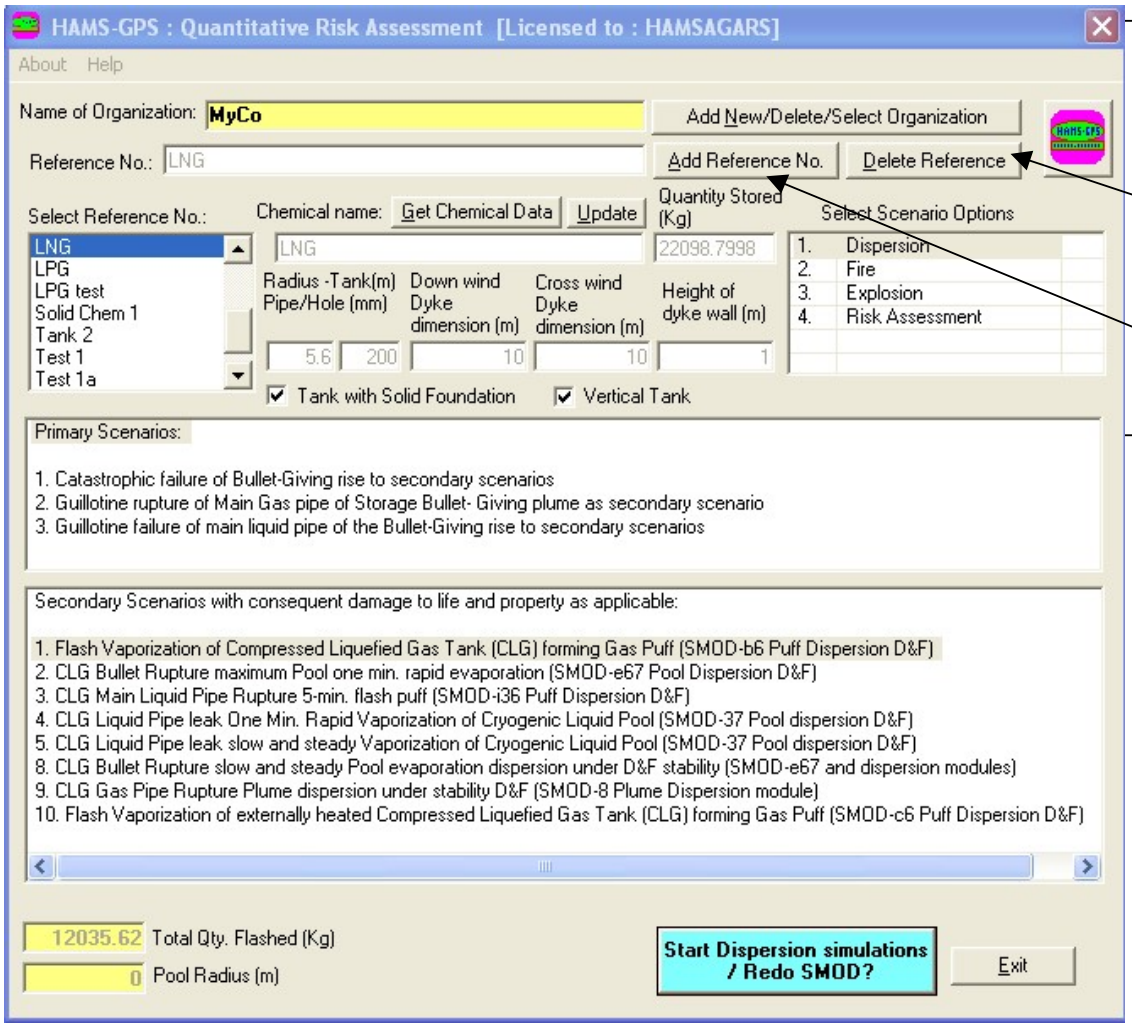


Fig-10: SMOD Performed and the button below now displays [Start Dispersion simulations / Redo SMOD]

As shown in Fig. above, SMOD has been Performed and the button below now displays **[Start Dispersion simulation / Redo SMOD].** You can Redo SMOD if need be by clicking **[No]** button. The SMOD results are displayed showing Total quantity flashed in Kg.

13.4 Start Dispersion or Redo SMOD?

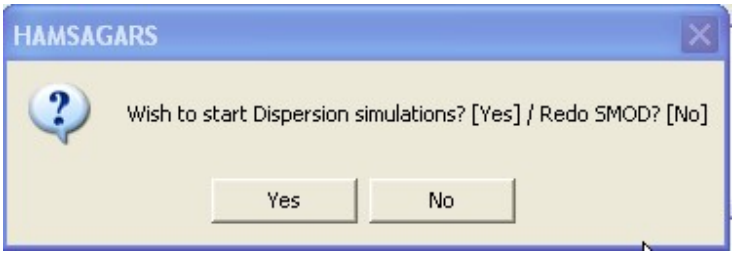


Fig-11: Dispersion / Redo SMOD Yes/NO dialog.

14. Dispersion Simulation: To start Dispersion click **[YES]** else to Redo SMOD click **[NO]**. Now Click **[YES]** button and the dispersion dialog opens:

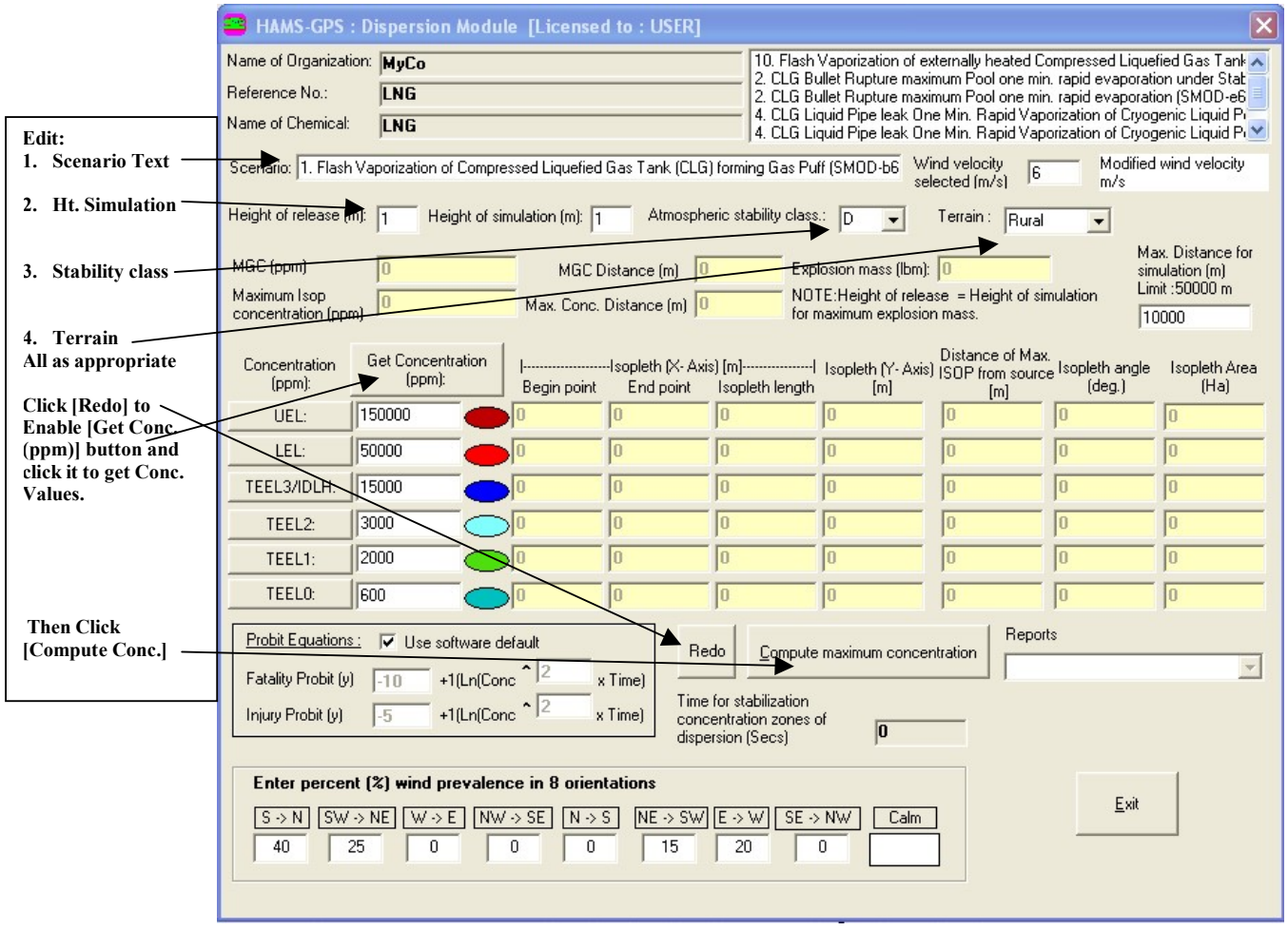


Fig-12: The Dispersion dialog box.

14.1 Understanding the Complex Dispersion Dialog Box:

Following Data are available on this Dialog Box:

i. **Scenario:** Most Important, First you have to Edit the Scenario appropriately. For example the default description says D&F stability class. You need one stability class at a time. There is “D” in the Atmospheric Stability class Combo Box as Default Stability Class. You may choose any required stability class from this Comnbo box and then Edit the Scenario showing your chosen stability class. Normally you need D first and then F as the two Atmospheric stability classes for dispersion in QRA study as D is the Most Dominant and F is longest Effect Stability Class. So choose first D stability and the rerun with F stability class later.
   The Scenario Edit Box is followed by the following:
   - **a.** Wind Velocity Selected (Default for Stability Class Selected at the Standard Height of Wind Measure of 10 m from Ground Level)),
   - **b.** Modified Wind Velocity at Height of Simulation,

ii. **Below Scenario Edit Box, you find the following Edit Boxes:**
   - **a.** Height of Release-Default is 1 m,
   - **b.** Height of Simulation Default is 1 m,
   - **c.** Atmospheric Stabilityy Class-Range Coambo Box: A, AB, B, BC, C, CD, D, DE, E, EF, F.
   - **d.** Terrain-default Rural.

iii. **Below above series of Edit/Combo Boxes you find the Following:**
   - **a.** MGC- i.e. Maximum Groundlevel Concentratyion,
   - **b.** MGC-Diatance from Source in m,
   - **c.** Explosion Mass in Lbm. (This is computed if the Gas is Flammable).

iv. **Next Edit Boxes are as under:**
   - **a.** Maximum Isopleth Concentration at Height of Simulation,
   - **b.** Maximum Isopleth Concentration Distance in m,
   - **c.** Maximum Distance for Simulation-maximum Limit is 50,000 m and is Re-alerted after every 10,000 m for continuation of Computations.

v. **Above is followed by the following Columns:**
   - **a.** Concentration in ppm: Here you find-UEL, LEL, TEEL3/IDLH, TEEL2, TEEL1, TEEL0. Note: These are Editable-Click on these one by one and Change as needed. For example, for Non-Flammable, you do not need UEL and LEL so you can change these to any other Concentration name.
   - **b.** Next Column of Data is on “Get Concentration in ppm”. This Button gets activated by Pressing [Redo] Button and gets Data from Preset Values for the Chemical selected. If maximum Concentration is Less than the maximum Concentration, then you

have to Change the Title of the Concentration in ppm Button text as required.

c. Coloured ovals from Reds to Greens showing levels of Hazards for each Concentration,
d. Begin Point, End Point, Isop. Length (X-Axis), Isop Length (Y-Axis), Distance of Max. Isop. From Source in m, Isop Angle suspended from Source Point in Deg., Isop. Area in Ha.

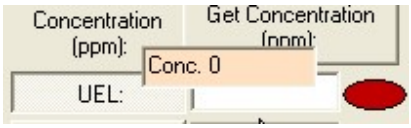
vi. **The above is followed by the following:**
   a. PROBIT Equations:
   b. [Redo] Button,
   c. [Compute Concentration] Button,
   d. Reports-Combo Box,

vii. **The above are followed by the following:**
   a. Time for Stabilization of Concentration Zones of Dispersion. Dispersion to stabilize to a fixed Isopleth Zones takes some time and this is computed and is unique in Dispersion Modeling,
   b. Final Set of Edit Boxes relates to % Wind Prevalence in 8-Orientations and this information is used in computing the Profile Graphs Contours of Dispersion.

14.2 Getting Isopleth Concentrations and Editing Isopleth Labels: You have to click **[Redo] Button** above the Concentration text boxes. These Preset Concentrations in ppm get displayed from Database of Scenario Developer option of Main Menu.

Then Maximum Concentration is to be computed. For this click **[Compute maximum concentration]** button. The maximum concentration gets computed and the button just clicked becomes **[Compute at given concentration].** The Software computes the Maximum Isopleth Concentration (ppm) and displays in the relevant Text Box. There are other computations also that get displayed. Note these.

Here you have to see and compare the values of Maximum concentration Isopleth (ppm) and the concentration values for UEL, LEL, TEEL3/IDLH etc. The UEL value has to be less than the maximum concentration. This is so here. Otherwise you will have to edit and change the default concentrations given by the computer from data base to ensure that first the UEL concentration is reduced below maximum concentration and title UEL can be changed to Conc-1 or some other title as felt appropriate. This can be done by click on the **[UEL]** press button and a new Text box with **"Conc. 0"** text appears.



You can either retain this text or edit this text as you like. Then click on the **[UEL]** press button and the **“UEL”** changes to **[Conc. 0]** or what ever you text you added. Similarly all other concentrations and their titles may be changed as suitable.

14.3 Computing Maximum Concentration: Then click the Button **[Compute at given concentration]**.

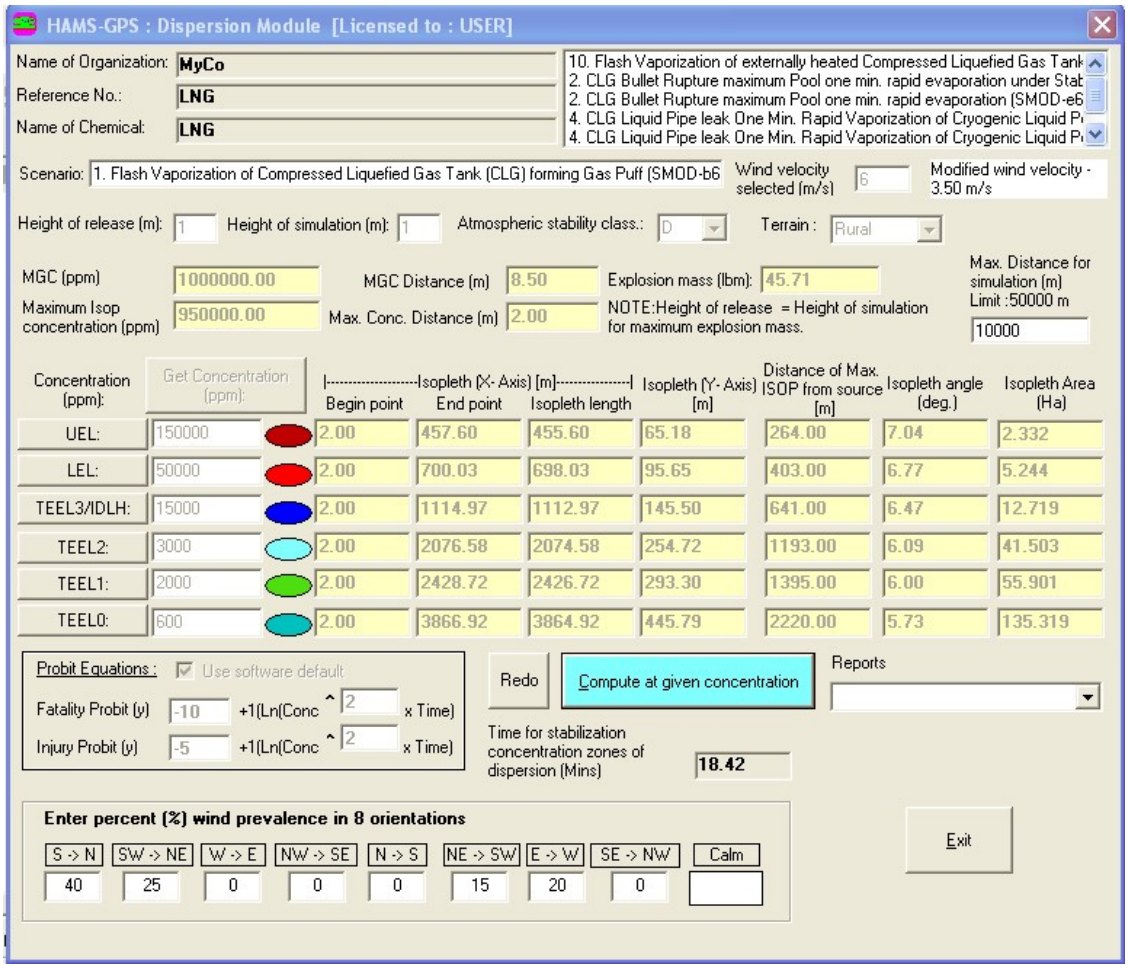


Fig-13: Dispersion computed and results displayed.

14.3.1 Re-Running/Editing an Already Run Dispersion:

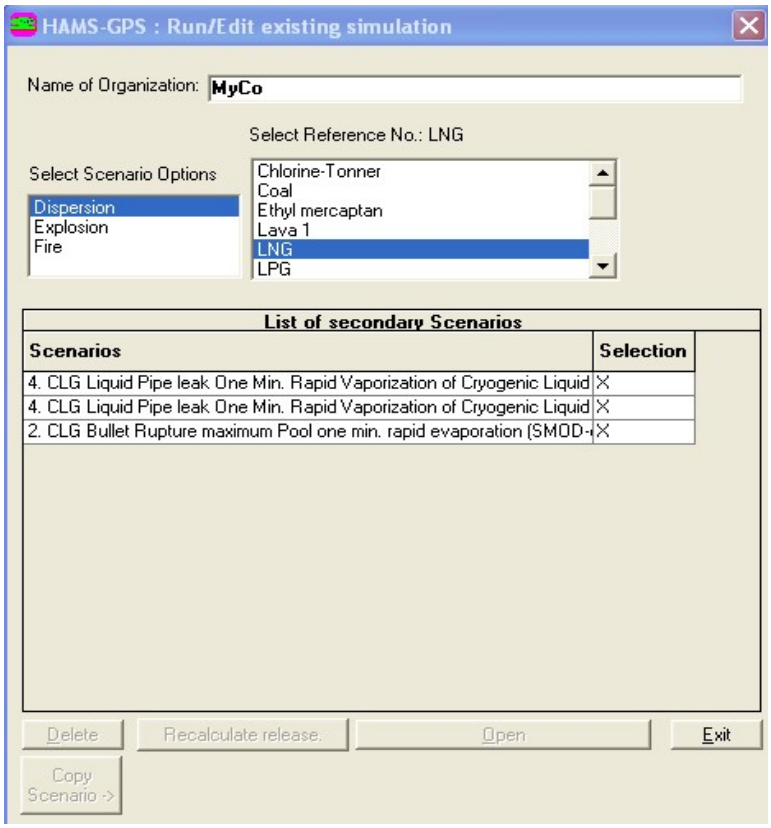
Once you have done Dispersion and other simulations, to be discussed hereunder, for a particular chemical and a particular scenario, you can Rerun/Edit dispersion and other simulations quickly, without going through all the steps, as per procedure given below:

First you do the following 3-Normal Steps you do for first Run:

Step-1: Select Reference No. in the QRA-Dialog Box.
Step-2: Select Dispersion (or other simulations) in the Scenario Options List Box,
Step-3: Select Secondary Scenario already done through SMOD and other normal steps,

These are the normal steps you do for Dispersion and other Simulations for first Run. Once these three normal steps are done, you can go straight to Rerunning/Editing Dispersion or other simulations as under:

Step-4: Double click Dispersion or other simulation already done. You will get a Message Box asking **"Wish to Run/Edit existing simulation?"** Click **[Yes]** button. The **"Run/Edit Existing Simulation"** dialog box opens. This Dialog Box for Dispersion is as under:



Fiog.-13.1: Run/edit Existing Simulation Dialog Box.

Step-5: Click Dispersion (or any other for Rerun/Edit), all the references of Simulations Run already appear in the **"Select Reference Number"** List Box.
Step-6: Select the Reference No. you wish to Rerun/Edit from this List Box. Notice all the Secondary scenarios already Run appear in the **"Secondary Scenario"** List Box.
Step-7: Double Click the Secondary Scenario, you wish to Rerun/Edit and the Simulation dialog box appears. Rerun/Edit this as required and the Rerun/Edited secondary Scenario gets stored.

14.4 Setting Distance Limit for Dispersion: The distance limit for dispersion simulation is kept at 10,000 m as default. If the dispersion distance exceeds this default value you get a dialog box to continue dispersion with increased distance and this continues in steps of 10,000 m till the dispersion can be completed. In

case you wish to limit the dispersion distance to a certain maximum distance, then, you will have to increase the last Isopleth value and others above if required, to enable dispersion within your maximum limit of dispersion distance. Maximum Limit is 50,000 m

14.5 Studying Results of Dispersion: Carefully study the results of Dispersion.

You can Redo by click on **[Redo]** button.

Note: Height of Simulation is which is kept 1 m as default representing the average breathing height of persons, is very sensitive and to be adjusted with care to meet your needs. If you want effect on persons at a height say a multistory building, then height of any floor may be used as height of simulation. For children on ground, use 0.5 m as height of simulation. This may be needed if the dispersion is near a school.

Once you do all dispersion scenarios for a chemical, these get displayed in the list box at RHS-Top. You can rerun any of these by merely double click on "Dispersion" option in the **"Select Scenario Options"** List Box and dispersion scenarios already run, get loaded and you can select and rerun. This Rerun options are also applicable to all the 4-Options available in the **"Select Scenario Options"** List Box namely 1. Dispersion, 2. Fire, 3. Explosion and 4. Risk Assessment.

15. Understanding Isopleth and Isoelevet: We shall now explain the meaning of Isopleth.

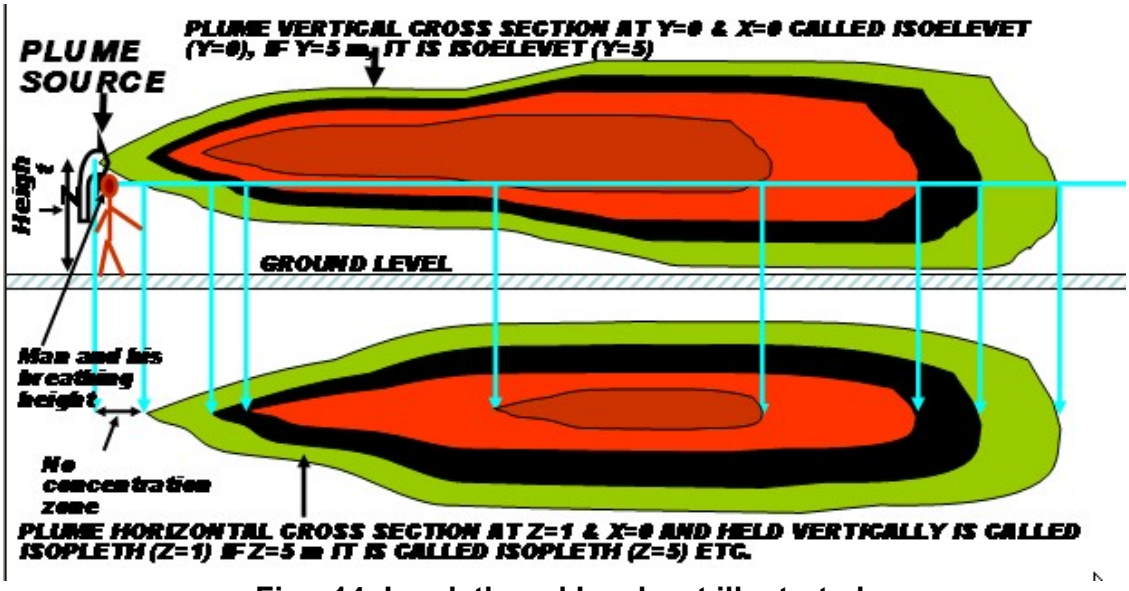


Fig-: 14: Isopleth and Isoelevet illustrated.

Now you understand all the results of dispersion simulation. First three columns of dispersion results (Col-Nos: 2-4) for Isopleth along X-Axis in m for Begin Point of each Isopleth, then End Point, then Isopleth length Then the 5th Column gives Isopleth width along Y-Axis. Then the 6th Column gives distance of Begin Point of Isopleth from source. The 7th Column gives Isopleth the angle in deg. Subtended

by each Isopleth by tangents drawn from source of each Isopleth. Finally the last 8th Column gives area of each Isopleth in m2.

