Inspection and Quality Control In Manufacturing
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Lecture – 12
Radiography Inspection

Hello my friends today we are going to discuss about the new topic that is the radiographic inspections.

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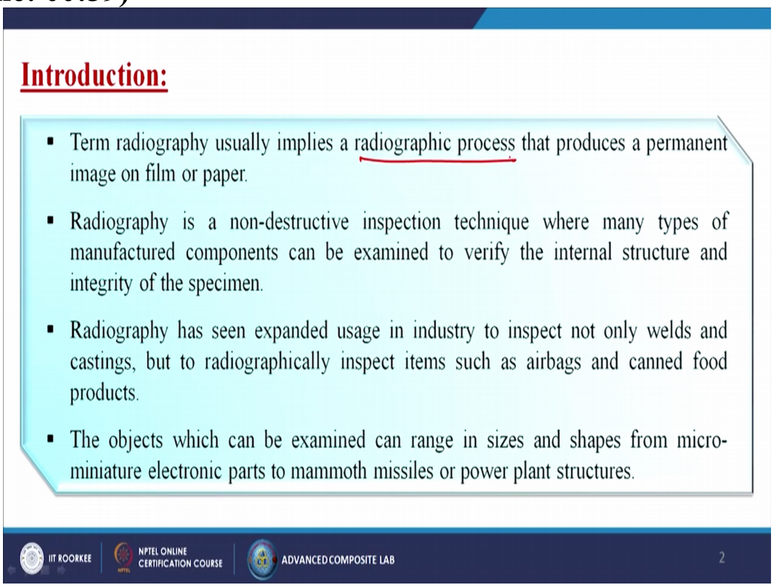

So, the term radiology usually implies the radiographic process that produces a permanent image on film or paper yes now we can understand that exactly which I am talking about. So, basically in this particular lecture we are going to discuss about the x-rays and the gamma rays. So, basically we are passing those rays through the samples and then the picture is coming as a film and then after that just we are recognizing that what kind of problems or maybe the defects are present inside the materials.

So, generally the radiographic is a non-destructive testing because we are not going to harm the element or maybe the substance or maybe the materials simply we are going to passes those rays through the materials and then from that we are going to predict the results or may we get the whole information's. So, it is a one kind of inspection techniques where many types of manufactured components can be examined to verify the internal structure as well as the integrity of the specimen.

So, if there is any cracks or pores are present inside the material so simply we can detect by these techniques. Now radiography has been expanded usage in industry to inspect it not only the welds and the castings but to radiographically inspect items such as airbags and the canned food products, yes. Because canned food products it has been already sealed so inside what is the conditions or may be any contaminants are there or may be some problems so we can from outside we can easily get the information's.

The objects which can be examined can range in sizes and shapes from micro miniature electronic parts to mammoth missiles or may be the power plant structures. So, there is no particular size specific testing so for a small component to a big large component also we can do this kind of testing.

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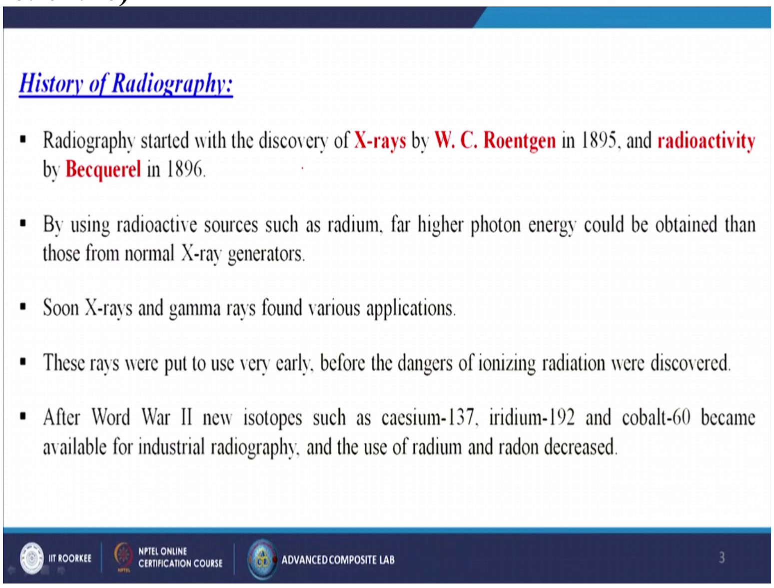

History: Radiography started with the discovery of the x-rays as we know by W.C. Roentgen in 1895 and radioactivity by Becker in the year of 1896. By using radioactive source such as radium for higher photon energy could be obtained than those from normal x-ray generators. Soon x-rays and gamma-rays found various applications nowadays we are extensively used this x-rays or maybe the gamma rays.

These rays were put to use very early before the dangerous of ionization radiation were discovered. After World War II new isotopes such as cesium 137, iridium 192 and cobalt 60 became available for industrial radiography and the use of radium and the radon has been decreased.

