NPTEL

NPTEL ONLINE CERTIFICATION COURSE

Health, Safety & Environmental Management in Offshore and Petroleum engineering (HSE)

Module 4:
Safety measures in design and operations
Lecture 1: Software used in HSE

So friends we have successfully completed lectures on three modules on the course on health safety and environmental management in offshore and petroleum engineering which is in NPTEL course offered at IIT Madras. Now subsequently we will look at the fourth module lectures where the fourth module will focus on safety measures in design and operations, in this lecture being the first lecture in module four I will talk about the use of software in HSE management.

In general I will also solve an example how to use a software for a specific application as picked up from the oil industry.

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Before you go into detail let us quickly see what are those topics we will be discussing in the fourth module we will talk about use of software in HSE, we will talk about safety measures as a summary in oil and gas industries, we will discuss some of the safety methods which can be used and implemented in design stage itself and successful application during the operation stages of the process plans.

We will also talk about very briefly a summary on process safety management which has been covered in detail in earlier modules for your understanding.

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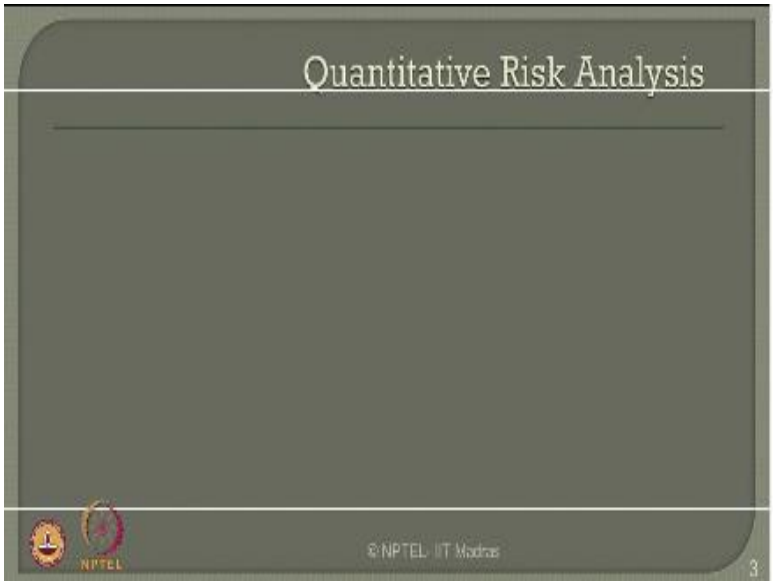

Now we will talk about what are the different software or regions or areas of software used in HSE we can broadly divide this into four segments, on the top is QRA which is quantitative risk analysis which has got variety of software used.

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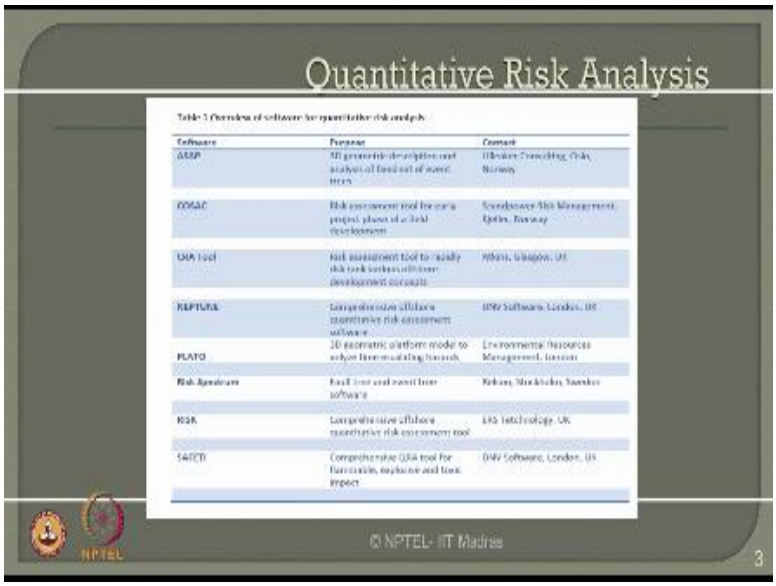

In the industry in practice now, the first on the list is ASAP which is actually a three-dimensional geometric description and analysis used for fixed set of even trees which case generally developed by Lilleaker consulting Oslo Norway the other list on the software is Cossack which talks about risk assessment tool for early project phase of a field development which is developed by Kichler Norway which is a scan power risk management software.

We can also use what is called CRA tool developed by Atkins grass Co in UK which is used for risk assessment to rapidly risk rank various offshore development concepts, Neptune and plateau are preferably used software's for comprehensive offshore QRA and 3-D geometric platform modeling respectively Neptune is of course developed by D&B software in UK whereas plateau is developed by ERM in London.

Risk spectrum is focused on fault tree and even tree analysis software which is developed by Relcon in Sweden risk is again a comparable software which talks about comprehensive QRA tools which is developed by ERS technology in UK, SAFETI is a very preferable and famous and public use software which is developed by D&B, UK which has comprehensive QRA tools for flammable, explosive and toxic impact releases which are very common in process industries.

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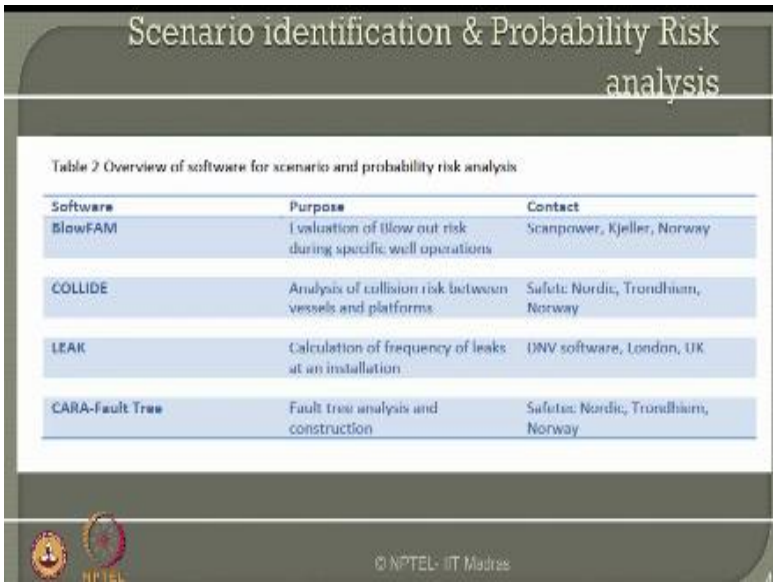

The next place of software talks about the scenario identification and probability risk analysis segments where blow FAM developed by scan power Norway is used for evaluating blow out risks during specific well operations, co-lead developed by Safe Tech Nordic Norway is used for analyzing collision risk between the vessels and platforms whereas leak developed by D&B UK is used to calculate frequency of leaks at any installation.

Kara fault tree developed by Safer Tech Norway is used for FDA and construction of FDA for different kinds of application where scenario identification and PRA becomes an effective tool.

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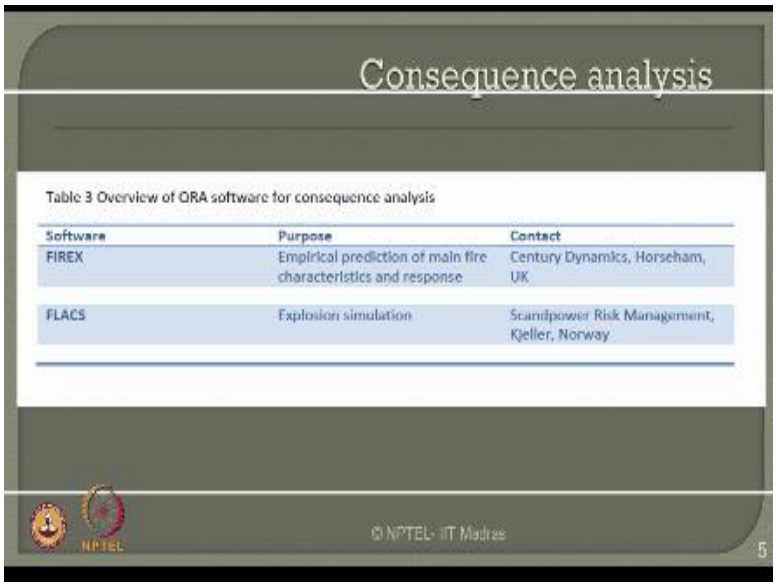

The third segment of software is focused on consequence analysis where FIREX and FLACS are very common models used software models used in this segment, FREX talks about empirical prediction of main fire characteristics and its response developed by century dynamics UK whereas FLACS software talks about explosion simulation which is developed by scan power risk management Norway.

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The fourth and the last segment is talks about qualitative risk analysis tools where PHA-PRO developed by DNB software UK talks about hazard recording reporting to FMEA what if and checklist etc, which is a very comprehensive and detailed software used and practiced in oil gas industries, cybertron is parallely another software used for FMEA and FMECA developed by Safetec Nordic Norway.

Now ladies and gentlemen these are some of the software which are very commonly and preferably used in oil and gas industries, now I will not be able to give access to all the software to you through this course however for developing interest and ensuring comfortability of using software for risk analysis I have decided to take you an example of using a software for risk analysis step by step procedure and I also run a quick video to show you how this can be easily used as an application end for oil and gas industries.