16. Obtaining Dispersion Reports: Now you can see the out put reports in tables and graphs by selecting the type of report from the **"Report's**" Combo box at the Right hand side bottom.

Now Reports of Dispersion can be displayed from the Report Combo box at the RHS bottom.

Click open this Reports Combo box and you will see the following report options:

Concentration levels and distances.
Concentration Levels and distances for Mixtures.
Concentration Profile.
Plot hazard Zones.

16.1 Concentration levels and distances in Tabular form: You may click the first option on "Concentration levels and distances." You will find the following Reports displayed:

Page 1 of 2

HAMS-GPS : Dispersion Module

[Licensed to : HAMSAGARS]

Date : Wednesday, September 22, 2010

Data Entered

Reference No. : LNG
Name of Chemical : LNG
Scenario : 5. CLG Gas Pipe Rupture Plume dispersion under stability DF (SMOD-8 Plume Dispersion module)
Height of release (m) : 1
Atmospheric stability class : D
Terrain : Level
Rate of Released (g/Sec) : 520

Results

Max Isop conc (ppm) : 298697.52
MGC (ppm) : 34000.02
Explosion mass (lbm) : 0.01
Max. Isop Conc. Distance (m) : 2.50
MGC Distance (m) : 8.50
Time for stabilization concentration zones of dispersion (Secs) 45.59

	Concentration (ppm):	Isopleth (X- Axis) [m] Begin point	End point	Time (Sec)	Isopleth length	Isopleth (Y- Axis) [m]	Distance of Max. ISOP from source [m]	Isopleth angle (deg.)	Isopleth Area (m2)
UEL:	150000	2.00	4.31	1.08	2.31	0.61	3.50	4.98	1.11
LEL:	50000	2.00	8.74	2.19	6.74	1.33	6.50	5.84	7.04
TEEL3/IDLH:	15000	2.00	20.83	5.21	18.83	2.86	12.50	6.53	42.30
TEEL2:	3000	2.00	67.09	16.78	65.09	8.74	40.50	6.16	446.80
TEEL1:	2000	2.00	86.95	21.75	84.95	11.27	52.50	6.13	751.93
TEEL0:	600	2.00	182.28	45.59	180.28	22.67	106.50	6.07	3209.88

NOTE: According to latest Emergency Planning, one has to use TEEL (Temporary Emergency Exposure Limits-15 min exposures) and ERPG (Emergency Response Planning Guidelines-1-hr. exposure) Limits are to be used

Fig-15: Dispersion Results as given in the Dispersion simulation Dialog box.

16.1.1 Entering Population Data:

Population data is needed for the next Report showing fatality and Injury. To enter the Population data click the option on Main menu on “Enter Population Density” and you will get the following diagram:

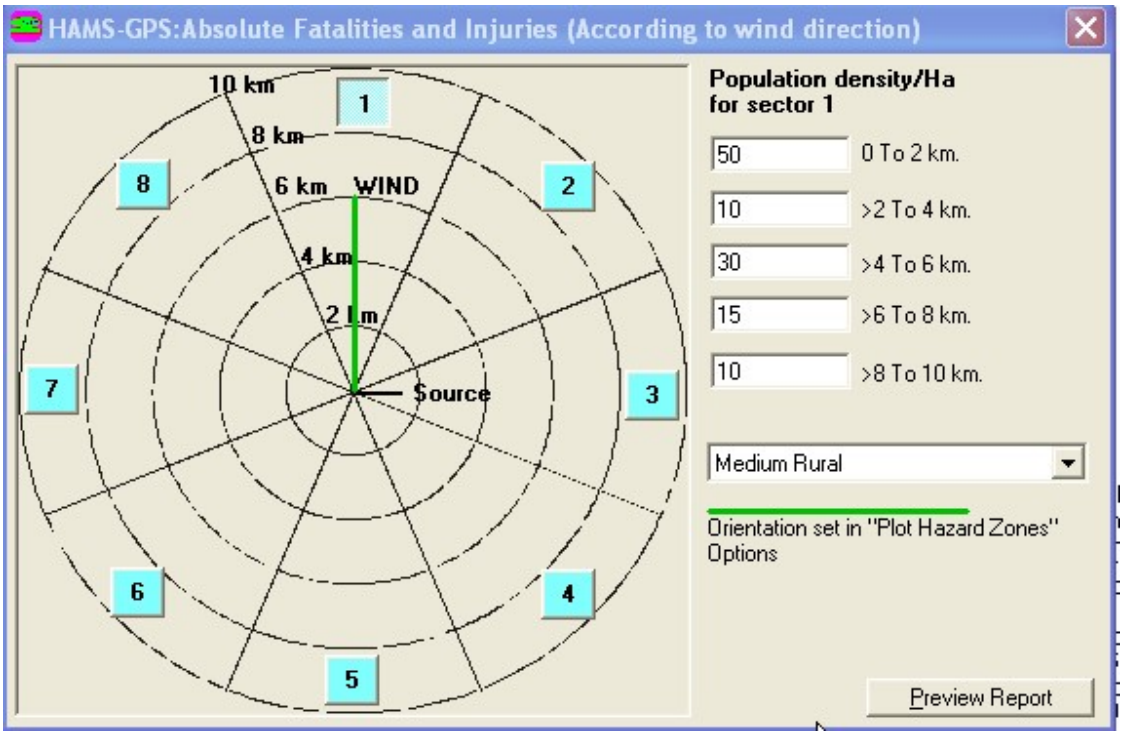


Fig-16: Population Density data entry Dialog Box.

There is option for entering data in any of the 8-Orientations at 0-2 km, >2-4 km, >4-6 km, >6-8 km and >8-10 km. There is a wind orientation line in the center and there are 8-squares for 8-Orientations. There is another dialog for changing the Wind orientation about which we shall tell a little later. For the present we shall retain the wind orientation and enter the Population data. This has been done as shown. There is a combo box for selecting the nature of Terrain. We have selected **“Medium Rural”.**

Now click **[Preview Report]** button and Report no-2 gets displayed as under:

16.2 Results of Dispersion for PROBITS i.e. fatality and Injury under dispersion:

HAMS-GPS : Dispersion Module

[Licensed to : HAMSAGARS]

Date : Wednesday, September 15, 2010

Probit Equations :

Scenario : 1. CLG Tank rupture Flash Vaporization forming Gas Cloud F

Fatality Probit (y) : -10.0 +1(Ln(Conc ^ 2.0 x Time)

Injury Probit (y) : -5.0 +1(Ln(Conc ^ 2.0 x Time)

Wind orientation selected :5

Probit Table and Absolute Fatality/Injury

Distance(m)	% Fatality	% Injury	Time (Sec)	Area (Ha)	Conc.(ppm) along X-axis	Dose (mg)	Absolute Fatality No.	Absolute Injury No.
158.4	0	56.03	79.24	1.136	151019.67	0.7397	0.000	31.825
460.29	0	100	230.26	3.275	389406.53	13.035	0.000	163.750
762.18	0	100	381.27	4.819	200096.13	16.6063	0.000	240.950
1064.07	0	100	532.29	6.062	108856.18	16.4721	0.000	303.100
1365.96	0	100	683.31	7.089	65396.72	15.5027	0.000	354.450
1667.85	0	100	834.33	7.944	42510.47	14.3556	0.000	397.200
1969.74	0	100	985.34	8.649	29338.15	13.1376	0.000	432.450
2271.63	0	100	1136.36	9.220	21202.5	11.8801	0.000	92.200
2573.52	0	100	1287.38	9.665	15889.22	10.6338	0.000	96.650
2875.41	0	100	1438.40	9.989	12260.28	9.4499	0.000	99.890
3177.3	0	100	1589.41	10.194	9689.46	8.363	0.000	101.940
3479.19	0	100	1740.43	10.280	7812.19	7.3887	0.000	102.800
3781.08	0	100	1891.45	10.240	6405.93	6.529	0.000	102.400
4082.97	0	100	2042.47	10.069	5329.35	5.7776	0.000	302.070
4384.86	0	100	2193.48	9.752	4489.57	5.1242	0.000	292.560
4686.75	0	100	2344.50	9.270	3823.73	4.5575	0.000	278.100
4988.64	0	100	2495.52	8.588	3288.18	4.0661	0.000	257.640
5290.53	0	100	2646.54	7.650	2851.94	3.6395	0.000	229.500
5592.42	0	100	2797.55	6.334	2492.56	3.2685	0.000	190.020
5894.31	0	100	2948.57	4.301	2193.48	2.9449	0.000	129.030

Fig-17: Results of Dispersion for PROBITS i.e. fatality and Injury under dispersion.

To understand these Results, you will have to understand what is an Isopleth. This is described below once again (See also Para-13):

Isopleth is a constant concentration dispersion horizontal cross section zone along down wind x-axis and at a height z (normally 1-m average breathing height).

In contrast the vertical cross section of a dispersion is called Isoelevet.

16.2.1 Obtaining Graphic Dispersion Reports:

On clicking Plot Graphic reports option on the Reports Combo box, you will get the following dialog box to modify orientation and wind direction as under. You can change the orientation (Shown by Red line and wind direction shown by green line by dragging the lower adjustment bars to right till you reach the desired positions for Orientation and Wind:

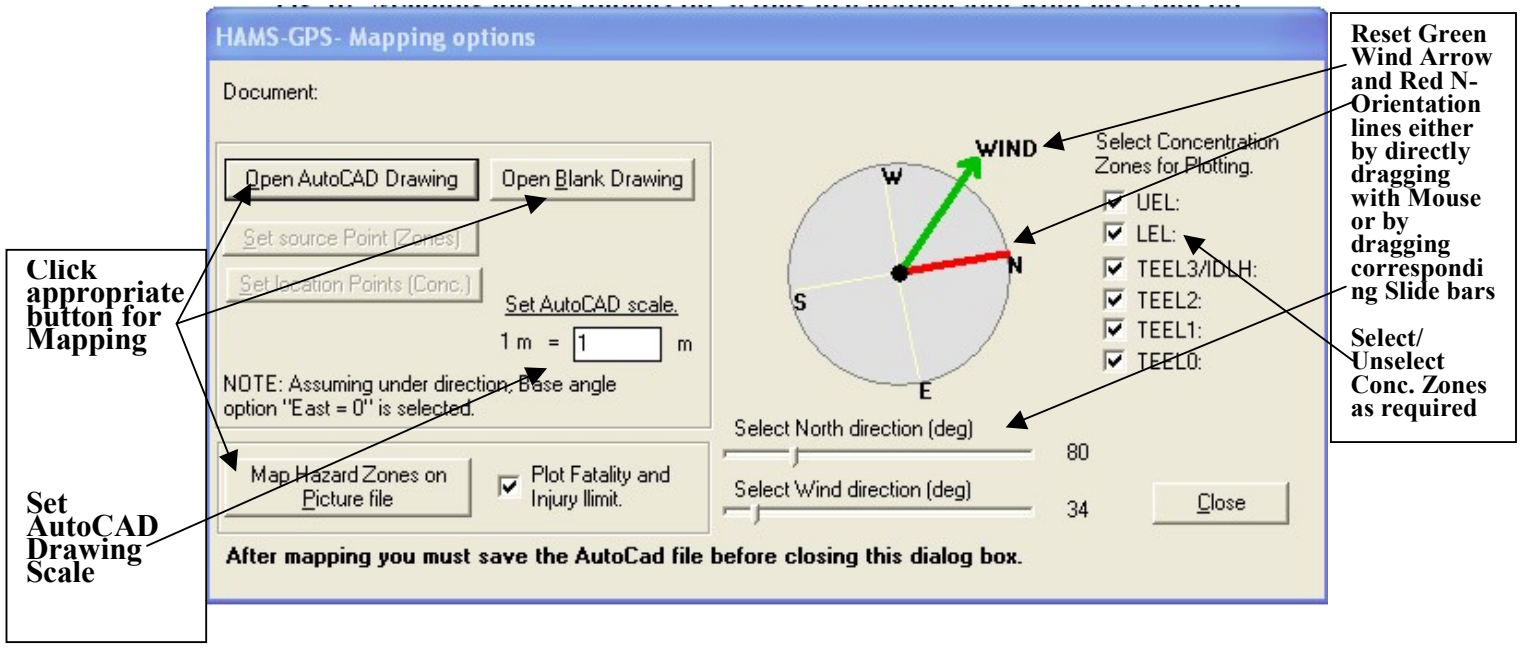


Fig-18: Mapping options for setting orientation and wind direction for Autocad/Graphic plot reports.

This dialog box also has options for selecting concentration zones. By default all are selected. This can remain. There are three buttons for **[Open AutoCad Drawing], [Open Blank drawing]** and **[Map Hazard Zones on Picture File]** for plotting the dispersion graphs. So there are three different ways of mapping the hazard zones. You can choose as appropriate. Autocad mapping takes Autocad-2000 file.

16.2.3 Plotting Hazard Zones on AutoCAD Drawing: Click on button **[Open AutoCAD Drawing] and select the AutoCAD File required to be opened.** click on **[Set Source Point (Zone)]** button. The Curser goes to Autocad map with + sign curser. With this + sign curser, select Source Point and click. The dispersion gets plotted. It may take some time to plot. So on clicking at the Source Point wait till dispersion zones are plotted. Following is an example of Dispersion Plotted on Autocad map of a Factory:

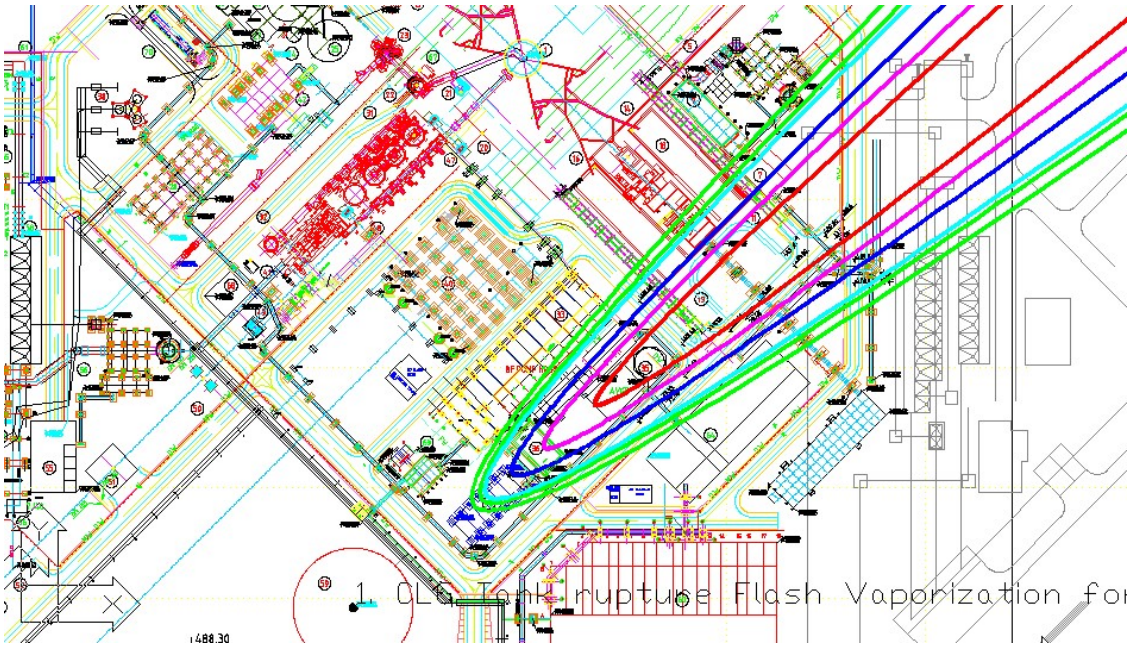
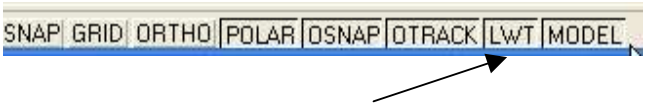


Fig-19: Dispersion plotting on AutoCAD Map.

Note: The dispersion line graphs may be too thin. To make them bold double click on the main blue Title bar of Autocad Drawing

On doing so several options appear at the bottom as shown:



Now click on the option **[LWT]** and the lines become bold.

16.2.4 Plotting Hazard Zones on Blank Drawing: Click on button **[Open Blank drawing].**

Plotting Hazard Zones on Picture File: Click on button **[Map Hazard Zones on Picture File]** The following dialog Box appears (Shown in part):

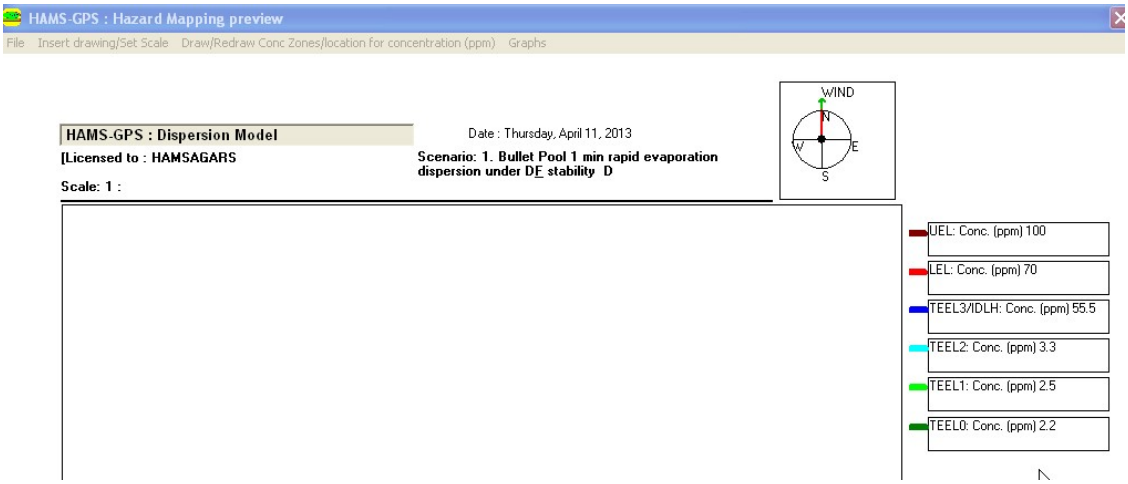
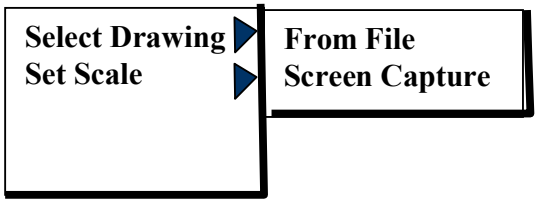


Fig-20: Dialog Box for Plotting hazard Zones on Picture File.

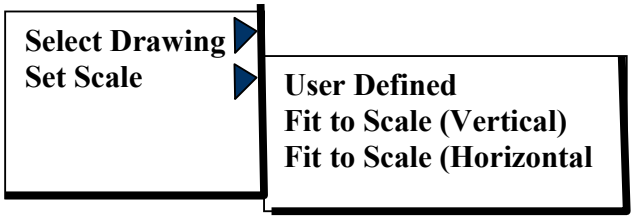
This has number of options as under:

Click on Menu Item **"Insert Drawing / Set Scale"** and you get the following options:

Insert Drawing / Set Scale -> Select Drawing:



Insert Drawing / Set Scale -> Set Scale:



So there are 5-Options in all as under:

1. **Drawing from File:** You can open a Drawing File and Plot the Hazard Zones,
2. Screen Capture: You can capture a Map/Drawing e.g. a Map from Google Map.

3. **User Defined:** This option enables Plotting Hazard Zones in the following ways:

    a. **You can insert a Picture File,**
    b. **You can Use Screen Capture to insert an AutoCAD Map, Google Map or a Picture:** For this purpose, first open AutoCAD File or Google Map or Picture File then Click on **"Screen capture"** Option. Where by the following Dialog appears:

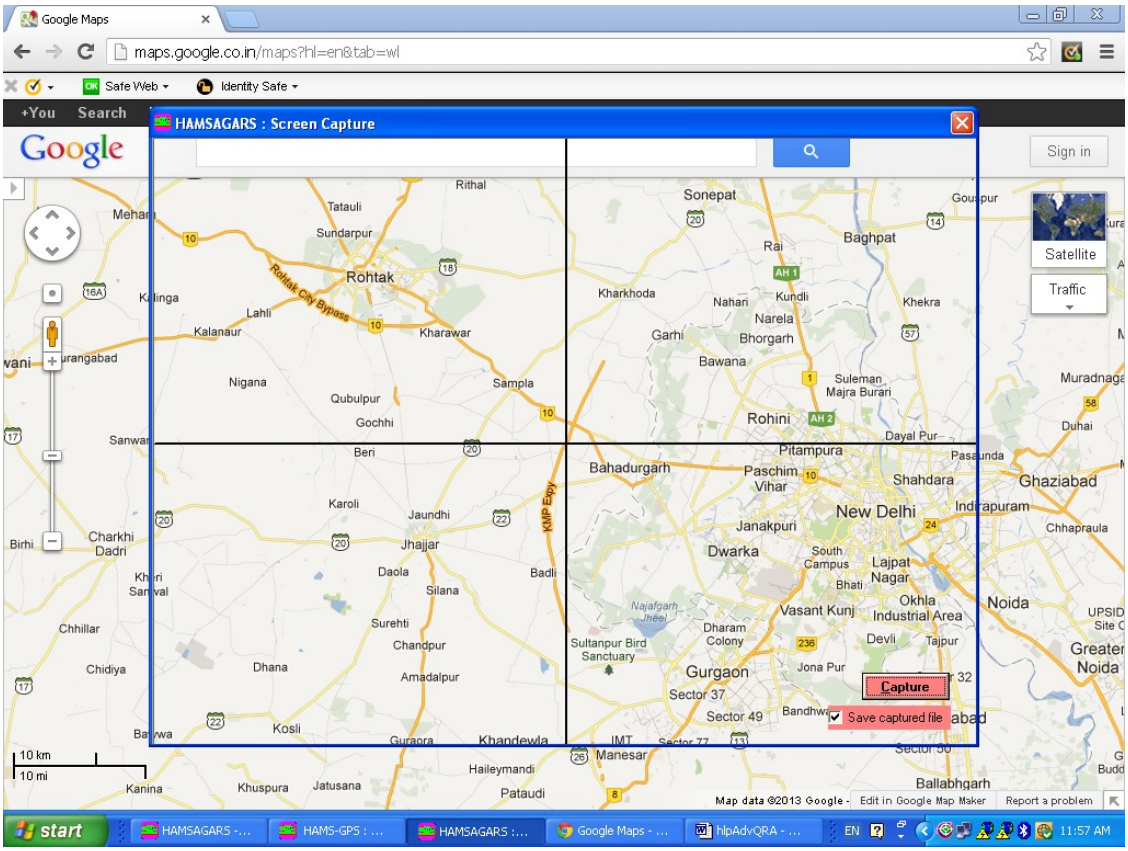


Fig-21: File capture Window on Google Map.

On the "Screen Capture" there is a Red Button for "Capture" of portion of Screen behind the "Screen Capture" Window. There is also a Red Check Box which if Checked saves the Captured Screen as BMP-File at the location choosen which can be used elsewhere also.