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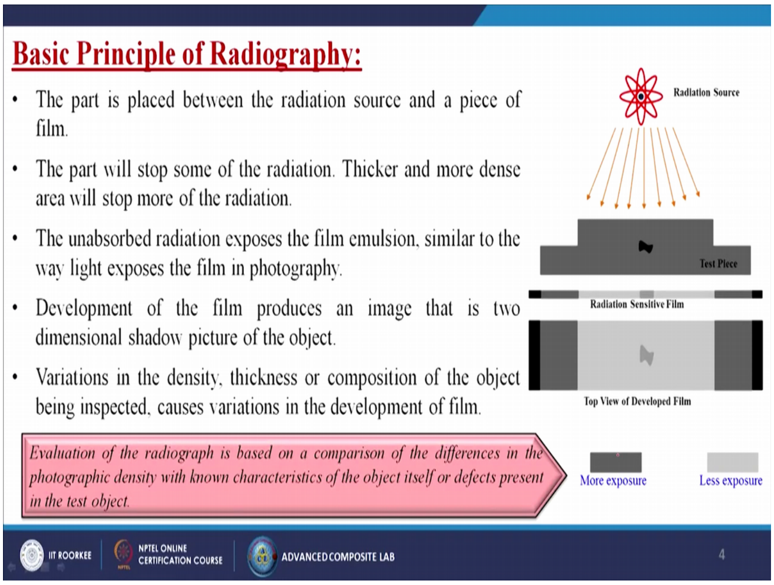

Now what are the basic principles how it works so the part first whatever the part we are going to check that is placed between the radiation source and a piece of film. So, it is simple like a camera. So, the part will stop some of the radiations thicker and more dense area will stop more of the radiations the unabsorbed radiation exposes the film emulsion similarly to the way light exposes the film in the photography as I told already.

Now development of the film produces an image that is 2 dimensional shadow picture of the object. So, from this particular case you can see that we are having that is taste piece over here now the radiation source is coming then after that we are having the film and if we see the film so simple we can get the image of our defects onto the film itself. But sometimes it may difficult to get its actual area or maybe the actual locations.

But if we take that image from the different sites so simple we can get the whole information’s about the location of that particular defect. Variations in the density thickness or compositions of the object being inspected causes variations in the development of the film. Evolution of the radiograph is based on a comparison of the differences in the photographic density with known characteristics of the object itself or defects present in the test object.

So, sometime to see certain kinds of crystal structure or maybe the morphology also we are doing this kind of testing.

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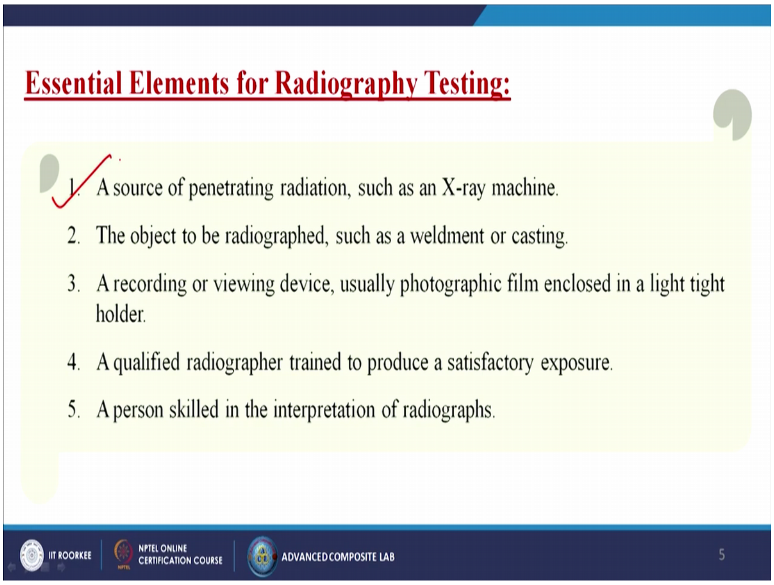

Now what are the essential elements for the radiography testing so first is that a source of penetrating radiation such as an x-ray machine or maybe sometimes we are calling it as a x-ray gun. The object to be radiographs such as the weldment or maybe the casting or maybe any kind of products as I told already third is the recording or maybe the viewing device usually photographic film enclosed in a light tight holder.

Number 4, a qualified radiograph are trained to produce a satisfactory exposure because sometimes we need to do the proper x-ray testing so that we can get the actual information's of that particular defects itself. And the last one is that a skilled person that is a very important thing because after getting the film then only you can recognize that whether this is the image of some elements or maybe some cracks or maybe there is some voids or maybe the some pores.

So that interpretations so that is why a highly skilled laborer or maybe the operator is required.

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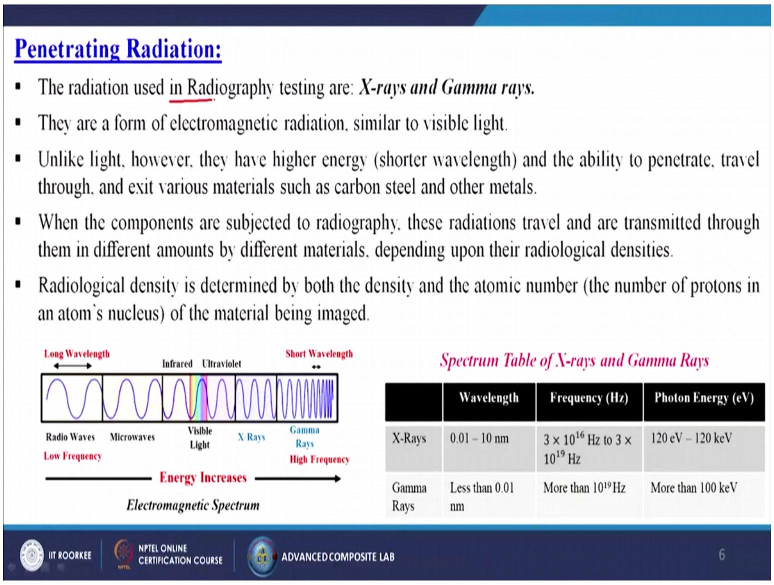