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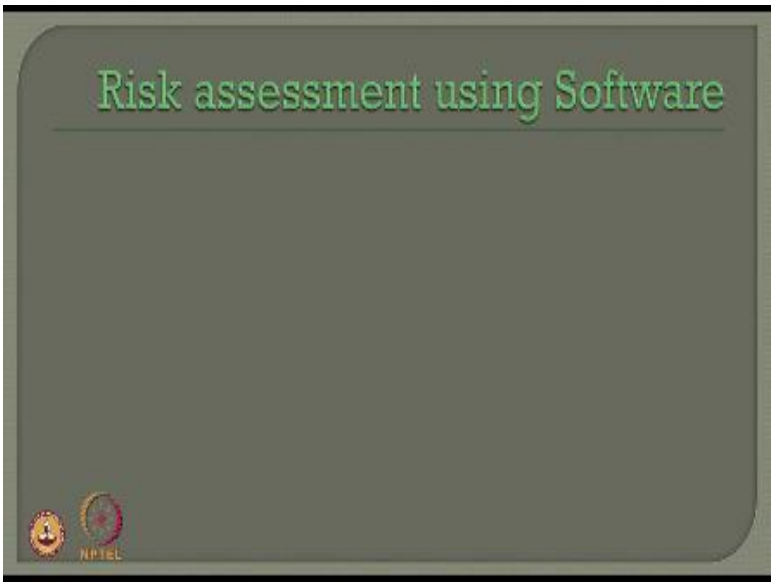

So in that front let us talk about risk assessment using a software directly we have talked about risk assessment in detail in the previous modules but in this set of lectures we will talk about how I will do risk assessment exclusively using a software.

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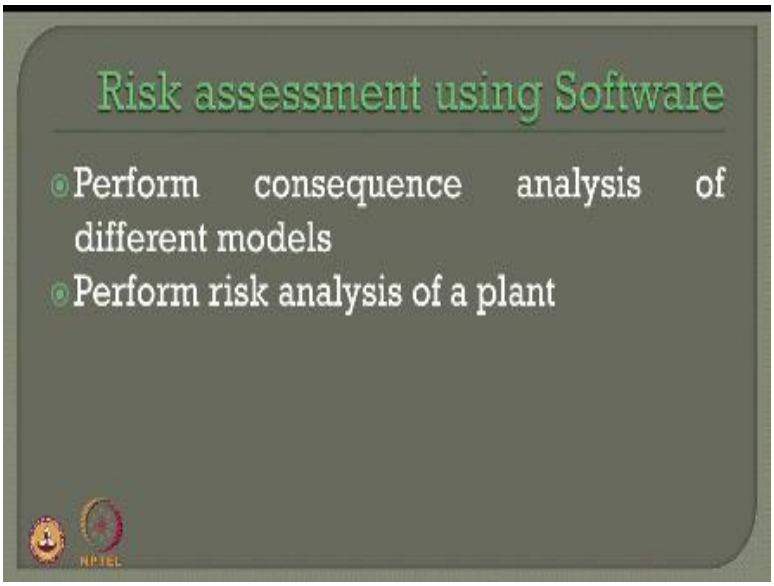

We would like to perform consequence analysis using different models we will talk about performing risk analysis of a process plant.

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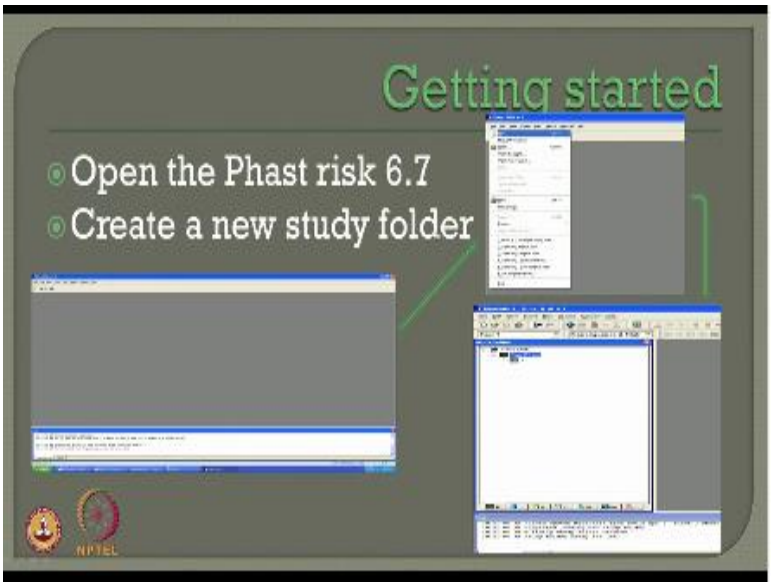

Using the software the software is actually fast Chris which is developed by D&B which I am going to explain you in briefly step by step I will also run quickly a video how the software can be implemented in use directly by practicing professionals, to talk about getting started let us see how we get open this software fast risk I am of course referring to the version 6.7 I would urge the viewers to contact NV software to look at the latest release of the versions of this model.

Of course this lecture will focus on step-by-step use of fast risk 6.7 for offshore and petroleum industry engineers as a practicing professional, I will take you through step-by-step involved in using the software for easy convergence of understanding, the moment you open the software you want to create a new folder where we talk about development of run rows.

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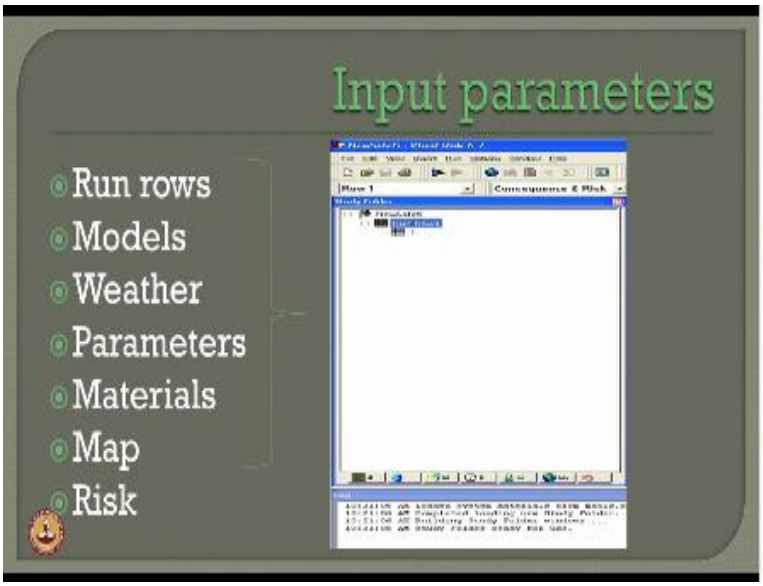

If you have to specify various input parameters where we talk about run Rows let us see what are those parameters which are generally required for consequence and risk analysis as you see here, let us say talk about Row 1 you are talking about different run rows you have got to prefer and develop different models we have to specify different weather data we have to specify other parameters.

Which are used for analysis we should also specify the inventory of the material all will now become input parameters for analyzing this, of course one should also specify and give an input of the map because societal risk is always preferably marked on a geographical map more specific location, then one can estimate societal as well as individual risk based upon the software output. Which is dependent on the characteristic and quantity of the input given by the user.

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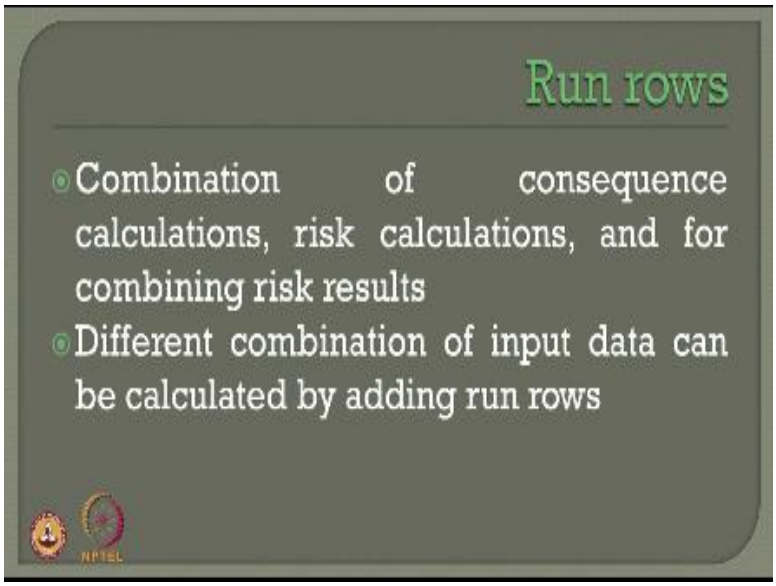

Let us talk about what do you mean by run Rows run, Rows actually give you a combination of different consequences for its calculation risk estimation and it is useful for combining the risk results, for different combination of input data one can calculate by adding the run Rows one by one in the given input parameter.

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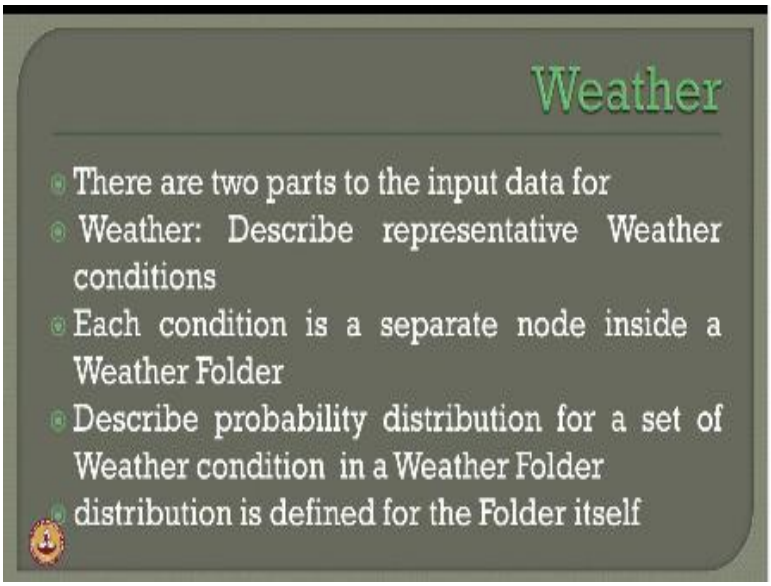

One should also specify something about the weather data there are two parts of the input data to be given for the weather, first one is about the weather which describes the representative weather conditions each condition of course is a separate note inside a given folder called a weather folder it describes probability distribution for a set of weather condition in a given weather folder.

