**INDIAN INSTITUTE OF TECHNOLOGY MADRAS.**

**Indian Institute of Technology Madras**
**NPTEL**
**National Programme on Technology Enhanced Learning**

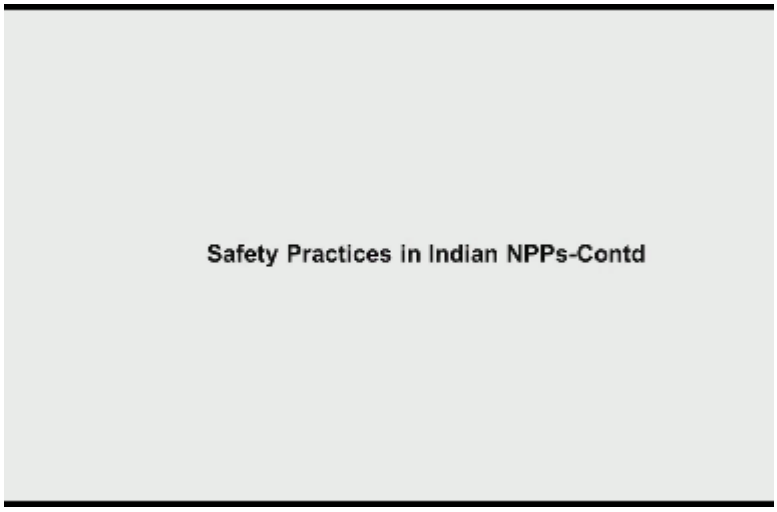
**NUCLEAR REACTOR AND SAFETY**
**AN INTRODUCTORY COURSE**

**Module 14 Lecture 02**
**Safety Practices in Indian NPPs Cont…**

**Dr. G Vaidhyanathan**
**School of Mechanical Engineering**
**SRM University**

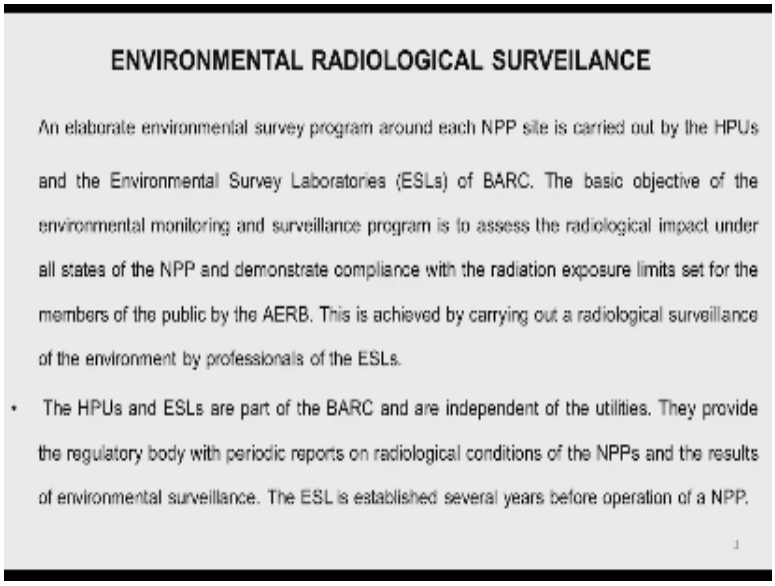
Good afternoon in the mornings lecture we had a look at the regulation being carried out by ARB we also looked at the safety practices which are being carried out in the different nuclear power plants. Wherein the aim and focus has-been to not only keep the exposures tote Occupational workers within limits not only that but to achieve as low as reasonably. Possible a minimal exposure to the Occupational workers we will go further and look at some more,

(Refer Slide Time: 01.21)




Safety practices in the context of the Indian nuclear power plants. We look at the environmental radiological surveillance.

(Refer Slide Time: 01.45)




See at the plant is within the site what the public receives the plant will not know the plant knows what it has released so for the public in the public domain we have established environmental safety laboratories so wherever we plan to build a site or build a nuclear power plant once we have decided on the site the first activity is to establish the environmental survey lab which is a part of the health physics unit of the Bhabha Atomic Research Center.

Mind you I mentioned that this agency is responsible for the radiological surveillance of all nuclear power. Plants and establishments now what is the purpose they purpose is to monitor the environment and assess the radiological impact under the condition. Before, setting up the plant before setting up the nuclear power plant what sort of activity has existed that debt also is collected then later when the plant has started.

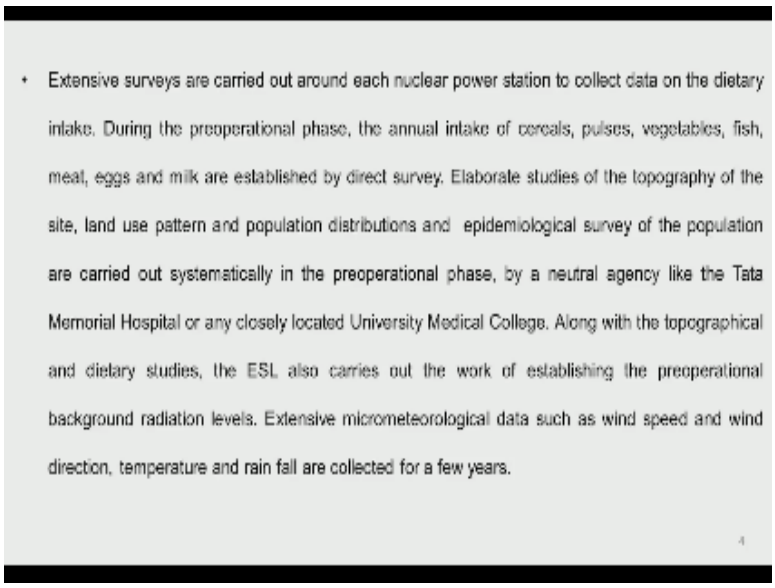
What are is the radiological exposure? Which is being seen so they measure the radiation in the environment and when we say environment it means what it means the human being? whatever we consume the vegetables the milk the fish or the meat because, I mentioned that the path taken could be a air path or a water path through which these two pathways it can reach how it can reach the human being so we have to see in this path what areal the radiation levels that are being reached and for this this environmental survey lab has the instrumentation and manpower to carry out all these activities. So not only that this as a part of the survey environmental survey

they also go wrong the different primary health centers or hospitals around in a 30-kilometer zone so that they try to get some basic data on the types of diseases what our existing maybe also let us say in cancers if suppose cancers are there how much number then pregnancy how babies are being born all sorts of background data and mind you.

Whatever, data we collect we always share with the state medical authorities so that they also can be an independent judge when we do after the plant Estrada operation anything is there we can always compare there is one more agency also to tell us okay or help us in case that is any issue so the health physics units and the environment.

