HEALTH PHYSICS TECHNICIAN FUNDAMENTALS

Course: RADIATION PROTECTION

Lesson: SURVEY TECHNIQUES AND EMERGENCY CONSIDERATIONS

TABLE OF CONTENTS

INTRODUCTION

Different techniques are used for conducing radiation, contamination and airborne radiological surveys. Decontamination of personnel and station areas require special procedures. This section will describe some of these techniques and procedures.

An understanding of the radiological conditions in the station is important to the operator. He uses levels of contamination and radiation in the plant as an indicator that the systems are operating normally. Radiation and contamination levels have to be known in order to protect station personnel entering an controlled area. Therefore, a knowledge of radiological condition is a necessity for personal protection and station operation.

OBJECTIVES

TERMINAL OBJECTIVE

The Contractor Health Physics Technician will describe proper radiological protection practices related to radiation surveys.

ENABLING OBJECTIVES

Upon completion of this lesson the Contractor Health Physics Technician will be able to:

1. List 3 basic reasons why radiation surveys are performed.
2. List 3 checks made on a survey instrument prior to use.
3. List potential sources of airborne contamination.
4. Describe various sampling media.
5. Describe some common causes of air sampling error.
6. Describe a method of sampling for each of the following contaminants.
7. Particulates
    a) Iodine

b) Noble gas
c) Tritium

8. Explain the significance of sampling in the breathing zone.
9. Explain the importance of representative sampling.
10. Calculate airborne concentration in uCi/cc when given sample and background count rate, volume, counter efficiency, ad filter efficiency.
11. Recognize situations in and round contaminated areas that may require increased survey frequency or special surveys.
12. List and describe proper practices for performing contamination surveys.

1.0 NUCLEAR REACTIONS

Radiological conditions in the station can be determined remotely by the use of radiation monitors. When a nuclear power station is designed, the engineers have a pretty good idea of where radiation areas will occur in the station. Designed into the station is a monitoring system to indicate to the operators in the control room the radiological conditions in various plant areas. These monitors are generally gamma sensitive devices and will indicate in either counts per minute or in units of mr/hr or R/hr as appropriate. As an example, stack radiation monitors generally read out in counts per minute where refuel floor monitors indicate in units of mr/hr.

These monitors indicate general area radiation levels only; there may be radiation levels considerably higher in the area, which need to be surveyed for with a portable radiation survey instrument. One must never count on an area radiation monitor as the primary indicating device when entering a high radiation area.

Area radiation monitors consist of a number of important components. A detector, local readout and alarm, remote readout and alarm, and failure indication are provided.

Generally, the monitors are located on an auxiliary panel in the control room, so the operator has ready access to their indications. Some radiological conditions do not lend themselves to remote detection however; contamination is a good example. The easiest method of determining contamination levels is with a smear survey. Remote monitors and local surveys can provide a good assessment of station radiological conditions.

What the constitutes a survey? A survey determines and documents radiation, contamination, and airborne activity in the plant. Documentation is probably one of the most important parts of a survey. All three surveys, radiation, contamination, and airborne, are not always necessary. Sometimes only a radiation survey is required; in other words, these surveys can be done in any appropriate combination.

Surveys can be of two different types, routine or special. Routine surveys are performed on a recurrent basis and scheduled in advance. A routine survey would be performed in an area such as the station lunch room; we would not expect to see radiation or contamination levels in such an area or at least no change in the levels in this area. Routine surveys could also be performed in areas where radiation and contamination levels are relatively constant. The ALARA concept should be considered in this instance since additional radiation exposure would be required to confirm existing levels. It may be prudent to survey such an area on a less frequent schedule to avoid unnecessary radiation exposure. Quarterly surveys are an example of this type of survey.

Special surveys are taken for a specific job in order to specify what type of protective equipment personnel need in the area. The special survey would also be used to complete the survey information section of the Radiation Work Permit (RWP).

Surveys provide us with a wealth of data. First, they tell us the current radiological status of the station areas. Second, they tell us where to post warning signs or whether previously erected signs are current. Third, as already mentioned, they provide information for completing the RWP. Lastly survey data used during inspections to demonstrate to the NRC that the station has been operated in compliance with federal regulations.

