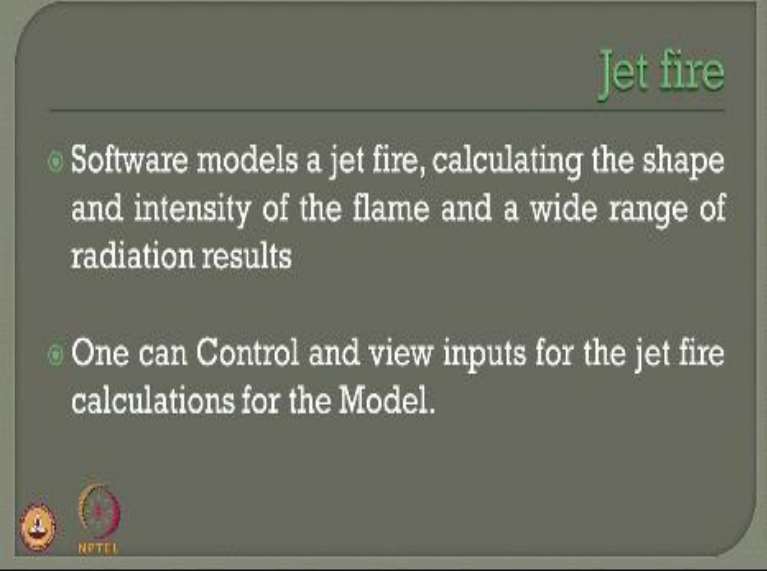Friends today we are going to look at the second lecture in module four which is going to focus as a continuation of the earlier one in the earlier lecture we saw use of software in HSE in this lecture today we are going to discuss about futuristic models like Jet fire pool fire another models using the software again this is lecture 2 and module four under the course on HSE which is done at NPTEL IIT Madras.

(Refer Slide Time: 00:45)

Let us quickly see how are you going to do now the jet fire modeling using the software.

(Refer Slide Time: 00:50)

Software actually models Jet fire it calculates the shape and intensity of the flame and a wide range of radiation results we all know a jet fire will cause different level of radiation to the public exposed to this kind of fire and of course what are those level of radiations is also specified in the literature for various intensities so the software should give me the output of the consequences arising from the radiation effects which is caused by the jet fire to estimate the societal damage as well as individual risk.

It is interesting for us to know that you can also control and view the inputs for the jet fire calculations while the model is being progressed.
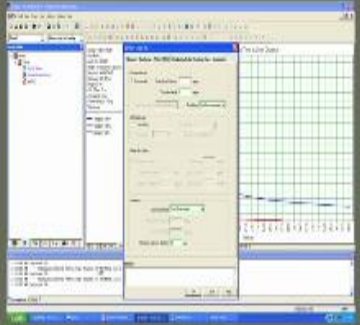
Let us see the input data how you are going to give it for a jet fire modeling if you look at the screen nowhere this is a jet fire menu which has got material discharged flame shape radiation data contour data and of course the geometry so let us see one by one quickly what would be those input to be given under these menu heads to run a jet fire model in this software if you look at the material part material tab is useful for specifying the flammable characteristics of the material and the coordinates of the source of the fire in a given grid system the discharge and the flame shape menus will be useful.

For describing the size shape and intensity of fire the radiation data-bar is useful for specifying the radiation results that you want as I told in the beginning there are different levels of radiation for which the societal risk and individual risk are generally plotted so let us try to see how we can give these results are obtained these results for the required input data for different radiation levels the next menu here is a contour data the contour data I can also estimate from the contour data the coordinates of a given plane you must give the input of the given plane and specify the given plane for three different levels of radiations.

In radiation data the program calculates radiation at single point or at intervals along the line you can also estimate the size of ellipse for a given radiation level from this particular problem of course the last menu in the jet fire model is the geometry which is useful for specifying the location of the explosion where you want to measure or mark or estimate the risk calculations.

(Refer Slide Time: 03:41)
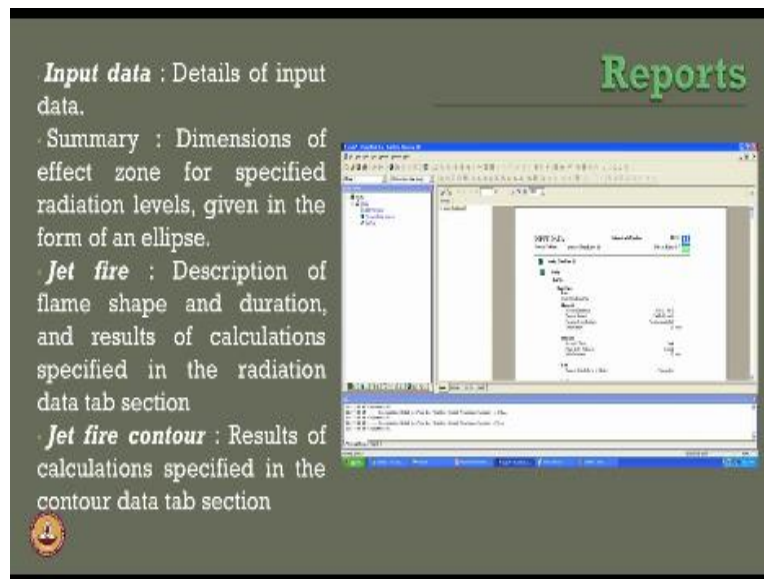
Once i give the input the model runs in execute and it will give me certain classification of reports let us see how the reports are generated for the jet fire model now in this left hand side of the screen if you see I have already created a jet fire model which is an indication of this order now i have given certain input data let us quickly see how the input data can be categorized and classified in this software for the specific model the input data available for the jet fire will be showing the details of input given by you the material the risk availability the flammability characteristics etc.