Survey labs are part of BRC but they are independent of the nuclear power plant and they will provide data to the means the review body that is the ARB and as I mentioned ESL is established several years before the operation of a nuclear power plant so they go around the plant they also look at the dietary intake for example:

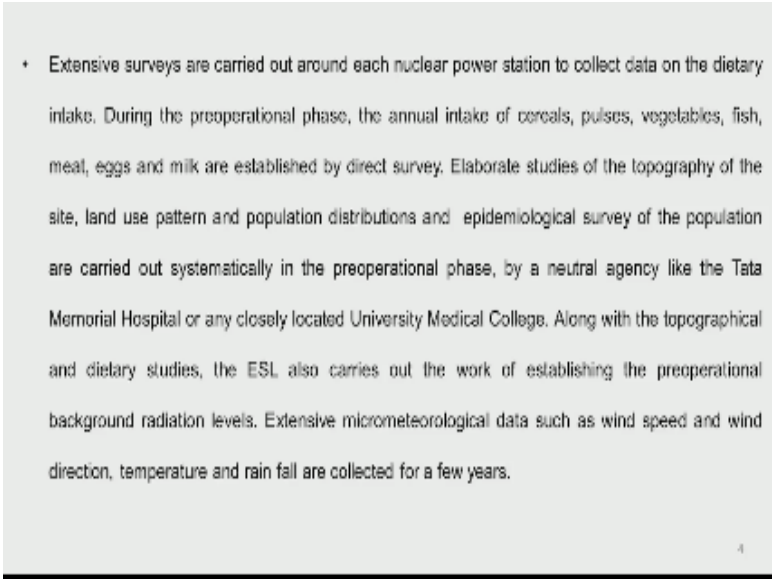
(Refer Slide Time:06.31)




Around kalpak am it was found that ricers the primary intake so they try to look at rice activity in rice more then as mentioned in x the fishes. Meet etcetera then the topography the population distribution which i mentioned was also no doubt during the site selection they would have done. But, here it is one more assessment by another agency so that we really have the actual ground data. They go to the villages in fact you would be surprised.

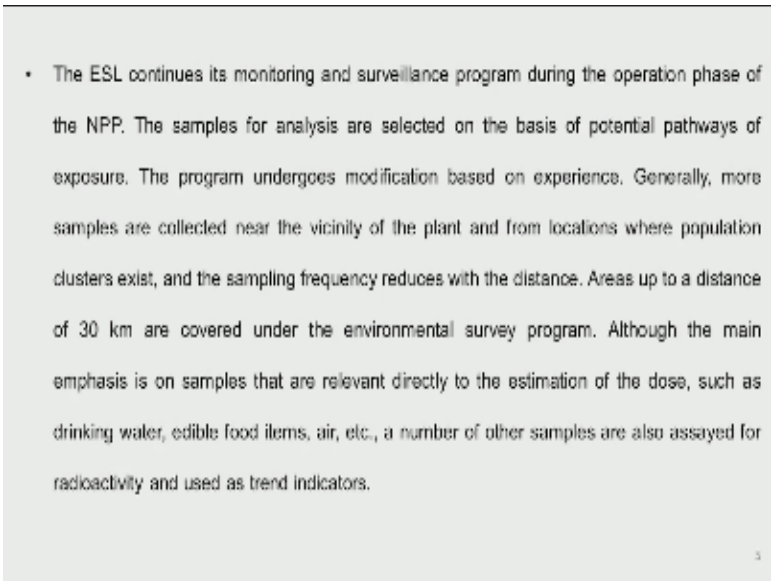
Our inherent will serve a lab people have very good contacts with the local population so in fact there are messengers so they are able to impress upon the people what they are doing and why they are doing so that it provides a confidence to the people that okay their health is being taken care of now we also have epidemiological service.

(Refer Slide Time :07:47)



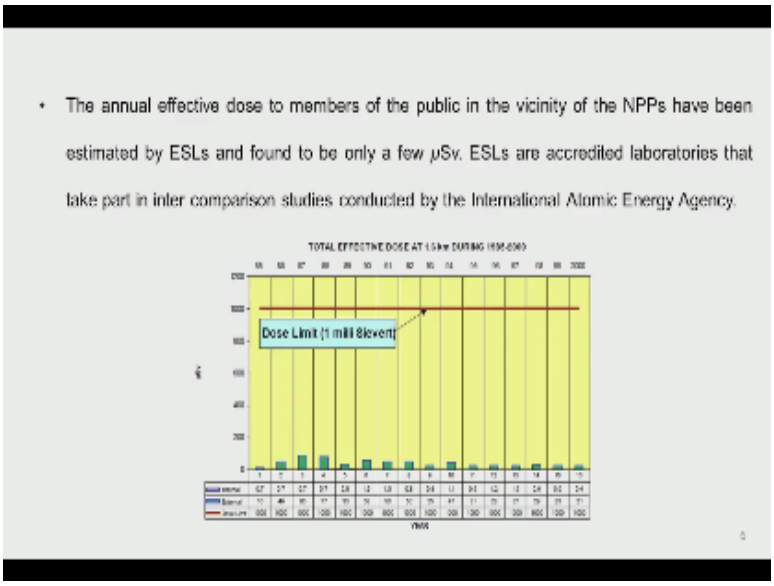

Survey that means we look at the population what sort of diseases? What sort of this have existed in any different areas for this we do not do it ourselves we utilize an agency like some hospitals or some university colleges where they have courses in medical physics so we use them and then these people carry out the epidemiological survey and give it to the Department of Atomic Energy and this epidemiological survey also helps the consultants who are going to present the report environmental impact assessment report that also becomes an input infarct many of these reports assessment reports are available in the public domain then not only that the environment survey lab also have got these mythological travels to measure the wind speed then rainwater collection all such data also again as I said this is a continuous up gradation of the data.

(Refer Slide Time: 09:19)




So once the nuclear power plant has been built the environmental survey lab continues it goes around contains collects the samples of the food items for analysis and on the basis of that it establishes how much activity would have been released by the plant. So as I mentioned earlier the plant has accounted for what it is released and here it is accounting for what it has been reached so there is a check on the plant the plant is independent the 1100survey lab is independent of the plant so that is a sort of better regulation there. So this sampling frequency the frequency of sampling of this we do more in areas which are closer to the plant and when we move away we know that the effect would be less our sampling frequencies are also less and as I mentioned earlier we cover a distance or radius of 30 kilometers around the plant and I should not forget that we also look at the water and any other edible food items.

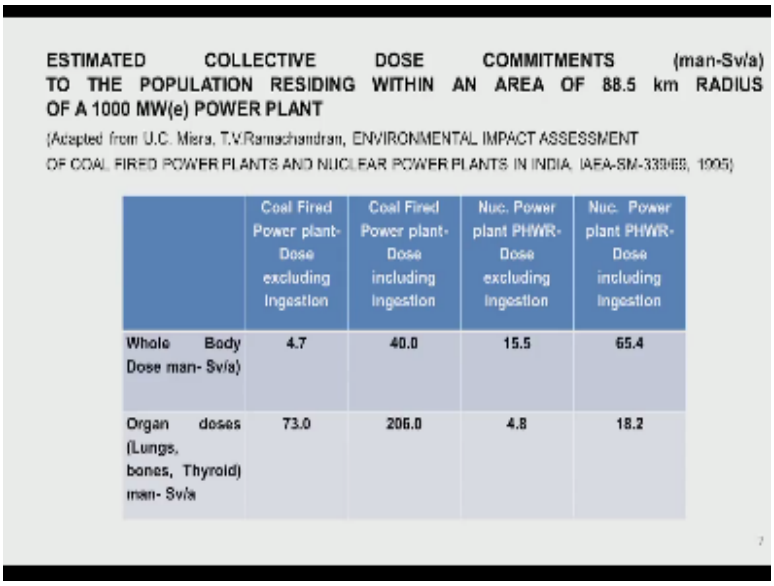
(Refer Slide Time :11:12)




Which the people take and they are also tested for any activity here as we saw that the dose limit to the public should be less than 1millisievert we have the data presented for the kalpak am area. Where in there are three data's the blue one is supposed to be an internal exposure and other one is an external exposure and the total exposure is what it is but the limits are much higher than that and this is for a period from 1985 up to 2000 and mind you this data we also share with the International Atomic Energy Agency now international atomic agency has got access to such data from other countries.