Now Click on [Capture] Button where by the Screen portion within the "Screen Capture". If the "Save Captured File" Check Box is Checked, you will be first asked to save the Captured File as "Default.BMP file. Choose the location and change file name if required and then save. Then Window gets captured and also gets inserted in to the Dispersion Hazard Zone Plotting Window automatically as shown below:

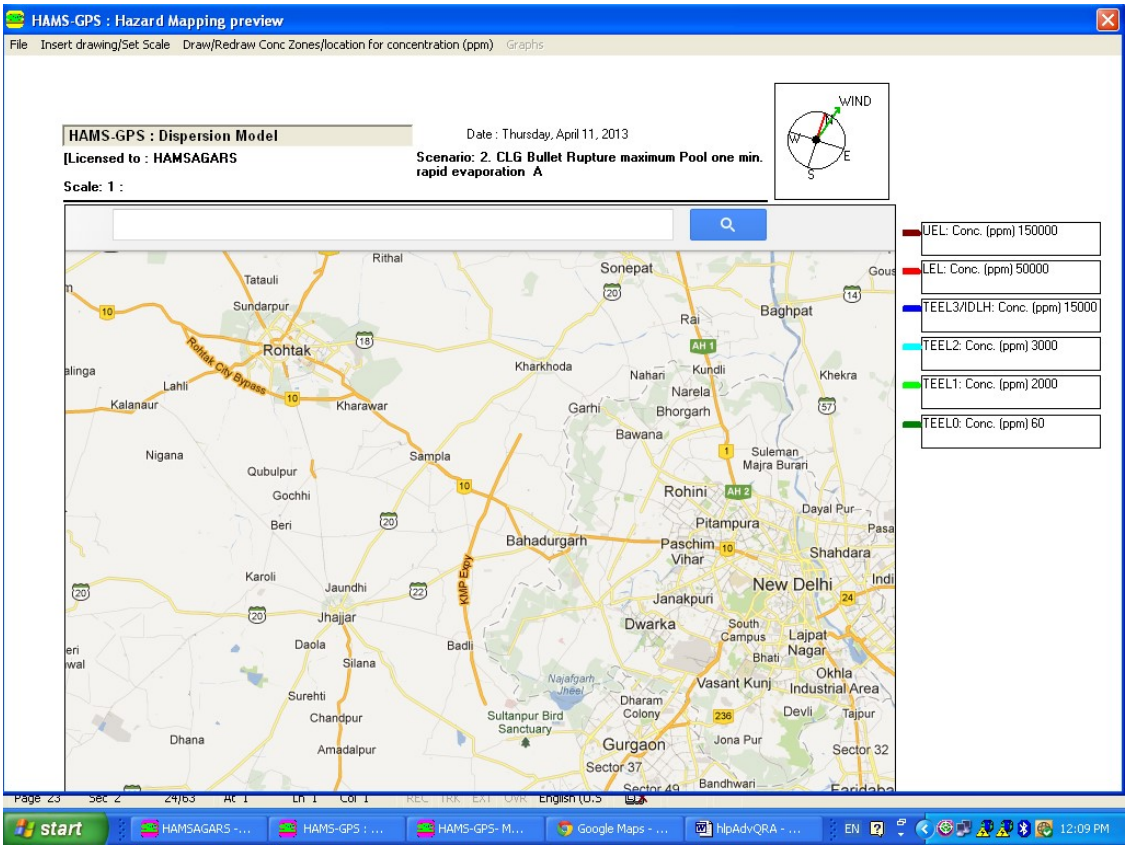


Fig-22: Captured File on Dispersion Plot Window.

c. Opens a Blank File.

In all these cases, a mini yellow dialog box for setting user defined scale appears. You select two points where by the Unit value of distance between points is displayed. and insert the value of scale for the distance between 2-Points selected and click on . **[Select Source]** button. The User defined Scale Dialog Box is.as under showing the Units of Distance selected and also the distance value entered by user..:

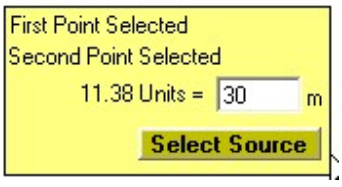


Fig-23: User defined Scale Dialog Box:

Setting Wind Direction: Set Wind direction from “Mapping Options Dialog Box as under by catching the green Wind Arrow and moving it to the Orientation

required. Red line shows North which is vertical by default by can be changed by catching the red line and moving as required. You can also change these by Slider Bars below:

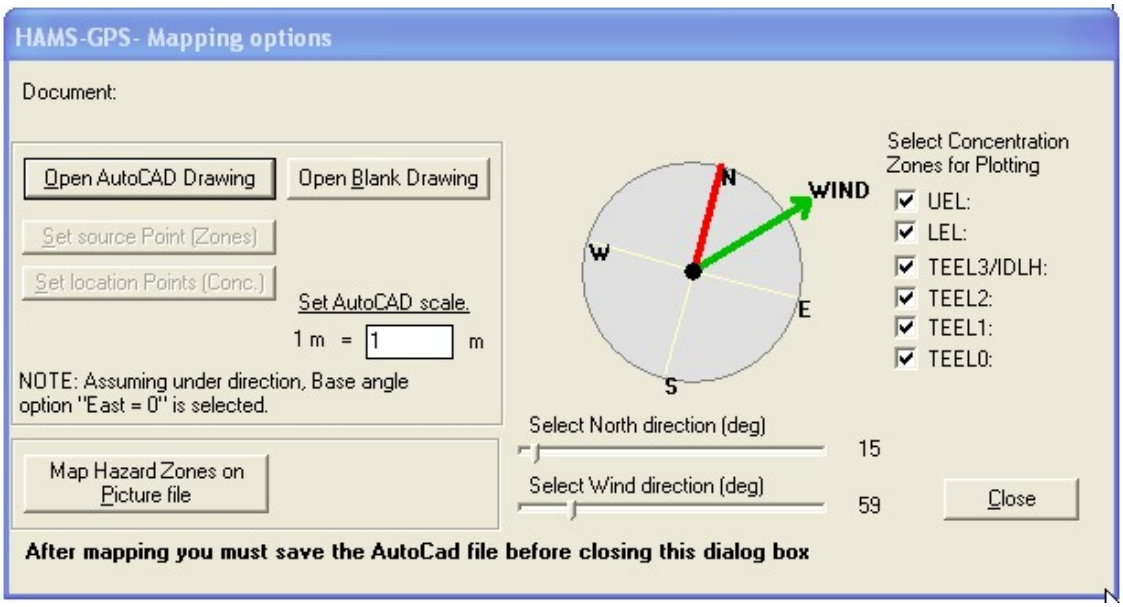


Fig-24: Mapping Options Dialog Box with Wind and North reset.

Move to the point for Plotting the Hazard Zones and Click. Hazard Zones get plotted as under:

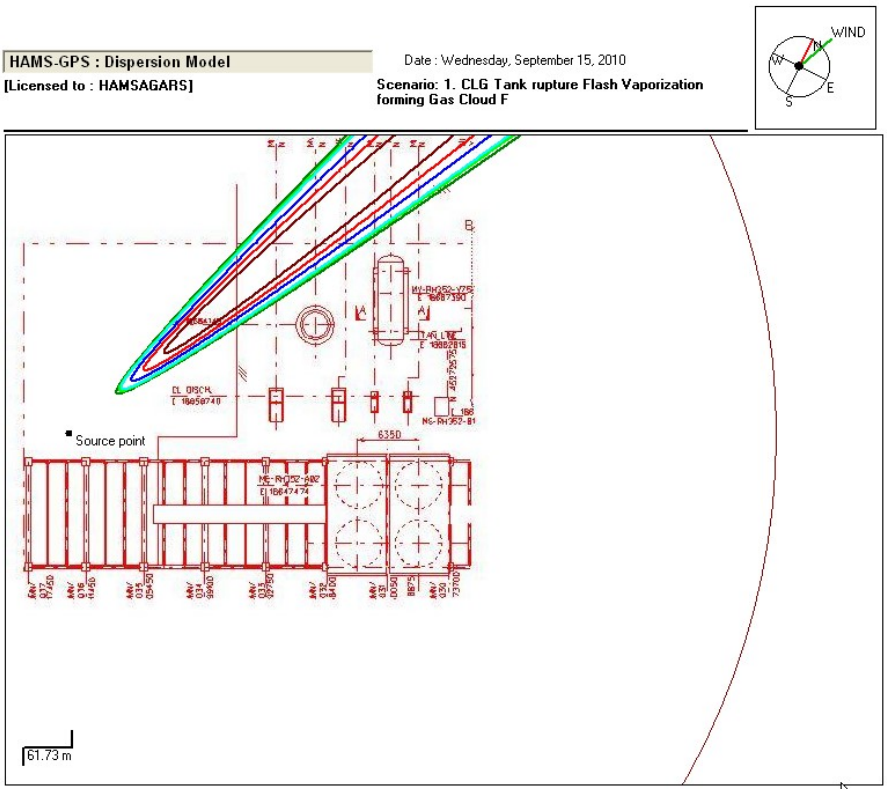


Fig-25: Dispersion Plot on Graphic Picture.

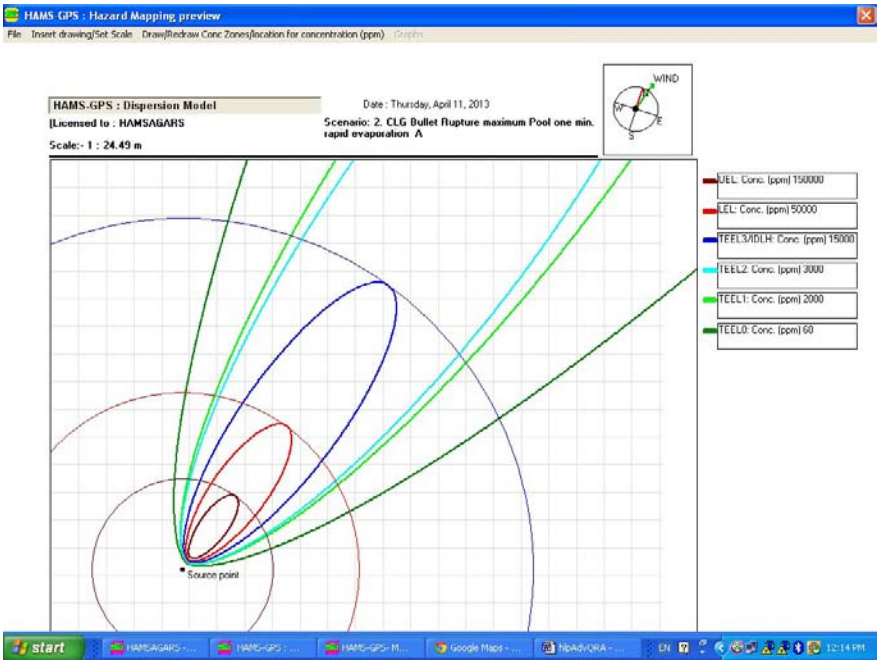


Fig-26: Dispersion Plot on Blank Page with selected Orientation.

Application of these Techniques of Plotting Hazard Zones: The above Techniques of Plotting Hazard Zones apply to all Scenarios-Dispersion, Fire and Explosions.

16.2.5 Zooming Option for Graphs:

i. Zooming AutoCAD Dispersion Graph: AutoCad Graphs can be Zoomed in and out by selecting Lens-Curser and dragging on the AutoCad area.

Checking dispersion Isopleth length and width: To check distances on AutioCad dispersion Isopleth lengths and Widths, Select the **[Distance]** button and clicking at begin and end points of required Isopleth, you will get distance displayed. Similarly width of Isopleth can be checked.

To generate this mapping of dispersion on Graphic map, you have to do the following:

ii. Zooming Graphics other than in AutoCad: For all other than AutoCad Graphics, you go to Main Menu and click on “Insert Drawing/Set Scale” option and find “Zoom” option that opens to 2-Zoom options, Select any one and click on the Graph, it gets zoomed in or out as selected. This Zooming facility is available for all Graphic Displays.

16.2.6 Plotting Location Points (concentration) in any direction and any distance: Click **“Open Blank Drawing”** button and double click any AutoCad file. It will open a blank AutoCad File. Select **[Set Location Points (Conc.)]** button from “Mapping Options” Dialog Box and click at a point on the blank AutoCad area where you want the source of release to exist. You will get the Scenario description printed at this Source Point clicked. A message box comes to click on Location Concentration Point **[Yes] [No]** buttons. Click on **[Yes]** button and click at any distance away from Source Point. You get distance in m, Concentration in ppm, and Hazard Level at this point displayed. You can continue to click more Location Points to display distance, conc. And hazard levels at these points. To close the Plotting of Location Point Concentrations, click on **[No]** button of Location Point Plotting Dialog box. You can do the same after Plotting dispersion on a AutoCad drawing, but the readability of text will depend on the blank spaces in the AutoCad drawing. So a blank AutoCad drawing is better. Following is a sample of such a plot on blank AutoCad drawing:

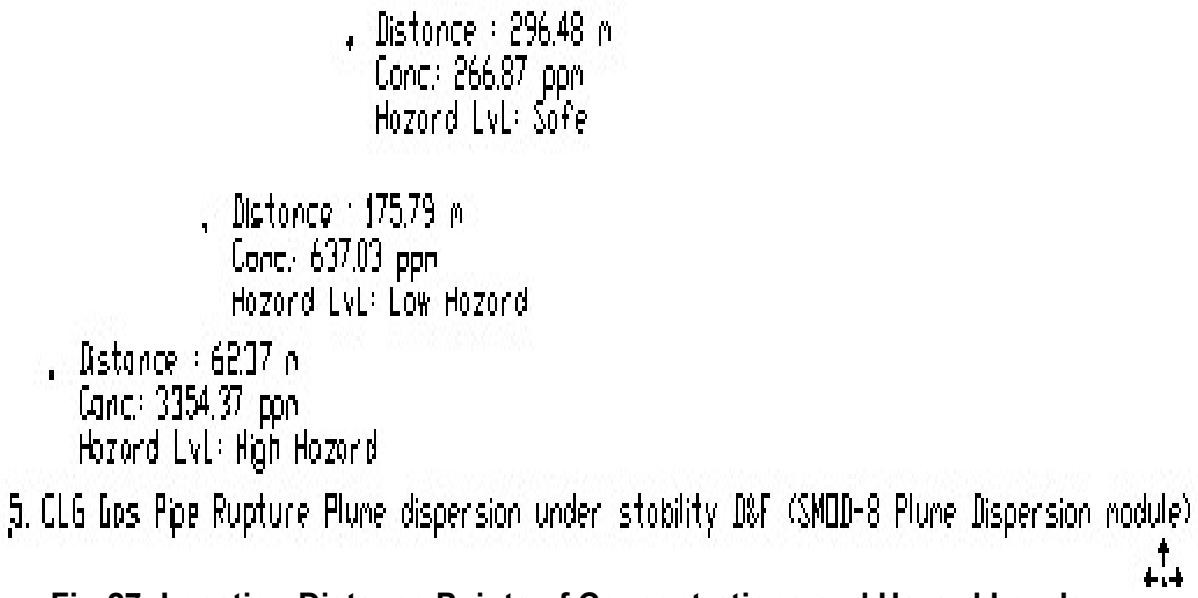


Fig-27: Location Distance Points of Concentrations and Hazard Levels.

This completes our discussion on Dispersion simulation for one stability class and repeat for other stability class as required. Note you normally require D and F stability class dispersions.

You can also display dispersion on blank sheet. For this click on [Map Hazard Zones on Picture file] button in Mapping options dialog (see Fig-18). A Blank sheet appears (see Fig-21). Now Click on **"Insert Drawing/Set scale"** option on main menu on **"Hazard Mapping Preview" dialog box ->Select Scale->Fit to page (Vertical) or (Horizontal)**. We have selected Fit to **"Page (Horizontal)"** option and the following dispersion diagram gets displayed on scaled grid with scale displayed at LHS-Top corner:

16.2.7 Plotting Profile and Fatality-Injury Graphs:

From Reports Combo Select **"Concentration Profile"** option. You get the following Profile Graph:

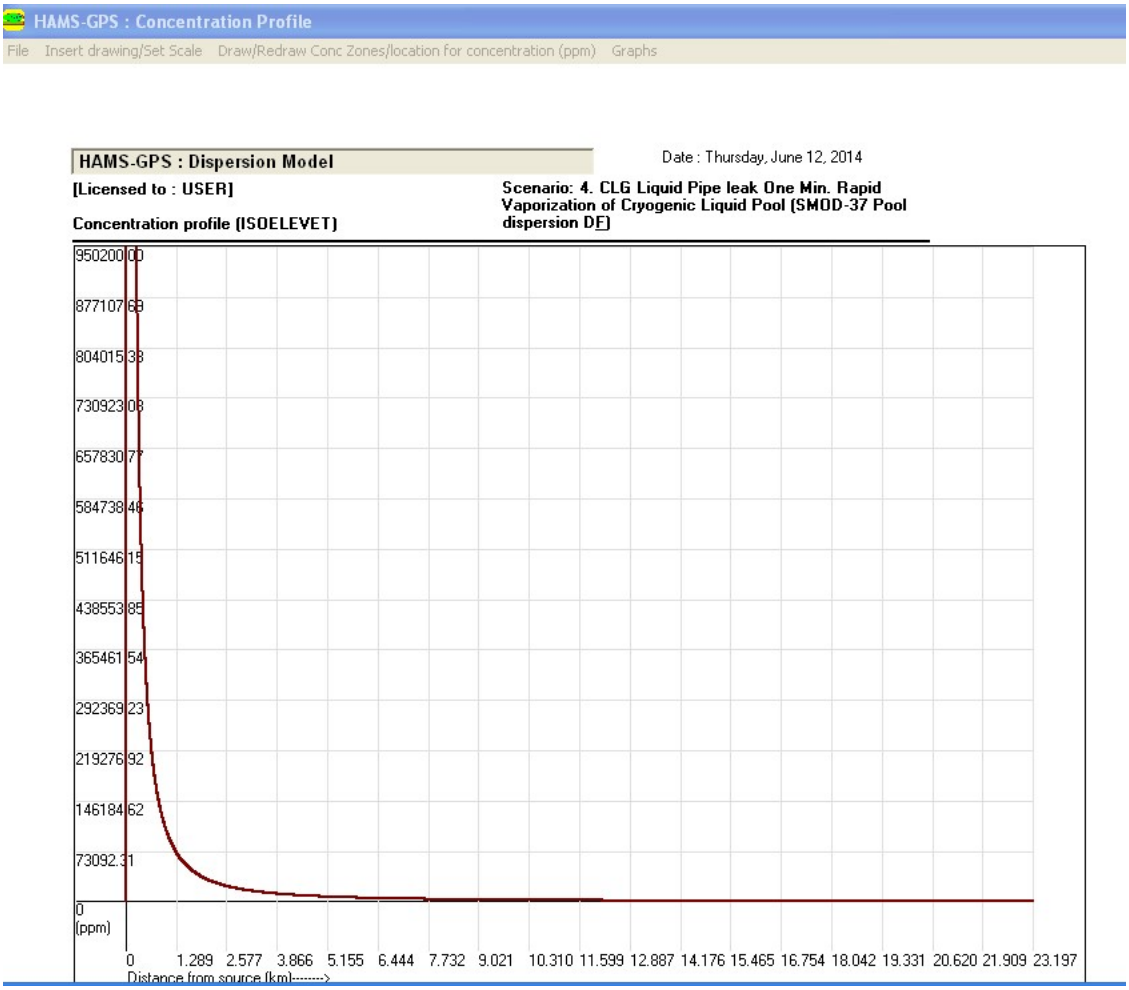


Fig.-28: Concentration Profile Graph of Dispersion.

Concentration Profile is Concentration Vs. Distance Graph. If you hold the Curser on any position of the Graph line, you get the Exact Concentration and distance of that Point.

Menu Options: for Profile Graph:

On the Top Left Corner there is Option for:

Print
Exit

In the Middle of main Menu Bar you have the following options for Graphs:

Concentration Profile
Fatality-Injury Profile
▶Zoom Select Distance

Reset

By Selecting **"Select Distance", you get a vertical line and place it on the Profile Graph at a distance required and click, you get Profile Graph within that limit only.**

If you Select **"Fatality-Injury Profile", you get the following fatality-Injury Prophile Graph:**

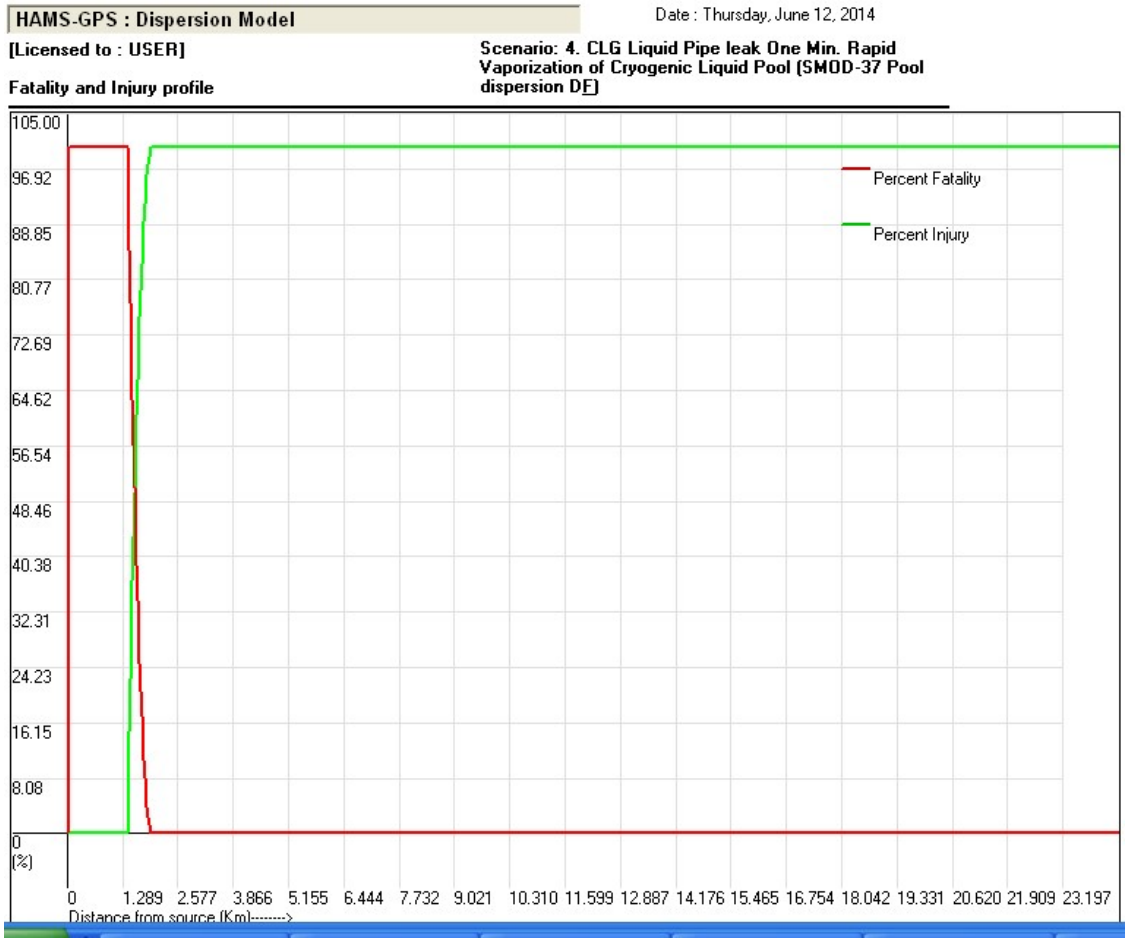


Fig.-28: Fatality-Injury Profile Graph of Dispersion

Here again you can use Zoom-> Select Distance option to redraw the Profile Graph within a Selected Shorter distance as illustrated for Concentration Profile Graph earlier.

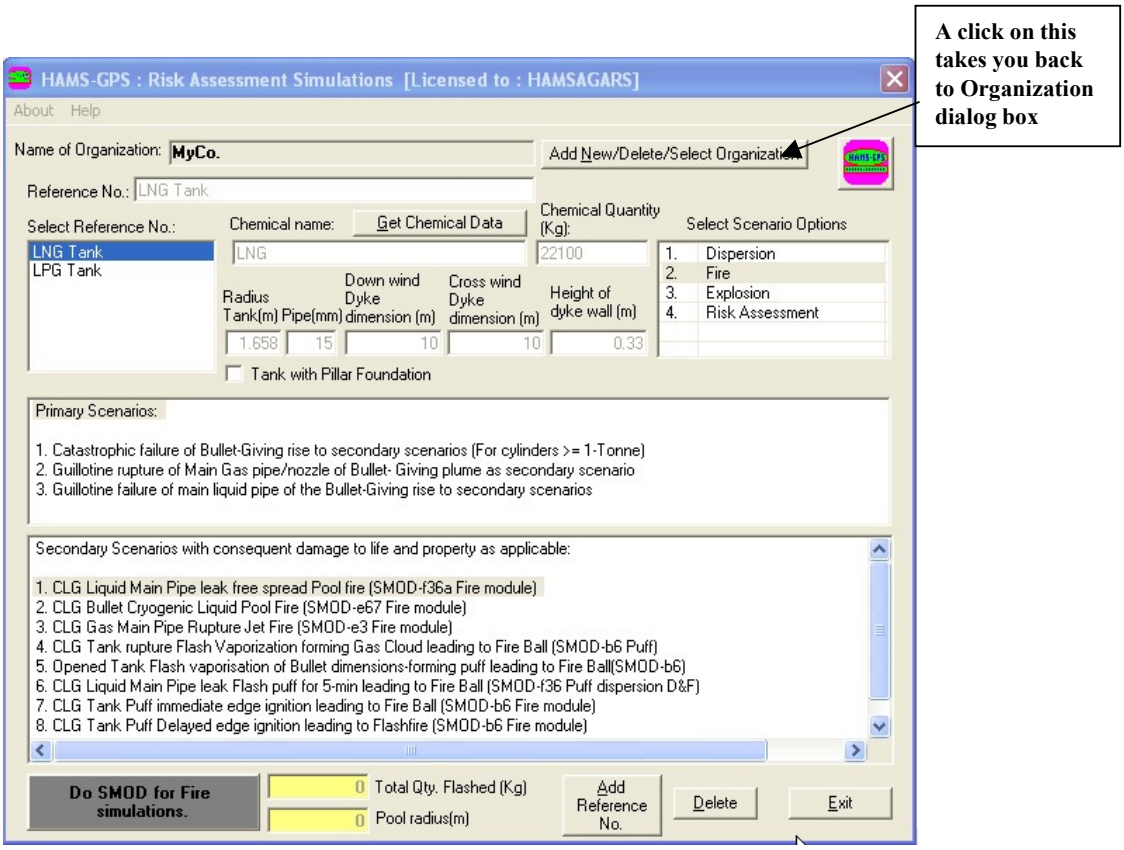
These Profile Graph options are also available in Fire and Explosion simulations.