The summary of this report should show me the dimensions of effective zone for specified radiation levels given in the form of an ellipse jet fire should describe the flame shape and duration and the results of calculation specify the radiation data tab section shown to you earlier

the jet fire also plots a contour in which will be giving the results of calculation specified in the contour data tab section available in the report.

(Refer Slide Time: 04:54)
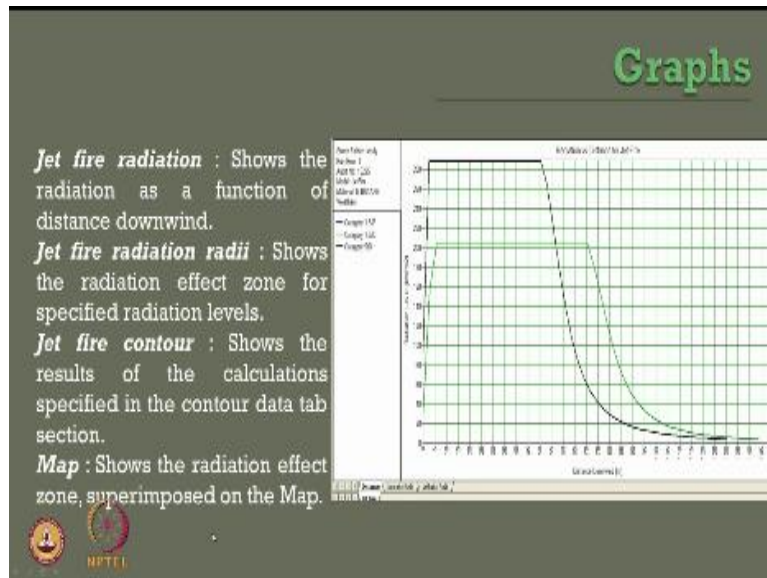
Graphical output can also be obtained for jet fire models from the software your typical graphical output is shown in the screen now which shows the radiation level in terms of kilowatt per square meter versus the distance downwind in meters for a given Jet fire model now in this specific example I am showing you different Pasqual stability class F D and the one which is shown here is nothing but the wind velocity in meter per second I am considering the jet fire model for a butane material and I am running Row one here which is follow up from the last lecture.

And now the audit number for the specific analysis is generated automatically from the software depending upon what kind of row you are generating for a given study so let us typically look at this report and see how can we interpret this report the jet fire radiation actually shows the radiation is a function of downward distance as you see in this plot here the jet fire radiation the radii also shows the radiation effect zone for specified radiation levels that is what intensity radii will show you and the jet fire contour will show you the results of the calculation specified.

In the contour data tab section and it of course reflects the entire result on the map which is superimposed on a given map.