Dear friends please understand once you specify different weather conditions one must also specify what are those probability of those weather conditions occurring in a given weather folder, so each weather folder will be attributed to a probability distribution for a set of weather condition which will all combined in a given single set and available in a consequence called weather folder. The distribution for each folder is defined within the folder itself.

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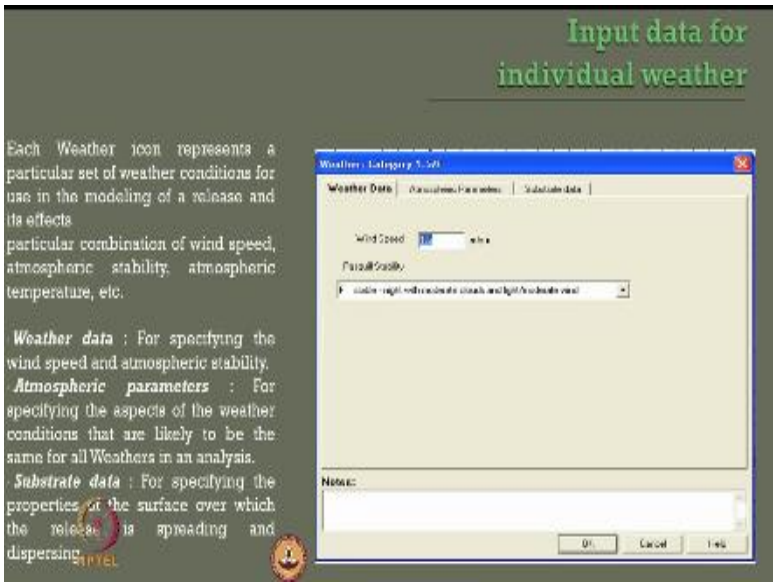

Let us quickly see what are those input data for individual whether folder, for example the screen which shows you now is a specific stability class where he winds p is 1.5 meter per second and it is corresponding to the Pascal stability class f which says it is stable it is a night condition with a moderate cloud and light and moderate wind speed where the wind speed is only1.5 meter per second.

Of course there is a cascade when available here which talks about other remaining Pascal stability classes varying from A to E where accordingly you can choose the stability class under the corresponding wind speed as given in the literature. So each weather icon represents a particular set of weather condition for use in the model of a release and its effects also, particular combination of wind speed, atmospheric stability, atmospheric temperature.

All will be combined together to create a weather category for example the screen which shows now is a weather category 1.5 stroke f means the wind speed is 1.5meter per second and the Pascal stability class is class F, so one can create different categories of this order which is a combination of wind speed, atmospheric stability and of course the temperature as well, if we talk about input of weather data.

For specifying wind speed and atmospheric stability we must use the weather data, the atmospheric parameters in this menu we will talk about all these used for specifying the aspects of the weather conditions that are likely to be same for all weather in a given analysis of course the substrate are date data which is a menu again here will talk about of its used Full form specifying the properties of the surface over which the release is spreading and dispersing.

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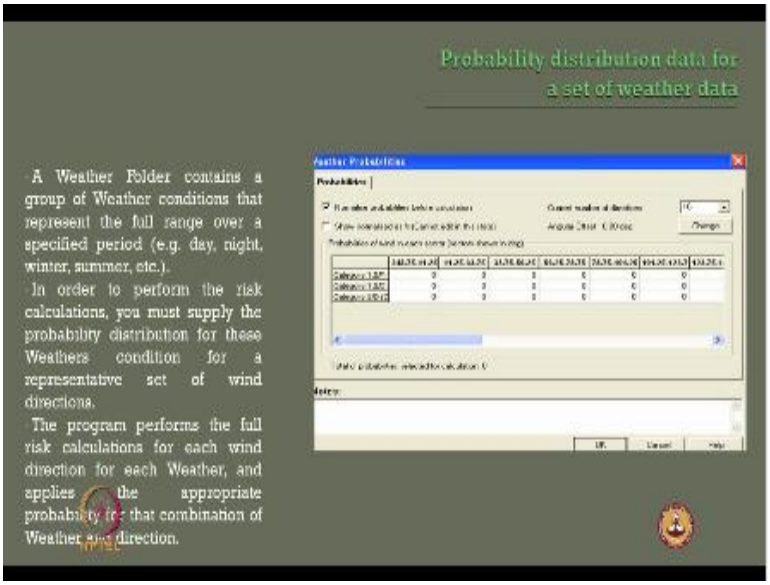

We also have to specifically say the probability distribution data for a set of weather data if you talk about the probability distribution menu as you see here there are different kinds of directions considered for the analysis as for the wind data is concerned this can be obtained directly with interface from wind rows diagram as you have can also change the angle offset of the wind direction depending upon the menu available here.

One can also pick up either normal probability before calculation or show normalized as percentage, now one can always say what would be the effect of different Pascal stability class for a given wind speed as you see in a different category, when you talk about probabilities a

weather folder contains a group of weather conditions for example in this case there are three groups 1.5 class F, 1.5 class D, and 5 class D.

So it talks about group of other conditions that represent a full range or a specified period which varies from day, night, winter, summer etc. Once this is specified in order to perform the calculation you must supply the probability distribution for these weather conditions for a refrigerated set of wind direction, so one must specify what is the probability of occurrence of these weather conditions specifically on a given wind direction.

As an input data, the program then performs the full risk calculation for each wind direction for each weather condition as an apply the appropriate probability for the combination of weather condition and direction for calculating the risk results.

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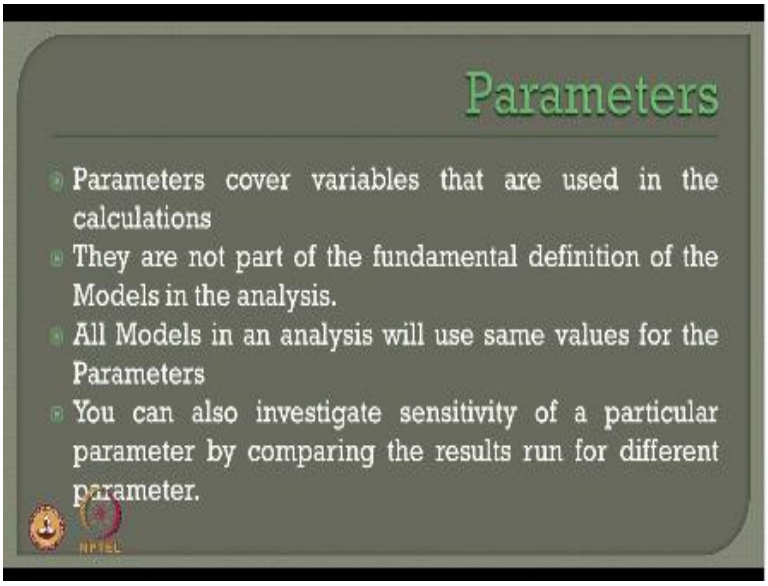

As we understand to do an analysis we must also give various other parameters as input data parameters cover variables that are used in the calculations in the software, they are of course not the part of the fundamental definition of the models in the given or the prepared analysis, all models in a given analysis will use same values of parameters for the analysis of course you can

also investigate the sensitivity of a particular parameter. If you really want to do that one must compare the results for different parameters and run different results separately and then compare them to find out the sensitivity index of a given parameter on the final risk result calculations.

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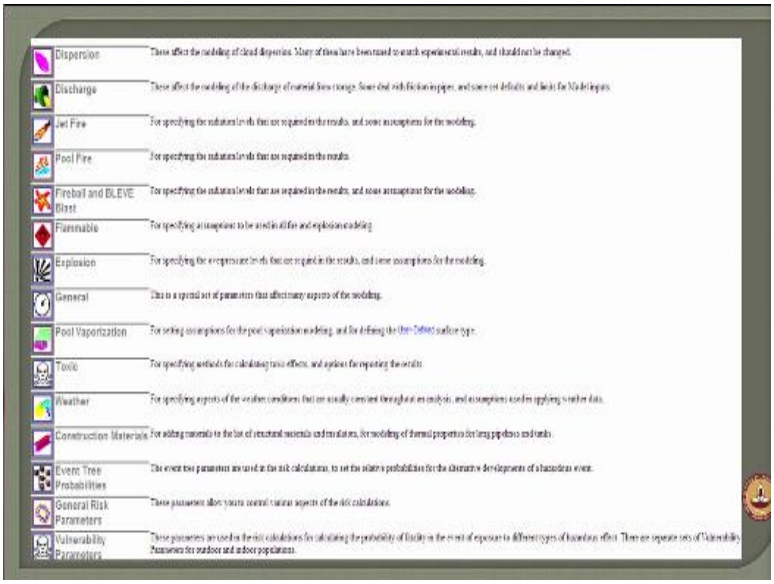

Now let us look at what are those parameters which simply given as an input for the given analysis, one can look at dispersion as a parameter which is the effect of modeling of cloud dispersion many of them have been tuned to match experimental results and therefore should not be changed or altered in the given analysis, when you talk about discharge as one of the analysis parameter.

These affect the modeling of the discharge the material from the storage some deals with friction in the pipes some set defaults and limits for model inputs, one can also use Jet fire for specifying the radiation levels that are required in the results and some assumptions for the modeling, one can use pool fire for specifying radiation levels that are required in the results one can also model fireball and BLEVE blast.

For specifying radiation levels that are required in the results of course it is based upon certain assumptions given in the modeling one can also do flammable more index modeling for specific assumptions to be used in all fire and explosion models, explosion models are used for specifying the overpressure levels that are required in the results of course this model has got certain assumptions which should not be violated.

One can also use general parameters which are set a parameters that may affect the aspect of different modeling status pool vaporization is one important aspect which is used for liquid release models is used for defining user defining surface type in a given system, of course for gaseous and vapor clouds toxic release models or parameters can be used which specifies the methods for calculating toxic effects and options for reporting the results.