Also so we do also have a data to compare and the environment survey laboratories are accredited after assuring that they are satisfying the standards because they must have calibrated equipment which they are using in the measurement. So it is very important that a tradition to these ESL labs important as i mentioned to earlier the in handle survey labs at the rapport then kalpak am or few of the accredited labs within the country.

(Refer Slide Time 12:53)



**ESTIMATED COLLECTIVE DOSE COMMITMENTS (man-Sv/a) TO THE POPULATION RESIDING WITHIN AN AREA OF 88.5 km RADIUS OF A 1000 MW(e) POWER PLANT**

(Adapted from U.C. Misra, T.V.Ramachandran, ENVIRONMENTAL IMPACT ASSESSMENT OF COAL FIRED POWER PLANTS AND NUCLEAR POWER PLANTS IN INDIA, IAEA-SM-339/68, 1995)

| | Coal Fired Power plant-Dose excluding Ingestion | Coal Fired Power plant-Dose including Ingestion | Nuc. Power plant PHWR-Dose excluding Ingestion | Nuc. Power plant PHWR-Dose including Ingestion |
|---|---|---|---|---|
| Whole Body Dose man-Sv/a) | 4.7 | 40.0 | 15.5 | 65.4 |
| Organ doses (Lungs, bones, Thyroid) man-Sv/a | 73.0 | 206.0 | 4.8 | 18.2 |

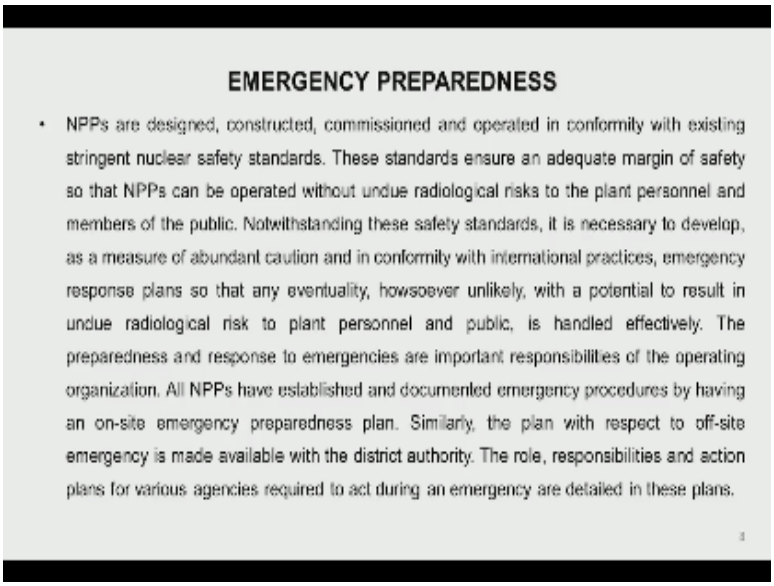
Have been telling you earlier in fact in my first few lectures I mentioned to you that radioactivity is release is therefore a nuclear power plant no doubt but a coal-fired power plant releases100 times of the radioactivity into the environment unlike a nuclear power plant because the coal taken from the ground also contains traces of uranium traces of thorium it is not just that uranium is separate and coaly separate but unfortunately awareness is not there we take the coal we burn it finally it comes to the ash.

So here lot of service have been conducted not only by the Department of Atomic Energy also by independent bodies in the different plants earlier I had mentioned to you about the nose thermal power plant and torero comparison so here there is a very nice IAEA publication which is by UC Mishra and TV Rama children on the environmental impact assessment of coal-fired plants and nuclear power plants in India so based on the measurements they estimate for a thousand megawatt electrical power plant in an 88.5 kilometer radius what are the doses man see what per annum coal-firepower plant without ingestion in winds not considering the injection is four point seven if you include ingestion it is 44 a nuclear power plant.

It is 15.5and if you include individually 65.4but you the whole body dose but you look at some organs doses received by our guns the lungs the bones the thyroid all you see here a huge number 73 million seabirds per year and to not six if you include ingestion whereas nuclear power plants it is low so that needs to be an awareness built into the environmental assessment of the coal-

fired plants. Unfortunately this is not picked up and it is very essential that revelation of this needs to be taken on a fast foot.

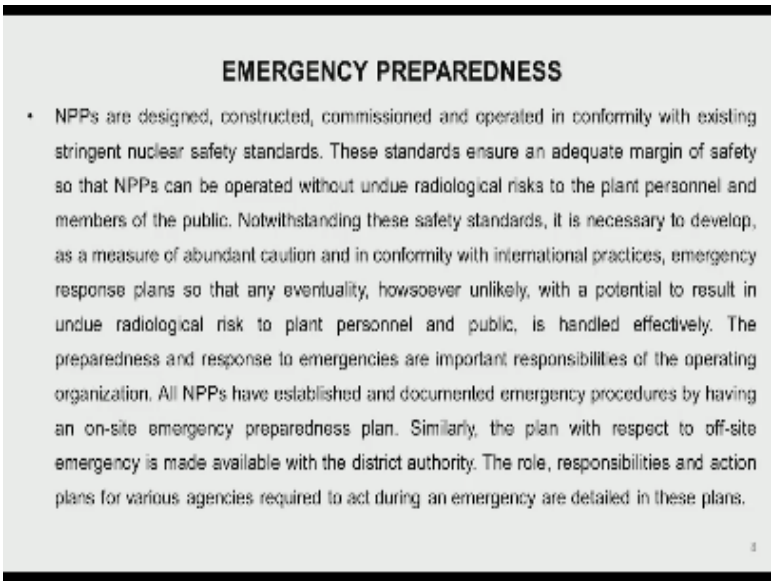
(Refer Slide Time 16:03)




Having talked about the regulation and safety we talked about emergency preparedness. As I mentioned many of the safety people are pessimists they always postulate this fails that fails what you will do like that so we need to because everything is man-made nothing is foolproof for that matter any industry any industrial activity is man mean you have a chemical explosion you have a Bhopal disaster everything is man-made so you cannot say that nothing will happen. So but we must prepare ourselves for the worst so that is where emergency preparedness is a part of the nuclear industry.

So even though we have provided enough margin of safety we have followed the defense in depth principle to minimize the exposure of the plant exposure. To the workers and the public we have provided a containment to mitigate the consequences of a an accident nevertheless should an accident happen. We must prepare ourselves one is we have a duty to safeguard our occupational workers the site and then also the public. So in order that this is done in very systematic fashion we have documented procedures of emergency preparedness.