(Refer Slide Time: 06:11)
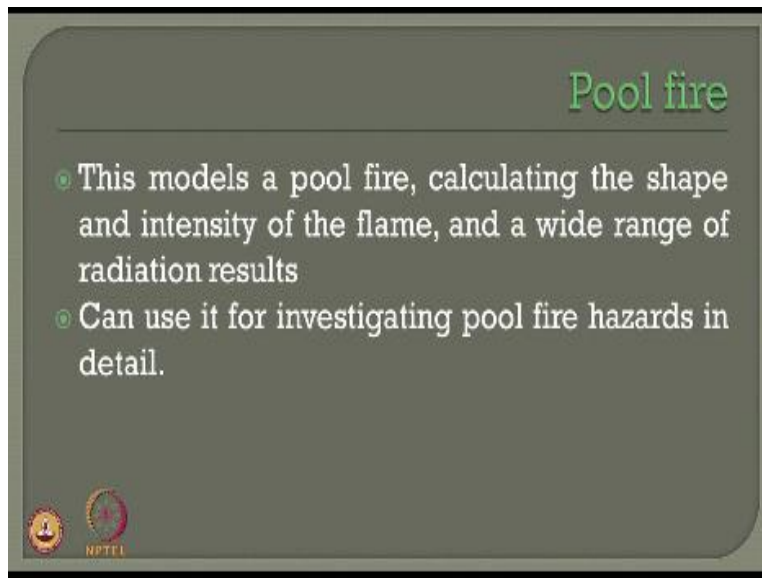
The second model which we will discuss today will be the pool fire this model is a pool fire calculating the shape and intensity of the flame and a wide range of radiation results as similar to the top the jet fire one can use this for investigating pool fire hazards in detail.
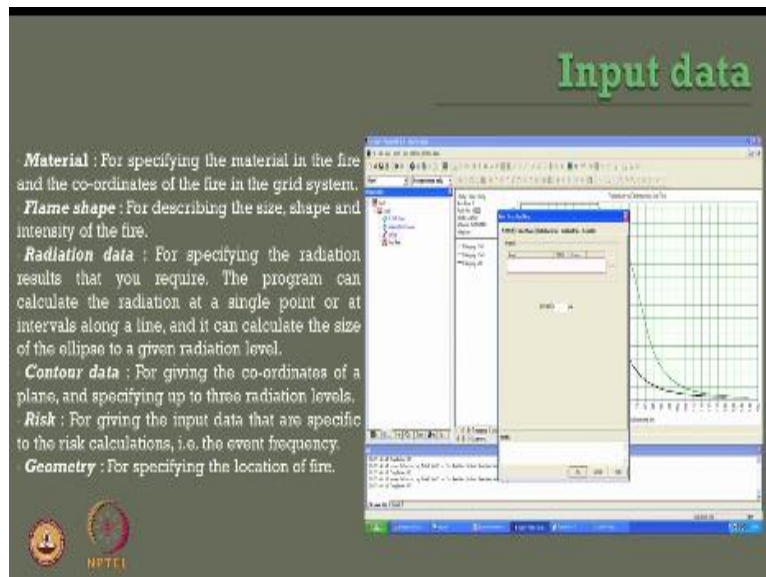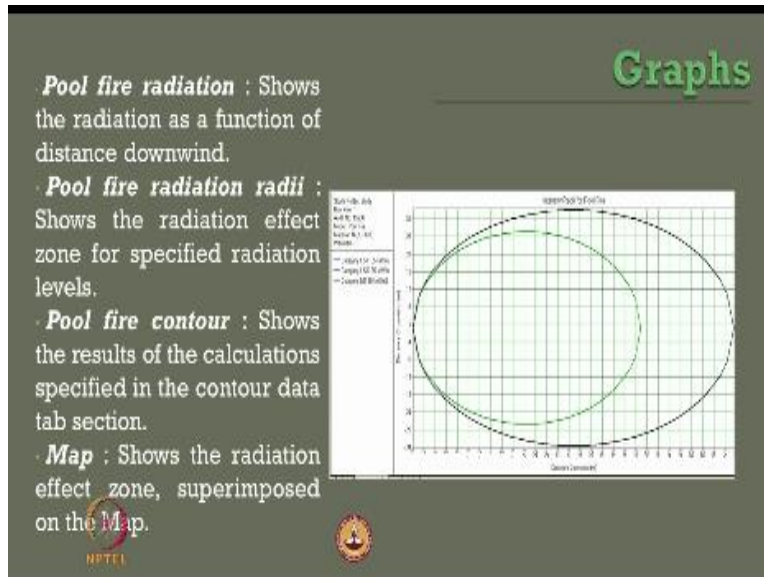
Let us see what are the input that are required for doing a pool fire model for doing a pool fire model the menu cascades as material flame shape radiation data contour data and geometry let us look one by one in detail now in the material tab we try to specify the material in fire and the coordinates of the fire source in a given grid system in the flame shape tap of this menu it is useful for describing the shape size and intensity of fire the radiation data tab in this menu is useful for specifying radiation results that you require to plot and get the results the program can calculate radiation.

A single point or intervals on a given line at specific time intervals can also calculate the size of the ellipse to a given radiation level as similar to that of a jet fire model the contour data what to see in the time here is useful for giving the coordinates of the plane and specifying them up to three radiation levels as required by the results of the design the risk data tab is useful for giving the input data that are specific to the risk calculations that is for example in the even frequency now of course geometry is useful for specifying the location of fire in terms of it geometric coordinate.

Let us see how the reports were generated for the pool fire now the report show a is for a pool fire so I have added pool fire in me run row again here is a study which is again an audit of the same order input data gives me in detail of input what I given forma pool fire data can see here how the input has been generated automatically for a given fuel or a flammable material the summary shows me the dimensions of effective zone for specified radiation levels given in the form of an ellipse pool fire describes the flame shape and results of calculation specified the radiation data tab section.

As seen in the earlier slide pool fire can also be expressed in form of a contour which shows me the results of calculation specified in the contoured tan section.

As you saw earlier a typical plot will be seen here which shows the intensity radio for a pool fire which shows the downward crosswind distance with that of the distant downward in terms of meters in terms of an elliptical plot for example here the radiation intensity is taken or 35 kilo watt per square meter different Pasqual stability class for different wind velocity in the downward direction the fuel is butane and the model is full for the audit number generated automatically for a given run row from the software and the plots are shown in different color index as blue green and dark green as you see here.

Grey green and of course the blue is overlapped with the same manner here as you see in the figure pool fire radiation shows the radiation is a function of the distance downward in meters pool fire radiation, radiation shows the radiation effect for a specific distance in terms of radiation levels the pool fire contour shows the elliptical results in terms of contour data plotted can also map them in a given particular configuration chosen for the analysis.

