

**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...**

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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 to 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,

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**Safety Practices in Indian NPPs-Contd**

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

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### ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE

An elaborate environmental survey program around each NPP site is carried out by the HPUs and the Environmental Survey Laboratories (ESLs) of BARC. The basic objective of the environmental monitoring and surveillance program is to assess the radiological impact under all states of the NPP and demonstrate compliance with the radiation exposure limits set for the members of the public by the AERB. This is achieved by carrying out a radiological surveillance of the environment by professionals of the ESLs.

- The HPUs and ESLs are part of the BARC and are independent of the utilities. They provide the regulatory body with periodic reports on radiological conditions of the NPPs and the results of environmental surveillance. The ESL is established several years before operation of a NPP.

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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:

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- \* Extensive surveys are carried out around each nuclear power station to collect data on the dietary intake. During the preoperational phase, the annual intake of cereals, pulses, vegetables, fish, meat, eggs and milk are established by direct survey. Elaborate studies of the topography of the site, land use pattern and population distributions and epidemiological survey of the population are carried out systematically in the preoperational phase, by a neutral agency like the Tata Memorial Hospital or any closely located University Medical College. Along with the topographical and dietary studies, the ESL also carries out the work of establishing the preoperational background radiation levels. Extensive micrometeorological data such as wind speed and wind direction, temperature and rain fall are collected for a few years.

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.

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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.

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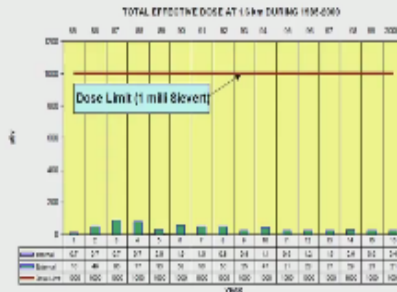
- The ESL continues its monitoring and surveillance program during the operation phase of the NPP. The samples for analysis are selected on the basis of potential pathways of exposure. The program undergoes modification based on experience. Generally, more samples are collected near the vicinity of the plant and from locations where population clusters exist, and the sampling frequency reduces with the distance. Areas up to a distance of 30 km are covered under the environmental survey program. Although the main emphasis is on samples that are relevant directly to the estimation of the dose, such as drinking water, edible food items, air, etc., a number of other samples are also assayed for radioactivity and used as trend indicators.

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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.

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- The annual effective dose to members of the public in the vicinity of the NPPs have been estimated by ESLs and found to be only a few  $\mu\text{Sv}$ . ESLs are accredited laboratories that take part in inter comparison studies conducted by the International Atomic Energy Agency.



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 1 millisievert 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.

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**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. Mishra, T.V.Ramachandran, ENVIRONMENTAL IMPACT ASSESSMENT  
OF COAL FIRED POWER PLANTS AND NUCLEAR POWER PLANTS IN INDIA. IAEA-SM-330/68, 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

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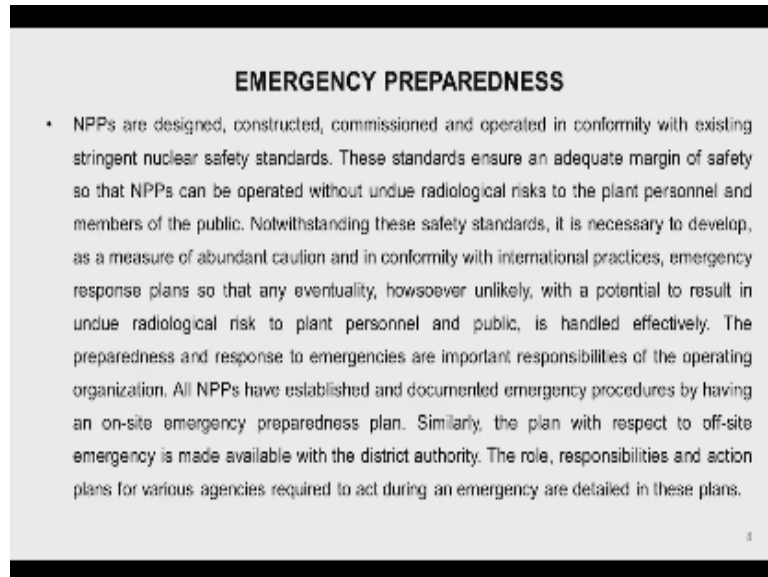
Have been telling you earlier in fact in my first few lectures I mentioned to you that radioactivity is release is therefore a nuclear power plant no doubt but a coal-fired power plant releases 100 times of the radioactivity into the environment unlike a nuclear power plant because the coal taken from 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 15.5 and if you include individually 65.4 but 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.