They specify whether aspects of weather conditions are generally specified which are usually constant throughout the analysis and it is based on certain assumptions while applying the weather data, of course the construction materials can be also added to the list of structural materials in insulators for modeling them using the thermal properties for long pipelines and tanks.

Even tree probabilities can be used for risk calculations to set the relative probability for alternative development of the hazardous evened general risk parameters can be used which will allow you to control various aspects of the risk calculation of course one can also include the vulnerable parameters which are used in this calculation for computing the probability of fatality in the event of exposure to different type of hazardous effects these are separate sets of vulnerability parameters which are used for outdoor and indoor populations.

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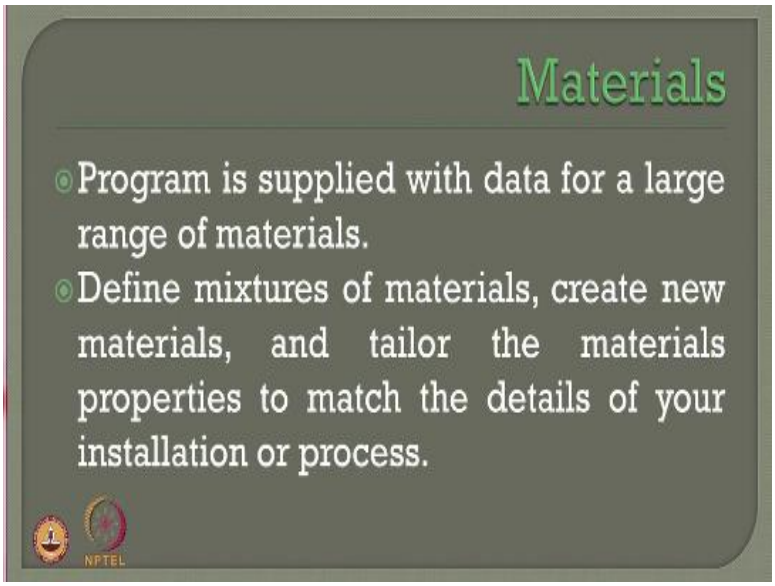

If you look at various type of materials which are used for risk assessment as we all understand material inventory plays a very important role in risk assessment and estimation this program is supplied with a set of data for large range of material which are commonly used in oil and gas industries it defines the mixtures of material creates new material and allows you to tailor the material properties to match details of installation or the process plant.

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Mapping is very important because maps can be useful for displaying the results of a consequence analysis, they give a clear presentation of the possible effects of a given event, maps are essential for risk analysis since the data on the distribution of operation and ignition sources will always be prepared and shown as a graphical output based upon any software. So it is important that map for given data in terms of population whether etc should be available as an input data which is used for software analysis.

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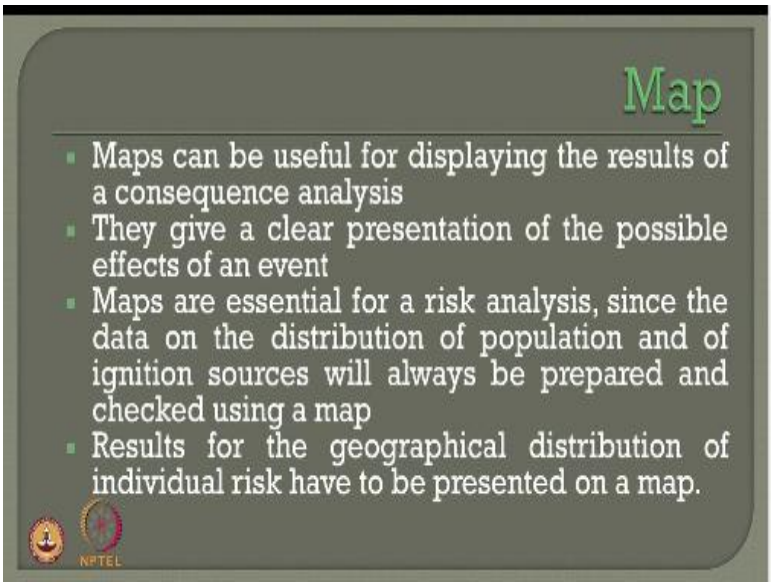

Results of course are available the geographic distribution of the individual risk which is generally plotted and presented on the map itself.

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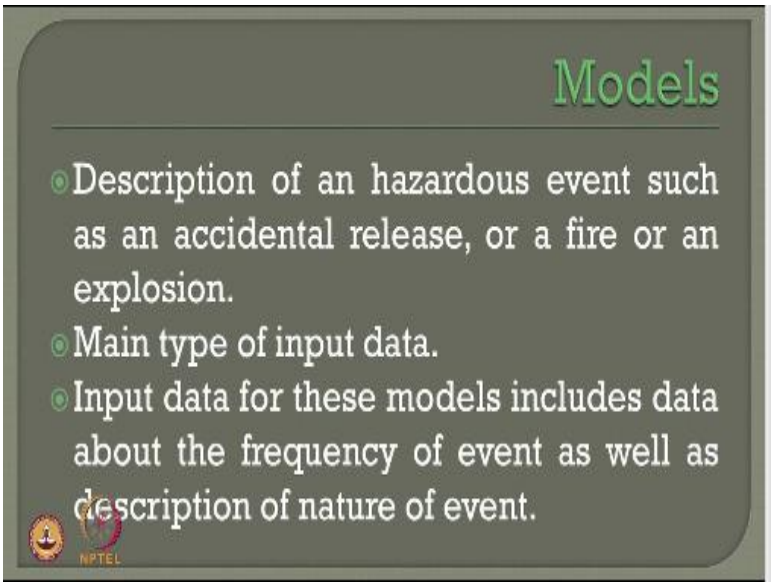

Now let us talk about various models available in the software for doing risk assessment, models are generally description of Hazardous event such as accidental release fire, explosion etc. It is dependent on a main type of input data available for risk assessment. So model is a very important input given for successful outcome or result or from the software, input data for these models include data about the frequency of even as well as description of nature of the event.

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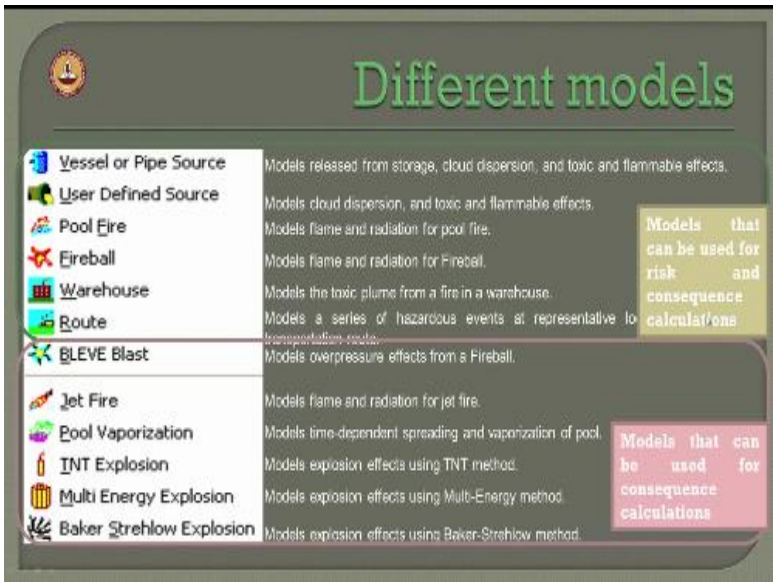

Let us see different models available in the software at random, for example one can use vessel or a pipe source model which is used for release of storage, cloud dispersion, toxic and flammable effects. One can also use user-defined sources which can be useful for modeling, cloud dispersion, toxic and flammable effects, one can use pool fire model to model the flame and radiation arising from pool fire.

One can also talk about firewall models which are useful for modeling the flame and radiation effect that arise from a fireball, one can use Warehouse model to model the toxic plume effect from a fire in a warehouse, one can use root model which models a series of Hazard events at representative value in the local listing, these models can be use for risk and consequence calculations.

Which are common as vessel a pipe source model, user define source model, pool fire model, fireball, warehouse and root. Alternatively one can also use the BLEVE blast model to model the over pressure effects which arise from a fireball, one can use jet fire model the model the flame radiation that arise from a jet fire, pole vaporization model is useful for modeling time-dependent spreading and vaporization of a pool.

TNT explosion models are useful for modeling the explosion effects arising using T&D method which one of the equivalence method available in the literature which has been discussed in detail in the existing modules, people also can use multi energy explosion and baker Strehlow explosion models for modeling the explosion effects using multi energy method or baker Strehlow method respectively.

These models are useful for consequence calculations whereas earlier models were useful for both risk and consequence calculations.

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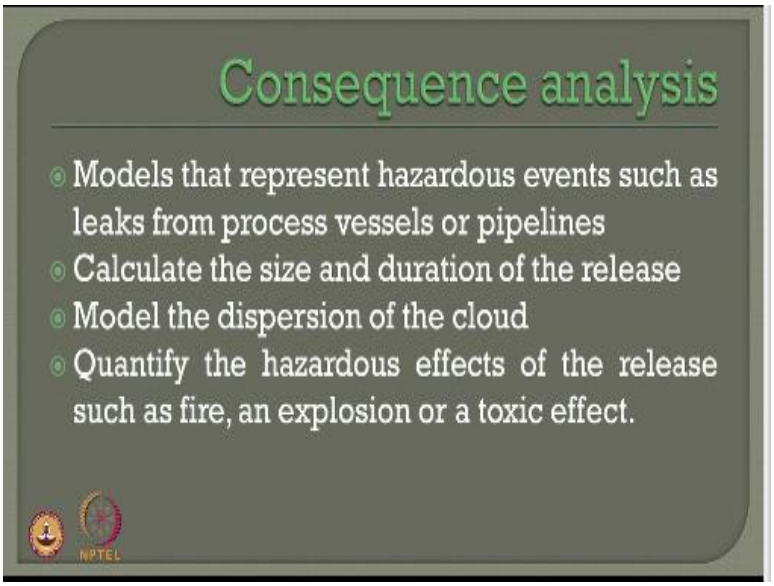

Let us talk about consequence analysis very quickly, how this is done and what are the models available, models that represent hazardous events such as leaks from process vessels or pipelines are generally formed a part of consequence analysis models, it calculates the size and duration of the release which is an input the model then talks about the dispersion of the cloud which arise from the consequence of a specific process. It quantifies hazardous effects of the release such as fire, explosion or toxic effect.