(Refer Slide Time: 09:48)
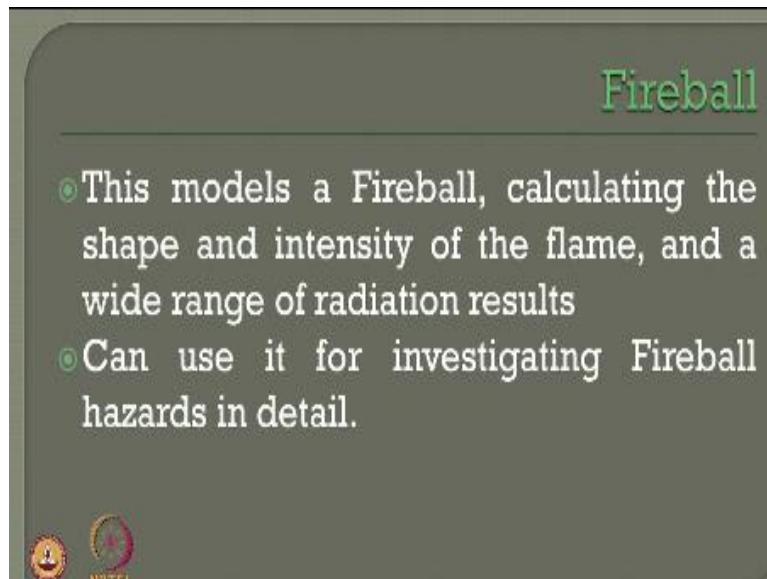
The third model what we will see today is a firewall model this of course models our firewall calculates the shape and intensity of the flame and a wide range of radiation results using this tab one can use this for investigating the firewall results in detail in a given process plant.

(Refer Slide Time: 10:06)

Let us look at the input data what will be available for a fireball let us see the tab available here material fire wall shape radiation data contour data and geometry can also see in the left hand side of the screen here I have added a run row to be a fireball we have computed jet fire we have computed vessel pipe source investigation we have done the bleve we have done the pool fire now we will discuss about the firewall the different input data starting from material is useful for specifying the material in the fire and coordinates where they are going to occur in a given grid system.

The flame shape will describe the size shape and intensity of fireball the radiation data is useful for specifying radiation results that you require because there are different radiation levels which are looked at the screen or which has looked at by given by the literature the program can also calculate radiation the single point or at equal intervals along the line and can also calculate the size of the ellipse to a given radiation level contour data is useful for giving the coordinates of a plane and specify up to three radiation levels.

Risk is then calculated for the given input data for depending upon the even frequency what you are choosing and geometry will be useful for specifying the location of the fireball.
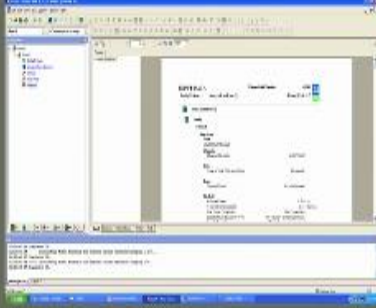
(Refer Slide Time: 11:25)

A typical report derivative for the fireball as you see in the screen here will be shown as such here we have already given the firewall mass vapor property vapor function etc. As an input data so the fireball is output data now here it shows the details of input given for analysis fastest 6.7 is under discussion now summary will show you the dimensions of effective zone for specified radiation levels given in the form of an ellipse fireball will describe the flame shape and duration results of calculation specified in radiation tab and the firewall contour will show you the results which can be mapped directly.
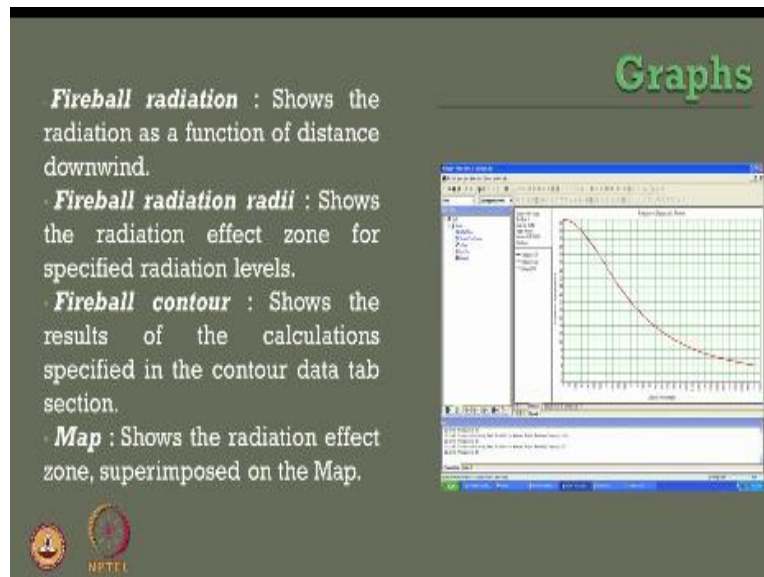
On the contour here you can also have a graphical output as you see in the screen now this is the radiation distance for a fireball in the downward distance plot with the top radiation level intensity in kilowatt per square meter in this case different Pasqual stability class have been selected and the plot is done for a specific radiation intensity level in this example it is 35 kilowatt per square meter one can also plot this for different radiation intensity levels you can see here the fireball radiation shows the radiation is a function of distance the downward wind fireball radii.
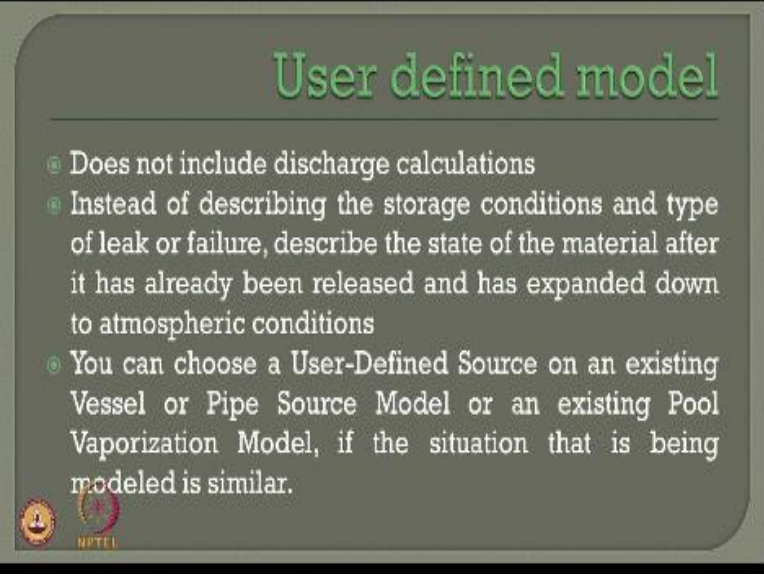
Shows the radiation effective zone for specification levels and firewall contour of course shows the results of the calculation specified in the contour data tab which can be also mapped directly by superposition name the results.