1.1 PLANNING A SURVEY

To conduct a proper survey some planning is essential. We need to know the conditions in the area. What are tank levels, value line

ups and pump operating status? What type of radiation can we expect in the area from past surveys? Consideration of the conditions in the area can also indicate what type of protective clothing or respiratory protection is required to perform the survey.

Another consideration in planning a survey is the status of the plant. We can see by looking at Figure RP-5-1 what happens to general area radiation levels in the containment building as the plant is cycled from cold shutdown to power operations to shutdowns.

The figure shows time the plant is on line on the horizontal axis and the vertical axis shows radiation levels present. As the plant starts up the radiation levels build up to some equilibrium level and when the plant is shut down, the levels decay as the radioactivity decays. The plant status tells us what we can expect when preparing to enter a radiological area.

The type of work that is to be done in the area should also be considered. If only an inspection is to be performed, a general area survey may be all that is necessary. But, if a valve or pump is to be disassembled radiation, contamination and airborne activity could all be concerns.

Previous surveys taken in the area should also be considered. These surveys can indicate long term trends, show levels at different operating conditions and indicate magnitude of contamination that might be in the area.

With all these considerations, we can perform effective planning for the survey and the proper survey instruments can be selected to complete the job.

1.2 RADIATION SURVEY INSTRUMENTATION

Once we have planned the radiological survey, we are ready to choose the proper survey instrument to complete the job. When choosing an instrument we need to consider the type of radiation to be measured, the magnitude of expected radiation levels and the type of measurement to be taken. Due to the design of the nuclear power station, beta and gamma radiation are the most frequently encountered types of radiation. We would expect then that a typical radiation survey would require an instrument that is capable of measuring both beta and gamma radiation. An instrument of this type has the ability to detect the combined levels of beta/gamma radiation and the individual components of a beta/gamma radiation field. This is important because beta radiation is primarily a skin dose contributor and gamma radiation is a whole body dose radiological concern.

For this discussion, we will limit our comments to beta and gamma radiation only, but there are other types of radiation that could be encountered in a nuclear station. The other two types, alpha radiation and neutron radiation, require special types of survey instruments. Generally, surveys for alpha and neutron radiation will be performed by the radiation protection personnel.

When selecting a radiation survey instrument the magnitude of radiation to be measured needs to be considered. Will the instrument we pick be able to measure the radiation? Is the range of the instrument sufficient? Usually, the instrument selected should have a range at least one decade higher than the radiation level expected in the area. If when entering an area where the expected dose rate is 75 mrem per hour, we would choose an instrument with the capability of measuring to at least 750 mrem per hour. This is a conservative approach to survey measurement.

The type of measurement to be taken is another consideration. Is the data collected to be used for posting a station radiological control area, or are we trying to determine the amount of exposure personnel will receive while working in the area? If we are setting boundary lines, ie: establishing where a radiation area begins, we would use a type of instrument that is very sensitive to low levels of radiation. The type of instrument used for such measurements is the Geiger-Mueller (GM) survey meter. A Geiger Mueller detector reacts to incident radiation with a avalanche effect. This avalanche of secondary ion pairs results in a detector that is extremely sensitive to low levels of radiation.

Several types of GM detectors are available; one has a very thin window of mylar that will allow detection of both beta and gamma radiation. This type could not be used to detect the individual component of either radiation. Another type of GM detector has a metal shield completely enclosing the detector. This type would be gamma sensitive only as the beta component would be shielded out. The third type is constructed with a sliding metal or plastic shield that allows measurement of both beta and gamma radiation or measurement of the gamma component alone.

Using the sliding shield type of GM detector, with the shield closed, only gamma radiation would be detected. Opening the shield would allow detection of both beta and gamma radiation. The amount of beta radiation present can be calculated by subtracting the gamma reading (shield closed) from the beta/gamma reading (shield open).

Another concern in radiation measurement would be dose rate measurement. An ion chamber survey instrument would be used to ascertain the amount of exposure personnel would receive as it accounts for all the ionization events occurring. The ion chamber could be accurately described as an ion collection instrument. This type of instrument counts all the ion pairs produced by each incident particle or photon of radiation.