Now first one is called the penetrating radiations what is that the radiation used in radiography testing's x-rays and gamma-rays as I already told you. They are a form of electromagnetic radiation similar to the visible light. Unlike light however they have higher energy shorter wavelength and the ability to penetrate means it is having very higher energy. So, that it can go inside the material itself travel through and exit various materials such as carbon steel and other metals.

When the components are subjected to radiography these radiations trouble and are transmitted through them in different amounts by different materials depending upon their radiological densities. Say suppose different materials is having different densities so after that when we will get the image in the film itself so there should be some different types of colors we can observe that will be depending upon the densities of different materials.

Radiological density is determined by both as the density and the atomic number the number of protons in an atom's nucleus of the material being imaged. So, now you can see this is the whole spectrum we are having electromagnetic spectrum starting from radio waves to gamma rays so this is the visible light spectrum so this one, we can see by our normal eyes and then after that when you are talking about the short wavelength.

So, that time we can find that x-rays and the gamma rays which is having a very high frequency and short wavelength. Now if we talk about the spectrum table so you can see that in x-rays the wavelength is generally 0.01 to 10 nanometers, frequency is 3 into 10 to the power 16 Hertz to 3 into 10 to the power 19 Hertz and the photon energy is 120, electron volt to 120 kilo electron volt. And if we talk about the gamma rays then it is less than 0.01, nanometer more than 10 to the power 19 Hertz.

So, you can see that the power of gamma rays are better than the X rays and here the proton energy for the gamma rays is more than 100 kilo electron volt.

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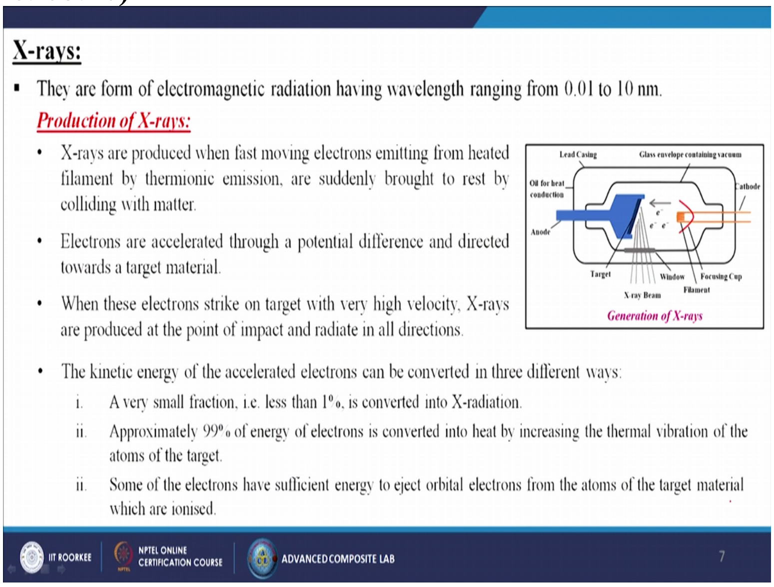

Now come to the X rays so they are form of electromagnetic radiations having wavelength ranging from 0.01 to 10 nanometer that we have already discussed in our last slide. Now how we are generating the x-ray that means production of the x-rays. So, generally x-rays are produced when fast moving electrons emitting from heated filament by thermo ionic emission are suddenly brought to rest by colliding with the matter.

So, you are generating a, thermionic emissions so that the electron will move from one place to the another that means from hotter to the colder one. Electrons are accelerated through a potential difference and directed towards a target material when these electrons strike on target with very high velocity x-rays are produced at the point of impact and radiated in the all directions. So, if we see this kind of image or maybe the pictorial view so here we can see that we are having that anode.

Now a node is our target or maybe that our materials and then we are having the cathode is nothing but the filament. So, now we are generating a thermionic emission over there and there is a huge potential difference in between the cathode and the anode so that the here the electron density in the cathode side is more. So, automatically that electron will move from the cathode to the anode side and it will hit the specimen.

Now when it will hit the specimen it will generate the X ray and that X ray will penetrate into the substance and after transmitting it will fall upon your film and it will generate the image itself after developing the film. So, the kinetic energy of the accelerated electrons can be converted in three different ways first a very small fraction that is less than 1% is converted into X radiation.

Approximately 99% of energy of electrons is converted into heat by increasing the thermal vibrations of the atoms of the target itself some of the electrons have sufficient energy to eject orbital electrons from the atoms of the target materials which are ionized.