(Refer Slide Time: 12:51)

The next model what we will discuss will be user-defined model the earlier one what we discussed or standard models which are available in the literature now we can talk about use a different model.

Which will not include the discharge calculations by default instead of describing the storage conditions and type of leak or failure by a standard model or through a standard model one can describe also the state of the material after it has already been released and has expanded down to atmospheric conditions you can also choose user-defined source on an existing vessel or a pipe source model or pool vaporization model if the situation is similar to that of what is available in the literature.
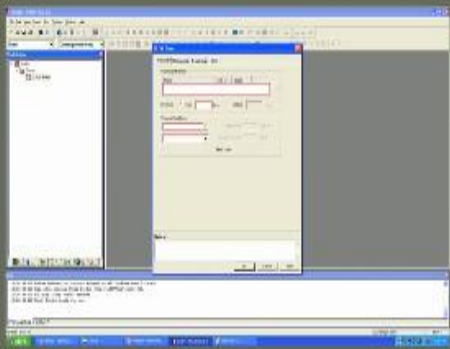
Let us look at the bleve blast model which is an user-defined model is available standard in the literature so it is got cascade menu as material distances geometry and the blast data now it is a blast wavy model for a study case in run Row one we are looking only the consequence analysis we are looking at the fastest 6.7 as a study material now the models overpressure and impulse from a BLEVE material is useful for specifying the material in the bleve and the conditions in the process vessel at the time of failure distances menu will be useful in describing the location of the blade in relation to the map location.

And to other events it is also useful to specify the range of distances at which the result should be calculated and deported.
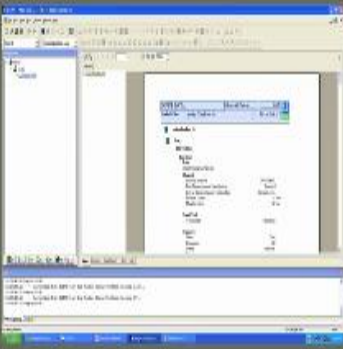
If you look at the kind of report generated for the bleve model the BLEVE model is what you see in the screen here sturdy model used from fastest 6.7 so there are different data available which is given as the input for this therefore let us see in the BLEVE blast what are the input detail available specific case the summary gives me the distances to over pressure specified in the explosion parameters BLEVE shows me the explosion energy distances to overpressure specified in explosion parameters and of course over operation impulses.