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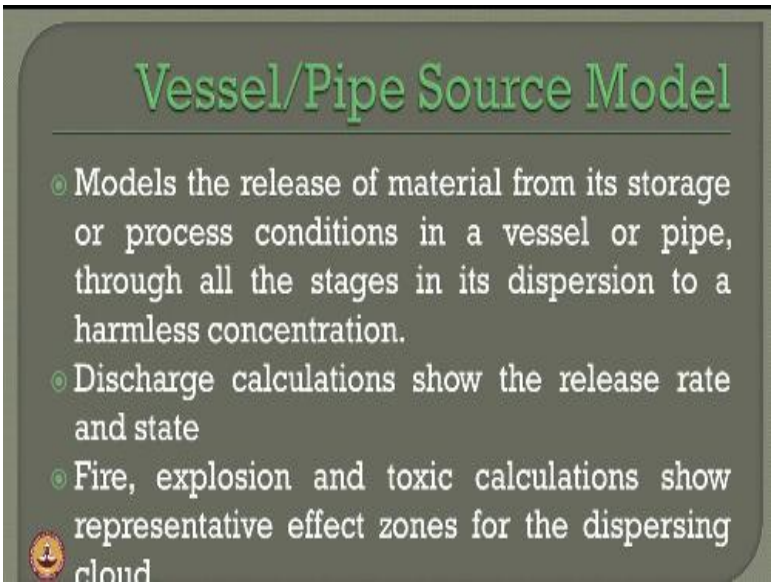

On public as well as societal damage, the vessel or the pipe source model talks about the release of material from its storage or process conditions in a given vessel or a pipe through all the stages in a descript dispersion to harmless concentration, the discharge calculation show the release rate and the state of release as well, fire, explosion and toxic calculations show representative effect zones for the dispersing cloud which are eyes as an output from the release model.

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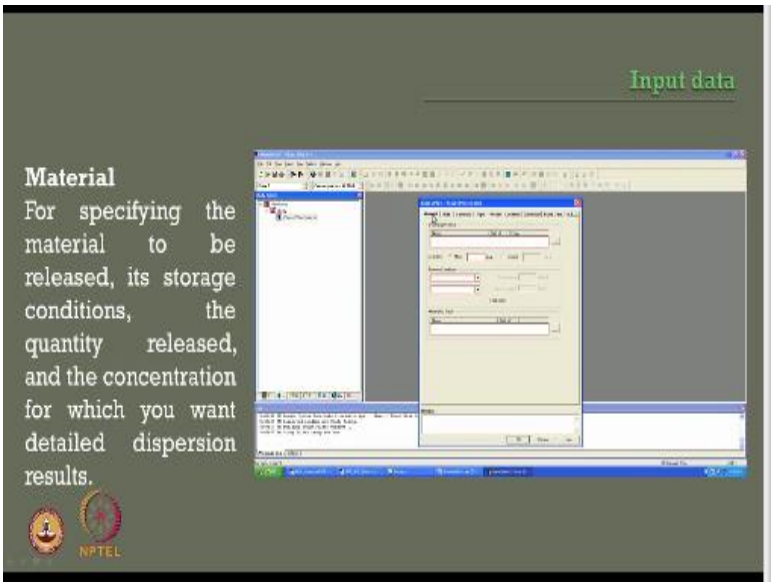

If you talk about the input data for these kinds of models as you see in the screen now, let us say we picked up a new SAFETI study the study is focused on vessel and pipe source which is a consequence model, now I want to pick up once I click this I get a screen of order I must specify the name, the process condition and the detail to be given here in terms of material the risk associated the difference scenario to be selected then the pipe diameter and geometric data or the vessel diameter geometric data.

The geographic location the geometry and the Bandit etc, which will now see one by one in the screen, let us talk about material which is available as the first cascade menu in the screen here for specifying the material to be released a storage conditions the quantity of release and the concentration you can use this specific menu.

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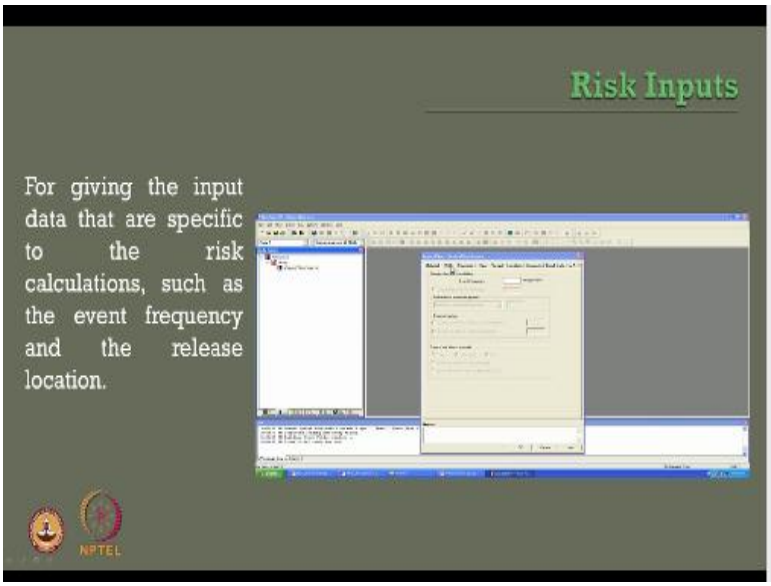

Subsequently the risk input can be also a part of the specific menu where for giving the input data that are specific to the risk calculation such as even frequency and the release location as an input here to be given in the specific menu.

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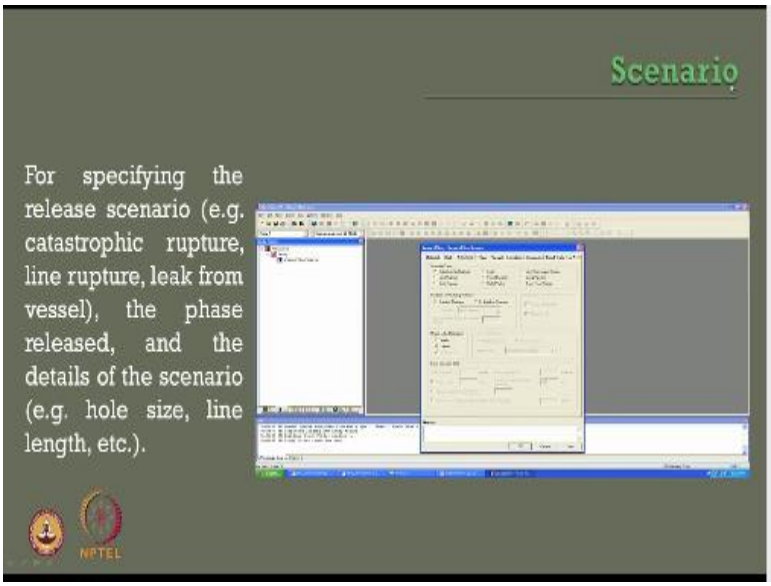

The next one could be the scenario for specifying the release scenario for example one should say whether scenario type is catastrophic rupture leak went from a vapor space is it the line rupture is for a fixed duration is it for a long pipeline is it for a description or relief valve rupture or a target root failure. So one can pick up the scenario type from this menu here one can also specifically say whether the condition of the release is outdoor or in building premises.

Because depending upon the condition of outdoor or indoor the parameters which specify for this calculation basically can be vary one should also say what is the phase of release is it a vapor or a liquid or a two-phase release one has got to specify this. So once you specify is the catastrophic rupture the leak from the vessel etc, the phase of release the outdoor window scenario the hole size, the line length etc will all be the input data in the specific menu where we talk about scenario.

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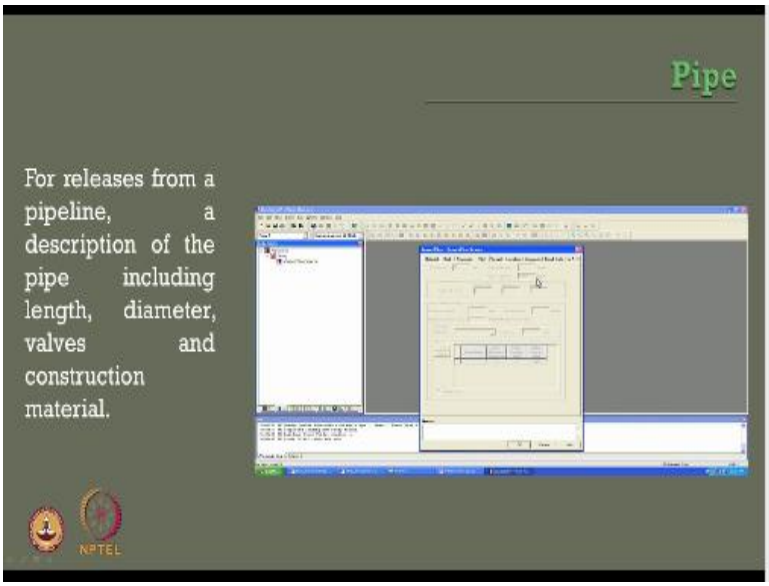

The next one could be details about the pipeline or the vessel, let us talk about the pipeline the moment you pick up the pipe from the Menu here I in specify the length of the pipeline the pipe roughness etc, so for releases from a pipeline the description of pipe including its length, its diameter its valves and construction material should be specified in detail.