This instrument shows no dead time and has linear energy response for low energy gammas. The ion chamber, like the GM detector, may have a sliding shield, so it could be used to determine beta and gamma components. Unlike the GM detector, the ion chamber will have a different efficiency for beta radiation than gamma radiation and correction factor will have to be applied to the reading for a correct beta radiation result. Typically, efficiencies for beta detection of ion chambers are approximately 20 - 25%.

The GM detector is not used for dose rate measurements. All GMs have a problem with dead time. Dead time is time during which no radiation is countered. Dead time can cause an incorrect reading by giving a reading much lower than the actual radiation level in the area being surveyed. The other problem with the GM is that it does not have linear energy response at low energy gamma levels unless special energy compensated shields are used in conjunction with the instrument. This is one reason why instrument manufacturers have installed energy compensated probes on GM instruments. The GM is useful for radiation detection, but generally not for dose rate determinations.

Once the proper survey instrument is selected, certain pre-use checks should be performed on the instrument. The first thing to check is the calibration due date. If the instrument is overdue for calibration, it should not be used for a survey, but should be returned to the radiation protection group for re-calibration. Secondly, check the condition of the battery power supply. If the batteries do not check out, either replace them or obtain another meter. Generally there is a battery check position on the instrument dial to check this. A third item to check is response to radiation or source checking. To accomplish this, take the instrument to a check source and place the instrument probe on the source per written instructions. The response of the instrument should be within the listed response on the check source. If it is not, report the finding to the radiation protection people and obtain another survey meter.

How you handle a survey instrument is a very important. If you contaminate the instrument, it will be out of service until decontaminated. If you drop it and it is broken, it will not be available to others. To avoid contaminating an instrument, it could be wrapped in plastic or simply held in your hand (as long as you did not touch anything). To avoid dropping the instrument, tie a small line to it or use the supplied shoulder straps. This all sounds very simple, and it is, but if you ask radiation protection personnel, they will tell you that misuse of equipment is one of their biggest problems. Do not drop or bump the instrument, keep it dry and uncontaminated!

1.3 THE RADIATION SURVEY

Although most radiation surveys are performed by Health Physics or Radiation Protection Department personnel, it is important that the operator be able to perform them. There may be times when the Radiation Protection personnel are not available or emergencies may arise requiring the operator to perform his own survey.

13. Two types of radiation surveys are routinely performed the general area survey and a specific job survey. General area surveys are just that, the area is surveyed to find out what the radiation levels are through out the area. This type of survey may be used to designate the point at which posting barricades will be erected. A job survey delineates what the radiation levels are on a specific piece of equipment or what levels are in a specific work area.

When performing a general area dose rate survey three objectives apply:

1. We want to determine the dose rate in areas that may be occupied by radiation workers.
2. We want to locate any "hot spots", radiation areas where the dose rate is approximately 4 times the background rate.
3. We want to survey certain fixed survey points to establish whether there has been any significant change in levels since the previous survey.

Prior to entering any radiation area to perform a survey, the technician or operator should double check his survey meter to insure that it is operating properly. This may require an additional battery check or with some instruments, a "zero adjust" check. Zero adjust checks can generally be made at any time. You don't have to leave a radiation area in order to reset the zero of the instrument.

When entering a radiation area the technician or operator should always place the instrument on a scale that is a factor of ten above the radiation level expected in the area. In fact, you could enter the area with the meter set on it's highest scale, slowly lowering the setting to an appropriate scale as you proceed. This procedure avoids "pegging" the instrument and is conservative. Of course, you would not enter the area and walk completely around it before lowering the setting to the point of optimum response. The dose rate should be determined immediately inside the access point to the area and then the survey may proceed.

1.3.1 GENERAL RADIATION SURVEY

General radiation surveys are performed repeatedly. Therefore, the survey method must be consistent.

Does rates should be measured at waist level. There could be a large deviation between the readings at waist level and the levels at contact with the floor in the area. If it is necessary to deviate from a waist level reading, note should be made on the survey form indicating the change.