This completes our discussions on Dispersion modeling.

17. Fire Simulations:

Fire and other simulations are very similar to but much simpler than dispersion simulations.

Now go to **"Select Scenario Options"** Dialog Box from where we selected "1. Dispersion" option and ran the dispersion simulation step by step. Now you select **"2. Fire**" option and the fire scenarios get displayed. Select the first secondary scenario on **"CLG-Liquid Main Pipe leak free spread pool fire"**



option. Following is displayed.

Fig-26: Fire simulation SMOD option.

Now Click on the LHS bottom button **[Do SMOD for Fire simulation]**. The SMOD is done and results are displayed and the LHS bottom button becomes **[Start Fire simulation/Redo SMOD]**.

Click this button and click **[YES]** on the **[YES][NO]** dialog that appears exactly as in Dispersion.

The Fire simulation dialog appears. Most Important, First Edit the Scenario to suit your need. Then Click on **[Compute IHR-for Isopleths]**. Following results dialog appears.

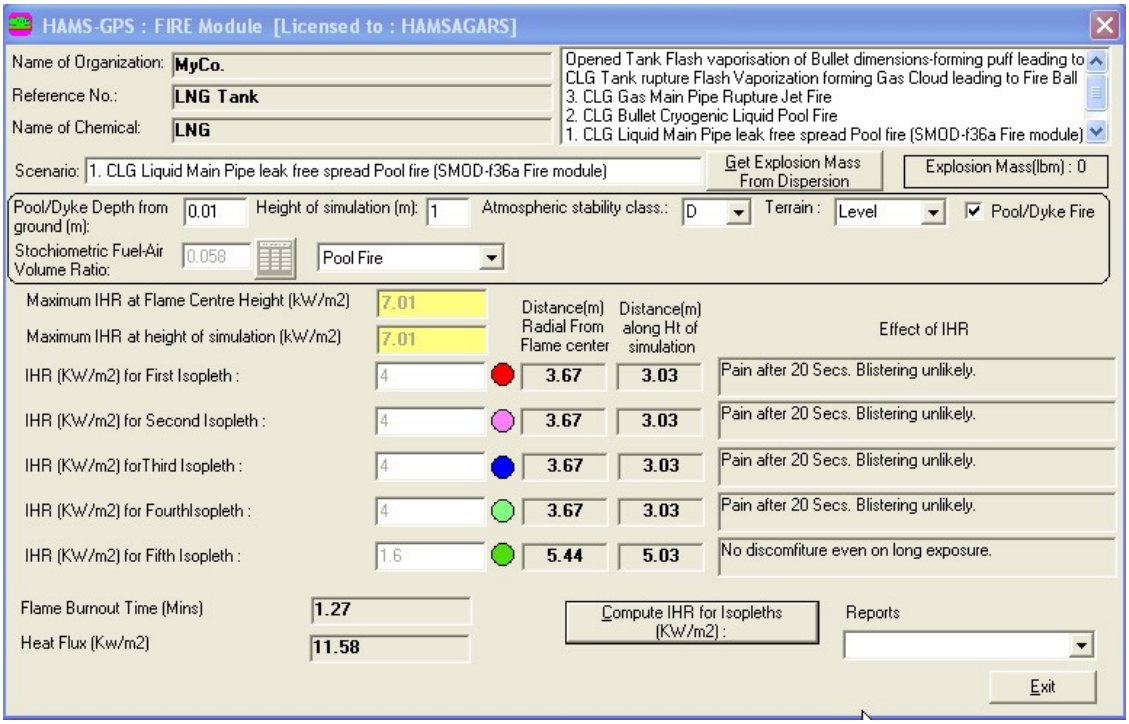


Fig-29: Pool Fire Simulation Dialog Box.

Carefully study these fire simulation results. IHR stands for Intensity of Heat Radiation in KW/m2.

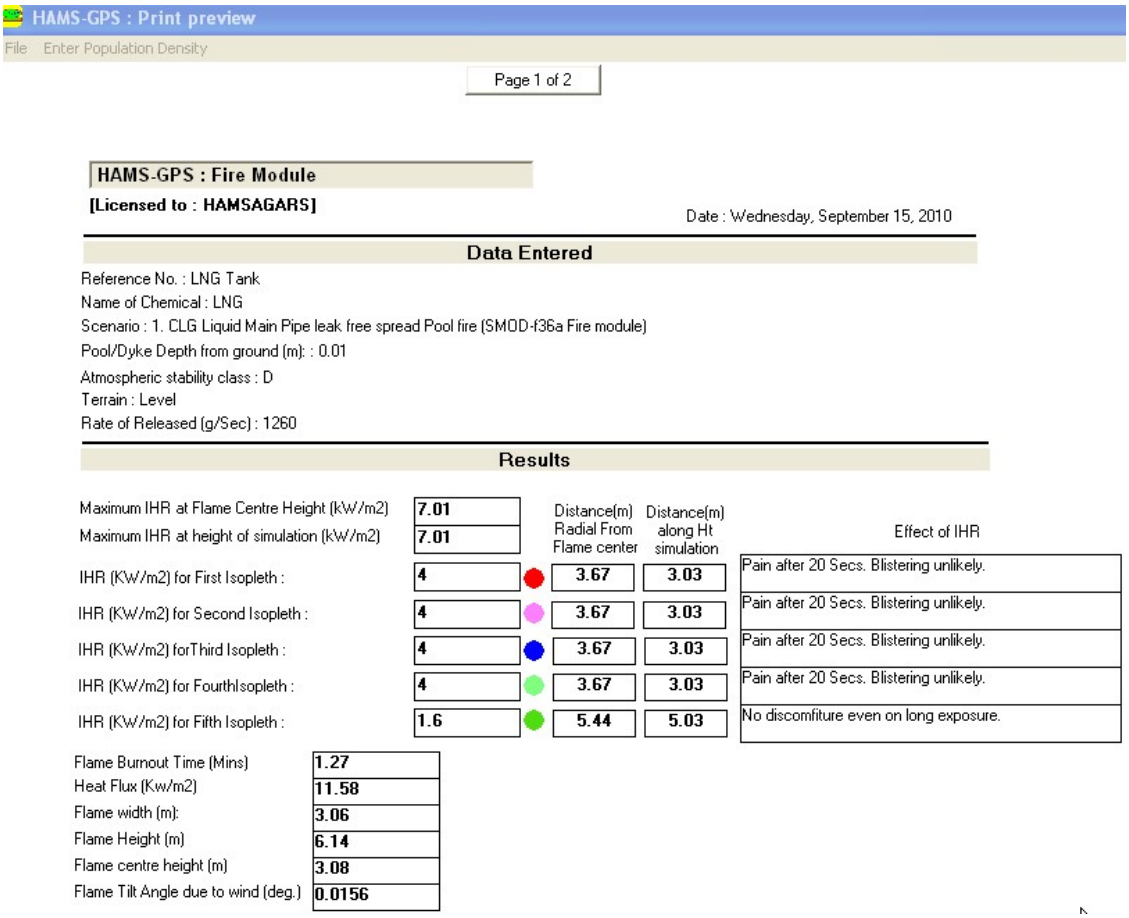
Note: Once you run all the available Fire scenarios, these get displayed in the list box on RHS-Top. Then merely by double click on any required fire scenario, it gets loaded and just click **[Compute IHR fir Isopleths (KW/m2)]** button. So once you run scenarios, you do not have to go through each step. You can redo all fire scenarios from the list box of done scenarios.

17.1 Obtaining Fire Simulation Reports: Now Reports can be obtained from the Reports Combo box exactly as in case of Dispersion.

Following Report options are available in the Reports combo box:

IHR-Distances.
IHR-Profile.
Fire drawings.
Plot IHR Zones.

First click on IHR-Distances Option and see the following Report:



HAMS-GPS : Print preview

File Enter Population Density

Page 1 of 2

HAMS-GPS : Fire Module

[Licensed to : HAMSAGARS]

Date : Wednesday, September 15, 2010

Data Entered

Reference No. : LNG Tank
Name of Chemical : LNG
Scenario : 1. CLG Liquid Main Pipe leak free spread Pool fire (SMOD-f36a Fire module)
Pool/Dyke Depth from ground (m): : 0.01
Atmospheric stability class : D
Terrain : Level
Rate of Released (g/Sec) : 1260

Results

			Distance(m) Radial From Flame center	Distance(m) along Ht simulation	Effect of IHR
Maximum IHR at Flame Centre Height (kW/m2)	7.01				
Maximum IHR at height of simulation (kW/m2)	7.01				
IHR (KW/m2) for First Isopleth :	4		3.67	3.03	Pain after 20 Secs. Blistering unlikely.
IHR (KW/m2) for Second Isopleth :	4		3.67	3.03	Pain after 20 Secs. Blistering unlikely.
IHR (KW/m2) forThird Isopleth :	4		3.67	3.03	Pain after 20 Secs. Blistering unlikely.
IHR (KW/m2) for FourthIsopleth :	4		3.67	3.03	Pain after 20 Secs. Blistering unlikely.
IHR (KW/m2) for Fifth Isopleth :	1.6		5.44	5.03	No discomfiture even on long exposure.

Flame Burnout Time (Mins)	1.27
Heat Flux (Kw/m2)	11.58
Flame width (m):	3.06
Flame Height (m)	6.14
Flame centre height (m)	3.08
Flame Tilt Angle due to wind (deg.)	0.0156

Fig-30: IHR-Distances for Pool fire.

As in case of dispersion, the second Report under IHR distances is for PROBITS i.e. Percent and absolute injuries and fatality. For this it is necessary to enter Population densities exactly in the same was as done for dispersion. The Population data entered earlier will be there. Second report is found as under:

Page 2 of 2

HAMS-GPS : Fire Module

[Licensed to : HAMSAGARS]

Date : Wednesday, September 15, 2010

Scenario : 1. CLG Liquid Main Pipe leak free spread Pool fire (SMOD-f36a Fire module)

Wind orientation selected :1

Probit Table and Absolute Fatality/Injury (At height of simulation)

Distance (m)	IHR (kW/m2)	Dose (Kwh/m2)	% Fatality	% Injury	Area (Ha)	Injury Type	Secondary Fire	Absolute	
								Fatality No.	Injury No.
3.03	4.9	48.97	0	26.53	0.003	Pain	Unlikely	0.000	0.008
3.13	4.59	45.89	0	22.2	0.000	Pain	Unlikely	0.000	0.000
3.23	4.31	43.09	0	20.85	0.000	Pain	Unlikely	0.000	0.000
3.33	4.05	40.54	0	18.35	0.000	Pain	Unlikely	0.000	0.000
3.43	3.82	38.21	0	16.14	0.000	Pain	Unlikely	0.000	0.000
3.53	3.61	36.08	0	14.12	0.000	Pain	Unlikely	0.000	0.000
3.63	3.41	34.12	0	12.19	0.000	Pain	Unlikely	0.000	0.000
3.73	3.23	32.31	0	10.46	0.000	Pain	Unlikely	0.000	0.000
3.83	3.06	30.65	0	8.83	0.000	Pain	Unlikely	0.000	0.000
3.93	2.91	29.11	0	7.38	0.000	Pain	Unlikely	0.000	0.000
4.03	2.77	27.68	0	6.04	0.000	Pain	Unlikely	0.000	0.000
4.13	2.64	26.36	0	4.79	0.000	Pain	Unlikely	0.000	0.000
4.23	2.51	25.13	0	3.54	0.000	Pain	Unlikely	0.000	0.000
4.33	2.4	23.98	0	2.48	0.000	Pain	Unlikely	0.000	0.000
4.43	2.29	22.91	0	1.42	0.000	Pain	Unlikely	0.000	0.000
4.53	2.19	21.91	0	0.46	0.000	Pain	Unlikely	0.000	0.000
4.63	2.1	20.97	0	0	0.000	Pain	Unlikely	0.000	0.000
4.73	2.01	20.1	0	0	0.000	Pain	Unlikely	0.000	0.000
4.83	1.93	19.27	0	0	0.000	Pain	Unlikely	0.000	0.000
4.93	1.85	18.5	0	0	0.000	Pain	Unlikely	0.000	0.000

Fig-31: Pool Fire PROBITS i.e. % and absolute Fatality and Injury

Similarly select the next Report option on IHR-Profile and the following result comes:

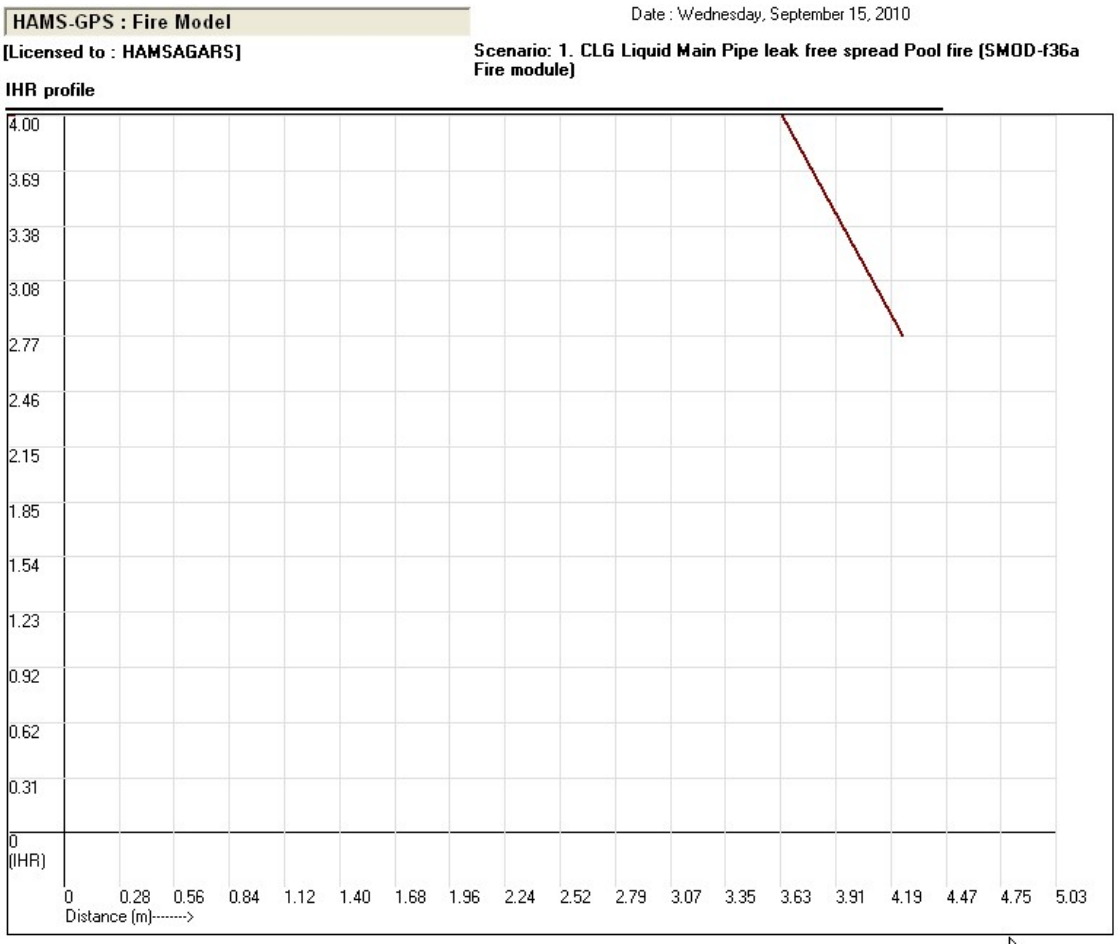


Fig-32: IHR Profile of Pool fire.

Now select the next Report option from Reports combo box for Fire Drawings and find the following Report:

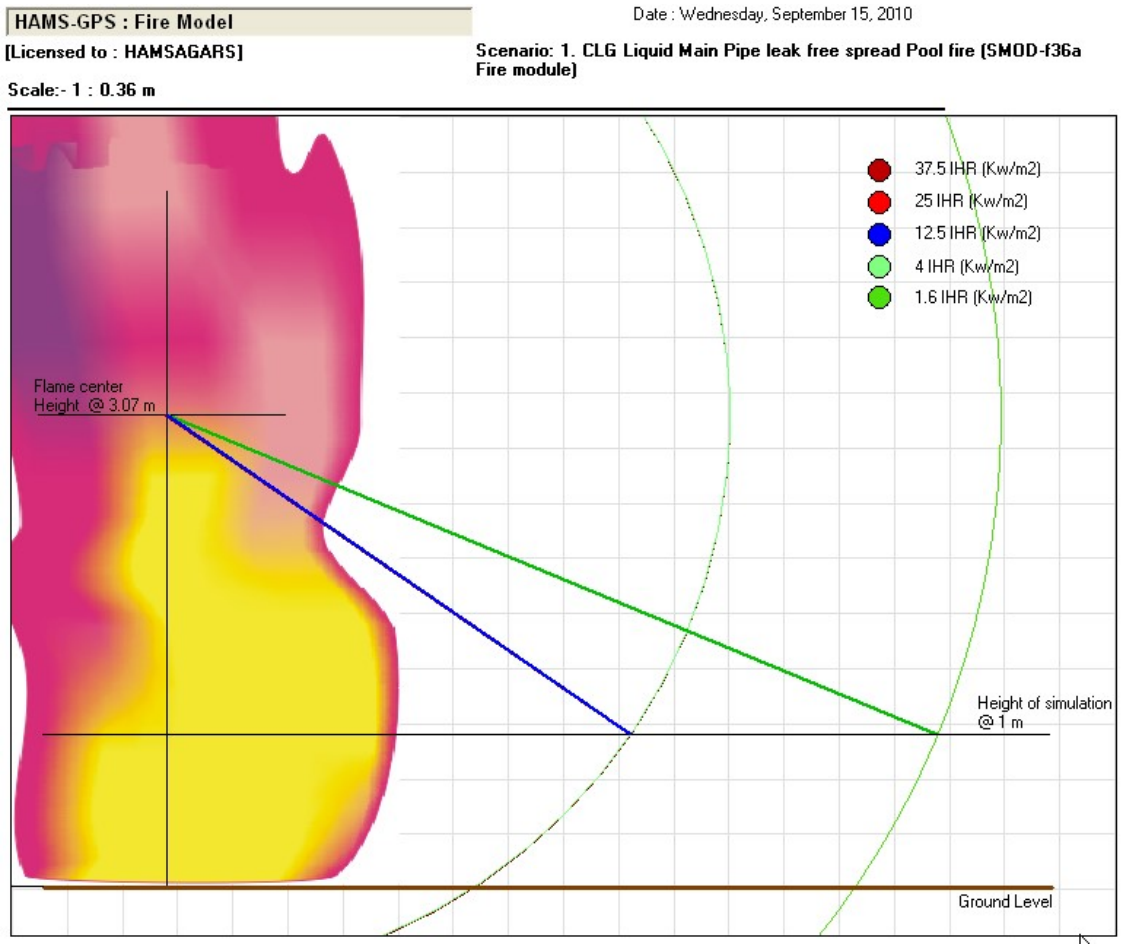


Fig-33: Pool Fire Drawing.

Study the details of Pool Fire drawing.

Next Report is on Plotting IHR-Zones and the procedure is exactly the same as for dispersion Plotting.

17.2 Flash Fire Simulation: "Flash Fire" is not a separate Scenario under Fire Option. It is a part of "**Pool Fire", "Fire Ball" and "Jet Fire"** Scenarios. In the Fire Module Dialog Box, when you select a scenario "**Pool Fire" or "Fire Ball" or "Jet Fire"** there is a Combo Box with default selection as "**Pool Fire" or "Fire Ball" or "Jet Fire"** as per your selection**.** Open this Combo Box you will find **"Flash Fire"** option and select this option, but by selecting **"Flash Fire"**, the Scenario title does not change, so you have to **manually change Scenario to "Flash Fire". It is Important to note always, to Edit the Scenario first before proceeding further in all cases. Once you correctly Edit Scenario, it gets stored and no problem in re-run of the same scenario. Now for "Flash Fire", the Explosion Mass can be directly obtained by remembering exactly which Dispersion Scenario has the required Explosion Mass, In that case after Selecting "Flash Fire" and Editing the Scenario, Click on [Get Explosion**

mass (Lbm) from Dispersion] press button. As soon as this button gets depressed, all the already run Dispersion Scenarios where Explosion mass data exists, appear in the Scenario List box above as shown below:

Fig-34: Dispersion Scenarios displayed on Depressing [Get Explosion from Dispersion] Press button.

Now, if you identify correctly which Dispersion Scenario has the required Explosion mass, Double click that Dispersion Scenario and if you have done the dispersion simulation, the required Explosion mass gets displayed in the [Explosion Mass] Button. However, you can make note of Explosion mass in corresponding Dispersion simulation and manually enter under "Flash Fire". This is done by double click on [Get Explosion Mass (Lbm)] button and Explosion mass entry Dialog opens where you enter the Explosion mass in Lbm which must be noted in dispersion simulation.

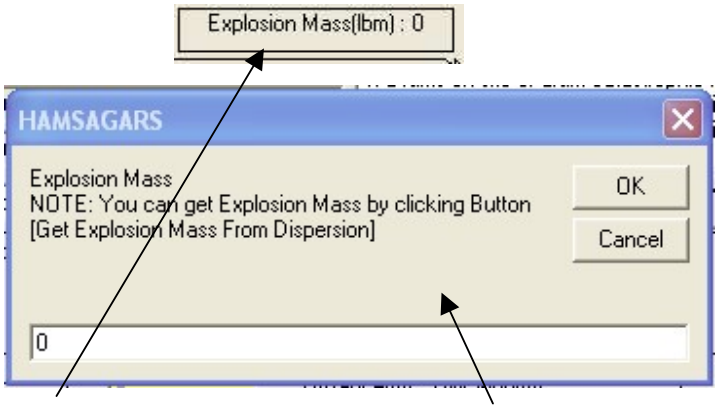


Fig-35: a. [Explosion Mass] Button and b. "Explosion Mass" data entry Dialog box.

17.3 Jet Fire Simulations: If you have Pipeline failure case of a Flammable Gas or Liquid, as Primary Scenario, you will get **"Jet Fire"** Option as a Secondary Scenario and you can do simulation for Jet Fire exactly in the same manner as for Pool Fire. Along with Jet Fire Secondary Scenario you will also find Gas Pipe leak **"Flash Fire"** Secondary Scenario also. If you select this **"Flash fire"** option you will get a Combo containing **"Jet Fire"** as Default and **"Flash Fire"** as second option in the Combo Box..

17.4 Fire Ball Simulations: In case of Flammable gas Puff Scenario as the Primary Scenario, you will also find a Secondary scenario as Fire Ball and by

selecting this Secondary Scenario, you can simulate Fire Ball. Along with the **“Fire Ball”** as Default, the Combo Box has **“Flash Fire”** option also and this can be run**.**

17.5 Rerunning/Editing Fire Scenarios: once done, by a shortcut method: See under this under Dispersion and follow the same procedure.