(Refer Slide Time 18:09)

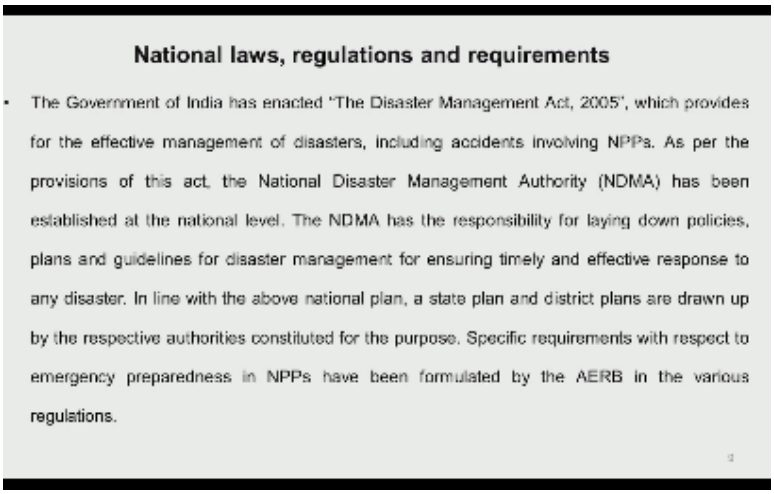



And here we talk about two types of emergencies one is on-site emergency we're in the plant only has got affected and this was the case of the Three Mile Island accident in the United States of America where in the containment was not breached but radioactive material had come into the containment so there there are no equation or anything of the public. Even though they were ready but that did not happen. So there was an on-site emergency then off-site emergencies let us say the containment has failed or as in the case of Chernobyl where there was no containment it is an off-site emergency.

So the procedures are there because why these procedures need to be laid out when you have an off-site emergency you have to deal with the public and in the public domain the plant authorities have a limited role they need to take into the support of the district authorities or also and also the state authorities. So, we have to have a clear-cut demarcation that in case of off-site Emergencies.

What will be the role of each person in case of an on-site emergency what will the role of each person within the plant so this is what is detailed outland that is called as the emergency preparedness plan? Now the Government of India India to formalize these measures has enacted the Disaster Management.

(Refer Slide Time 19:56)

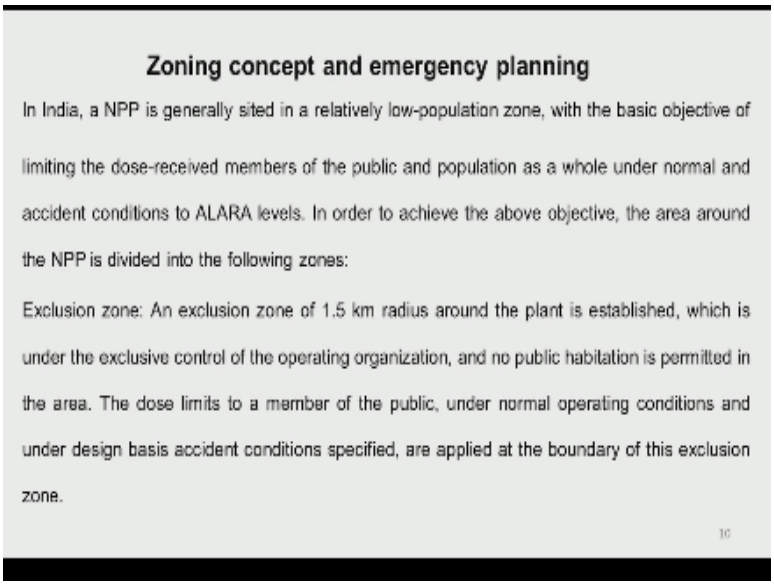



Act in 2005 which provides for effective management of disasters including accidents involving the nuclear power plants and radiation establishments so what we have one called as the National Disaster Management Authority now this authority has the responsibility of making the policies plants and guidelines for disaster management as you know last week we had a large cyclone which hit the Andhra coast but fortunately the deaths were minimal though there was lot of damage.

To the property and here there was enough planning by the national disaster management authority by evacuating people to safer areas well before the cyclone reached the coastal Andhra Pradesh so these plants are really in place and this NDMA draws up the plan with reference to the central agency then the state again the district level there is a clear-cut demarcation for natural disasters and also desires involving the nuclear power plants in fact the first when the authority was formed the one of the important persons in the authority was a retired director from the barber chronic user filter.

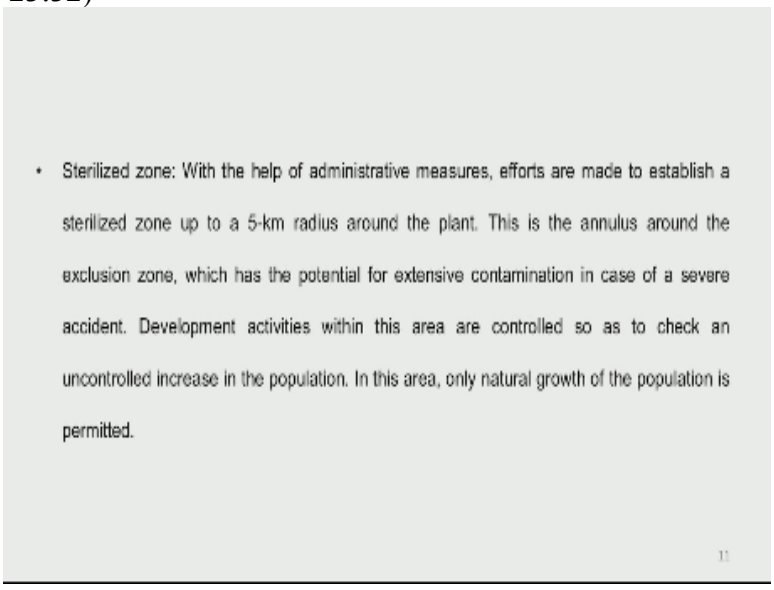
So that then there could be for the nuclear power plants he could help in drawing up the clear policies and also support because already we have been we have the plants but when we are making a disaster management authority, so it provided a real backup background for other industrial units to make such emergency plants.

(Refer Slide Time: 22:29)



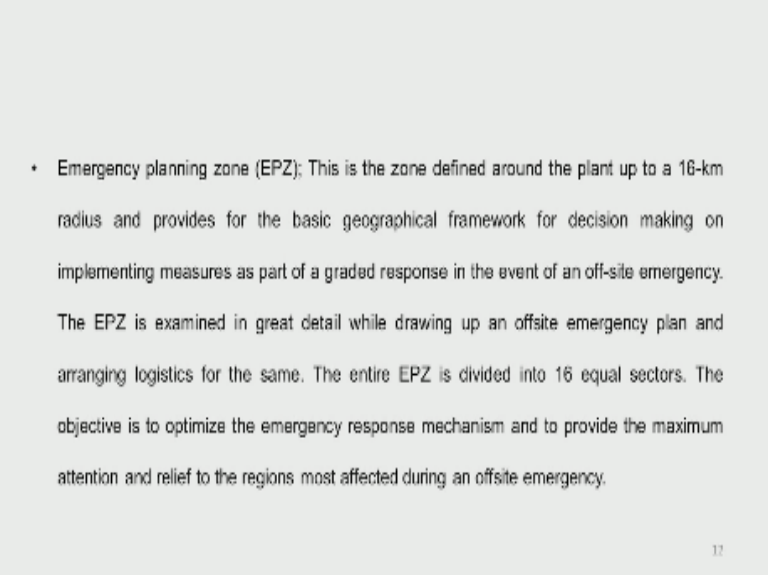

Now as earlier indicated to you should rate we have got a zone concept we have exclusion zone then we have a relatively low population zone so that people receive minimal radiation that is number of people who receive such radiation is minimal so we have the exclusion zone of 1.5 kilometers around the plant and here it is under the total control of the unit or the operating plant and public inhabitation is not provided no public habitation can be there then at the boundary of the exclusion zone beyond that we have certain people of course up to five kilometers but it is very thin population and beyond.