The actual survey begins with readings in generally accessible portions of the area. Other locations in the area are surveyed to determine the locations of any hot spots, and any fixed survey locations in the area are also monitored. The readings are recorded on a data sheet. The location of any abnormally high reading (which, by definition, depends on plant guides, but is generally 4 time the background rate) and the actual reading should be recorded on the data sheet. In some plants, hot spots are tagged to alert personnel to the higher than usual radiation. All facilities performing radiation surveys to comply with the federal regulations in 10 CFR 20 are required to keep the results of these surveys on file for at least the "life of the plant". Some administrative procedures require that the results be posted on "status boards" to alert general station personnel to the levels in different areas of the plant.

1.3.2 JOB SURVEY

The second type of radiation survey is the job survey. Job surveys are used to determine the exposure rates to a worker on a particular job You should make sure that readings are taken where the work is to be performed. For example, if the work is going to be done two feet from equipment, readings should be taken there. If workers will have to lean against the equipment, drape over it, or handle it, then they need to know what the dose rate is on the surface of the equipment.

A job survey may require a beta radiation survey. Beta surveys are accomplished by first taking a reading with the probe's shield closed (this is the gamma component) and then with the shield open (this is the beta plus gamma component). By subtracting the first reading from the second reading, we can determine the beta component of the radiation field.

Job surveys may also require that "contact" radiation surveys are performed. "Contact" is generally within one inch of the surface being measured. This is sufficiently close to the surface to consider the reading to be a contact reading. If the surface is contaminated, we would not want to actually touch the surface of the probe to the surface being measured and risk contaminating the instrument.

Once the beta component reading has been determined, it is necessary to multiply the beta reading by a beta correction factor to indicate the true beta dose rate at the surface of the equipment. This is necessary because the beta efficiency of the instrument is different from the gamma efficiency of the instrument. Beta efficiencies will be listed on the instrument for this calculation.

Radiation Dose Limits When should be considered when conducting a radiation survey and when analyzing the results of the survey. If, for instance, be beta component is more than twice the gamma component, skin exposure could be a limiting factor to the radiation worker. If exposure to the extremities is more than six times the whole-body exposure, then extremity dose could be a limiting factor. The point is, just taking a survey is not enough; the results need to be analyzed to take into account the particular radiation and job to be performed.

1.4 CONTAMINATION SURVEY

There are two types of radioactive contamination that concern us: fixed and loose surface contamination. Fixed contamination occurs when radioactive material is ground into a surface. An example would be: wooden shoring material that has been placed in a contaminated area. The wood is porous, and radioactive material would easily become lodged in the wood fibers. This radioactive material would not easily rub off, hence it is fixed contamination. Loose surface contamination is just that, loose; it will be on surfaces in the area. It may be manifest as radioactive dust, rust, or water. Being loose, it may easily be tracked or moved from one area to another. Loose surface contamination control may be somewhat more difficult because of this.

To survey for fixed radioactive contamination, a GM survey meter with a hand held probe is the instrument of choice. A distance from the item being measured is usually specified in plant procedures, but a distance of about 1 inch from the surface would give appropriate readings. A typical radiation limit value for fixed contamination would be: less than 0.5 mR/hr at 1 inch form the surface being measured. If the readings are higher than this, the time is considered contaminated; if less than 0.5 mR/hr at 1 inch, the item is released for general use.

To survey for loose surface radioactive contamination, we must use sample papers or what is more commonly known as smears. A loose surface contamination survey is appropriately called a "Smear Survey". These smears or sample papers are attached to a waxed paper backing slip that is labeled to provide information on sample date, time, location and any other pertinent information. The smear is usually round and about 2 inches in diameter.

To conduct an actual smear survey, the technician or operator would obtain a supply of smears and pre-number them before entering the area to be surveyed. On entering the area, the technician would pick a spot on the wall, floor, or equipment to be surveyed and wipe the cloth side of the smear over the surface covering an area of approximately 100 cm squared. This is an area of approximately 4 inches by 4 inches or sixteen square inches. An alternate method of conducting the smear survey would be to pass the smear over the area in a S shaped pattern with the length of the S being 18 inches.

Once the smear has been taken, the backing paper can be folded over the sample area thus protecting the smear and eliminating the possibility of cross contaminating other smears. Once folded, the outside of the paper backing may be used to note any specific of the survey being taken. You may want to write down information as to location, time, date, and operational situation.