18. Explosion Simulation:

Explosion Simulation is very similar and you have to start with Selecting Explosion option and scenarios get displayed. Now Select a secondary scenario. And click LHS bottom Button **[Start SMOD for Explosion simulation]**. Following Dialog appears:

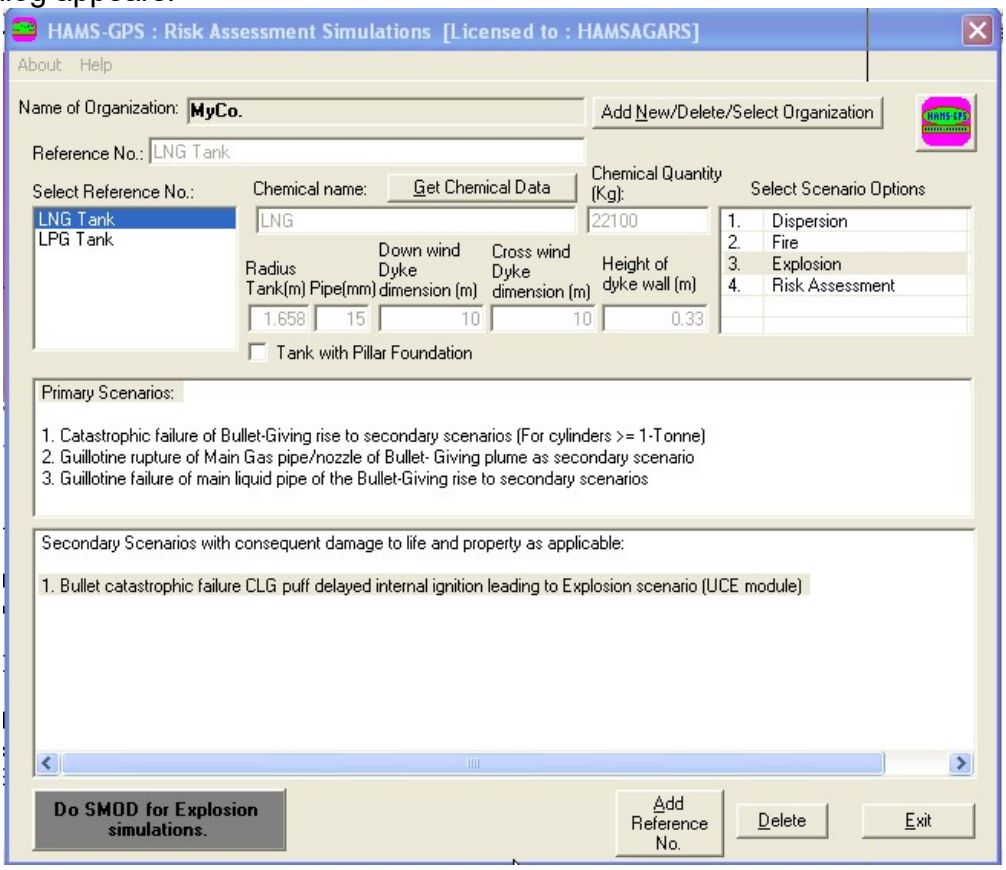
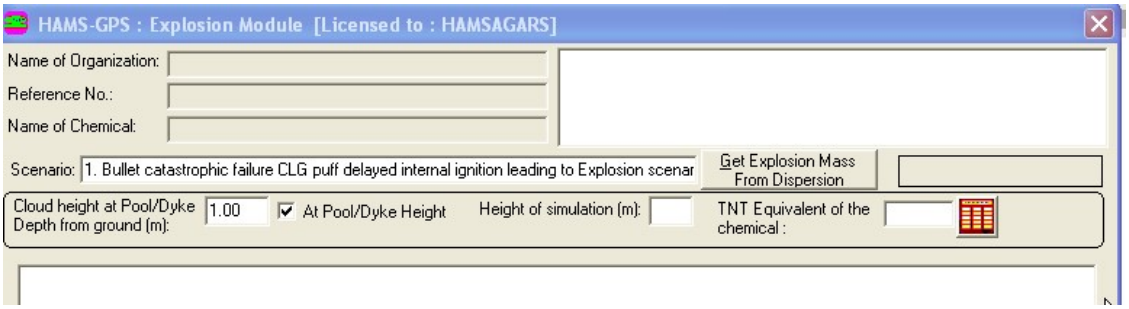


Fig-36: Explosion simulation for SMOD.

After SMOD is done Important You Must Edit the Scenario as appropriate. Then Click on the same button now labeled **[Start Explosion simulation/Redo SMOD]**. Click **[YES]** option in the **[YES][NO]** dialog. Following dialog appears:



Fog-34: Explosion Simulation dialog.

Now you have to get Explosion mass. You will have Explosion mass only if you have done dispersion of the flammable gas before doing explosion. If you have done Dispersion for the scenario for which you need Explosion mass, then:

First Press the [Get explosion mass from Dispersion] press button (Note: **[Compute Over Pressure (psi)]** Button gets Disabled and you have to release the Press Button after getting the Explosion Mass). All Scenarios get displayed in the Scenario List Box. Now select the scenario required for explosion and double click it. You get the following dialog with Explosion mass. **Now you must release the Pressed [Get explosion mass from Dispersion] Press Button to Enable the disabled [Compute Over Pressure (psi)]** Button. If you have not done the required Dispersion of any Flammable Gas Scenario, then you can manually enter the Explosion mass in Lbm by double Clicking the Explosion Mass (Lbm) box and a dialog appears for entering Explosion Mass in Lbm and then click **[OK]** button to store the Explosion Mass. Note: The Explosion Mass depends on the Size of Puff and time of attainment of maximum LEL-Zone and is computed by Dispersion of Flammable Puff Scenario only. So you must do Dispersion and get the Explosion Mass (Lbm) and this is displayed on Dispersion Simulation Dialog. You can note down this and enter under Explosion simulation manually.:

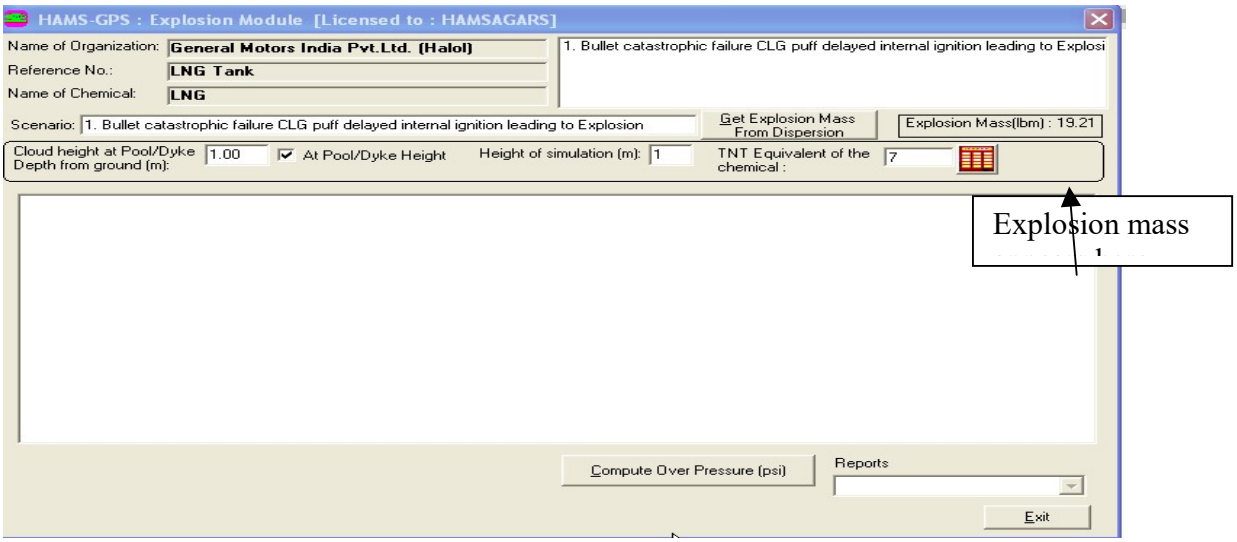


Fig-37: Explosion Simulation dialog with Explosion mass from dispersion.

Now Press on the Pressed **[Get Explosion Mass from Dispersion]** button to release back to Enable the disabled **[Compute Over Pressure (psi)]** Press Button.

Following results of Explosion appear:

Note: Once you do all the Dispersion scenarios, these get displayed in the list box on RHS-Top. Then you can **double click** on any of these done scenarios to load it and run without going through stepwise. If explosion mass does not appear on the top RHS-Text box, then click press button **[Get explosion mass from dispersion]**. All Flammable gas dispersions already done, get listed in the above List Box. You can double click required one, to get the Explosion Mass (Lbm) for this Flammable gas dispersion scenario. **After display of the Explosion Mass (Lbm), you must press the [Get Explosion mass from dispersion] button to release it. Then only the [Compute Over Pressure] button gets enabled and you can run the explosion scenario loaded. Explosion mass must be displayed in any explosion scenario otherwise error message comes.**

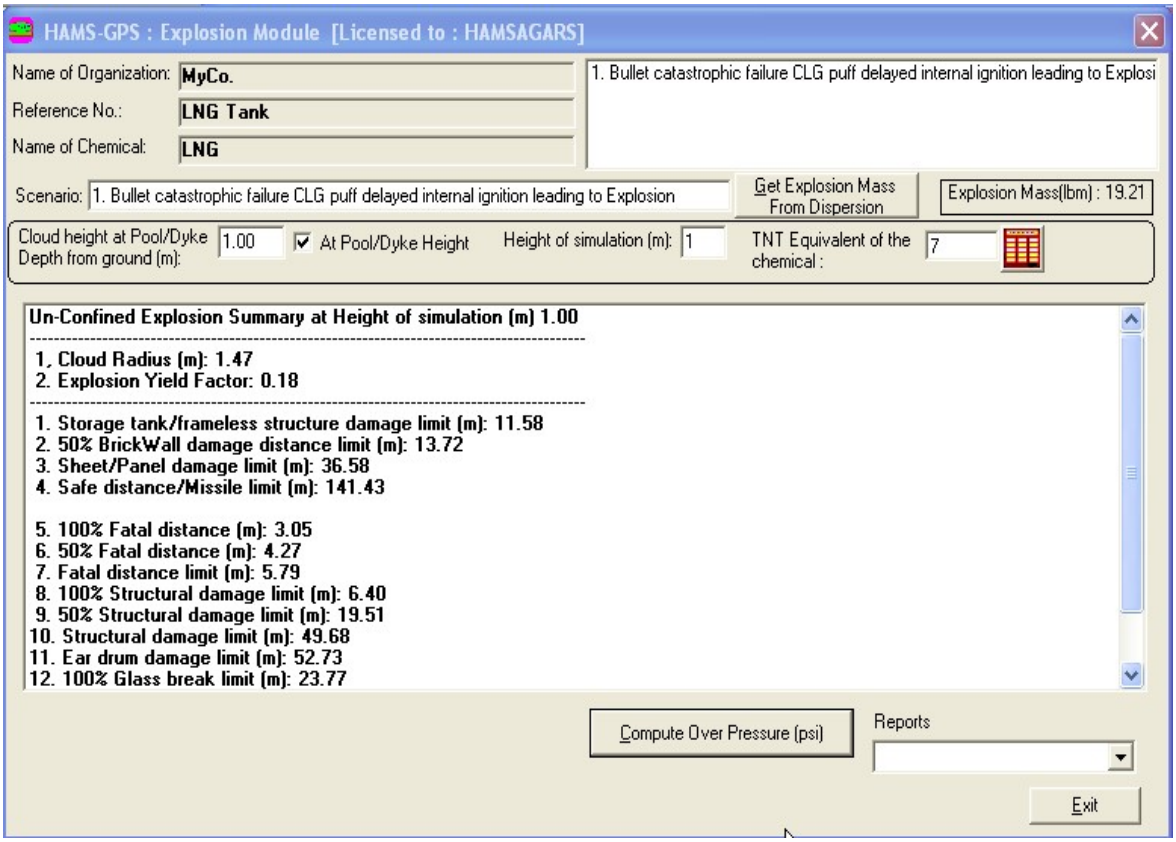


Fig-38: Explosion simulation results dialog.

You can develop reports by selecting Explosion report options from Reports combo box. The various reports generated are given below:

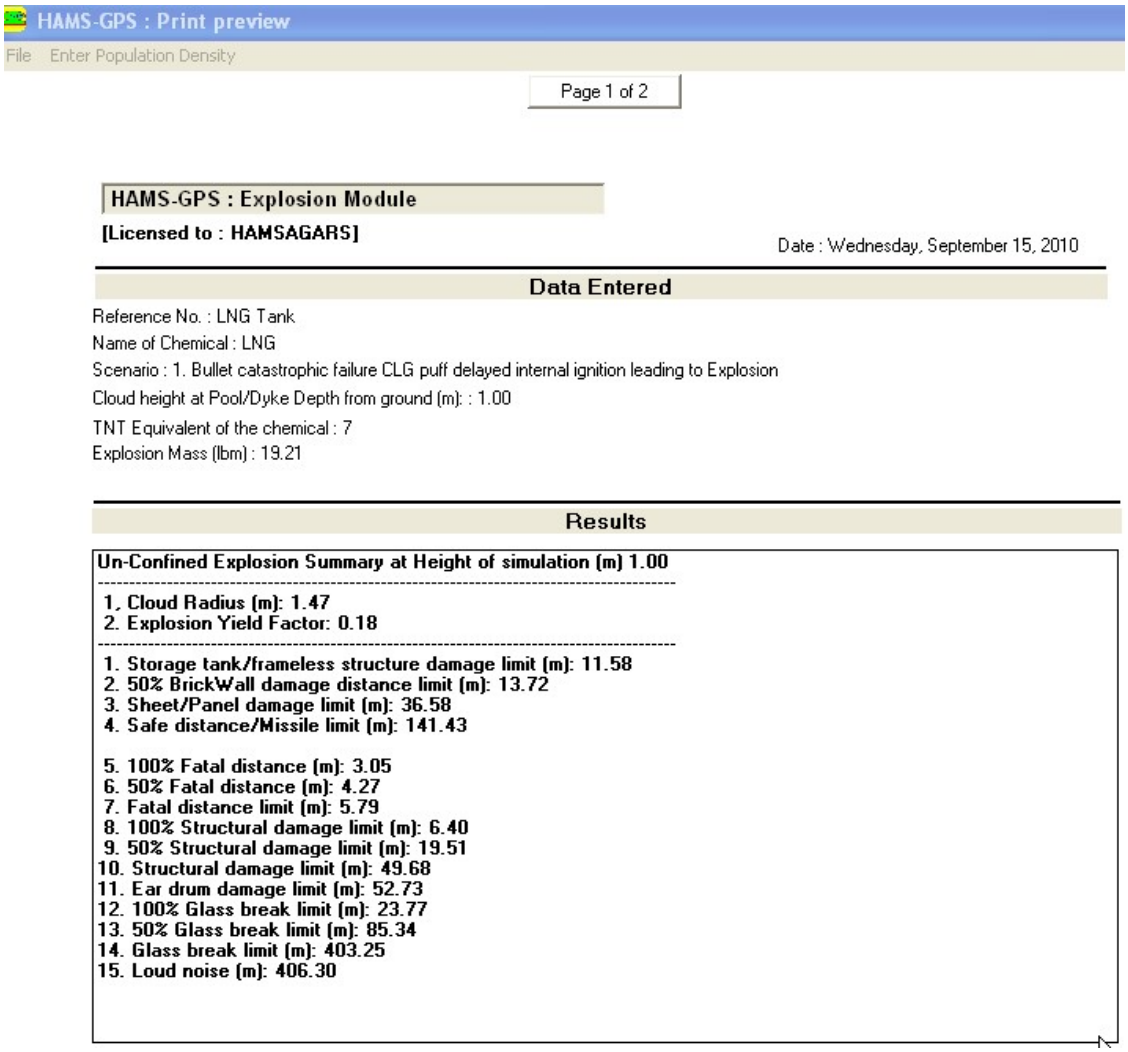


Fig-39: Report on Unconfined Explosion damages.

HAMS-GPS : Explosion Module

[Licensed to : HAMSAGARS]

Date : Wednesday, September 15, 2010

Scenario : 1. Bullet catastrophic failure CLG puff delayed internal ignition leading to Explosion

Probit Table and Absolute Fatality/Injury (At height of simulation)

Distance (m)	Over Pressure (psi) Invert	%Fatality Lung Rupture	% Ear Drum Rupture	% Structural Damage	% Glass Break	Area (Ha)	Absolute	
							Fatality No.	Injury No.
4.267	17.62	10.16	95.73	100.00	100.00	0.006	0.006	0.057
6.690	6.25	0.00	54.03	97.31	100.00	0.008	0.000	0.043
9.114	3.97	0.00	17.67	85.39	100.00	0.012	0.000	0.021
11.537	3.04	0.00	9.22	60.88	100.00	0.016	0.000	0.015
13.960	2.50	0.00	5.70	36.61	100.00	0.019	0.000	0.011
16.383	2.12	0.00	3.80	19.86	100.00	0.023	0.000	0.009
18.806	1.84	0.00	2.68	11.72	100.00	0.027	0.000	0.007
21.229	1.63	0.00	1.97	7.37	98.68	0.030	0.000	0.006
23.652	1.46	0.00	1.50	4.87	98.04	0.034	0.000	0.005
26.076	1.32	0.00	1.17	3.35	97.20	0.038	0.000	0.004
28.499	1.20	0.00	0.94	2.38	96.13	0.042	0.000	0.004
30.922	1.11	0.00	0.76	1.74	94.78	0.045	0.000	0.003
33.345	1.02	0.00	0.63	1.31	93.12	0.049	0.000	0.003
35.768	0.95	0.00	0.53	1.00	91.10	0.053	0.000	0.003
38.191	0.97	0.00	0.55	1.06	91.63	0.056	0.000	0.003
40.615	0.92	0.00	0.49	0.89	90.11	0.060	0.000	0.003
43.038	0.88	0.00	0.44	0.76	88.44	0.064	0.000	0.003
45.461	0.85	0.00	0.40	0.65	86.59	0.067	0.000	0.003
47.884	0.82	0.00	0.36	0.56	84.57	0.071	0.000	0.003
50.307	0.79	0.00	0.33	0.49	82.37	0.075	0.000	0.002

Fig-40: Report-2 on Explosion for PROBITS.

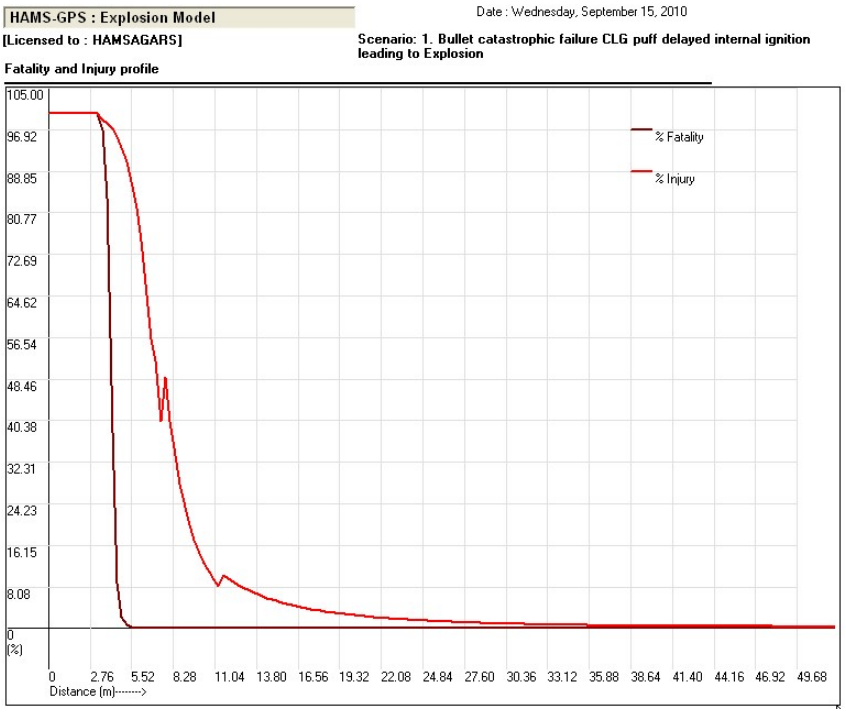


Fig-41: Explosion fatality/Injury Profile.

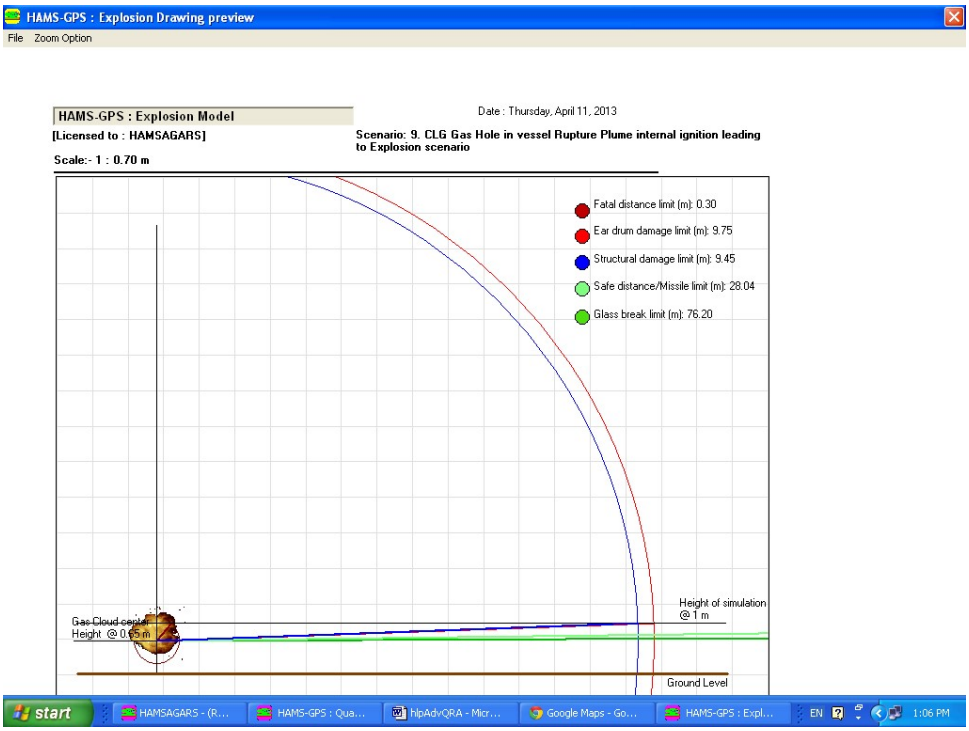


Fig-42: Explosion Consequences Diagram.

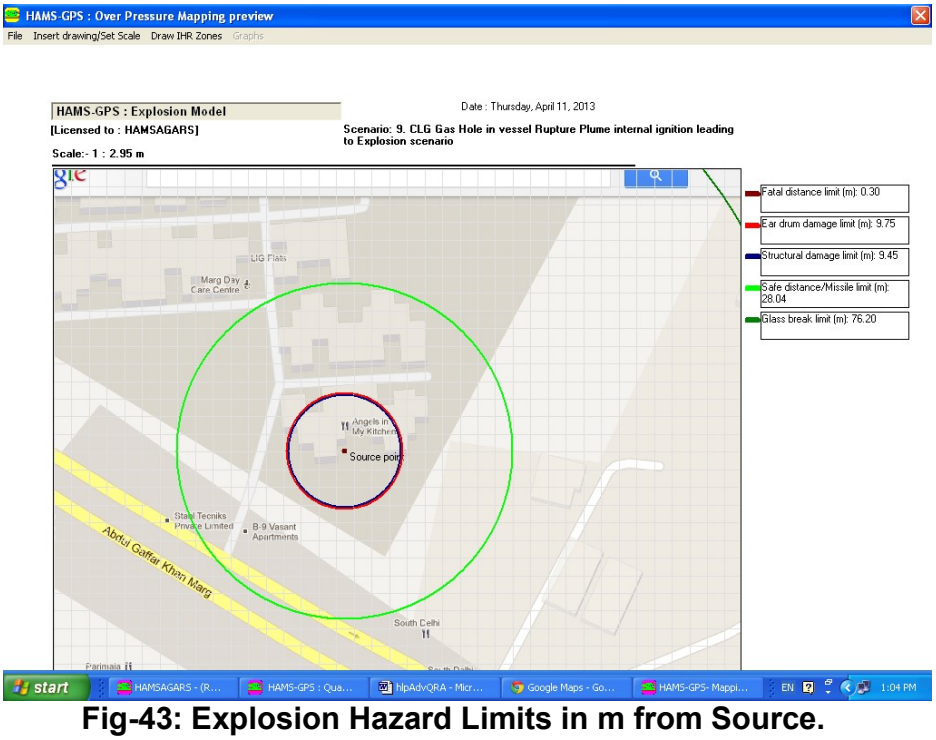


Fig-43: Explosion Hazard Limits in m from Source.

You can Plot Explosion Hazard Zones on Autocad drawing or Graphic Picture as explained under Dispersion.

Rerunning/Editing Explosion Scenarios once done, by a shortcut method: See under this under Dispersion and follow the same procedure.