(Refer Slide Time: 23:32)



That some more so the that zone is called as a sterilized zone from the 1.5 radius 25 kilometer radius so this zone has got chance for contamination in case of an accident so we need to see that there should not be a continuous growth of operation what the population is there let it be there but not uncontrolled growth of this so no we do not allow any new populations coming over there.

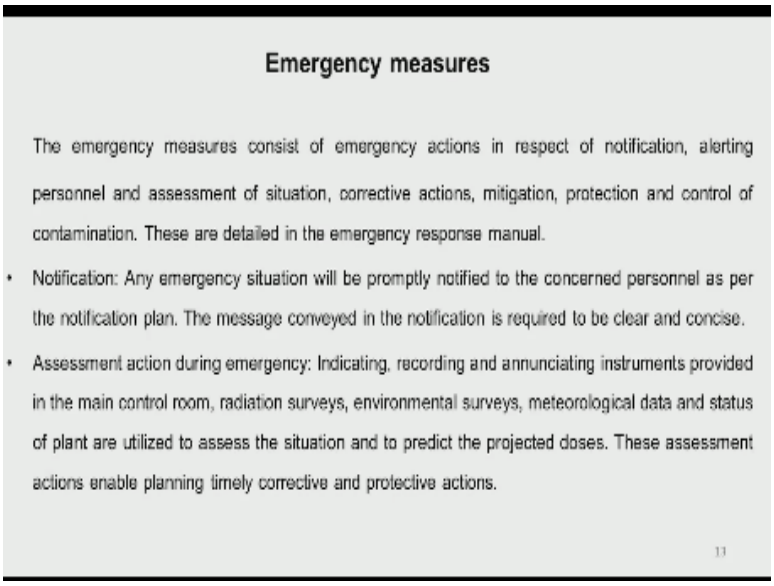
(Refer Slide Time: 24:08)




Then the next is the emergency planning zone which is from the five kilometers to the 16 kilometer radius and here is where we have to drop the off-site emergency plans for evacuations what are the different equipments needed what are the different agencies which will need to the picture for example, you need the services of the state transport to acquit people you need the support of the local police you need the support of the different hospitals so all this are put down in a formal way and normally there is a division is the emergency planning zone.

Itself is divided into some sectors so that we can concentrate on a particular sector more easily let us say the wind was in a particular direction after an accident we know in that direction we have to take so we say in this direction what Jones come okay zones 1579 okay, this need to be evacuated so it is easy for the people to execute during the emergency and give relief to the people.

(Refer Slide Time: 25:57)



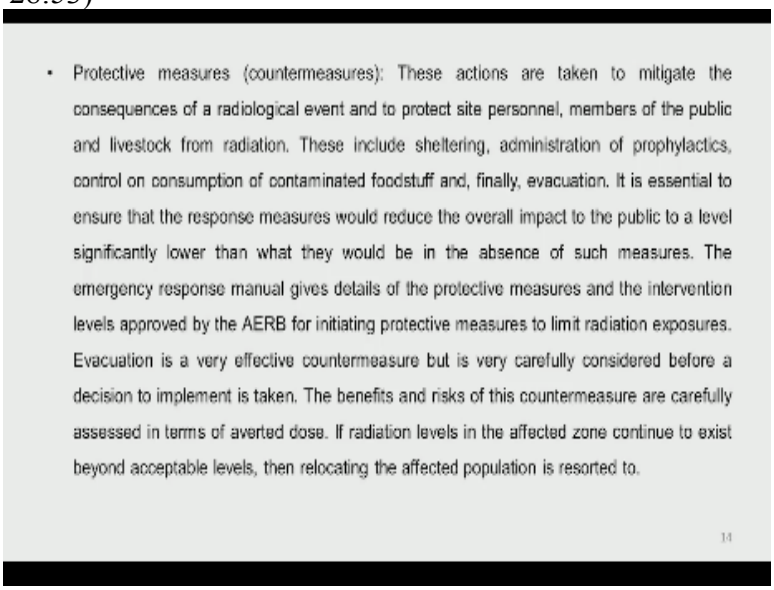

Then what does this emergency plan include first and foremost is to say that the emergency has happened that means you have to notify an emergency so that you can alert the people that an emergency has occurred so one is notification then next is your assessment of the situation then corrective actions if any then as we say mitigation protection and control of the contamination the contamination has happened because of the accident whether I can control all these things are detailed out in the emergency response manuals notification.

So as per the plan the notification will be done by the person who is connected with administering the whole plant at a given site that is actually called as the site emergency director we shall see that in the organization later and the message has to be very clear emergency yes or not is not like vague so he has to make notification before he makes a notification he has to assess so assessing is what involves it involves recording the data and then you will have alarms in the main control rooms.

You must have inputs from the radiation service you must have inputs from the environmental survey labs you must have the input of the meteorological data so that immediately I can say which area is getting affected I must get a idea about the status of the plant then only, I can say okay this much does this much one thing I can tell you because of this distance in case of a radiation accidentally activity accident nothing is immediate there are two to three hours available before dicks really reaches the public in fact much more but surely does enough time there is nothing to runaway even for the people in the plant nothing to run away it.

We have got lot of you know barriers in between so that this data once available to the side emergency director he can make assessment and also will be able to give directions.

(Refer Slide Time: 28:53)




Now what sort of protective measures one is for the site personal that they should put more protective clothing or they should move into certain areas so that the people are able to work without any difficulties the public why is the protective measures could include sheltering for example when you say the sedation accident people say remain indoors do not come out and maybe keep a handkerchief to your nose that is the best way nothing will enter then the other mitigation measure would be administration of prophylactics like iron tablets for example, see thyroid has got the affinity for ideal so radioactive idea.

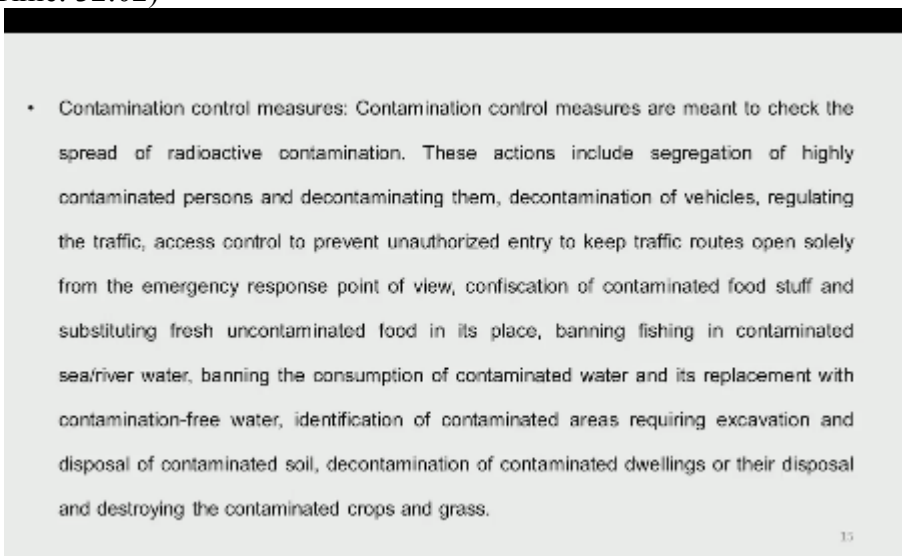
If it comes it will go to the thyroid so what we do we give the iodine tablets to the public they take that will go and fill the thyroid so this radioactive iodine cannot diffuse into the thyroid so this is one way is a prophylactic then control on the consumption of contaminated foot stuff suppose you feel that things would have got contaminated then you have to put a order saying that contaminated food subs until they are checked should not be consumed and of course evacuation.