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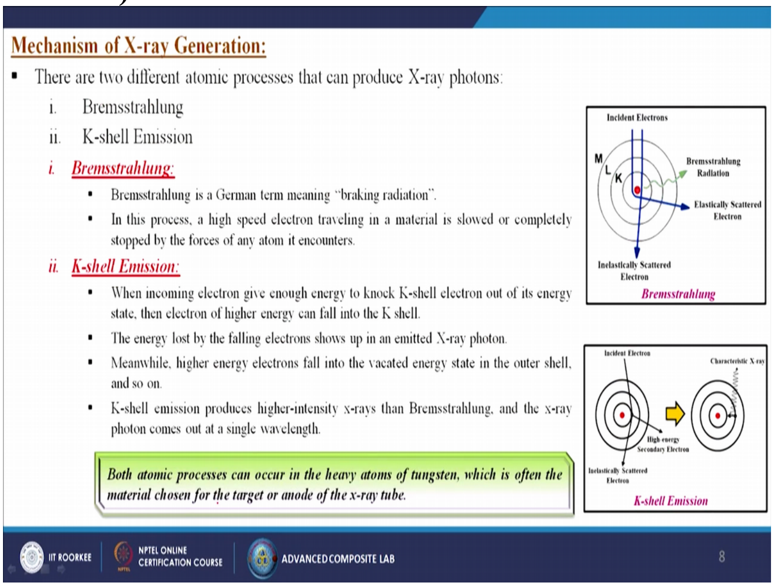

Now what are the mechanisms so there are two different atom processes that can produce the x-ray photons. So, first one is called the Bremsstrahlung so it is a German word and second one is called the Kachelle Emission. So, when you are talking about the Bremsstrahlung, Bremsstrahlung is a German term meaning the breaking radiation. In this process a high-speed electron traveling in a material is showed or completely stopped by the force of any atom it encounters.

So, this is the pictorial image over there so now we are having the K orbital L orbital M orbital. So, now you can see that we are having that electron so now the electron will directly hit the target itself. When you are talking about the K shell radiations so in this particular case when the incoming electron give enough energy to K shell electron out of its energy state then electron of higher energy can fall into the K shell.

The energy lost by the falling electrons shows up in an emitted x-ray Photon. So, now simple the thing is that here the electron will change its position. So, it will come to the K shell means the outermost shell meanwhile higher energy electrons fall into the vacated energy state in the outer cell and so on. So, that is a continuous process so first the electron is inside it will come to the K shell and then after that it will be radiated and so inside electron again it will come to the K shell and it will be radiated. So, it is a continuous process.

Now K shell emission produces higher intensity x-rays than the Bremsstrahlung and the x-ray photon comes out at a single wavelength. Both atomic processes can occur in the heavy atoms of tungsten which is often the material chosen for the target or anode of the x-ray tube.

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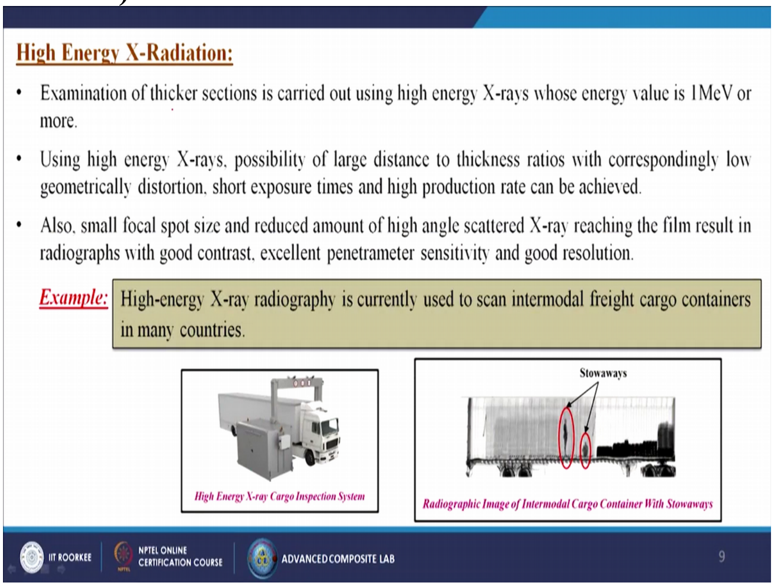

High-energy x-radiation examination of thicker sections is carried out using high-energy x-rays whose energy value is 1 mega electron volt or more. Using high-energy x-rays possibility of large distance to thickness ratios with correspondingly low geometrically distortion short exposure times and high production rate can be achieved. Also small focal spot size means how much area you are going to cover onto your surface itself and reduce the amount of high angle scattered x-rays reaching the film result in radiographs with good contrast excellent penetrameter sensitivity and good resolution.

Example high-energy x-ray radiography is currently used to scan intermodal Freight cargo containers in the many countries. So, when the truck from one country to another country it is traveling with some product so it is a big size so simple we are passing that truck container through the x-rays and we are getting the image. Not only is that best example that we are using these techniques in the airport itself for scanning our luggages.