19. Risk Assessment:

Risk Assessment is Final stage in QRA study. There are three final Risk measures as under:

19.1 Fatality Accident Rate (FAR): is the risk of fatality to Employees which is voluntary risk as the employees have accepted to work in the plant having known the risks of fatality from accidents of Toxic gas dispersion, fires and explosions. FAR is not dependent of Population Density as it assumes 1000 persons working in a factory and represents how many are at fatal risk.

FAR is defined as under:

1000 people likely to be exposed to work hazard during an active work life of 40 years 300 days covering a single shift of 8-hours. 100,000,000 hours / (24 hrs. Per day).(365 days per year) = 11415.5 years of exposure *or say* 11000 years:

$$FAR = \frac{10^8}{H.N} \sum_{i=n}^{i=1} (Fi.\ Ni.)$$

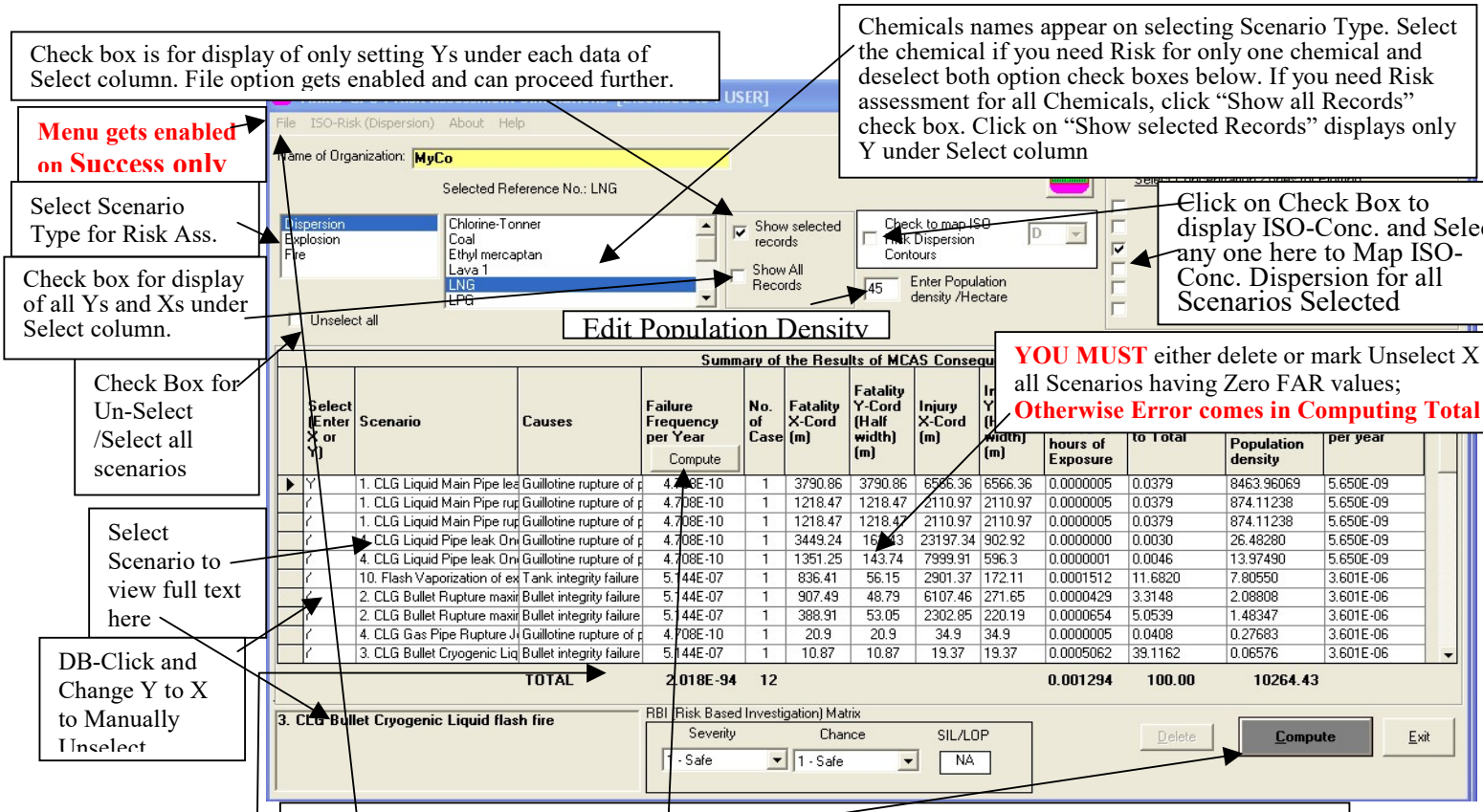
19.2 ISO-Risk or Individual Risk: is the risk of fatality to neighboring population. This is involuntary Risk as the neighboring population has not accepted the Risks of the facility in whose neighborhood they live. Individual risk is in contours showing Fatality risks in all directions around the factory where people live. ISO-Risk is again not dependent density but only shows the Fatality Risk Distance for each secondary risk.

19.3 FN-Curve: is the relationship between Frequency (F) and fatality Number (N) of potential Maximum Credible Loss Scenarios (MCLS). MCLS refers to worst accident from one facility. FN-Curve is dependent on Population Density.

It is a Natural law that Higher Fatality accidents have a lower Frequency of occurrence. Frequencies are computed for major leaks from vessels computed by Frequency-magnitude relation and for Pipeline failures based on the internal diameter per meter. In a set of frequency computations for different failure scenarios the law of inverse relation between Frequency of failure and magnitude of leak may not be strictly inverse relation. The Frequencies are therefore

smoothened to conform to the inverse law. So FN-Curve is for Smoothened Frequency (F) and Absolute Fatality Number (N).

19.4 Risk Simulation Dialog Box: Study carefully this Most Complex



After setting all the requirements as above, Click **[Compute]** Button and if Computation is successful, the **File option on Main Menu** gets Enabled as mentioned on Top Left Text Box in Red Alphabets otherwise, if Computation is un-successful, **the Computation stops, gives an Error Message and stops at Error Scenario. Then You MUST EITHER MARK IT AS X OR DELETE IT by pressing [Delete] Button or Click [Compute] Button in Frequency Column and Change Zero values. Then Click this small [Compute]** Button to Edit Frequency or Delete Error Scenario. **[Compute]** again if there is Error again, Computation again stops and action to mark as X, Edit Frequency or delete required till all errors are removed and Computation is Successful. Now the **File** option on main menu may be clicked to open Risk Simulation Options. Select the required Risk option and you get the Output. Following Options are available for Risk Simulation.

Print Preview
FN-Curve Preview (Cum. Frq Vs. Abs. Ftl)
FN-Curve Preview (Abs. Ftl)
FN-Curve Preview (% Ftl)
F Vs Dist-Curve Preview
RBI-matrix

Dialog Box.

RBI-Matrix: Select Each Scenario and open RBI-matrix Combo Box on "Severity" and Select one of the 5-Options for Severity namely: 1. Safe, 2. Low, 3. Medium, 4. Medium High, 5. High. Then open "Chance" Combo Box and Select corresponding one of the 5-Options. Note, if Severity is Safe, then Chance has to be Safe. For Industrial Severity-Chance, High Severity

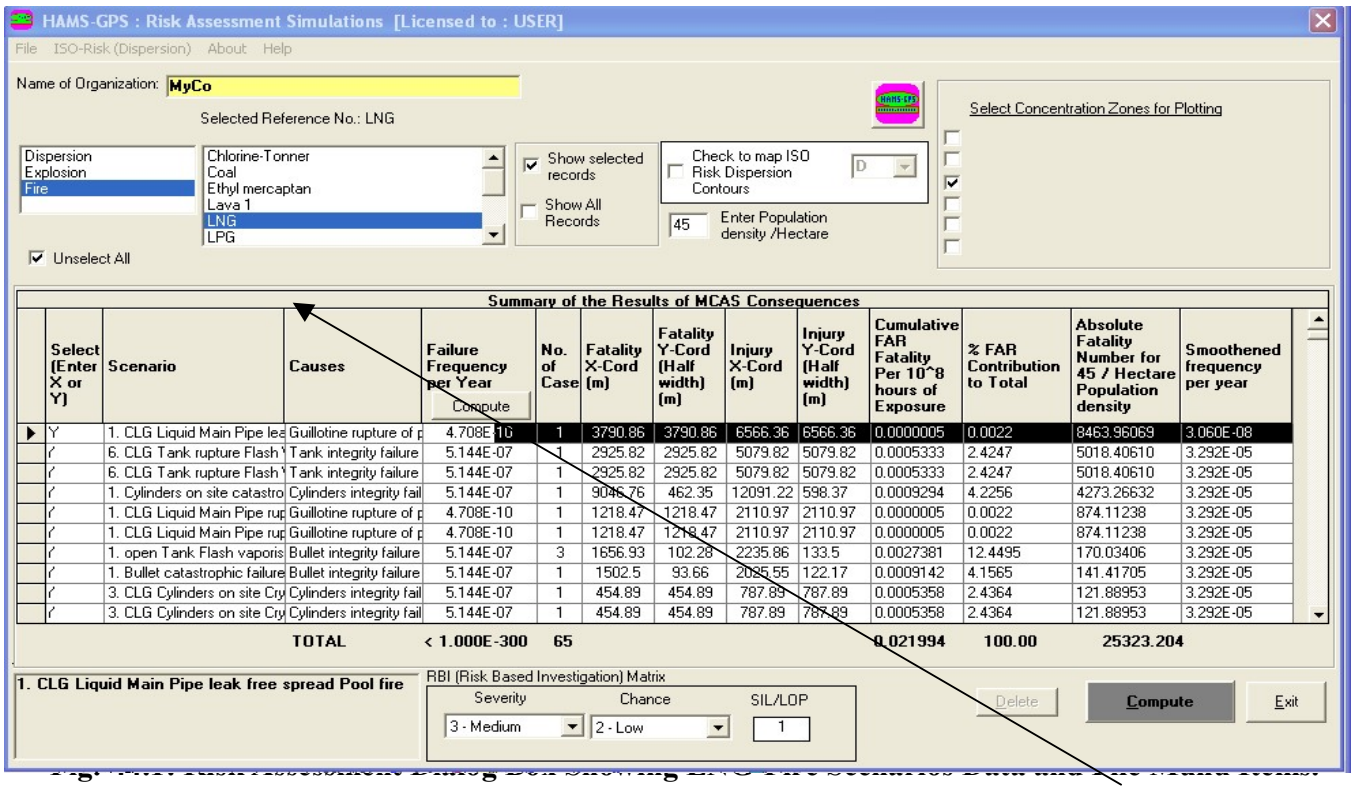
and High Chance is not present and should be avoided. Both Severity and Chance are High only in Adventure Sports.

Fig.-44: Risk Assessment Dialog Box (The Most Complex Dialog Box).

This is a Complex Dialog Box and very detailed Instructions are Provided in it. Carefully study the text boxes in the above diagram of **"Risk Assessment"** Dialog Box. Normally you need Risk Assessment for all Selected Scenarios. So Select Check Box Option **"Show Selected Records"** and click **[Compute]** button. The number of cases, Cumulative FAR and % FAR Contribution column totals get computed for all Selected Records and **"File"** option from Main Menu gets enabled. You can open **"File"** Option and Select any Sub-option required and proceed further. **Note:** You can proceed further in QRA-Options only for all **"Selected Scenarios" and NOT For individual Chemical Scenarios although you can just view the results in the above dialog box for selected chemical. So for enabling "File" option from Main Menu and to proceed further always check only "Show Selected Records" Check box.**

Important Note for Printing Risk Assessment Summary: It is required to Printer page Setup as landscape before Print Preview option is selected from File->Print Preview. If this is not done Error Message Comes to Setup Print page to Landscape. To Setup Print Page to note, the Print Preview is available only in PDF-File Format. So you must go to Start->Control Panel->Printers and Other hardware->Printers and faxes->Adobe PDF->Printer option from Main Menu->Properties->Printing Preferences->General Tab->Printing Preferences->Layout tab->Click landscape radio Button->PDF page Size set A4->Adobe PDF Settings Tab->Adobe PDF page Size->Set A4->Apply->[OK}. Now you can Select from File Menu->"Print Preview" option and your Risk Assessment Summary gets Print preview displayed.

19.5 Risk Assessment Dialog Box Showing LNG-Fire Scenarios Data and File Munu Items:



19.6 ISO-Concentration Dispersion Simulation for LNG-Scenarios:

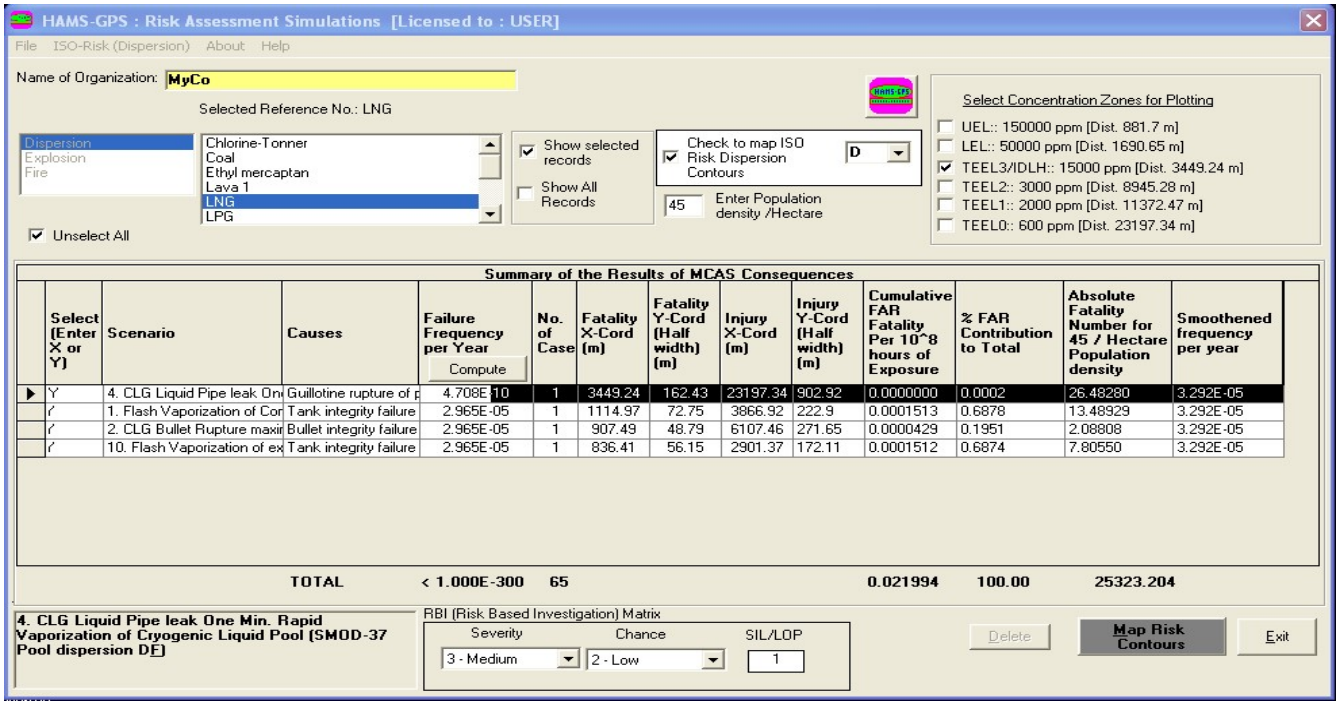
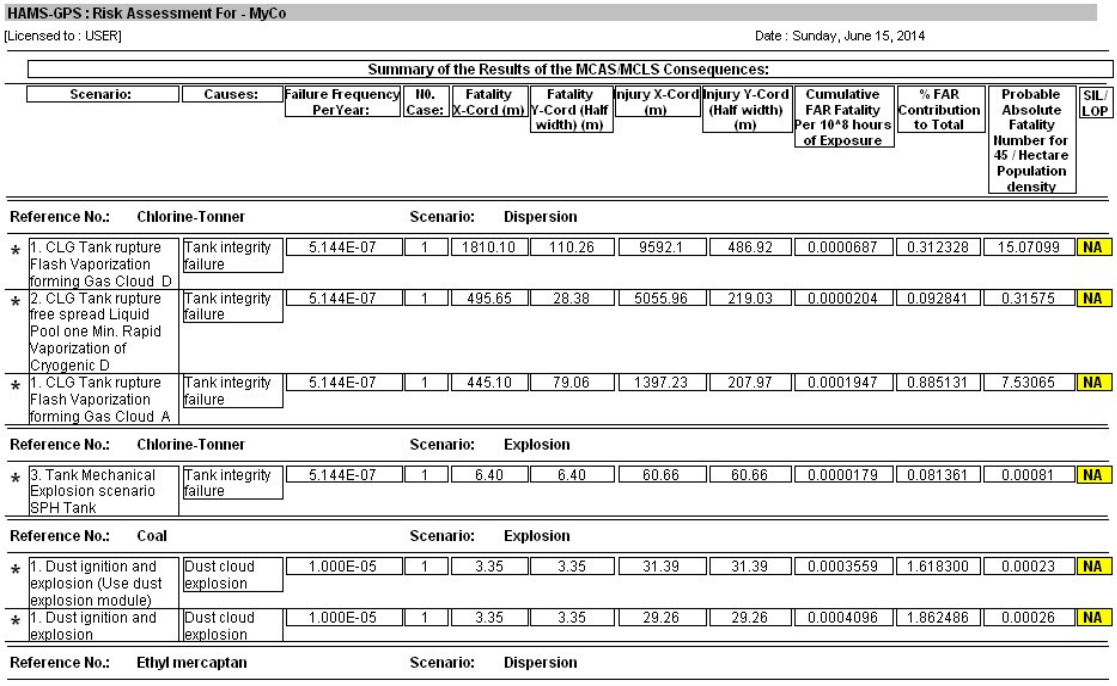


Fig.-45.2: Risk assessment Dialog Box Showing ISO-Risk Dispersion Simulation Data Displayed.

19.7 Print preview of Risk Assessment Output:



HAMS-GPS : Risk Assessment For - MyCo

[Licensed to : USER] Date : Sunday, June 15, 2014

Summary of the Results of the MCAS/MCLS Consequences:

Scenario:	Causes:	Failure Frequency PerYear:	N0. Case:	Fatality X-Cord (m)	Fatality Y-Cord (Half width) (m)	Injury X-Cord (m)	Injury Y-Cord (Half width) (m)	Cumulative FAR Fatality Per 10^8 hours of Exposure	% FAR Contribution to Total	Probable Absolute Fatality Number for 45 / Hectare Population density	SIL/ LOP
Reference No.: Chlorine-Tonner			**Scenario:**	**Dispersion**							
* 1. CLG Tank rupture Flash Vaporization forming Gas Cloud D	Tank integrity failure	5.144E-07	1	1810.10	110.26	9592.1	486.92	0.0000687	0.312328	15.07099	NA
* 2. CLG Tank rupture free spread Liquid Pool one Min. Rapid Vaporization of Cryogenic D	Tank integrity failure	5.144E-07	1	495.65	28.38	5055.96	219.03	0.0000204	0.092841	0.31575	NA
* 1. CLG Tank rupture Flash Vaporization forming Gas Cloud A	Tank integrity failure	5.144E-07	1	445.10	79.06	1397.23	207.97	0.0001947	0.885131	7.53065	NA
Reference No.: Chlorine-Tonner			**Scenario:**	**Explosion**							
* 3. Tank Mechanical Explosion scenario SPH Tank	Tank integrity failure	5.144E-07	1	6.40	6.40	60.66	60.66	0.0000179	0.081361	0.00081	NA
Reference No.: Coal			**Scenario:**	**Explosion**							
* 1. Dust ignition and explosion (Use dust explosion module)	Dust cloud explosion	1.000E-05	1	3.35	3.35	31.39	31.39	0.0003559	1.618300	0.00023	NA
* 1. Dust ignition and explosion	Dust cloud explosion	1.000E-05	1	3.35	3.35	29.26	29.26	0.0004096	1.862486	0.00026	NA
Reference No.: Ethyl mercaptan			**Scenario:**	**Dispersion**							

Note: The Risk Assessment Output is in Landscape and to enable Printing, you have to go to Control Panel-> Printer-> Print Preferences-> Layout-> Land scape->Apply-> OK

Fig.-45.3: Print Preview of Risk Assessment output.

19.8 Print Preview of Individual Risk or ISO-Risk:

To Run Individual Risk also called ISO-Risk, File->Individual Risk. You will get Individual Risk dialog as below:

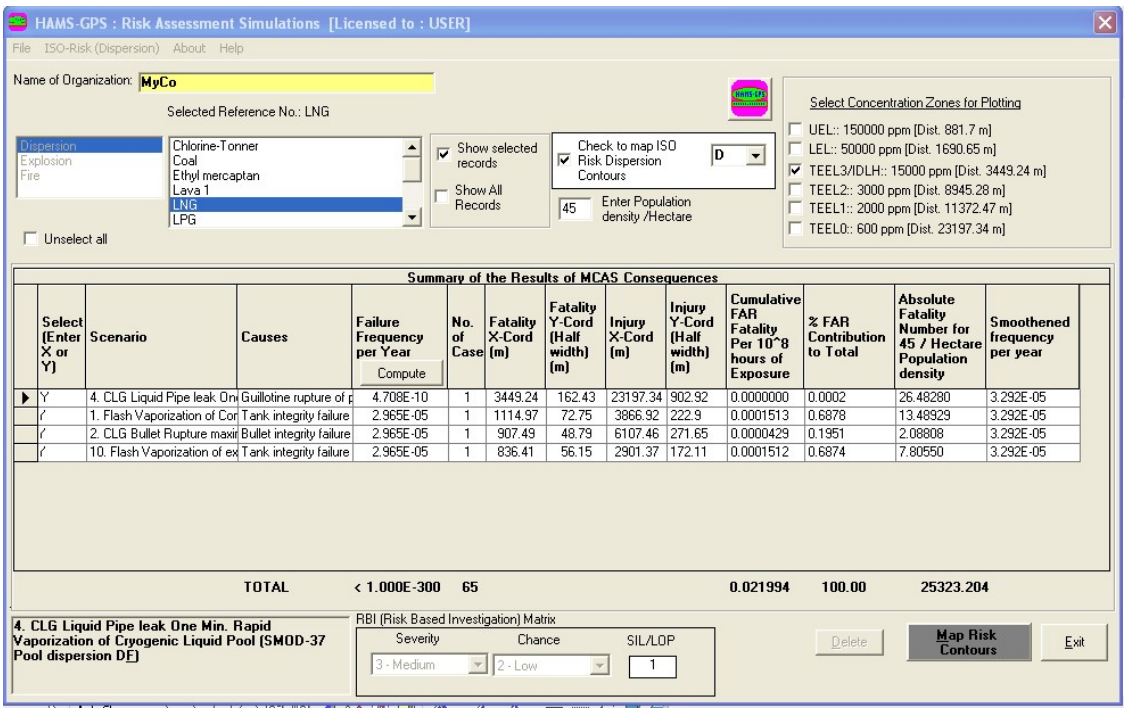


Fig-46: Individual Risk Dialog Box

Individual Risk data requires Wind Prevalence in 8-orientations as shown and Wind Prevalence data needs to be added.. To see Print Preview File->Print Preview. You will see the Print Preview. You can print using Print command on Print Preview page by clicking the Printer Icon on LHS-Top of Print Preview. **IMP-NOTE: If Wind data is not available, then an error message box comes for entering wind data. Enter wind data and proceed further.**

19.9 Plotting Individual Risk Contours on Autocad Drawing:

Procedure is same as done for Dispersion Graph Plotting.