Now it is very essential that the overall impact should be as low as possible then only the real emergency preparedness plan is success so not only that the emergency plan are brought out in an emergency response manual all these protective measures for each individual item or all put down in the manual and also at what level intervention is needed all these are indicated in the

manual so it is all written down there is nothing vague about it and these procedures for every unit every site is approved by the Atomic Energy Regulatory board.

Then the if the radiation levels within the affected zones then are not coming continuing to you know be high then of course we will have to look whether permanent relocation of the people that also has been thought about in the plan and luckily for us we are not faced such situations then.

(Refer Slide Time: 32:02)



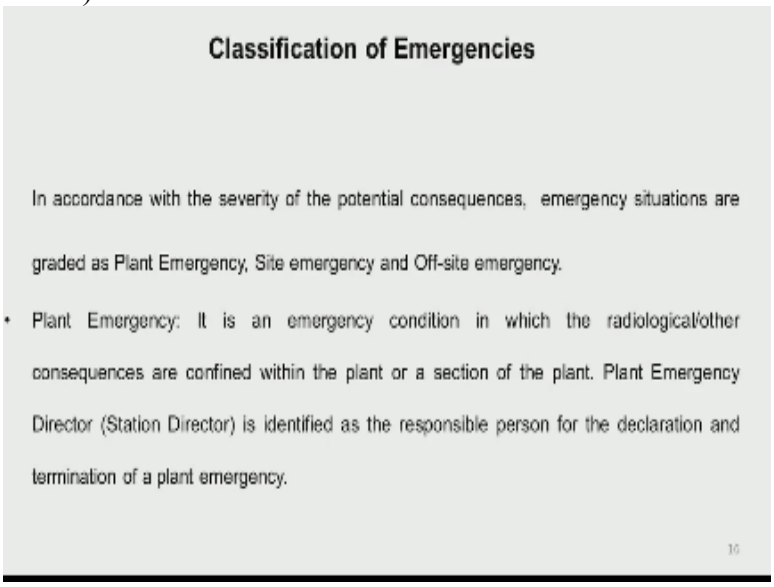

What are the contamination of control measures now let us say some people have who are working occupational workers who are there in the plant when the accident happened and in the vicinity of the radioactive material they would have got contaminated so first is try to segregate them and send them for the decontamination within the plant we do have a decontamination center at every unit I mentioned this to you in my previous two three lectures before then when the transportation of people is taking place these vehicles might be carrying some DD activity.

So once they come out they should be decontaminated and then only sent out so this is another and another thing is revelation of the traffic so once this emergency has been declared normal traffic should be stopped no normal traffic no normal movement in fact in the odds on side emergency exercises the moment the emergency siren is sounded we all get collected within our building we are there we do not move nobody should move because in the open activity could be there.

So we do not want it to happen in a closed shelter it is less likely that you get exposure having said this we also should take measures in case of any contaminated footsteps we should see take the help of the district authorities to confiscate them so that they are not given to the public sometimes you know you know some occurs and sellers would like to sell it off fast and people may try to store it array we will not get for some more time because of this disaster so all this is the responsibility of the district authorities based on.

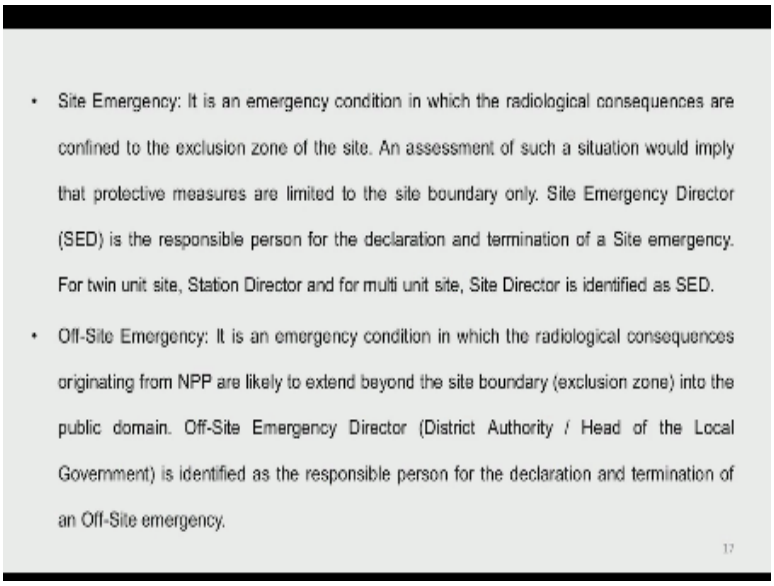
The advice by the plant authorities then in case water is contaminated we have to see that they are not drunk by the people and they are supplied with non contaminated water here the in case you find that some crops or have been contaminated we must see how to destroy them so these are different things all these are put down clearly in the emergency manuals and needs to be followed in total so what are the classifications of emergencies.

(Refer Slide Time: 35:10)




So I mentioned you could be a side emergency and off-site emergency. But also we have one more called as a plant emergency that means it is only restricted to the plant other one is restricted to the site third one is beyond the site so plant emergency generally we say an emergency condition where the radiological confuse Confed to a part of the plant, so the station director of the plant is the person who will declare and maybe later once everything is smooth he may terminate the emergency, so this is the plant emergency.

(Refer Slide Time: 35:22)

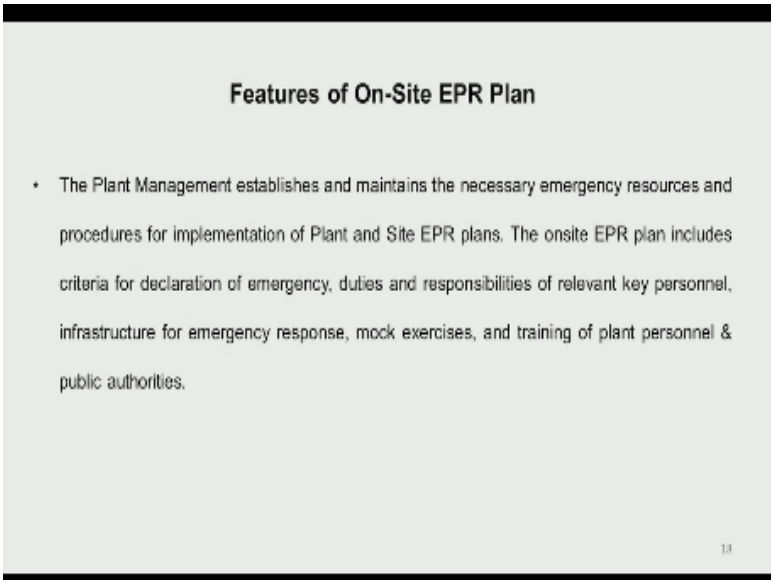



So site emergency again here as I mentioned it is the side the exclusion zone of 1.6 kilometers that is where the effect is beyond that that is going to be no radiation effect so the site emergency director will be the person here in most of the cases it could be a station director but if suppose there are multiple units let us take kalpakkam site we have got units of the Nuclear Power Corporation of India you have got the units of the DIE you have got the units of the BRC so here one of them is the emergency station emergency director for that period.