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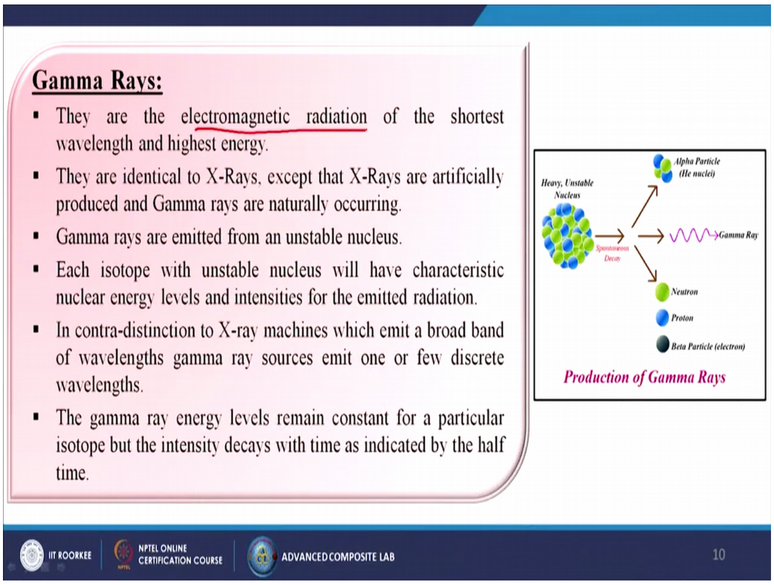

So, now we are coming to the gamma rays they are the electromagnetic radiations of the shortest wavelength and the highest energy. They are identical to x-rays except that x-rays are artificially produced and gamma rays are naturally occurring. Gamma rays are emitted from an unstable nucleus. Each isotope with unstable nucleus will have characteristic nuclear energy levels and in densities for the emitted radiation.

In contradistinction to x-ray machines which emit a broad band of wavelengths gamma ray source emit one or few discrete wavelengths. The gamma ray energy level remain constant for a particular isotope but the intensity decays with time as indicated by the half time because it is life is going to be reduced. So, now in this particular case you can see that we are having that heavy unstable nucleus and then after that the spontaneous decay means it is life is decreasing.

And then it is for me dividing into three parts one is called the alpha particle that is the helium nuclei then it is generating the gamma rays over there and the rest is that composed by neutron proton and the beta particle. So, this way we are generating the gamma rays.

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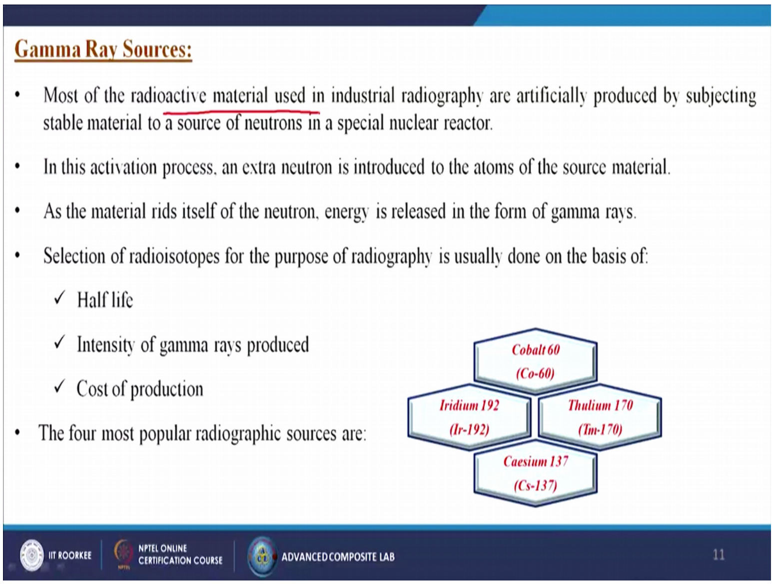

Now gamma ray source most of the radioactive material used in industrial radiography are artificially produced by subjecting stable material to a source of neutrons in a special nuclear reactor. In this activation process and extra Neutron is introduced to the atoms of the source material as the material reads itself of the neutron energy is released in the form of gamma rays. So, knowingly we are introducing one extra Neutron like a doping inside the material to make it unstable.

Selection of Radio isotopes for the purpose of radiography is usually done on the basis of half-life intensity of gamma rays produced and the cost of the production itself. The four most popular radiographic sources are cobalt 60 or generally we are calling it as a co 60, Thulium 170, cesium 137 and the iridium 192.

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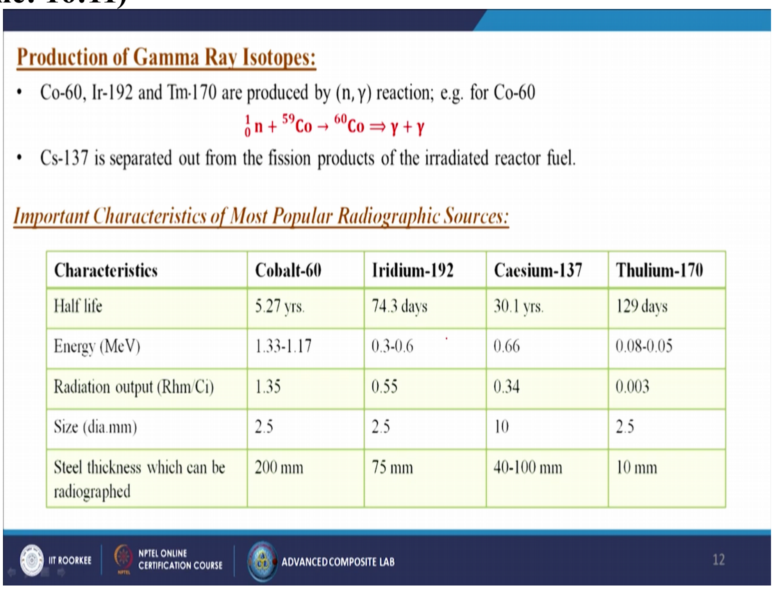