Over a given range of distances set in the distance stabbed in the earlier screen it also gives me an audit report identifying the current set of programs and the background data used for this kind of model.
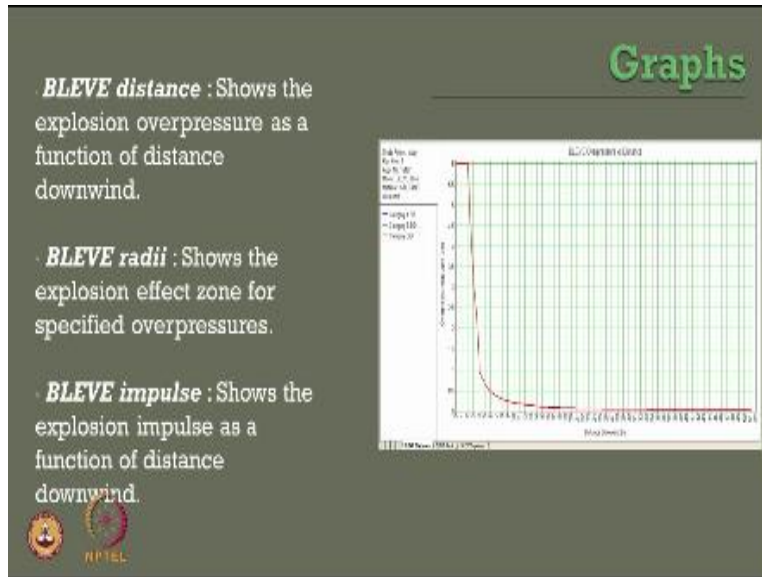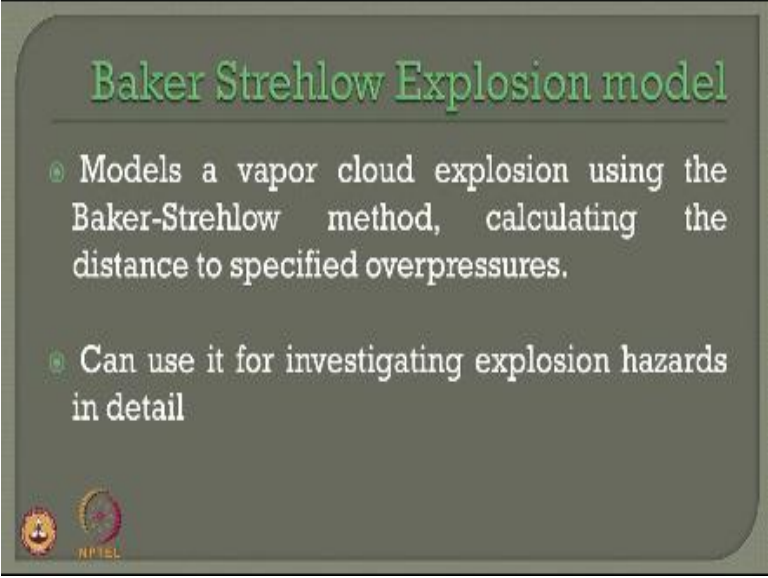
Releases graphical output is also available for BELVE blast models a typical BLEVE blast model a ty6pical BLEVE overpressure was a distance plot is shown on the screen here the screen plots x axis as downward distance in meters whereas the y plot shows the overpressure in bar as a gauge pressure we are looking for different stability class dnf for different wind velocity is 1.5m/s and 5m/s we are looking for a BLEVE blast model material is butane and run Row 1 and the audit number the self generated by the software for different kinds of case studies as you see here the red plot what you see here is available showing the intensity of category.

5D 5m/s Pasqual stability class d BLEVE distance shows the explosion over pleasure as a function of distance downward BLEVE radii shows the explosion effect zone for specific over pressures and BLEVE impulse shows me the explosion impulse as a function of distance.

In the downward direction you can also use different kinds of model like baker Strehlow explosion model as an alternative to the existing standard models available in the software this particular explosion model is useful for modeling vapor cloud explosion what we call VCE using the Baker strehlow method it calculates the distance to specify over pressures arising from the blast models it can be useful for investigating explosion hazards in detail.

(Refer Slide Time: 16:54)
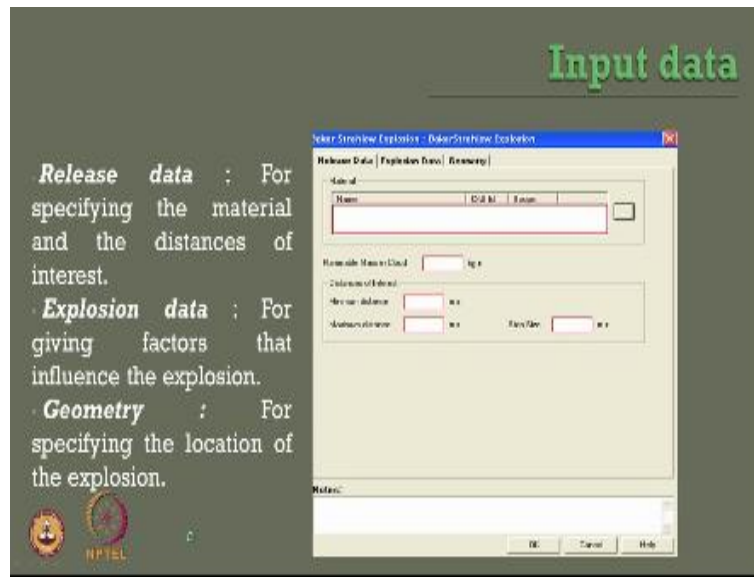
Let us quickly see what are those input data available and require for performing this kind of analysis in the software one must tell me what is the release data available what the explosion data and what are the different geometry available for this case the release data should be useful for specifying the material and the distances of interest the explosion data is useful for giving factors that influence the explosion and of course the geometry is useful for specifying the location of the explosion in the given.