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**EMERGENCY PREPAREDNESS**

- NPPs are designed, constructed, commissioned and operated in conformity with existing stringent nuclear safety standards. These standards ensure an adequate margin of safety so that NPPs can be operated without undue radiological risks to the plant personnel and members of the public. Notwithstanding these safety standards, it is necessary to develop, as a measure of abundant caution and in conformity with international practices, emergency response plans so that any eventuality, howsoever unlikely, with a potential to result in undue radiological risk to plant personnel and public, is handled effectively. The preparedness and response to emergencies are important responsibilities of the operating organization. All NPPs have established and documented emergency procedures by having an on-site emergency preparedness plan. Similarly, the plan with respect to off-site emergency is made available with the district authority. The role, responsibilities and action plans for various agencies required to act during an emergency are detailed in these plans.

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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.

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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.

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### **National laws, regulations and requirements**

- The Government of India has enacted 'The Disaster Management Act, 2005', which provides for the effective management of disasters, including accidents involving NPPs. As per the provisions of this act, the National Disaster Management Authority (NDMA) has been established at the national level. The NDMA has the responsibility for laying down policies, plans and guidelines for disaster management for ensuring timely and effective response to any disaster. In line with the above national plan, a state plan and district plans are drawn up by the respective authorities constituted for the purpose. Specific requirements with respect to emergency preparedness in NPPs have been formulated by the AERB in the various regulations.

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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.

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### **Zoning concept and emergency planning**

In India, a NPP is generally sited in a relatively low-population zone, with the basic objective of limiting the dose-received members of the public and population as a whole under normal and accident conditions to ALARA levels. In order to achieve the above objective, the area around the NPP is divided into the following zones:

**Exclusion zone:** An exclusion zone of 1.5 km radius around the plant is established, which is under the exclusive control of the operating organization, and no public habitation is permitted in the area. The dose limits to a member of the public, under normal operating conditions and under design basis accident conditions specified, are applied at the boundary of this exclusion zone.

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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.

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- **Sterilized zone:** With the help of administrative measures, efforts are made to establish a sterilized zone up to a 5-km radius around the plant. This is the annulus around the exclusion zone, which has the potential for extensive contamination in case of a severe accident. Development activities within this area are controlled so as to check an uncontrolled increase in the population. In this area, only natural growth of the population is permitted.

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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.

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- Emergency planning zone (EPZ); This is the zone defined around the plant up to a 16-km radius and provides for the basic geographical framework for decision making on implementing measures as part of a graded response in the event of an off-site emergency. The EPZ is examined in great detail while drawing up an offsite emergency plan and arranging logistics for the same. The entire EPZ is divided into 16 equal sectors. The objective is to optimize the emergency response mechanism and to provide the maximum attention and relief to the regions most affected during an offsite emergency.

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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.

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## Emergency measures

The emergency measures consist of emergency actions in respect of notification, alerting personnel and assessment of situation, corrective actions, mitigation, protection and control of contamination. These are detailed in the emergency response manual.

- Notification: Any emergency situation will be promptly notified to the concerned personnel as per the notification plan. The message conveyed in the notification is required to be clear and concise.
- Assessment action during emergency: Indicating, recording and annunciating instruments provided in the main control room, radiation surveys, environmental surveys, meteorological data and status of plant are utilized to assess the situation and to predict the projected doses. These assessment actions enable planning timely corrective and protective actions.