Now production of the gamma ray isotope so generally cobalt 60, iridium 192 or maybe the thulium 170, are produced by n and the gamma reactions example for Co 60 so, generally in n+ cobalt = cobalt 60 = gamma + gamma that means it is generating the gamma rays over there. Cesium 137 is separated out from the fission products of the irridiated reactor fuel. Now some important characteristics of most popular radiographic sources like half-life of the cobalt 60 you can see it is 5.27 years.

But if we are talking about the EDTM 192 it is 74.3 days if we talk about the cesium 137 it is 30.1 years and if we are talking about the thulium 170 it is nothing but that 129 days. So, now if you see the energy so in this case cobalt 60 it is 1.33 to 1.17 mega electron volt and that is the highest one compared to others. If we talk about the radiation output then it is cobalt 60 is giving the 1.35 that is also the highest one.

if we talk about the size for cesium 137 is the higher side that is 10 millimeter. steel thickness which can be radio graphed it is generally 200 millimeter, 75 millimeter 40 to 100 millimeter and the 10 millimeter. So, from this particular case you can get the cobalt 60 is the best one among these four.

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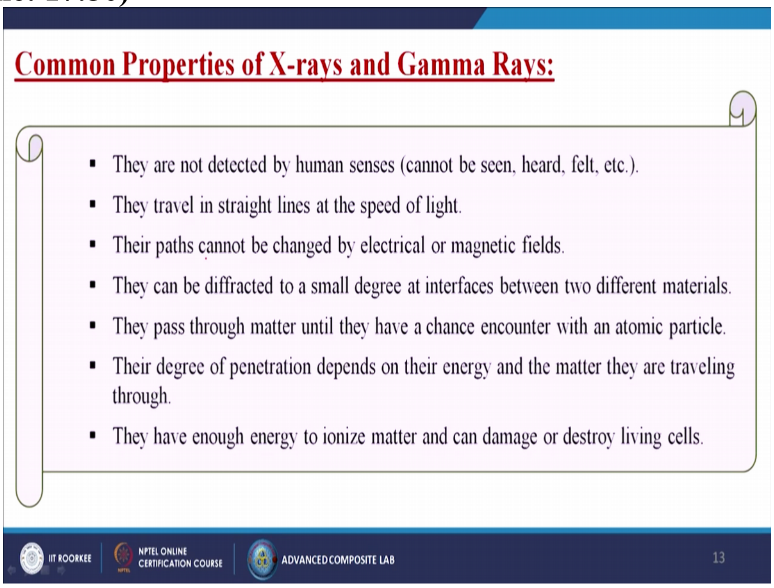

Now common properties of extras and the gamma rays they are not detected by the human senses. As I told already we cannot see it by our normal eye or maybe the naked eye. We cannot feel it we cannot hear it so we cannot recognize it by our organs. They travel in straight lines at the speed of light their paths cannot be changed by electrical or maybe the magnetic field. They can be deflected to a small degree at interfaces between two different materials they pass through the matter until they have a chance encounter with an atomic particle.

Their degree of penetrations as I told already it depends upon the thickness of that particular material its activation energy and the matter they are traveling and what is the density of that particular material. They have enough energy to ionize matter and can damage or destroy the living cells.

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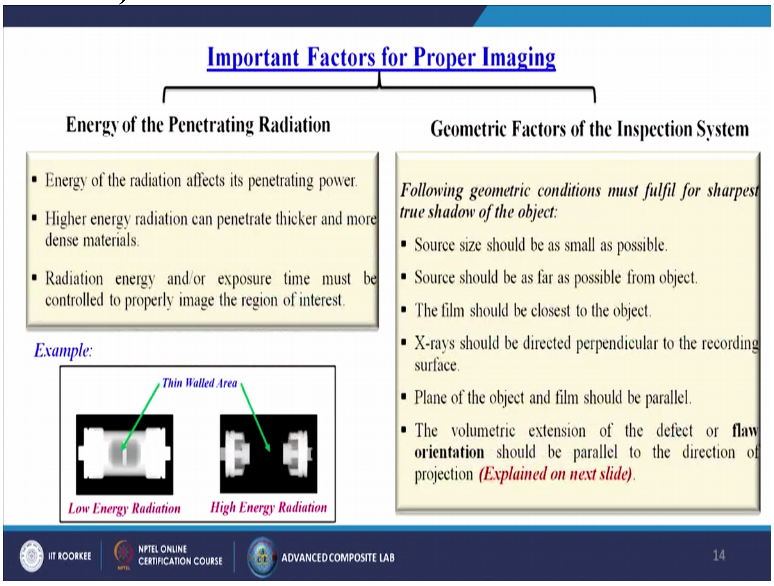

Now come to the imaging now we have already gone through the sources. Now how to take the image first it is divided into two parts depending upon the important factors one is called the energy of the penetrating radiations another one is called the geometric factors of the inspection systems. So, when you are talking about the energy of the radiation effects is penetrating power, yes of course.