(Refer Slide Time: 17:26)

Coordinate system the reports generated for this analysis can also give a different order now in this case it is a study report which is on a run Row one where we are talking about Baker still 0 explosion we are talking about the materialist butane and we are giving different Baker store explosion requirements like the distance in step size the minimum distance the maximum distance of influence and the firm will mass participating in the BLEVE and mass modification factor etc. As an input data the input data shows me all summary of inputs what they are given in the previous tabs.

Summary shows me the distances to specified overpressure calculations and early Baker strehlow explosion summary shows me the details of overpressure an impulse as a function of distance.
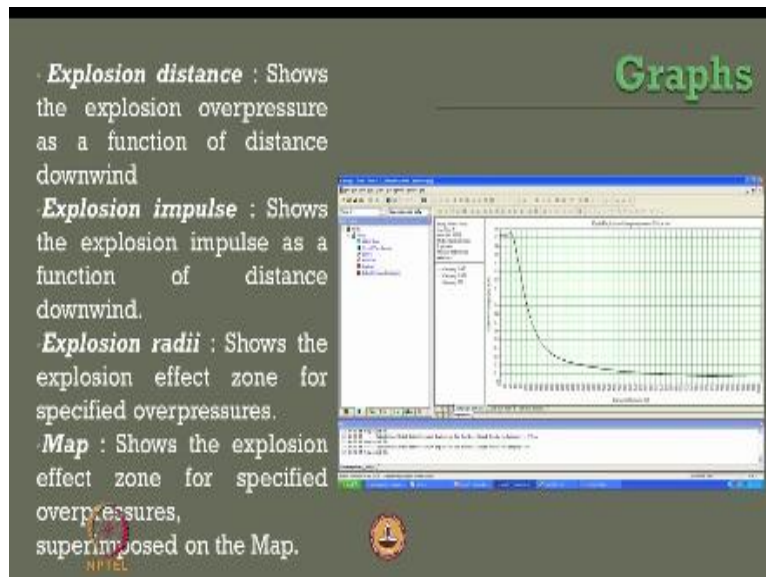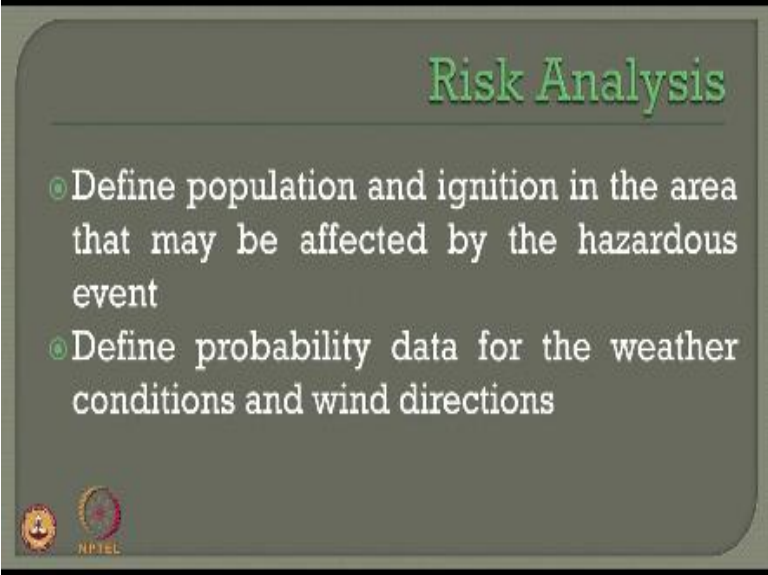
As you saw in the graphical plot now the graphical output shows me the early explosion both pressure was a distance there is an overpressure engage in terms of bar and of course this is my downward downwind is this in meters we looking for this analysis for different Pascal stability class fuel used audit report generated and Baker strehlow model we are talking about blast explosion computed from the specific models time the explosion distance actually shows the plot varying explosion overpressure in terms of gauge pressure as a function of distance in the downwind distance direction.

The explosion impulse shows me the explosion as a function of the distance and downward and explosion radiate shows me the explosion effect zone for specific overpressure the plot shows you is for a category Pasqual stability 5D which is 5m/s downwind speed and D is a Pascal stability class of course the whole results can be also mapped for a given overpressure superimposed on existing contour map.

(Refer Slide Time: 19:14)

One can also now interested to see what are the result risk analysis results outcome from these kind of standard models one has to define the population and ignition in the area that may be affected with as are as even to do risk analysis one should also define the probability data for the weather conditions and wind direction because it is important for different weather combination what is that probability of occurrence we must specify in a given weather window or the weather folder.

If you talk about population again you have got the Cascade menu coming up for editing population as day population one can also categorize them in different headings like security near way plant village area filling area water tank and canteen you can also specify the category of this kind of population can give the numbers as population and this case specifically if you say the village areas residential population is about 100 and an airway plant is again industrial where the popular is150 and remaining all our doc numbers kept for the specific analysis.