Contamination surveys will normally be carried out in conjunction with radiation surveys. The same data sheet may be used to record results from both types of surveys. All smear survey points should be numbered on the data sheet and radiation levels may be written directly on the sheet as well. It is a good idea to circle the numbered contamination survey points on the data sheet and write the radiation levels followed by mR/hr, i.e.: 10 mR/hr at (12). As part of the area contamination survey, areas that are heavily used, such as doorways, doorknob, halls, handrails, and ledges that collect dust, are checked for removable contamination. Contamination in these high traffic areas can be spread quickly, so it is important that they are surveyed regularly.

The smear, unlike the direct fixed contamination survey, cannot be countered in the area where the survey has been taken. The smears, in numbered order, must be taken to a counting laboratory for counting. Usually, a counter/scaler that is sensitive to beta and gamma radiation is used for this counting.

Another type of contamination survey is the equipment survey. Since background radiation levels would interfere with the determination of whether a piece of equipment were contaminated or not, that equipment must be removed from the contaminated area to be surveyed for radioactive contamination. To remove potentially contaminated equipment form a controlled area the equipment is bagged to prevent the spread of loose contamination to other areas of the plant. Generally a plastic bag is taken into the work area with the equipment.. When the time comes to remove the equipment from the area, it is first placed in the bag and taped shut. This first bag is potentially contaminated itself. To avoid spreading any contamination that may be on the outside of the first bag, it is taken to the step-off pad or control point and placed into a second clean bag held open by an assistant standing in the clean area. This second bag is also taped shut, identification tags are placed on the bag as directed by Radiation Protection, and the bagged equipment is taken to the Health Physics office for counting. It is important to remember that any equipment taken into a contaminated area is potentially contaminated and must not be released for use outside the area until it is checked for contamination.

To check for contamination on a piece of equipment Radiation Protection personnel may use a number of different techniques. A loose surface contamination survey may be performed using smears, a fixed survey may be performed using GM friskers. Decontamination, as appropriate, will follow the contamination survey. Once the equipment has been decontaminated, a final survey will be made to establish that the equipment is in fact decontaminated.

1.5 AIRBORNE CONTAMINATION SURVEYS

The basic types of airborne contamination surveys conducted in nuclear power stations are for airborne particles, halogens, and gases. Very small particles of material become suspended in the air similar to dust. Cesium - 137, and cobalt - 60 are examples of particulate airborne contaminants. These particulates are not readily visible; the size of the particles is in the micron range. Radioactive gases that are a concern in a nuclear power station include the noble gases xenon and krypton. Both noble gases are termed "Noble" because of their location on the periodic table and the fact that they do not react chemically with other elements.

Besides the suspended particles and noble gases, halogens are another class of airborne contamination. These halogens occur primarily as vapors, particularly iodine-131. Iodine-131 is a concern because it has the most restrictive Derived Airborne Concentration (DAC) for vapors, and it is a thyroid seeker. That is, if iodine 131 is breathed into the body, it will concentrate in the thyroid gland.

But where does this airborne contamination originate in the plant? Potential sources of airborne contamination include:

- a leak or venting of primary coolant,
- a steam leak in a BWR,
- breaches in containment systems (i.e, glove boxes, tents, etc.),
- suspension of loose surface contamination,
- radioactive spills (both dry and liquid),
- disturbing radioactive dust on a filter,
- suspension of fixed surface contamination (includes grinding, etc.),
- explosive plugging of S/G tubes,
- reactor vessel head removal,
- BWR steam dryer and separator unit removal.

Airborne contamination surveys may be routine or special. A common special airborne survey is performed to provide information for the Radiation Work Permit (RWP). Radiation protection personnel use this survey to ascertain whether respiratory protection is required to complete the job. Other special surveys include job progress surveys. If a particular task has the potential for stirring up airborne contamination, Radiation Protection personnel will monitor the airborne levels as the task proceeds. Routine surveys are taken to provide an indication of long term trends and to check areas where airborne contamination is not normally expected.