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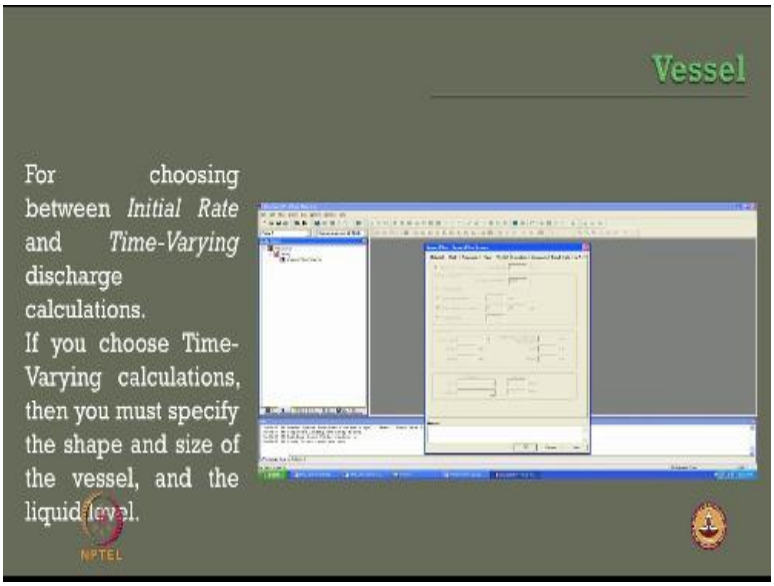

When you talk about the vessel as you see from this menu here then we should specify whether it is an initial rate or time varying discharge from the vessel because depending upon whether the time varying release or initial release the parameters associated for input data will weigh, so if you choose time varying calculation then one must specify what is the shape and size of the vessel and the liquid level present in the vessel in terms of meters.

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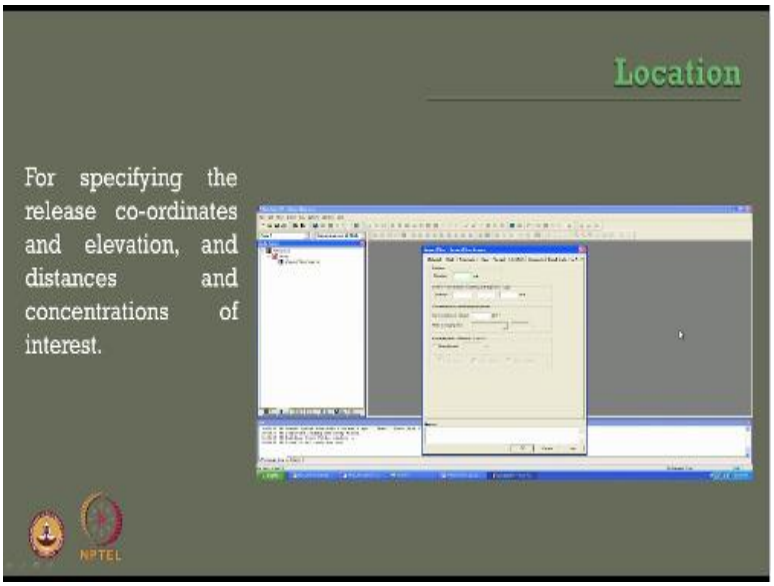

One can also specify a location as another important data in the given menu, the moment you say specific a location I must specify the elevation, the coordinates and the distances in terms of elevation and concentration of our interest to be specified as an input data one can also specify this say user-defined data which you can also specify the release rates based upon the ERPG or IDLH or still concentration as specified in the literature which has been also discussed detail in the earlier modules dear friends.

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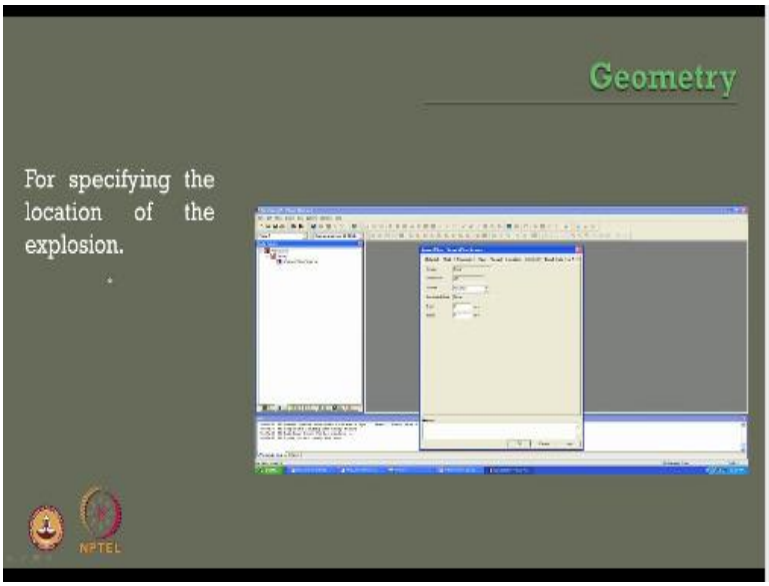

As I said geometry also becomes an important input for a given analysis to get the results under this class of the menu we specify the location of the explosion.

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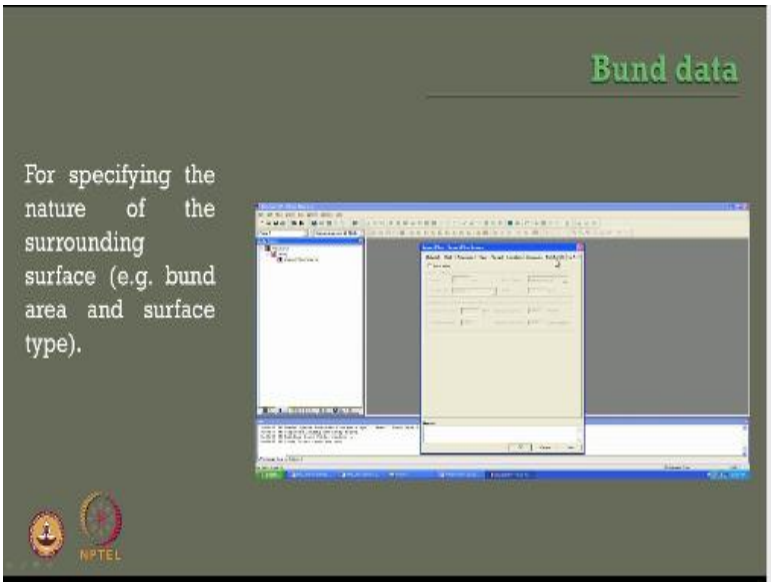

Whereas the bund data which is also an input data in this we must specify the nature of the surrounding surface for example the height of the bund the bund failure then the surface type of the bund interms of its material use construction type etc, one cannot specify what is the properties of the Define bund whether it is minimum thickness whether the thermal diffusivity etc can be all specified in input data in the Bund data in this menu in the software.

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As we said the risk results will also depend upon the condition of exposure is it indoor or outdoor someone to specify.

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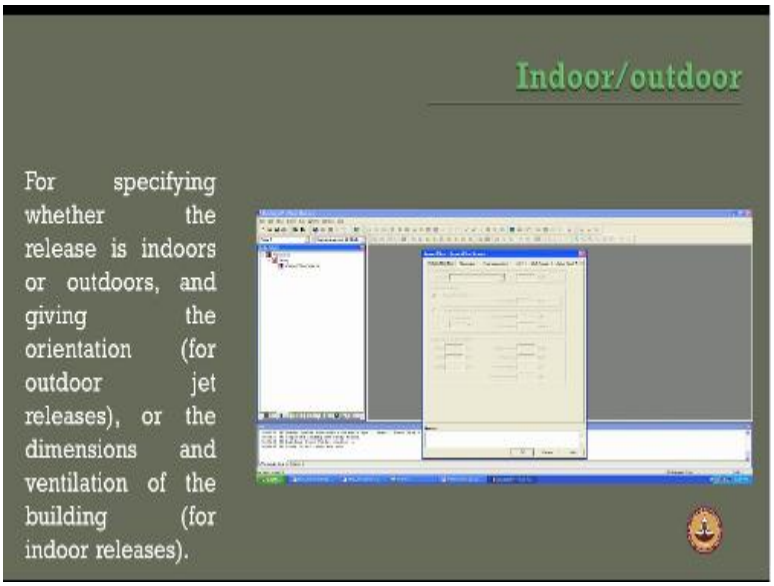

The indoor or outdoor conditions has given here for specifying the weather the release is indoor or outdoor it this menu is specifically used the orientation for outdoor Jet fire releases or dimensions for indoor releases which is important in terms of ventilation of the building should be given as an input data because if you say in building or indoor specification one should say whether the building as natural ventilation or a forced ventilation then one must specify the volume in terms of length, breadth and height.

And of course the building angle, the wind angle etc because this will specify and determine what would be the dispersion distance when the risk is calculated for a given societal area.

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Flammability characteristics are very important for risk analysis models.

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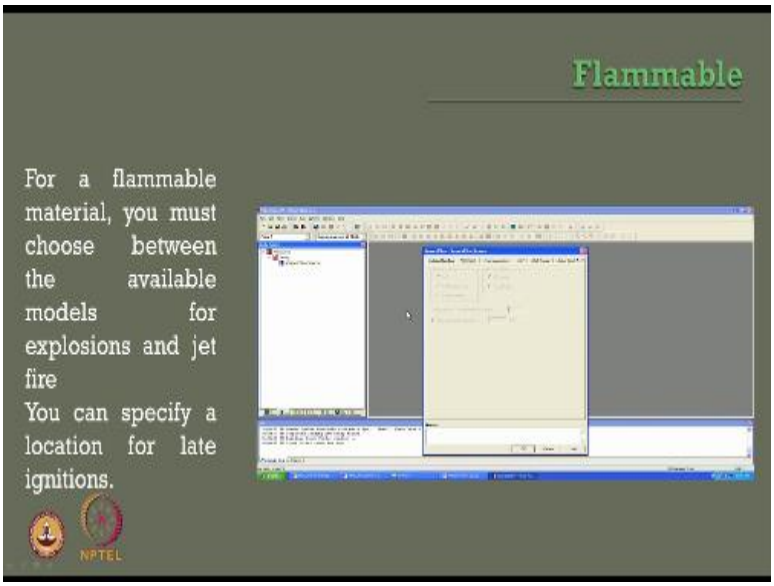

The moment I say flammable characteristics I must either specify them using standard expression methods like TNT, TND or break a store haul model or I can also use the jet fire model based upon API or cone model as specify in the literature, so for a flammable material one must choose the available between the explosion and the jet fire whether you are going for an explosion method or a jet fire model.