If it is power own power is very high so that means automatically it will go inside the material itself more. Higher energy radiation can penetrate thicker and more dense materials radiation energy or maybe the end exposure time must be controlled to properly image the region of interest. So, in this particular case if we are getting the low energy radiations so we can get some kind of blurred image over there.

When you are talking about the high energy radiations so in that particular case we are getting a clear image. Now come to the geometric factors so generally the following are the geometric conditions must fulfill for surface true shadow of the object itself so we can get the real image. So, first one is that source size should be as small as possible source should be as far as possible from the object itself. The film should be closest to the object x-rays should be directed perpendicular to the recording surface itself.

So, it is like this plane of the object and film should be parallel the volumetric extension of the defect or flaw orientation should be parallel to the direction of projections okay which we are going to discuss shortly.

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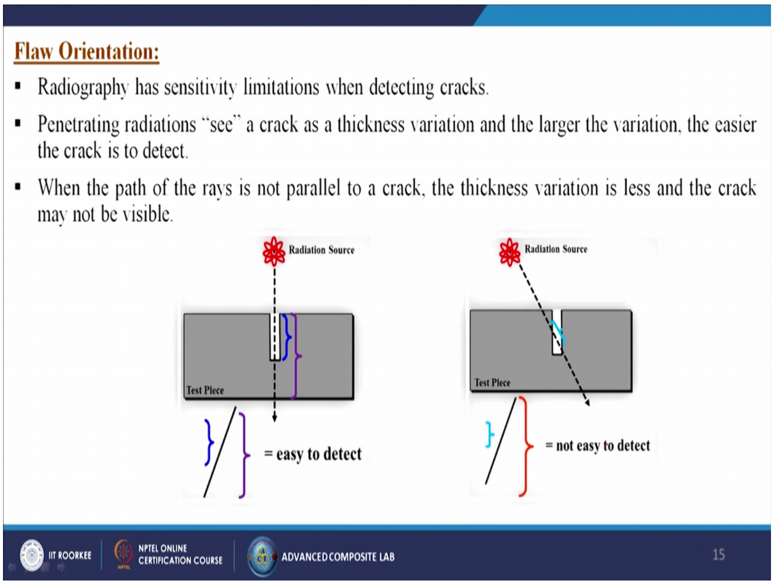

Now what is the flaw orientations, so thing is that how you are going to put your gun so that you can get the best image. Radiography has sensitivity in you mutations when detecting the tracks itself because from the outside we do not know that how the cracks are present inside the materials. Whether it is into the horizontal positions or maybe the longitudinal positions or maybe it is creating some kind of angles over there.

So, what kind of cracks we do not know from the outside so now penetrating radiations see a crack as a thickness variations and the larger the variation the easier the crack is to detect if it is very, very hairline. So, automatically either we can get a very fine line over there or maybe sometimes we cannot detect it. When the path of the Rays is not parallel to a crack the thickness variation is less and the crack may not be visible yes of course.

Say suppose that we are we are having that samples and the cracks are present inside the material like this and we are passing the x-rays from the top itself as I told already it should be the perpendicular one. So, automatically we cannot get the width and thickness properly over there or maybe it is having some kind of inclinations. If it is something like that then from the top you can get a clear image over there. Same thing we are talking in this particular case.

So, in this particular case if you see that this is not easy to detect. But when the radiation is coming in this so, automatically you can detect this all the dimensions.

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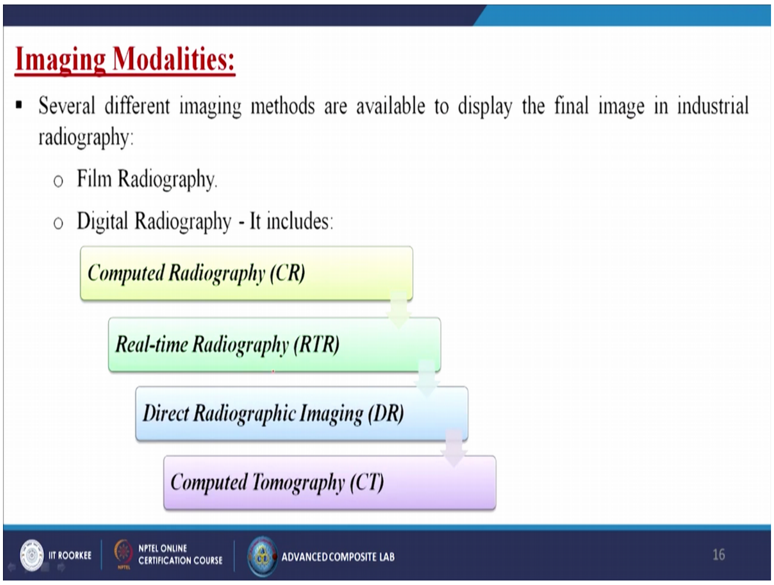

Now imaging modalities several different imaging methods are available to display the final image in industrial radiography. First one is called the film radiography and second one is called the digital radiography it includes that computed radiography, real-time radiography, direct radiographic imaging and the computed tomography. So, in this particular case you see that nowadays when you are talking about the x-rays normal for the medical purpose.