Considering that there are three types of airborne activity that we are concerned with, how do we actually take a sample of the air? Most air samplers consists of three parts: an air pump, a flow indication device, and some type of collection medium.

The air pump provides the motive power to actually move a sample of the potentially contaminated air through the collection medium. The flow indication device is used to calculate the integrated volume of the sample. If we know the flow rate and the time the sampler has run, we can multiply the two together and obtain the total volume of sample.

Different media must be used to collect the different types of contaminants: Particulates are collected on some type of physical filter such as paper, fiberglass, or cellulose. Gases are collected in sample chambers that actually contain a small volume of the Contaminated atmosphere. Vapors are generally collected on activated charcoal cartridges, silica gel cartridges, silver zeolyte cartridges, or cryogenic traps. Other methods of collecting samples include condensation using a dehumidifier and counting with liquid scintillation, passing air through water and counting with liquid scintillation, and continuously passing air through an ion chamber.

Common sources of air sampling error stem from: inaccurate sample volumes, counting instrumentation errors (poor calibration, geometry errors, counting statistics, or variable background), sampler efficiency, lack of representative sample, inaccurate decay correction, loss of sample, contributions from other radioactive sources.
Once the sample has been collected, the filter media may be checked for gross contamination in the field or counted in a counting laboratory. The field check normally includes a count of gross beta-gamma alpha activity. Air samples should be checked for alpha activity when work is being performed on systems with significant alpha contamination. Gamma spectroscopy is used to determine the individual isotopic composition of the sample.
Another type of airborne sample is breathing zone sampling. Radiation Protection personnel are concerned with protecting the worker, including what that worker has actually breathed. To do this, a breathing zone air sampler is affixed to the worker with the sample head close to the worker's mouth. These devices are usually battery powered, portable devices, but they can be bulky and may become contaminated. The sampler generally runs for the entire time the worker is in the contaminated area. Counting of the sample medium gives information that can be used to calculate the airborne concentration breathed by the worker.

1.5.1 AIRBORNE CONCENTRATION CALCULATION

Once a sample is collected, the radiation protection technician normally performs a field calculation of the gross beta-gamma airborne concentration in terms of microCuries per cubic centimeter (μCi/cc) . This calculation is performed with the following formula:

$$\text{uCi/cc} = \frac{(\text{ncpm})\ (\text{uCi})\ (1\ \text{liter})\ (\text{saf})}{(\text{efficiency})\ (\text{volume})\ (2.22\text{x}10^{6}\ \text{cpm})\ (1000\ \text{cc})}$$

$$\text{uCi/cc} = \frac{(\text{ncpm})}{(\text{efficiency})\ (\text{volume})} * \quad (\text{correction factor})$$

The correction factor is a simplification of the constants from the above first formula:

$$\text{correction factor} = \frac{1\ \text{uCi}}{2.22\text{x}10^{-6}\ \text{cpm}} * \frac{1\ \text{liter}}{1000\text{cc}} = 4.5\text{x}10^{-10}$$

This correction factor is sometimes called the filter factor. The filter factor in use must correspond to the units of volume and filter size.

Example:
Given: 20 liters per minute flowrate
5 minute sample
Background = 5 cpm
Sample = 125 cpm
Counter Eff. = 10%

What is the airborne concentration in uCi/cc?

Volume: 20 LPM x 5 min = 100 liters
nCpm: 125cpm – 5 cpm = 120 cpm

$$\text{uCi/cc} \quad \frac{(120\ \text{ncpm})}{(0.10\ \text{efficiency})\ (100\ \text{liters})} * (4.5\text{x}10\text{-}10) = 5.4\text{x}10^{9}\ \text{uCi/cc}$$

1.5.2 CONTINUOUS AIR MONITORS

Continuous air monitors are used to monitor airborne particulate, noble gas and iodine activity. They can monitor all three types of contaminants simultaneously or any single contaminant individually. The sample is collected on a mechanical filter for particulates, some type of charcoal cartridge for iodines and a GM monitored sample chamber for noble gases.