Click on **[Map Risk contours]** Button->Mapping option dialog displayed->Click **[Open Autocad Drawing]** button->Select your Autocad Drawing and double click-> Autocad drawing opens->From Mapping Option dialog Click on **[Set Source point]** button->click on Autocad Drawing at the appropriate point where the Individual Risk Contours are to be plotted. You will get the following mapping of Individual Risk Contours. Note: If the Graph is too small or too large, you Select Size adjustment curser (Magnifying Glass) and drag curser up or down to

adjust size as required. Following is an size adjusted Graph of Explosion on AutoCAD Drawing:

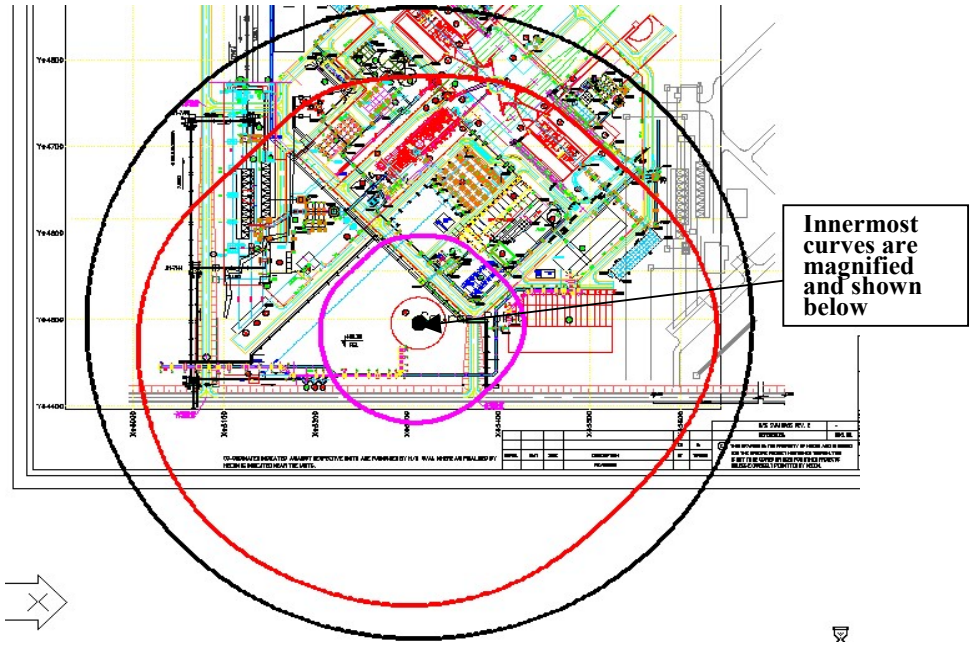


Fig-47: ISO-Risk Contours on AutoCad Drawing.

19.10 Plotting ISO-Concentration Dispersion Graphs for LNG-Scenarios:

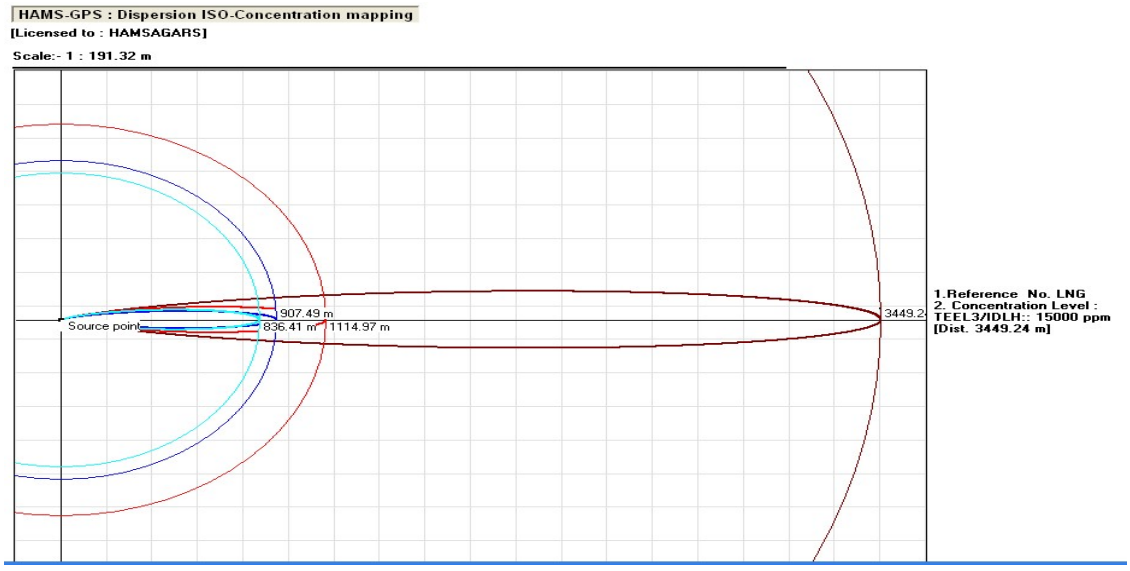


Fig.-47.1: ISO-Risk Dispersion Maps of LNG-Release Scenarios.

A magnified view of Individual-Risk contours shows the innermost curves as given below:

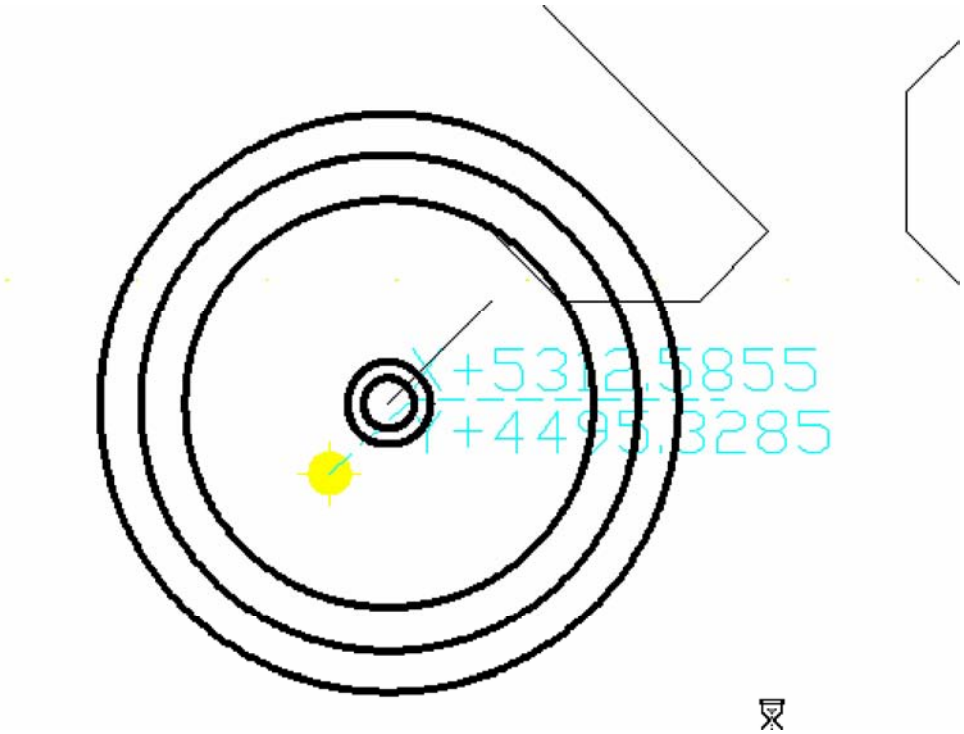


Fig-48: Magnified view of Risk Counters.

Note, some curves are perfectly circular while others are deformed curves. The perfect circles are for Fires and explosions that are not affected by wind while the dispersions are affected by wind and wind prevalence being different in different orientations, the dispersion ISO-Risk counters get deformed. In the directions of wind the Risk distance is less. In the Autocad drawing, the counters are smoothened while in the Graphic diagram, there is no smoothening as is depicted in the same ISO-Risk counters plotted on a graphic diagram as shown below:

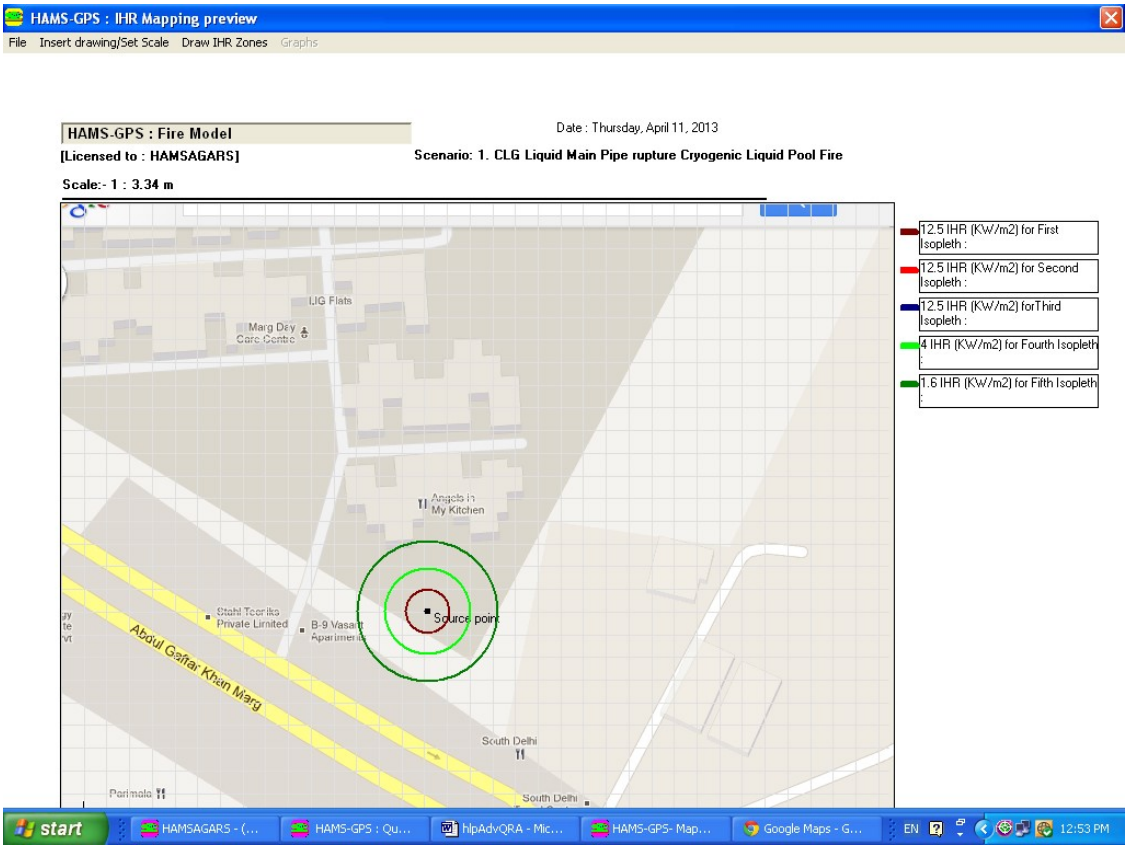


Fig-49: Risk-Contour Mapping on Goggle Map.

19.11 Print Preview of FN-Curve:

To Run FN-Curve go to File->FN-Curve. You will get the following diagram displayed:

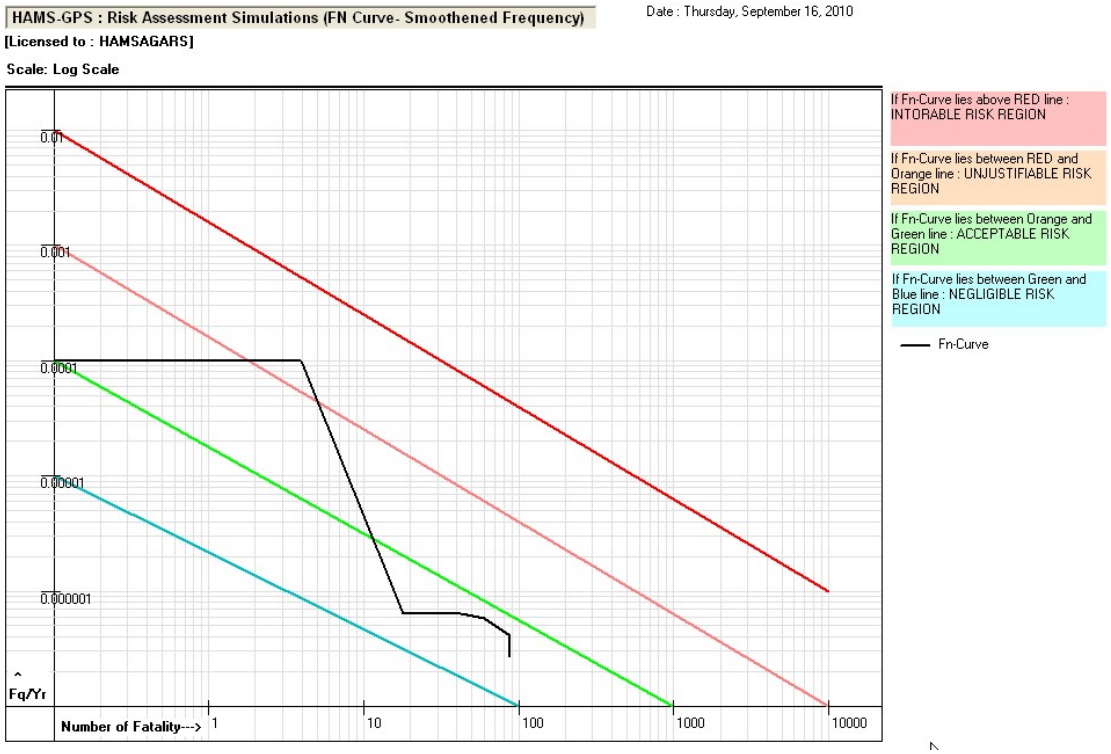


Fig-50: FN-Curve.

You will notice that Frequency (F) is on Y-Axis and Fatality Number (N) is on X-Axis. There are 4-diagonal lines in Red, Orange Green and Dark Green forming 5-zones of acceptability of FN-points. Top zone above Red is intolerable zone. Between Red and Orange lines is Unjustifiable Risk and needs reduction. Between Orange and Green is Acceptable Risk. Between Green and Dark Green is Negligible Risk and below Dark Green Very low Risk.

20. ALARP:

ALARP is short for “At Least As Low as Practicle”. This is an UK Model from Health and Safety Executive (HSE(for acceptability of Risk to Employees and neighboring population. ALARP is now integrated in the Advanced Risk Assessment System.

To Run ALARP from Advanced Risk Assessment Software, Select Risk Assessment option. Click **[Start Risk Assessment Simulations]** Button. Check Records by Click on **[Show All Records]** Check Box. Either delete or **Deselect by typing X all Scenarios having zero FAR Values.** These will cause error in

computation. After ensuring that there are no Scenarios having Zero FAR Values, Further you may Deselect also
One of those Scenarios having Values matching up to 2-D-ecimel Places as these would clutter in the ALARP Graphic Display. Once these are done, Click on **[Show Selected Records]** Check Box and the **[Show All Records]** Check Box Gets Unselected autonmatically. Now Click on **[Compute]** Button. See the Cputed value of Total FAR. Now Click on Main **"Menu File"** Option **Select "ALARP".** You will find yje following ALARP Diagram showing in 4-Colours the complete range of FAR Scale from 0 at the bottom of the inverted Tnriangle till 100 at the Top. The 4-Colours are Light Blue from 0-10 (The Range of Chemical Ibndustry FAR Range, followed by Green fom 10-25 (The Range of Oil/Gas Well Drilling FAR, followed by Straw Coloured zone (The Range of Road accidents by Cycling, followed by the last zone in Red Colour (Unacceptable Zone for all).

Normally you will find, all FAR Values generally fall in the small lowermost Light Blue Zone of FAR Range from 0-10 and your Scenarios would be Cluttered at almost just at or little above 0-Point of the scale frpm 0-100. It is necessary to Zoom-in the ALARP Diagram to see distinctly the Positions of the Top 4-FAR positions. For this, you have to Click **"Zoom"** option fnrom Main Menu FAR-Zones visible. You will find a thin **[Slider Bar]** visible at the Top. Click on the **[Slider bar]** to set Focus on it. Then Hold **[UP-Arrow Key] lightly Pressed.** You will find, the upper portions gradually move out and-Values in the Zones Enlarged and the scale also changes. Finally a small lowest part of the Light Blue Lowest zone is left in the Scale of 0-0.1 and you will see the Top 4-FAR value Scenarpo's Positions clearly displayed showing their exact positions in the ALARP Diagram. If you want ALARP Diagram for next Lower FAR Values, Unselect the Top-4 FAR Scenarioa and rerun, you will see ALARP for these. You may use any of ALARP views from 0-100 scale to 0-0.1 Scale and Print it or prepare a PDF-File and use it in your Reports. You may also Specifically Select any 4-Scenarios of interest after Unselecting all by Clicking on **[Unselect all]** Check Box and Individually Selecting any 4-Scenarios of your Choice and Recompute and Rerun ALARP .You can have any number of useful ALARP Diagrams as needed. To Zoom-out simply Press the **[Down Arrow Key].** You can also use **[Left], [Right**], **[Page UP], [Page DOWN]** Keys as well to do Zooming.

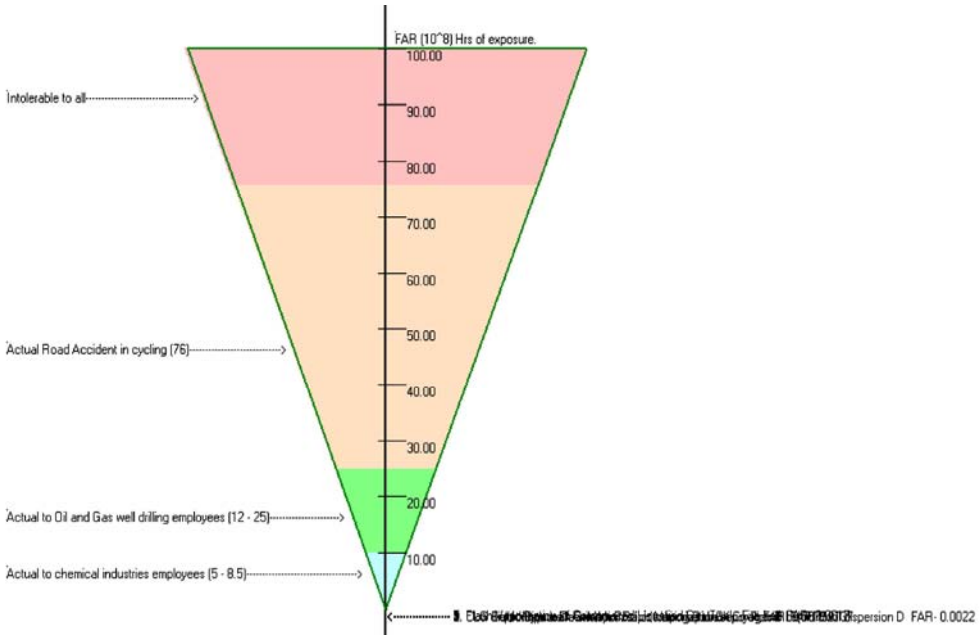


Fig-51: Full ALARP Scale view showing 4-Distinct FAR Zones Ranging from 0-100.

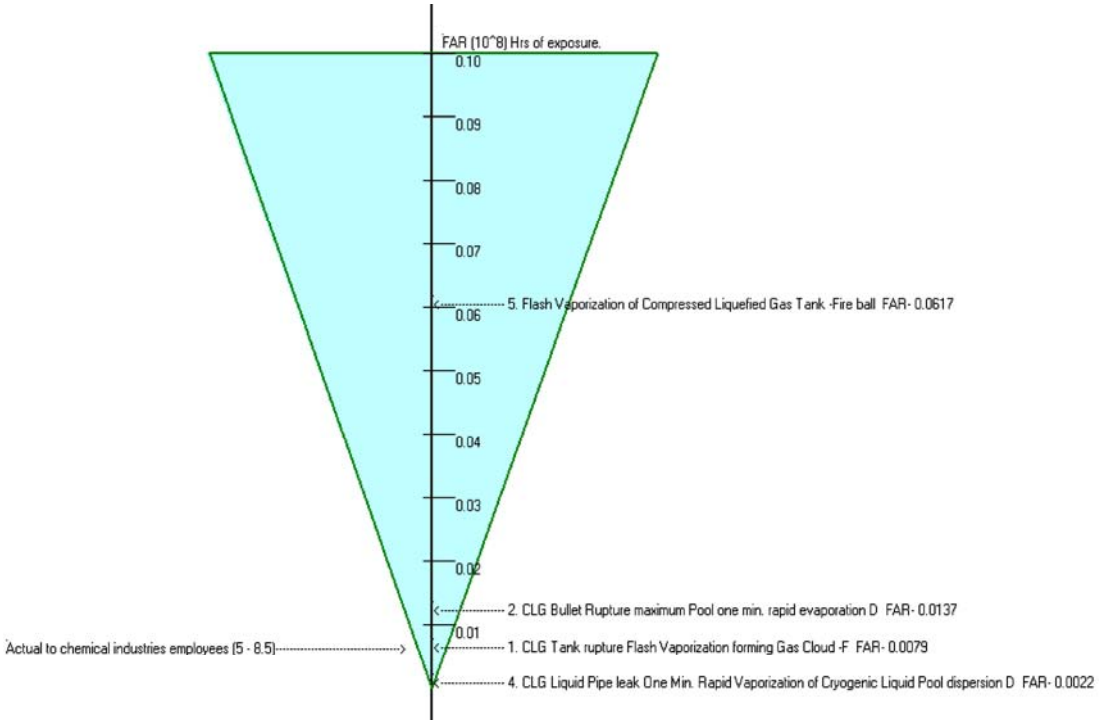


Fig-52: Fully Zoomed-in ALARP Scale view showing Top 4-FAR Scenarios in a FAR-Scale of 0-0.1

21. Manage Your Study Files and Backup database Files Option:

Click the **[Manage Your Study Files/Backup database Files]** List Box whereby the
following Dialog Box Appears:

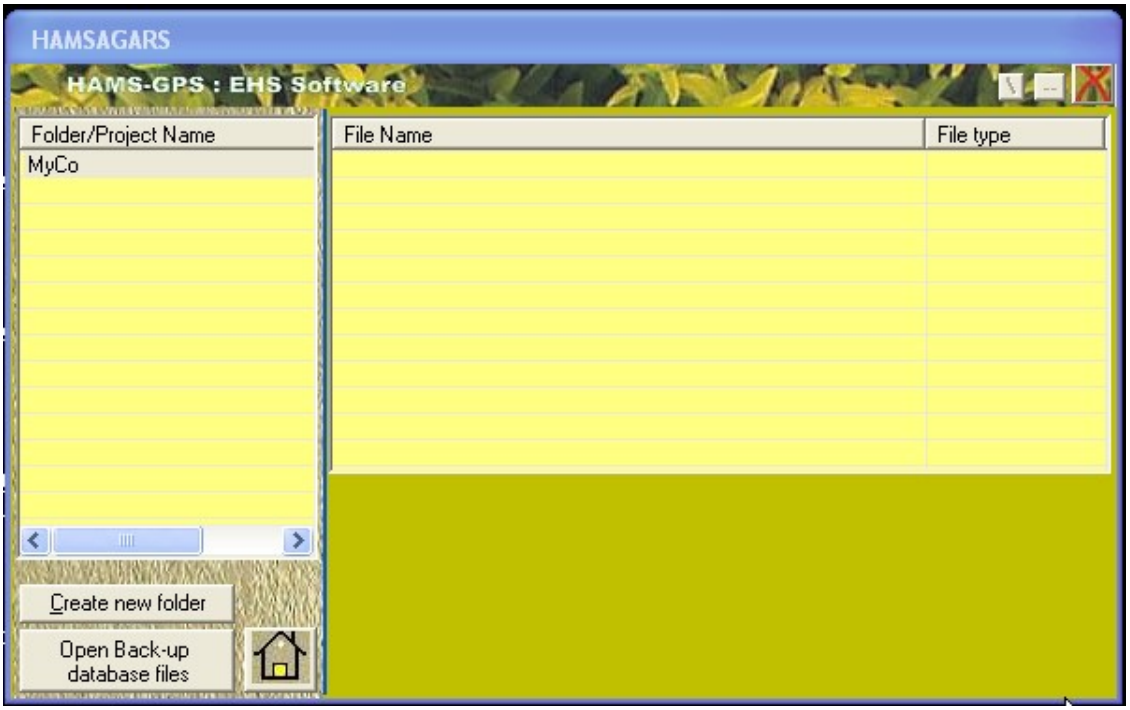


Fig-53: Manage Your Study Files/Backup database Files Dialog Box.

To create a Folder/Project name, Click on [Create new floder] button when the following Dialog Box appears. You can Click **[Floder/Project name]** Check Box and Change Text1 to name of your Folder.Project name. We have done this with MyCo and clicked [Create] Button. This Project has appeared in the dialog above.

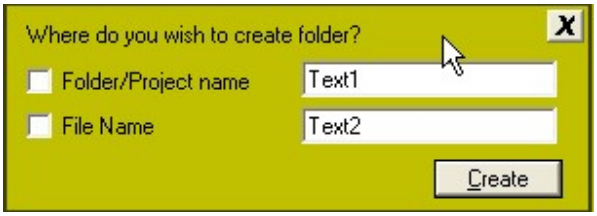


Fig-54: Folder/File Creation Dialog Box.

Similarly, Click [File Name] Check Box and add a File Name and Click Create.

To backup Database Files, Click on **[Open backup Database Files]** Button. The following Dialog Box appears.