You can also specify the location for late emissions if it is there for example you got series of cascading effect to be seen in the analysis one can specify at what meter the ignition will become delayed because of the distance of this specific source or cascading effect from the source of ignition.

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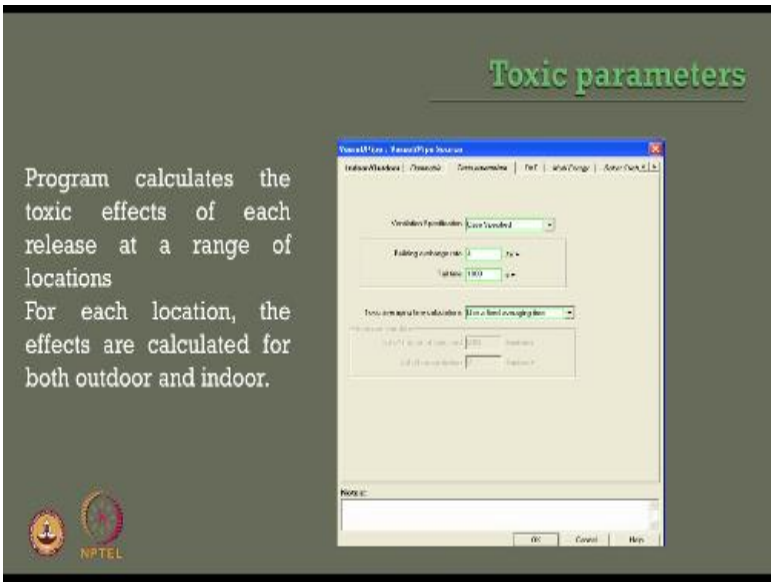

One should also specify the toxic parameters in a given menu, toxic parameters depends upon the ventilation of course one can say specified one can also tell what would be the tail time and in terms of building exchange rate in terms of seconds and per hour one can also specify the toxic average and calculation used for a fixed time average, one can also specify the exposure time data depending upon the cutoff fraction or the cut off concentration.

The program calculates the toxic effects based upon input given by you for each release at the range of locations specified by you in the map for each location the efforts are computed for both indoor and outdoor parameters as given in the input in the model.

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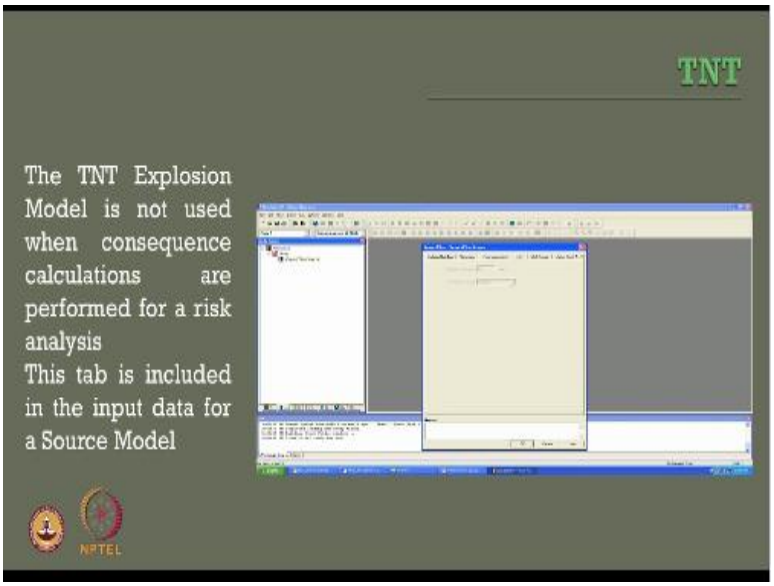

If we talk about explosion release models TNT is one of the equivalence method available in the literature therefore the explosion efficiency for TNT friends if you remember the equation one must specify the efficiency in percentage here one can also specify whether it is air or ground bond .So the TNT explosion model is generally not used when the consequence calculations are performed for risk analysis.

If you allow the software to perform the consequence calculations then we do not use the Readymade TNT model however in the given folder this tab is therefore included in the input data for a source model.

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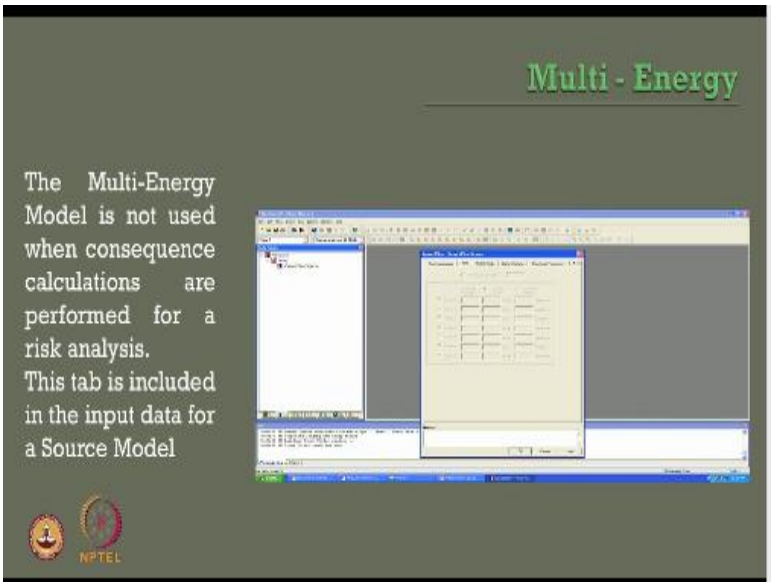

The second could be a multi energy model which is also one of the method by which one can specify for different source of combination present in a blast source, each source one if its way the confined strength the confined volume or the convent fraction available for explosion, the multi energy model is also generally not used when the consequence calculations are demanded as an output from the risk analysis. This tab is included in the input data for the source model.

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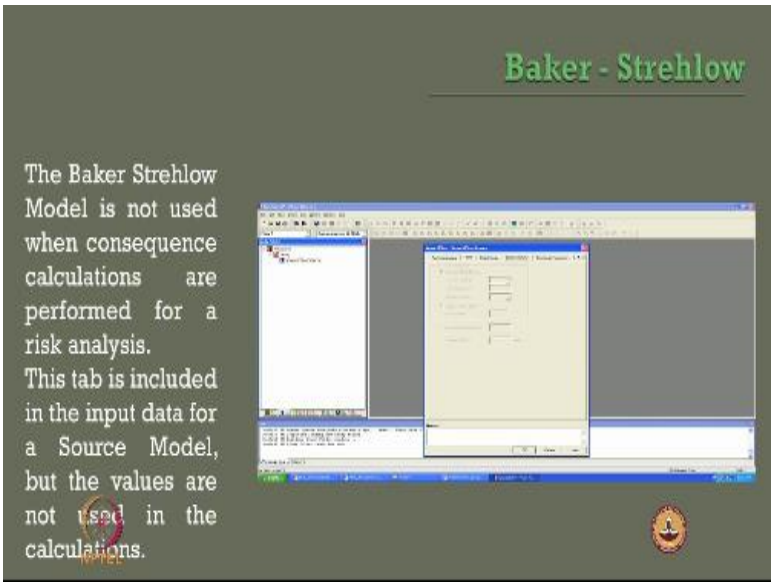

The third one could be Baker Strehlow model which can also be a parallel alternative method for explosion release models the Baker Strehlow model is not used however when the consequences are demanded as calculations are formed by the software for risk analysis this is of course included in input data for source model but the values will not be used and not used in the calculation if you demand the consequence calculation from the software directly for risk analysis.

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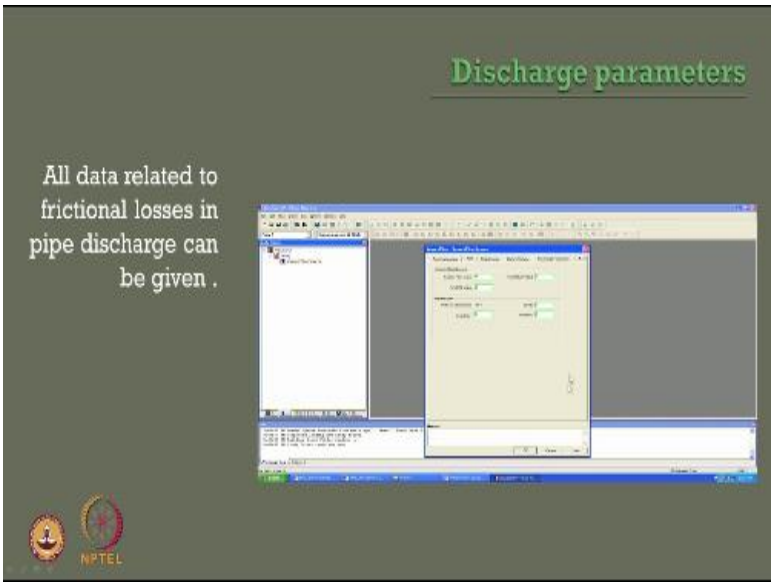

We ought to also specify the discharge parameters for the given analysis which arise from the same menu bar here as you see here, the discharge parameters will be related to all data which can associate the frictional loss in the pipe discharge should be given as an input data here for example the velocity head loss the frequencies can be given as an input here where what will be the head loss at non-return valve the head lose shuttle valve and the excess flow valve all etc… Can be given as an input data here in the software.