These monitors are used to monitor airborne particulate activity in occupied areas to give a constant record of activity levels. This record can be used as a trend recorder. If work is going on in an area, the constant air sampler can indicate an increase in airborne activity caused by the work. They are a useful monitoring device for use in surveillance. If a piece of equipment is likely to release airborne radioactivity, the constant air monitor will indicate when this release occurs. They can also be used to monitor releases from the station. An example would be ventilation stack airborne monitors. The CAM is also useful for documentation purposes and as an early warning to increased airborne activity levels.

Particulate activity can be collected on either moving or fixed filter paper in constant air monitors. These filters are approximately 99% efficient in collecting particles of approximately 3 microns in size. This is a size that concerns us in respiratory protection. Fixed filter paper CAMs will indicate total activity collected and could indicate upward trends. Moving filter CAMs will indicate current activity levels. One advantage of using fixed filter CAM is the ability to remove the collected sample and request the counting laboratory perform an isotopic analysis.

Both types of CAMs have their advantages. A fixed filter CAM is less expensive than a moving filter CAM as an example. Choices can be made and a sampling system designed to meet the requirements for the particular location.

Constant air monitors can also measure the activity of the halogens, iodine-131 being an example. The sample is collected on an activated charcoal cartridge just as was done in portable air sampling. This cartridge is monitored continuously by a GM end window detector that indicated iodine activity.

The information that a CAM collects is usually displayed locally. No readout is provided in the control room as a CAM is a self-contained air sampling device. Most CAMs have strip chart recorder with, three different colored pens to indicate activity of particulates, iodines and noble gases. The strip chart provides a continuous record of the air in the area being monitored.

2.0 EMERGENCY CONSIDERATIONS

While emergency situations occasionally occur in the nuclear power industry, the emergency can often be effectively mitigated by proper planning. There are two federal organizations that are in charge of emergency planning, the Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA). These organizations set down, in NUREG-0654, published in November 1980, the criteria for preparation and evaluation of radiological emergency response plans and preparedness in support of nuclear power plants. FEMA is essentially responsible for off-site emergency planning and the NRC is responsible for on-site emergency planning.

Station emergencies are classified by the NRC and FEMA into four categories.

* Unusual Event
* Alert
* Site Area Emergency
* General Emergency

In addition to these four classifications, some states have classification schemes that are more definitive. An example would be the state of Connecticut classification system that is broken down to lettered sequences from a delta incident to the most serious alpha incident.

An Unusual Event covers two subject items, the first being any event in process or having occurred which indicates a potential degradation of the level of safety of the plant; and the second having to do with personnel injury or death requiring medical assistance which may be complicated by contamination or radiation exposure. This classification is designed to bring the operating staff to a state of readiness in the event of escalation to a more severe action level classification.

An Alert refers to an event that is in progress which involves an actual or potentially substantial degradation of the level of safety of the plant. This includes emergency situations which are not expected to threaten the public, but for which it is deemed prudent to alert the off-site emergency organizations.

A Site Emergency classification refers to an event that is in progress that involves actual or likely major failures of plant functions needed for protection of the public. This classification is very likely to involve some radiation exposure to the public.

A General Emergency refers to an event that involves actual or imminent substantial core degradation or nuclear fuel melting with potential for loss of containment integrity. It also the most severe classification of emergency and some protective actions may be recommended by the emergency coordinators.

The purpose of this emergency planning is to provide guidance for the assessment of events, which are in progress or have occurred, which involve potential or actual degradation of the level of safety of the unit. Assessment of the initiating events and conditions, in accordance with this pain, will yield accurate and efficient classification of emergencies. This planning also provides a procedure which delineates preplanned emergency response actions dependent on the assessment and subsequent classification of an emergency.

Initial authority and responsibility for assessment, classification and declaration of emergencies generally is assigned to the shift supervisor. Other responsibilities for emergency response are specified in procedures commonly known as Emergency Plan Implementing Procedures (EPIP's).

The NRC requires all station to provide immediate notification to the NRC if the station declares itself in any of the four incident classification states. There are also state required notifications that vary from state to state.

3.0 SUMMARY

Routine and special radiological surveys are vital to the safe operation of any nuclear power facility or radiological isotope user. Operations need to be conducted properly so that radioactive material is not being released inadvertently. The use of proper survey techniques, therefore, is required. The various types of surveys were discussed in this lesson.