The fraction of population in doors for societal risk is also taken as a fraction of the indoor population one can also specify the density is automatically calculated otherwise one can also specify the area either can be taken from the contour map directly and one can give them in kilo meter square so the population data is very useful in the calculation for societal risk.

(Refer Slide Time: 20:41)
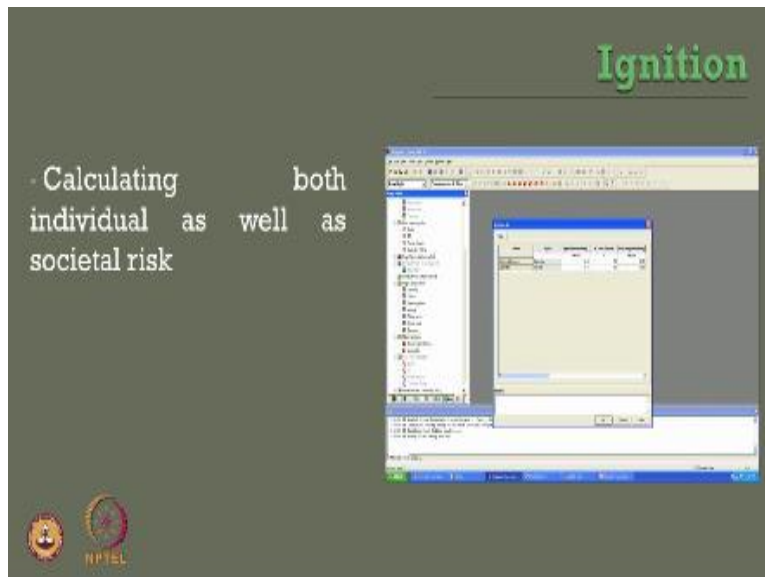
We have to also give the ignition data because that is also one of the important source the menu which tells me is about what the name of the ignition or the type of the ignition what the ignition probability in time period and operating probability infraction we have to specify this calculating both individual and societal risk will be useful if you are giving the ignition data.

Now if you give these data now the risk analysis will have different forms of results the first form of result which is very interesting and very important outcome of the software could be the one which is shown as a risk contour in the screen now the run row status for different kinds of storage fluid or gaseous States which has been understood are taken for the analysis is indicated here individual contours are plotted for a different audit report for a different combination for an outdoor contour and the study folder is on specific example of faster 6.7.

Now the contour shows me different risk levels plotted in different legends as you see here for example the yellow one which is focusing concentric is a risk level of 0.01 for average year whereas the green one which you see here is there is contour having a legend of $1 \ 10^{-7}$ average per year so the intensity of risk is increasing concentric from the center and linear as it go outwards now this is plotted for a specific fuel or a chemical which is in this case chlorine so one can also easily find out what would be those default risk ranking points sets as you see in the plots here.

So these are very important in terms of risk ranking plots which are automatically generated one can also see the legends if it is industrial or residential so all these informations are packed in a

graphical format as a scene here for individual risk so individual risk is plotted in the form of a risk contour as you see here it shows a geographical distribution of risk from the given Google map or specific site it explains how the risk varies at different distances and directions from the site of explosion.

(Refer Slide Time: 23:03)

The second form of result can be a societal risk which is available in terms of FN curve where F stands for fatalities per average here and n tends for the number of fatalities and F stands for the frequency in average here this is also plotted with the different kind of legend which is available for different combination of maximum risk criteria and minions criteria as i said the minimum risk criteria can be the specified or can be referred to the standard literature available as a database in the software.

Now the societal risk is plotted as an outcome the software in the form of FN curve the societal risk results show the risk distribution of the scale of effects on people in the near vicinity of the plant so now the software has been exposed off to you for various modules where risk analysis can be carried out as an outcome for different varieties of models which are very important for process plants so this is only a glimpse of summary how the software can be conveniently used

for such analysis I have shown you drift out list of different software's which has been used in PE programs in industries common so I have given an example in the next lecture to show you a video where this can be easily handled step by step the results can be plotted and interpreted thank you very much please post your questions and doubts to NPTEL IIT Madras.

(Refer Slide Time: 24:29)

Online Video Editing /Post Production

K.R. Mahendra Babu

Soju Francis

S. Pradeepa

S. Subash

Camera

Selvam

Robert Joseph

Karthikeyan

Ramkumar

Ramganesh

Sathiaraj

Studio Assistants

Krishnakumar

Linuselvan

Saranraj

Animations

Anushree Santhosh

Pradeep Valan .S. L

NPTEL Web & Faculty Assistance Team

Allen Jacob Dinesh

Bharathi Balaji

Deepa Venkatraman

Dianis Bertin

Gayathri

Gurumoorthi

Jason Prasad

Jayanthi

Kamala Ramakrishanan

Lakshmi Priya

Malarvizhi

Manikandasivam

Mohana Sundari

Muthu Kumaran

Naveen Kumar

Palani

Salomi

Senthil

Sridharan

Suriyakumari

<u>**Administrative Assistant**</u>

Janakiraman .K.S

<u>**Video Producers**</u>

K.R. Ravindranath

Kannan Krishnamurty

IIT Madras Production