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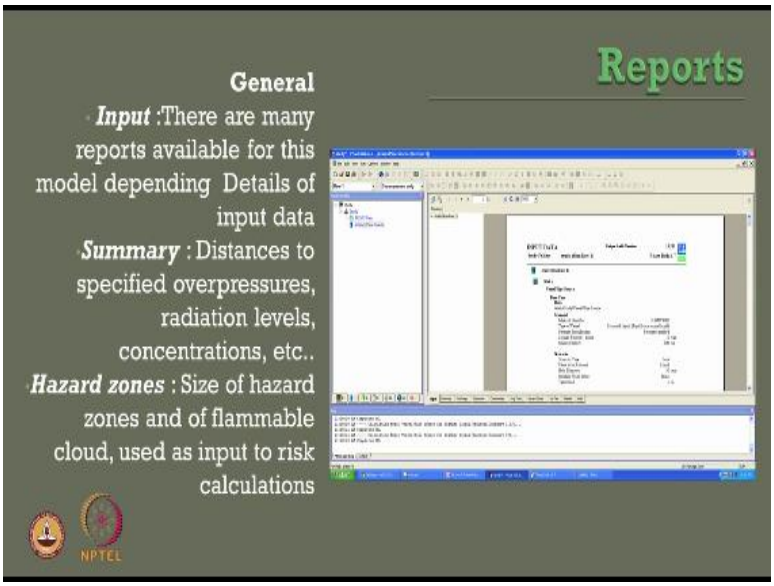

One can also generate a variety of reports which can arise from the results of risk analysis using this software the input data water has been given by you will all appear as a standard data file which will tell you what the material you are specifying what is the surface scenario type we are specifying etc what is the physical diameter you have given etc…

All available as input data in the given report the report has got two forms let us say the general one which talks about the input data there are many reports available for this model depending upon the integrals of the input data given by you the summary will talk about the distances they specified over pressures radiation levels and concentrations etc…The hazard zones will also be an output from this report which is in the general format it talks about the size of hazard zones the flammable cloud which will be used as input for performing risk calculations.

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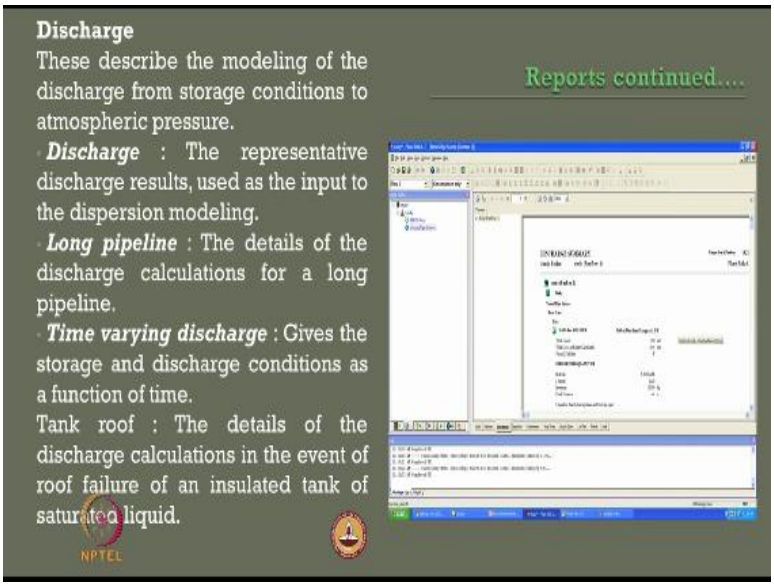

Report will also have details about the discharge which you have specified they describe modeling of discharge from Storage conditions the atmospheric pressure the discharge will show representative discharge results used as an input to the dispersion models used in the calculation for risk analysis if you use long pipeline details of discharge calculations for wrong pipeline plane will also be present in the report as a discharge summary the time varying discharge which gives that storage and discharge conditions as function of time

Will be also a part of the report of the discharge summary as you see on the screen now there are details about that discharge calculation in tank roof in the event of roof failure of an insulated tank can also be seen as output result the discharge summary of the problem.

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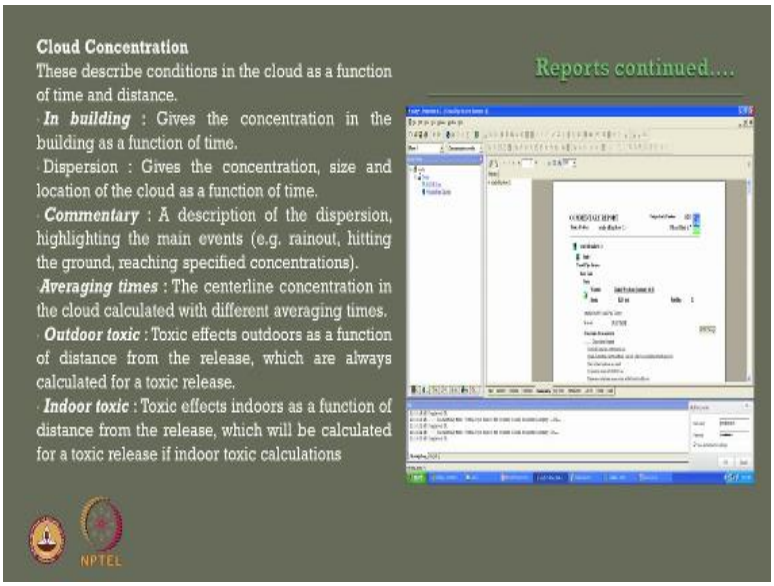

One can also see commentary in the report the commentary will talk about cloud concentration which describes conditions in the cloud as a function of time and distance gives also concentration in the building as a function of time it gives concentration size and location of the cloud as a function of time as a dispersion output models the commentary gives a description of the dispersion highlighting main events like rain out hitting the ground what we call touchdown point for plume and puff release models reaching specific concentration levels as calculated from the relays models analytically also which has been seen in different modules earlier indifferent lectures.

Averaging times is also seeing as a central lien concentration then based on this one can also plot espouse outdoor toxicity will also be indicated as a function of distance from the release which are always available as a calculated value for a given toxic release models indoor toxicity will also be as an output data available in the report which talks about function of distance from the release which will be calculated for a toxic release if indoor toxic calculations are available in chosen in the given model as an output data.

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The output also gives you about fire and radiation reports generated if the material is flammable it also gives you a description about the fire Ball the flame shape and duration and ground level radiation ellipse calculated for the plume and puffs release models if the model is a jet fire model it describe the flame shape and the ground level radiation ellipse available in the model pool fire description of plume shape and ground level radiation ellipse will also be available if the model is a pool fire model.

If the pool vaporization is an output then the reports are generated if the release contains liquid which rains out to form a pool and then the pool get vaporized off pool vibration in summary will indicate description of the representative pool vaporization segments giving the rate of vaporization duration pool radius and pool temperature everything depending upon whether the liquid is arising or leading to a pool vaporization or not pool details showing the pool state and vaporizations behavior as a function of time will be also available from the report.

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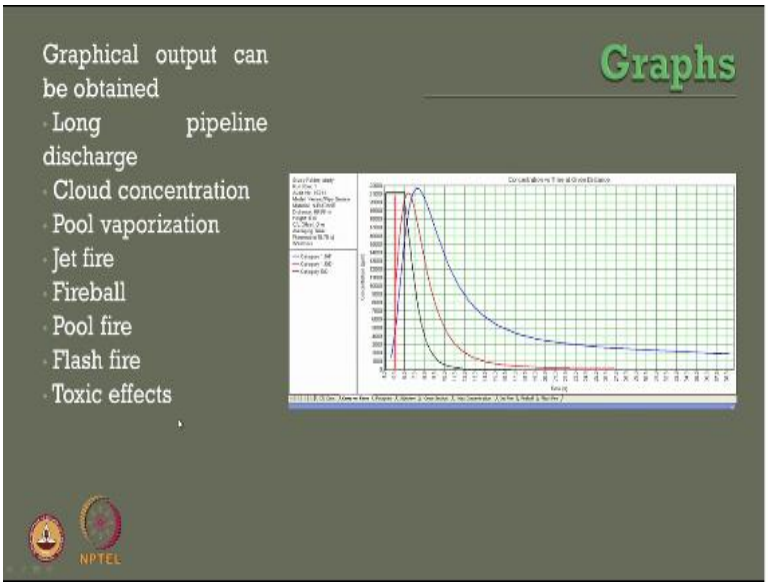

The reports are also available in the graphical format for example a typical graphical format which shows concentration at a given distance in terms of parts per million for in a very instant of time in seconds is also plotted here from the time of release till the release becomes accepted under given ERPG level so if you look at the result typically available on the screen now it shocked it talks about the study as a study folder which is the folder name given by use an input the run row.

As we discussed is number one audit number is generated depending upon the run row schemes available we are talking about a vessel or a pipe source talking about consequence release model material in the specific example is a butane the distance is about 70 meters height is 0 we are talking about the ground level concentration offset is also 0 we do not talk about espouse in this specific case the averaging time of release about eighteen point seven five seconds the weather category is analyzed for three cases blue indicates Pasqual stability class F with wind speed 1.5 meter per second.

The red indicates Pasqual stability class D with 1.5 meter per second as wind speed and of course the green indicates Pasqual stability gas D with 5 meter per second so a typical graphical output

can also be obtained as an output from the software so friends in this lecture we talked about graphical output obtained long pipeline discharge cloud concentration pool vaporization etc…

We also talked about use of software specifically in general for all kinds of models analysis risk analysis in oil gas industries we are now discussing in detail about a specific problem of indication where I am using a software which I will explain you different modules present the software we will also talk about different areas of interest like pool vaporization, jet fire, fire ball, pool fire, flash fire and toxic effects from this software.

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I will show a running example of this as a video for better use of the software by the practicing engineers thank you very much you.

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