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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.

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- Protective measures (countermeasures): These actions are taken to mitigate the consequences of a radiological event and to protect site personnel, members of the public and livestock from radiation. These include sheltering, administration of prophylactics, control on consumption of contaminated foodstuff and, finally, evacuation. It is essential to ensure that the response measures would reduce the overall impact to the public to a level significantly lower than what they would be in the absence of such measures. The emergency response manual gives details of the protective measures and the intervention levels approved by the AERB for initiating protective measures to limit radiation exposures. Evacuation is a very effective countermeasure but is very carefully considered before a decision to implement is taken. The benefits and risks of this countermeasure are carefully assessed in terms of averted dose. If radiation levels in the affected zone continue to exist beyond acceptable levels, then relocating the affected population is resorted to.

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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 iodine so radioactive iodine.

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 food stuff suppose you feel that things would have got contaminated then you have to put a order saying that contaminated food stuffs 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.

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- Contamination control measures: Contamination control measures are meant to check the spread of radioactive contamination. These actions include segregation of highly contaminated persons and decontaminating them, decontamination of vehicles, regulating the traffic, access control to prevent unauthorized entry to keep traffic routes open solely from the emergency response point of view, confiscation of contaminated food stuff and substituting fresh uncontaminated food in its place, banning fishing in contaminated sea/river water, banning the consumption of contaminated water and its replacement with contamination-free water, identification of contaminated areas requiring excavation and disposal of contaminated soil, decontamination of contaminated dwellings or their disposal and destroying the contaminated crops and grass.

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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 away 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.

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**Classification of Emergencies**

In accordance with the severity of the potential consequences, emergency situations are graded as Plant Emergency, Site emergency and Off-site emergency.

- \* Plant Emergency: It is an emergency condition in which the radiological/other consequences are confined within the plant or a section of the plant. Plant Emergency Director (Station Director) is identified as the responsible person for the declaration and termination of a plant emergency.

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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 confuses Confined 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.

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- Site Emergency: It is an emergency condition in which the radiological consequences are confined to the exclusion zone of the site. An assessment of such a situation would imply that protective measures are limited to the site boundary only. Site Emergency Director (SED) is the responsible person for the declaration and termination of a Site emergency. For twin unit site, Station Director and for multi unit site, Site Director is identified as SED.
- Off-Site Emergency: It is an emergency condition in which the radiological consequences originating from NPP are likely to extend beyond the site boundary (exclusion zone) into the public domain. Off-Site Emergency Director (District Authority / Head of the Local Government) is identified as the responsible person for the declaration and termination of an Off-Site emergency.

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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.

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### Features of On-Site EPR Plan

- The Plant Management establishes and maintains the necessary emergency resources and procedures for implementation of Plant and Site EPR plans. The onsite EPR plan includes criteria for declaration of emergency, duties and responsibilities of relevant key personnel, infrastructure for emergency response, mock exercises, and training of plant personnel & public authorities.

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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 exercises 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.

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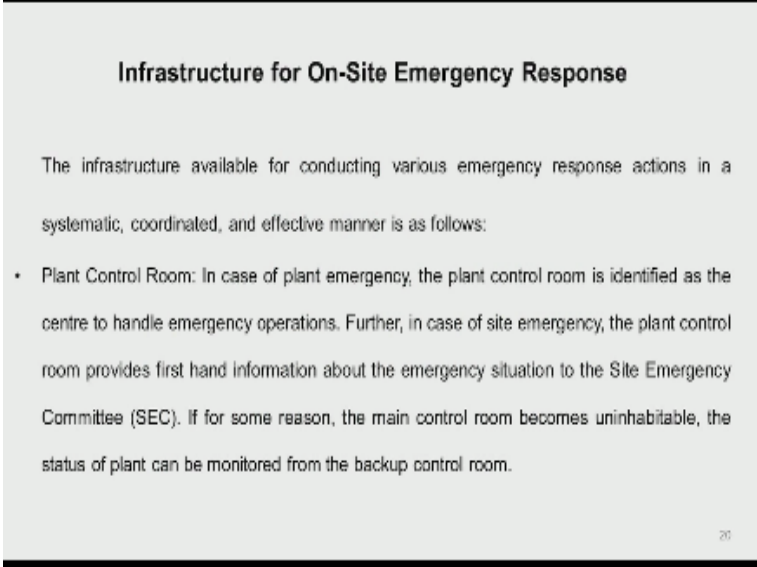
#### Criteria for declaration of emergency:

- Plant/ Site emergency is declared by SED if the plant condition is such that actual or projected dose within the plant/site boundary is likely to reach emergency reference level as specified in the EPR plan.
- The emergency is terminated by SED after ensuring that the following conditions are met:
  - The plant condition is under control
  - The sources of incident causing emergency within the plant have been located and confined/ restricted.
  - Effluent releases from the plant are within acceptable limits.

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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.

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**Infrastructure for On-Site Emergency Response**

The infrastructure available for conducting various emergency response actions in a systematic, coordinated, and effective manner is as follows:

- Plant Control Room: In case of plant emergency, the plant control room is identified as the centre to handle emergency operations. Further, in case of site emergency, the plant control room provides first hand information about the emergency situation to the Site Emergency Committee (SEC). If for some reason, the main control room becomes uninhabitable, the status of plant can be monitored from the backup control room.

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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.

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- Site Emergency Control Centre (SECC): An Emergency Control Centre (ECC) for Site Emergency is suitably located away from the plant but within the site, for use by the Site Emergency Committee to direct emergency actions. Further, it is used for coordinating with off-site emergency authorities, so that control room staff is not distracted from performing control room operations. This facility houses emergency equipment centre, treatment area, personnel decontamination area and has sufficient space to accommodate SEC members, rescue teams, health physics staff, emergency maintenance unit staff, stores and industrial safety group. It is equipped with communication systems, public address system, emergency equipment/instruments, standard operating and emergency procedures, design basis reports, P&I diagrams, maps of EPZ, potassium iodate tablets, iso-dose curves etc for undertaking emergency response actions.

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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.

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- Communication System: The NPPs have diverse communication systems which are available for emergency purpose. Direct communication link is available between the emergency control centre, fire station and plant control room for communication within the plant. In addition, during on-site emergencies NPCIL Headquarters, CMG-DAE, AERB and District Authorities with Off-Site/ local government are required to be kept informed for which, NPPs have redundant and independent communication system in place. The contact details of the identified key personnel are maintained and updated from time to time by the NPPs. Siren and announcement system with adequate number of points for warning the plant personnel are available. The declaration and termination of emergency is done through this system. Communication system includes wireless, telephone, radio sets, satellite communication and electronic mail facilities which are tested daily to ensure their availability. These systems are available for use at all times.

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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 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.

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- **Emergency Equipment and Protective Facilities:** Various equipments required for emergency management are kept available in the NPP. To protect the plant personnel essential facilities such as plant assembly areas, emergency shelters, first-aid centre, treatment areas, de-contamination kits, prophylactics, respirators, ambulance etc are provided within the site area. In addition, for monitoring the radiological conditions, the required number of instruments such as GM survey meter, teletector, iodine sampler, contamination monitor and emergency survey vehicle etc are available.

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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.

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### SUMMARY

- In this lecture you came to know how the regulations of safety are implemented in the Indian NPPs. The organisation has separate wing for Health Physics, for protection to workers and public. Should an emergency. AERB has a role in giving clearances at different stages after ascertaining that safety has not been compromised. The regulatory process involves authorisations to be obtained for every activity including license to operating personnel.
- Experience so far indicate that due to the operation of 20 NPPs, Public get less than 1% addition to the existing natural background radiation which they would be exposed to whether NPP is there or not.

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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.

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