So they will have a turn by turn they will be the emergency director so that instructions are given by a single person not by multitude of persons then off-site emergency when you come to the offsite emergency it is a situation where the radiological consequences have started from the nuclear power plant it is a big one accident has happened and this is going to cross the site boundary and it will go into the public domain so the off-site emergency director will be the district authority or the head of the local government could be collectors who is responsible for declaring our of the emergency of state emergency.

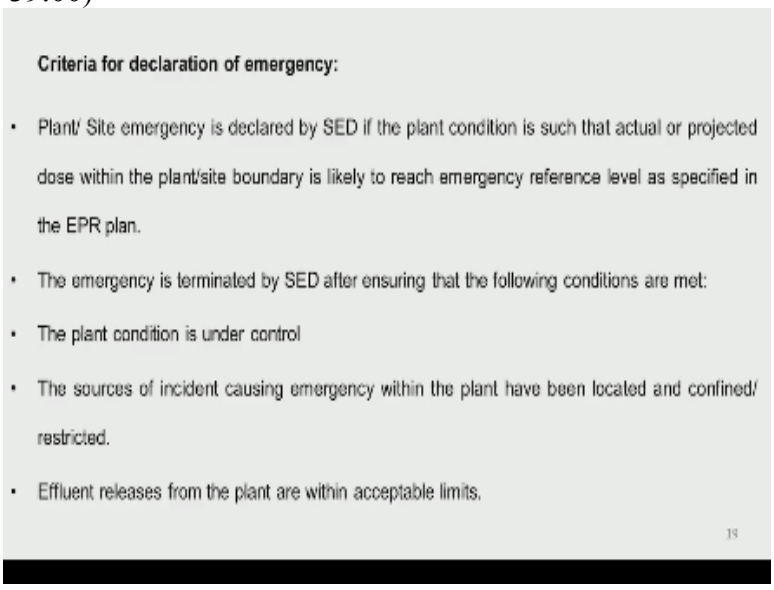
So normally it is the collector for example with kalpakkam we used to have the Kanchipuram collectors a person and all these communication between these people is hotlines they are working through wireless through mobile all sorts of routes are established and all these things are checked on a weekly basis every week to see that all this are working well so this is again a part of the manual the testing frequency of this communication equipment even that is put on then.

(Refer Slide Time: 38:13)



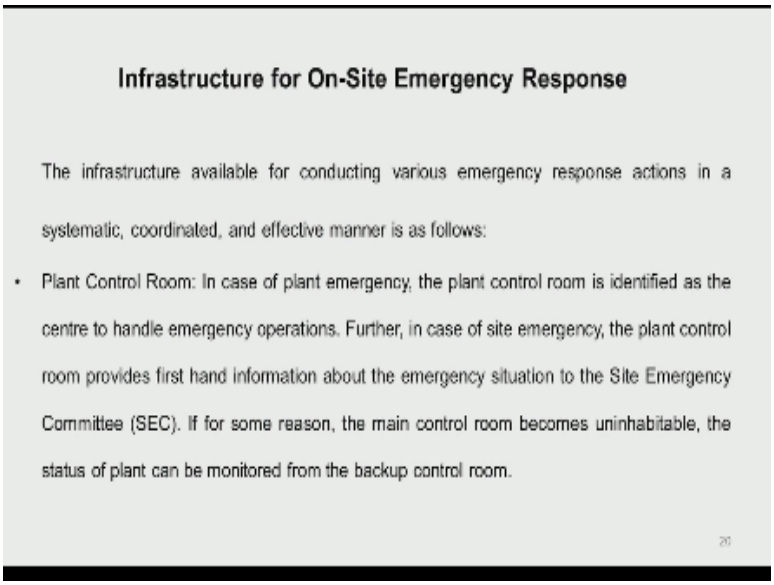

Let us look at what are the features of a non-site emergency plan so the emergency plan includes declaration of emergency duties and responsibilities of the key personnel and what infrastructure you require for the emergency response not only that even though there is no emergency you should conduct mock drills excises to assess whether the infrastructure is in place no doubt you should train the people from time to time and impress upon them the relevance of these plants and their implementation.

(Refer Slide Time: 39:00)



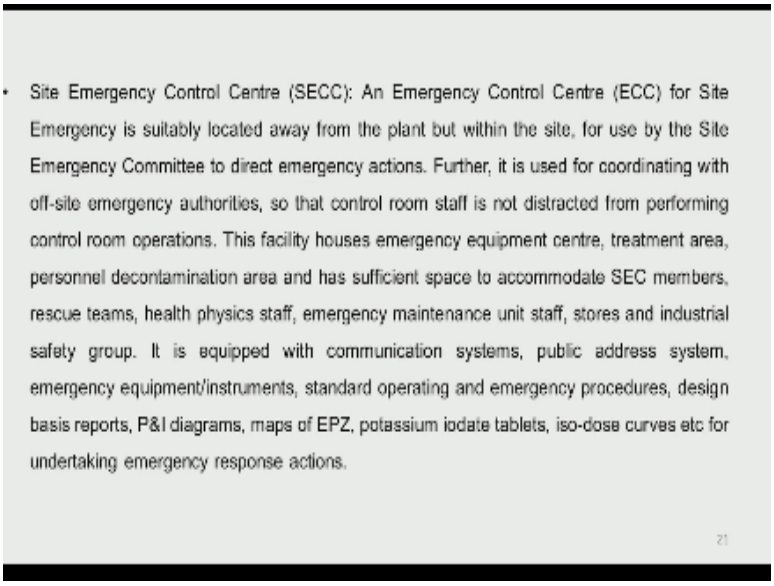
Now let us look what is the criteria for declaration of a plant or site emergency so it is basically an accident which has happened in the plant and is not likely to cross this site boundary so that is where the whole control is within the plant by the plant authorities and you know the source of the incident which is causing emergency you only need to say that your effluent releases are within the acceptable limits that is what has to be taken care of then what is the infrastructure.

(Refer Slide Time: 39:49)




One is the plant control room must be available so that you can control the plant but as we saw earlier should there be a situation like a fire in the control room we need to have a emergency control room from whereas the operation needs to be done and the sometimes it is also called as a backup control room so because that is what is the place where you get the first data of the emergency so this again becomes important from an emergency point of view emergency planning point of view the backup control rooms becomes very important one.