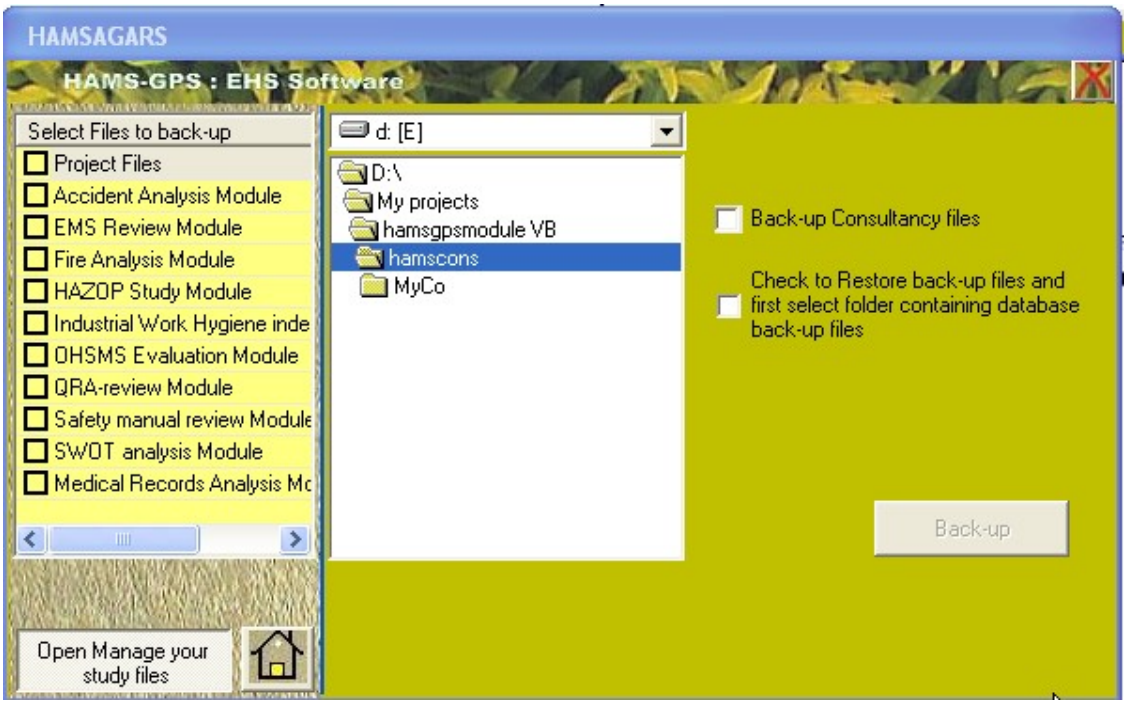


Fig-55: Open backup Database Files Dialog Box.

To backup Consultancy Files, Click **[Back-up Consultancy files]** Check Box when, the next Check Box and its Text disappears, the **[Back-up]** Button enables, and the newly created Project MyCo appears. If you have created more Projects all these appear. Click the **[Check]** box to Back-up.

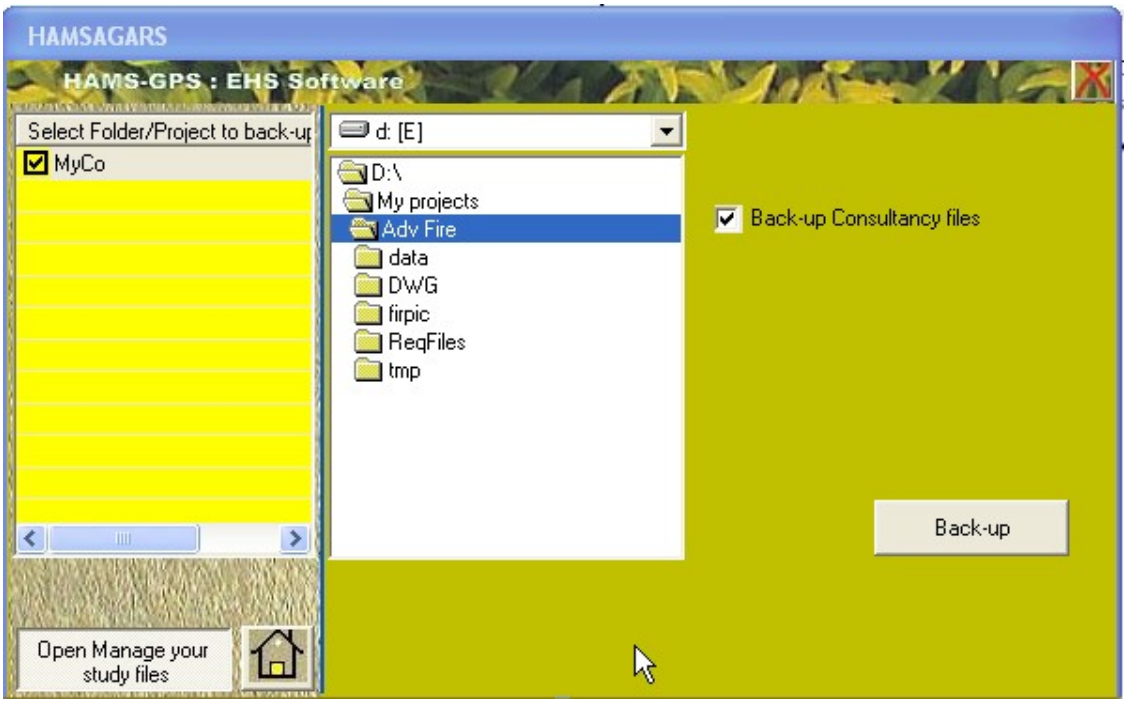


Fig-56: Consultancy File Back-up Dialog Box.

Now select the Folder where you want to Back-up this Consultancy Files. Naturally, you must first create a Folder named [MyCo-Back-ups]. Select this folder and your MyCo Project Files get backed up.

To Check and Restore back-up files, first Uncheck the [Back-up Consultancy Files] Check Box, whereby the other Check Box below that disappeared on Clicking [Back-up Consultancy Files] Check Box, reappears. Now Check the [Check to Restore…….] Check Box whereby the upper Check Box disappears and the following Dialog Box appears:

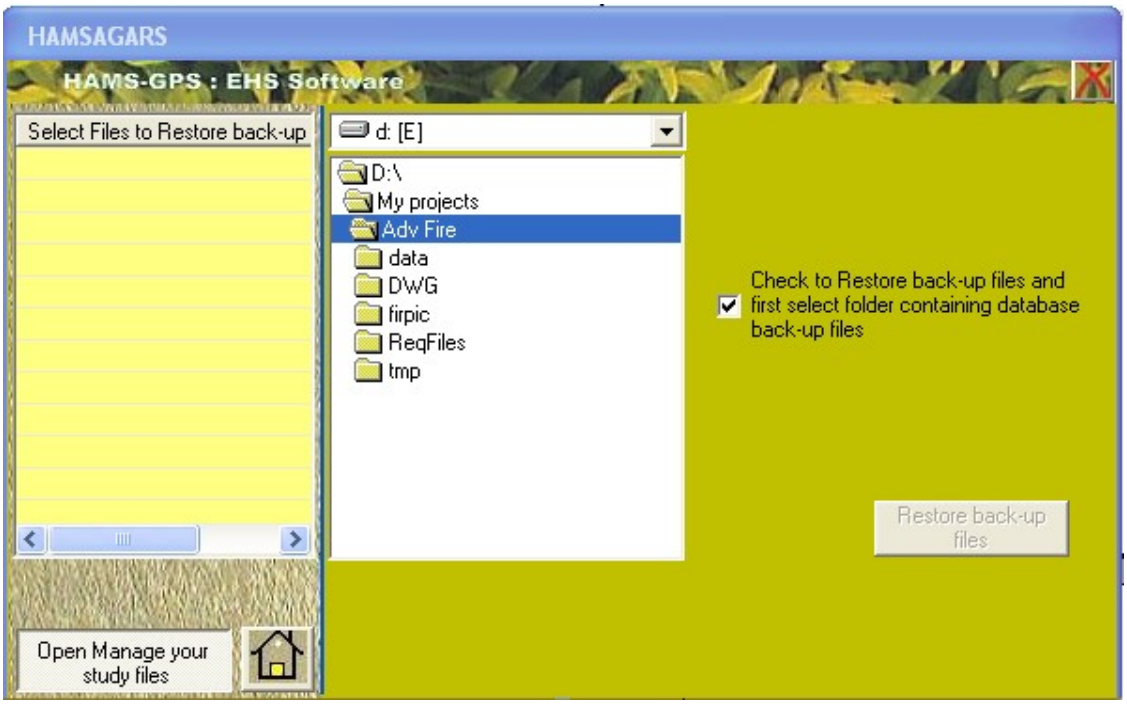


Fig-57: Check to Restore back-up files Dialog Box.

If you had any Back-up files these will appear in the Yellow **[List Box].** You can Check the **[Check Box]** open and check and if required restore your back files by Selecting the particular Backed up file.

Your Project manahement becomes very handy using this Unique Facility not available in any HSE-Software.

22. Comparison between FAR, ISO-Risk, FN-Curve and ALARP:

FAR	Risk of fatality to Employees during lifetime work from 20 yrs to 60 years. It is independent of Population density as it is for employees over 11000 years.
ISO-Risk	Fatality Risk Contours in 16-orientations does not depend on Population density. It shows for each scenario, the Fatality risk to neighboring population.
FN-Curve	Is relationship between Smoothened Frequency and Absoluty Fatality number and is dependent on Population density.
ALARP	Is acceptability of Risk to employees and neighboring population.
Note	FN-Curve may show unacceptable scenarios whileALARP shows same scenarios acceptable. This is because, the for high smoothened frequencies, the absolute fatality based on population density, may not be acceptable while in ALARP, the FAR values show acceptable fatality risk to employees based on life time service of 40 years. The unacceptable FN-Curve scenarios shows that for the

	available population density, it is necessary to reduce frequency of unacceptable scenarios or reduce populatuion around.

23 Summary of Advanced QRA Procedure:

Sr. No.	Step in Advanced QRA	Procedure
1.	Add new chemical	Click [Add]->Enter chemical name in top Text box->Open each combo box below select chemical property->Enter Physical and chemical properties in white Text boxes-> Enter Storage conditions in Green Text boxes-> Click Home icon to finish adding new chemical.
2.	Update existing Chemical data	Open existing chemical->Enter Storage conditions specific to your plant for the chemical in the Green Text boxes.
3.	Scenario development for selected chemical.	Select the chemical->Click on [Develop Scenario]->Click on Print Preview.
4.	Creating New Organization.	Click on [Risk Assessment Studies]->Double Click “Advanced QRA Module” from List Bix->Select Organization Dialog opens->Select and existing organization or Click [New Orgn.] button and Enter a new organization name-> Click inside New Organization List Box-Organization name disappears from Text box this completes creation of New Organization.
5.	Starting Advanced QRA	After selecting Organization and name of selected organization appears in the Text box click on [Open QRA] Button->QRA-Dialog appears-> Click on [Get Chemical Data] button->Select chemical from “Select Chemical Name” Combo box of “Select Chaemical” Dialog->Click [Get Data] button->data is displayed if data is extered in the chemical data base. If data is partial or not there, then Enter data here-> Click on [Insert data] button->Click Exit button-> Data gets entered in the QRA Dialog box.
6.	Running Dispersion	Select Reference No. from Lust Box and see that the selected Reference No. appears in the Text box just above. And Chemical properties from data base appear in the Text bix below-> Click on Dispersion in the “Select Scenario” List box on the RHS.->Primary and secondary Scenarios appear-> Select the first Scenario or any other if you like->Click on [Do SMOD for Dispersion Simulation] Button->:”Some more data required” dialog appears->Open combo on “Some

		More Chemical Data" and select LNG->More LNG data Required appears->Click [Compute] Button]-> SMOD gets Computed and results appear in the yellow Text boxes below->Click on [Start Dispersion Simulation/Redo SMOD] button->Click [YES] button to Run Dispersion-Dispersion dialog appears ->Click on [Compute Maximum Concentration] button. Note the maximum concentration-> Claick on [Get Concentration (ppm) button->Concentrations appear if entered in the data base. Otherwise enter as required. Note concentrations to be less than the Maximum concentration. If Concentrations exceed maximum, reduce about 10% below the maximum->Change titles of Concentration levels if required->Click on [Compute at Given Concentration]->Dispersion results appear. If End points of Isopleths exceed, Error message showing End Point exceeds 10000 m. You may try changing "Maximum distance for simulation" in the Text box up to 50000 m. Still if any Isopleth end points exceed even 50000 m, then you need to reduce quantity released. This is obly possible by reducing storage qyantity and size of main piping.
7.	Generating Reports	Once dispersion simulation is over open reports Combo Box and select repuired Report and required Report appears. Foar Plotting hazard Zones option of Report you have follow steps for mapping hazard zones.
8.	Fire and Explosion Simulations	These are very similar to dispersion simulation and specific differences may be seen in the detailed descriptions in the Detailed help above.
9.	Risk assessment	"Click on Risk Assessment" option in the "Select Scenario" List box->Click on [Start Risk Assessment Simulations] Button->Risk Assessment dialog appears.-> Click on Show all Check box. All scenarios run get displayed. Check any unselected Scenarios X marked and Select it and press Y Key or Deselect any scenarion by changing Y to X. -> Click on "Show Selected scenarios" Check box->Click on [Compute] button->open from "File" option from main menu FN-Curve and ISO Risk and for these Risk simulations.
10.	ALARP	Select "ALARP Comparison Module" from "Other Inter Related Study" option in Main Menu->Fill in the Top 5-FAR Scenarios and their % Contribution and click [Compute] button->Click [OK] button-> ALARP Diagram gets displayed.

24. Conclusions:

The above Help on Advanced Risk Assessment gives a comprehensive instructions of all Modules in Advanced Risk Assessment in a very easy to understand and executive. All input data Dialogs and outputs and reports are illustrated. It is hoped that users of HAMS-GPS users shall have and entertaining and educutive sessions with the Software.

25. TEEL Values for some common chemicals:

APPENDIX-1

No	Chemical	CASRN	TEEL-0	TEEL-1	TEEL-2	TEEL-3	UNITS
1.	**Acetaldehyde**	**75-07-0**	10	10	200	1000	ppm
2.	**Acetic acid**	**64-19-7**	5	5	35	250	ppm
3.	Acetic Anhydride	108-24-7	5	5	5	200	ppm
4.	**Acetone**	**67-64-1**	200	200	3200	5700	ppm
5.	Acetonitrile	75-05-8	40	60	60	500	ppm
6.	Acetylene	74-86-2	2500	2500	2500	6000	ppm
7.	**Acrolein**	**107-02-8**	0.03	0.03	0.1	1.4	ppm
8.	**Acrylonitrile**	**107-13-1**	2	10	35	75	ppm
9.	Alcohols, C6-C12 (N.O.S.)	68603-15-6	10	30	50	250	mg/m3
10	Alkylbenzene (C10-C16)	68648-87-3	10	30	50	500	mg/m3
11.	**Allyl alcohol**	**107-18-6**	2	2.1	4.2	20	ppm
12.	**Ammonia**	**7664-41-7**	25	30	160	1100	ppm
13.	**Aniline**	**62-53-3**	5	8	12.5	20	ppm
14.	Anthracene	120-12-7	1.5	4	30	150	mg/m3
15.	Aqua regia (75% hydrochloric + 25% nitric	8007-56-5	0.85	1.6	18	94.5	ppm
16.	Aromatic hydrocarbon solvents; (High	64742-95-6	500	750	750	750	ppm
17.	**Arsine**	**7784-42-1**	0.05	0.05	0.17	0.5	ppm
18.	Asbestos	1332-21-4	0.005	0.5	0.5	2.5	mg/m3
19.	Asbestos (Chrysotile)	12001-29-5	0.005	0.5	50	250	mg/m3
20.	**Benzene**	**71-43-2**	1	50	150	1000	ppm
21.	**Bromine**	**7726-95-6**	0.033	0.033	0.25	8.5	ppm
22.	Butane	106-97-8	800	2400	4000	19000	ppm
23.	Carbon dioxide	124-38-9	5000	30000	30000	40000	ppm
24.	**Carbon disulfide**	**75-15-0**	4	4	160	480	ppm
25.	**Carbon monoxide**	**630-08-0**	50	83	83	330	ppm
26.	**Carbon tetrachloride**	**56-23-5**	10	44	190	520	ppm
27.	**Chlorine**	**7782-50-5**	0.5	0.5	2	20	ppm
28.	**Chlorine dioxide**	**10049-04-4**	0.1	0.15	1.1	2.4	ppm
29.	**Chloroacetic acid; (Monochloroacetic**	**79-11-8**	0.5	1.5	6.6	20	ppm
30.	**Chloroform**	**67-66-3**	2	2	64	3200	ppm
31.	**Chlorosulfonic acid; (Chlorosulfuric**	**7790-94-5**	1.43	2	10	30	mg/m3
32.	**Ethylene oxide; (Oxirane)**	**75-21-8**	1	5	45	200	ppm
33.	**Fluorine**	**7782-41-4**	0.1	1.7	5	13	ppm
34.	**Formaldehyde**	**50-00-0**	0.3	1	10	25	ppm
35.	Formic acid	64-18-6	5	10	10	30	ppm
36.	Hydriodic acid; (Hydrogen iodide)	10034-85-2	0.035	0.1	0.5	5	ppm
37.	Hydrobromic acid; (Hydrogen bromide)	10035-10-6	3	3	3	30	ppm
38.	Hydrogen	1333-74-0	60000	145000	280000	500000	ppm
39.	**Hydrogen chloride; (Hydrochloric acid)**	**7647-01-0**	0.5	1.8	22	100	ppm
40.	**Hydrogen cyanide; (Hydrocyanic acid)**	**74-90-8**	2	2	7.1	15	ppm
41.	**Hydrogen fluoride; (Hydrofluoric acid)**	**7664-39-3**	1	1	24	44	ppm
42.	**Hydrogen peroxide**	**7722-84-1**	1	10	50	100	ppm
43.	**Hydrogen sulfide**	**7783-06-4**	0.51	0.51	27	50	ppm
44.	Iodic acid	7782-68-5	0.125	0.125	0.125	2.5	mg/m3
45.	**Iodine**	**7553-56-2**	0.1	0.1	0.5	5	ppm
46.	**Maleic anhydride**	**108-31-6**	0.2	0.2	2	20	ppm
47.	**Mercury vapor**	**7439-97-6**	0.025	0.1	2.05	4.1	mg/m3
48.	Methane	74-82-8	1000	3000	5000	25000	ppm
49.	**Methyl alcohol; (Methanol)**	**67-56-1**	200	530	2100	7100	ppm
50.	**Methyl bromide; (Bromomethane)**	**74-83-9**	1	20	50	200	ppm
51.	**Methyl chloride**	74-87-3	100	100	400	1000	ppm

52.	**Methyl iodide**	**74-88-4**	5	25	50	125	ppm
53.	**Methyl isocyanate**	**624-83-9**	0.02	0.025	0.067	0.2	ppm
54.	**Methyl mercaptan**	**74-93-1**	0.5	10	47	68	ppm
55.	Methyl parathion	298-00-0	0.2	0.34	0.35	15	mg/m3
56.	Methyl salicylate	119-36-8	0.125	0.4	2.5	12.5	ppm
57.	**Methylene chloride**	**75-09-2**	25	200	750	4000	ppm
58.	Naphtha (coal tar)	8030-30-6	100	100	500	1000	ppm
59.	Naphtha (petroleum), heavy catalytic	64741-54-4	6	15	125	500	mg/m3
60.	**Nickel carbonyl**	**13463-39-3**	0.003	0.036	0.036	0.16	ppm
61.	**Nitric acid WFNA; (White Fuming)**	**7697-37-2**	0.53	0.53	24	92	ppm
62.	**Nitric oxide**	**10102-43-9**	0.50	0.50	12.5	20	ppm
63.	Nitroaniline, p-	100-01-6	6	9	150	300	mg/m3
64.	Nitrobenzene	98-95-3	1	3	20	200	ppm
65.	Nitrogen	7727-37-9	60000	145000	280000	500000	ppm
66.	**Nitrogen dioxide**	**10102-44-0**	0.50	0.50	12.5	20	ppm
67.	Nitrogen tetroxide	10544-72-6	3	5	5	20	ppm
68.	**Nitrogen trifluoride**	**7783-54-2**	10	30	400	800	ppm
69.	Nitrogen trioxide; (Dinitrogen trioxide)	10544-73-7	25	50	100	500	ppm
70.	Oil gas; (Oil fog)	z-0035	450	1750	3000	4500	ppm
71.	**Oleum; (fuming sulfuric acid)**	**8014-95-7**	1	2	10	30	**mg/m3**
72.	Oxalic acid, anhydrous; (Ethanedioic acid)	144-62-7	1	2	5	500	mg/m3
73.	Oxygen (liquid)	7782-44-7	35000	100000	280000	500000	ppm
74.	Ozone	10028-15-6	0.1	0.1	1	5	ppm
75.	**Phenol**	**108-95-2**	5	15	23	200	ppm
76.	**Phosgene**	**75-44-5**	0.10	0.10	0.30	0.75	ppm
77.	**Phosphine**	**7803-51-2**	0.3	1.0	2.0	3.6	ppm
78.	Phosphoric acid	7664-38-2	1	3	5	500	mg/m3
79.	Phosphorous pentafluoride	7647-19-0	3	3	15	75	ppm
80.	Phosphorous trifluoride	7783-55-3	4	4	20	150	ppm
81.	Phosphorus (red)	7723-14-0a	0.1	0.3	0.5	4	mg/m3
82.	Phosphorus (yellow)	7723-14-0b	0.1	0.3	3	5	mg/m3
83.	**Phosphorus oxychloride**	**10025-87-3**	0.1	0.479	0.5	0.85	ppm
84.	Phosphorus pentachloride	10026-13-8	1	2	4.25	70	mg/m3
85.	Phosphorus pentasulfide	1314-80-3	1	3	5	250	mg/m3
86.	**Phosphorus pentoxide**	**1314-56-3**	1	1	10	50	mg/m3
87.	**Phosphorus trichloride**	**7719-12-2**	0.5	0.62	2.0	5.6	ppm
88.	Phosphorus trioxide	1314-24-5	0.4	1.25	7.5	40	mg/m3
89.	**Sodium hydroxide**	**1310-73-2**	0.5	0.5	5	50	mg/m3
90.	Sodium hypochlorite	7681-52-9	25	75	500	500	mg/m3
91.	Sodium nitrate	7631-99-4	0.4	1	7.5	100	mg/m3
92.	Sodium nitrite	7632-00-0	0.04	0.125	1	60	mg/m3
93.	Sodium oxalate	62-76-0	10	30	50	50	mg/m3
94.	Sodium phosphate	7632-05-5	0.75	2.5	15	75	mg/m3
95.	Sodium salicylate; (Salicylic acid, sodium	54-21-7	40	100	500	500	mg/m3
96.	**Styrene**	**100-42-5**	50	50	250	1000	ppm
97.	Succinic acid	110-15-6	7.5	25	200	500	mg/m3
98.	Sucrose	57-50-1	15	30	50	500	mg/m3
99.	Sulfamic acid	5329-14-6	12.5	40	250	500	mg/m3
100.	Sulfanilamide	63-74-1	1	3	20	500	mg/m3
101.	Sulfonic acids, petroleum; (Petrolatum acid	61789-85-3	10	30	50	250	mg/m3
102.	Sulfur	7704-34-9	0.125	0.4	2.5	12.5	mg/m3
103.	**Sulfur dioxide**	**7446-09-5**	0.20	0.20	0.75	27	ppm
104.	Sulfur monochloride	10025-67-9	1	1	1	5	ppm
105.	Sulfur pentafluoride	5714-22-7	0.01	0.01	0.01	1	ppm
106.	Sulfur tetrafluoride	7783-60-0	0.1	0.1	2.08	2.08	ppm
107.	**Sulfur trioxide**	**7446-11-9**	0.6	2	10	30	mg/m3
108.	**Sulfuric acid**	**7664-93-9**	1	3	10	30	mg/m3

109.	Sulfurous acid	7782-99-2	0.0125	0.04	0.3	1.5	mg/m3
110.	Sulfuryl chloride	7791-25-5	0.4	1.25	7.5	15	ppm
111.	**Thionyl chloride**	**7719-09-7**	0.2	0.2	2	10	ppm
112.	**Toluene**	**108-88-3**	200	200	510	2900	ppm
113.	**Vinyl acetate**	**108-05-4**	5	5	75	500	ppm
114.	**Vinyl chloride**	**75-01-4**	1	50	5000	20000	ppm
115.	Xylenes, m-	108-38-3	100	150	200	900	ppm
116.	Xylene, o-	95-47-6	100	150	200	900	ppm
117.	Xylene, p-	106-42-3	100	150	200	900	ppm
118.	**Xylenes**	**1330-20-7**	100	130	920	2500	ppm