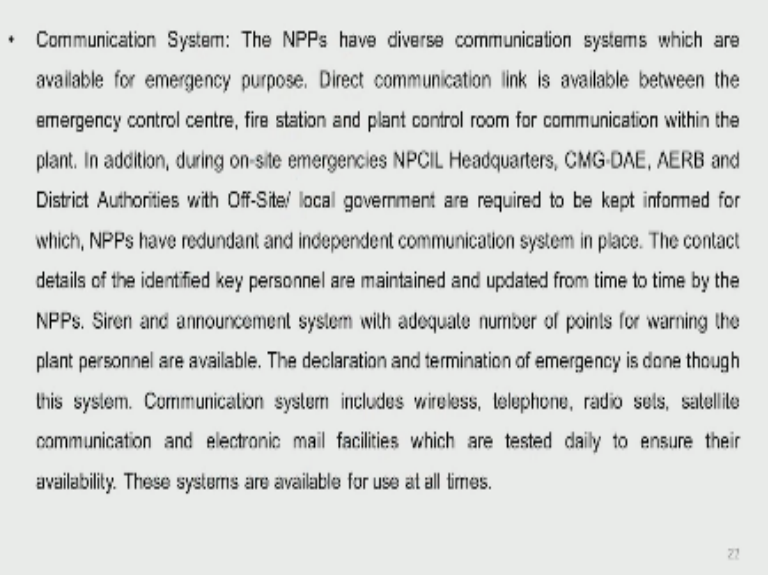
(Refer Slide Time: 40:42)




Then a site emergency control center then you have to control the different actions by different agencies so it is essential that you must establish a control center for a given site which could be within the site but away from the plant away from the plant or away from the radiation you know where it is a radiation plant or inactivity or it is a nuclear power plant so that he can operate comfortably from there so from that control center the coordination is done with all the authorities with the district authorities with the state authorities with the central government authorities with the NDMA as we shall see and this emergency control center should have provisions equipments emergency equipment treatment medical treatment area.

Then personal decontamination and should be able to accommodate the health physics staff must have some stores for these prophylactics or equipments and last but not the least as I mentioned a good communication system and preferably public address system wherein we could address the public around to say keep them in form of what sort of things and the communication system should include the media also and for all this and not only that the procedures the emergency procedures the manuals all would be kept in this emergency control center.

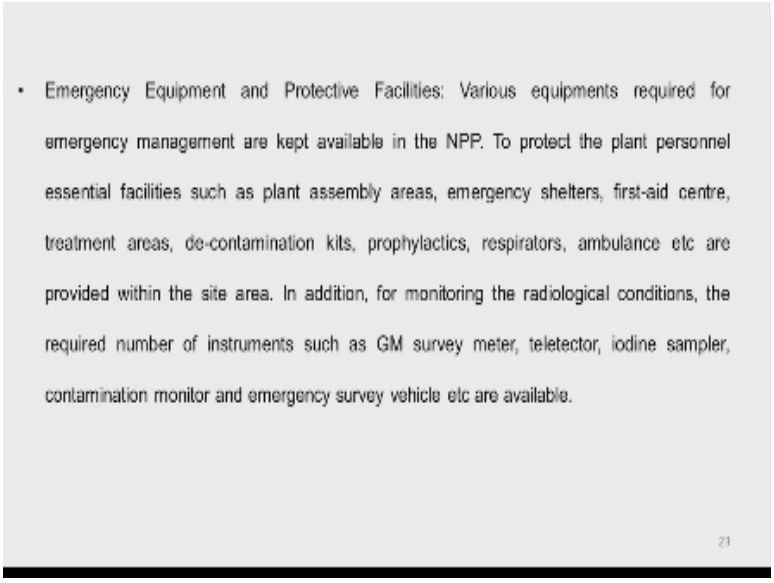
(Refer Slide Time: 42:45)




Communication system as I mentioned here there is a direct communication system between the emergency control cylinders. Then the fire station local fire station of course the plant control room is the place from where you get the communication about the plant then the utility headquarters here the Nuclear Power Corporation of India then the Atomic Energy Regulatory board then the crisis management group in the atomic energy DA the crisis management group which is there the district authorities and all local government authorities the panchayat everybody and all are required to be kept informed of so you have redundancy and diversity and independent communication systems.

In place here we also applied that principle and the contact numbers of the details of the key personnel are updated from time to time and this is a very important one and this is what is helps us when you can like this mock drills we update this incase we are not updated so the declaration or the termination of the emergencies is done through this so as I mentioned earlier we have wireless we have telephone sets we also have satellite communication and email facilities and all these are tested on a daily basis.

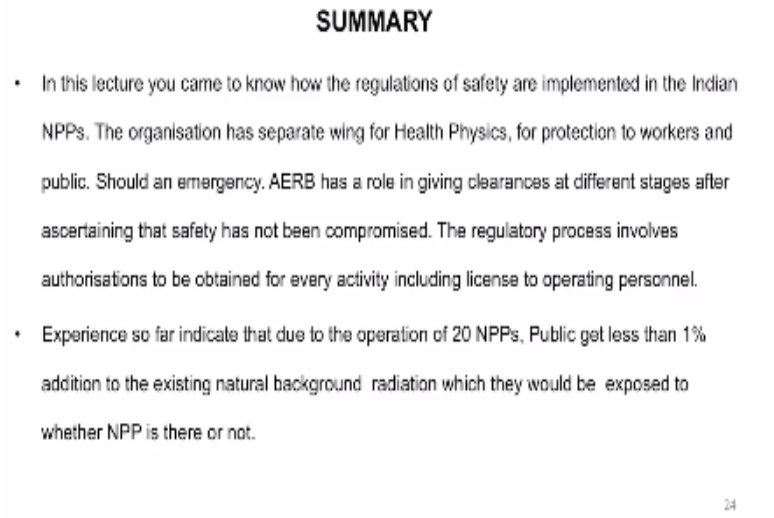
(Refer Slide Time: 44:20)




Emergency equipment and productive facilities as I mentioned the emergency shelters the first state center should there be any persons affected with radiation you must have decontamination kits and you must have areas where the treatment can be done segregating the people who are affected respirators ambulance etcetera all need to be provided as an infrastructure then not only that monitors survey meters tell adductor wherein from a distance you can measure the what is the activity iodine sampler survey vehicles and whatnot all these.

So this is where all exercises  give us a sort of keep ourselves ready so this is an alert situation for which these are very helpful.

(Refer Slide Time: 45:38)



So in this lecture we have seen that how the environmental survey been a very important one not only to know the background data before the plant started it is seen what sort of radioactivity is present when no nuclear power plant was no nuclear activities around as a consequence of the natural background what does the radioactivity in the fish what are the radioactivity in the milk what are the reactivity in the plant different plants different vegetables,so all this data so the moment.

When the plant operates should there be any increase in the levels of these then this becomes an important pointer to us to examine whether there has been released elsewhere in the from the plant if so caution the authorities much before the levels have risen then we also looked at the emergency preparedness basically we looked at the on-site emergency preparedness now in the next lecture we will see about the some more about the off-site emergencies and our experience with the measurements of the environmental survey labs indicate that public gets less than 1% compared to the existing natural background which they anyway would be exposed to thank you.

**Online Video Editing /Post Production /Camera**

R. Selvam
S Subash
F Soju
S Pradeepa
M Karthikeyan
T Ramkumar
R Sathiaraj

**Video Producers**
K R Ravindranath
Kannan Krishnamurty

**IIT MADRAS PRODUCTION**

Funded by
Department of Higher Education
Ministry of Human Resources Development
Government of India

www.nptel.iitm.ac.in