Now they are calling it as a digital x-ray so earlier we are not getting the very sharp or maybe the proper image but nowadays we are getting a very sharp and proper image. So, you can see that for MRI or maybe something like that it has been written some kind of CT scan so that means computed tomography scan generally we are talking about. So, we are getting a very clear image of our body parts.

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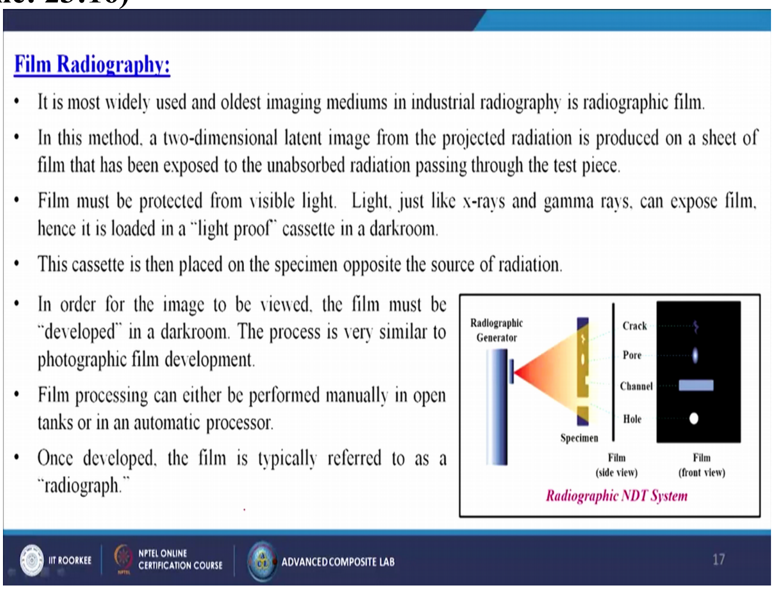

Now let us talk about the film radiography it is most widely used and oldest imaging mediums in industrial radiography is radiographic film. In this method a 2-dimensional Latin tinge from the projected radiation is produced on a sheet of film that has been exposed to the unabsorbed radiation passing through the test piece. Film must be protected from visible light, light just like x-rays and gamma-rays can expose films hence it is loaded in a light proof Cassette in a darkroom.

So, if the normal light will fall onto this film prior to the testing so this film will be damaged so that is why generally we are using a very dark room over there. This Cassette is then placed on the specimen opposite the source of the radiations. In order for the image to be viewed the film must be developed in a darkroom the process is very similar to photographic film development. Earlier also when you are using that film role or into our camera also after taking the picture also we are using this kind of techniques to develop the image or maybe the photographs.

Film processing can either be performed manually in open tanks or in an automatic processor. Once developed the film is typically referred to as a radiograph. So, now you can see radiographic generated we are having we are having that specimen and then here you can see the image into the film itself. So, I can see the crack you can see the pore you can see the channel you can see the hole. So, all kind of images will come on to the film itself.

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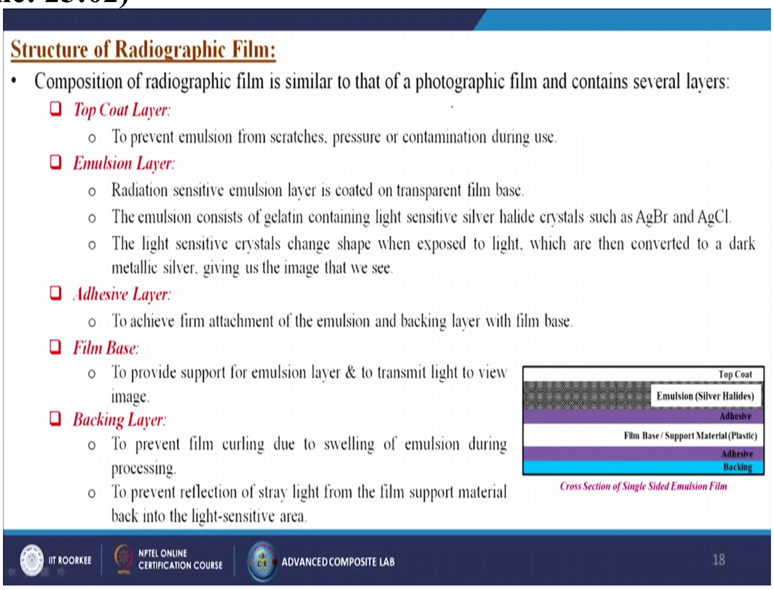

Now what is the structure of the radiographic film composition of the radiographic film is similar to that of a photographic film and contains several layers. First one is called the topcoat layer to prevent emulsion from scratches pressure or contaminations during use because after taking the image we are putting it into in front of some visible lights and then we are seeing that how the image has been come or maybe we are putting it into some envelopes so that it may be it should be scratch proof or maybe it should be some kind of contamination free.

Next one is called the emulsion layer radiation sensitive emulsion layer is coated on transparent film base. The emulsion consists of the gelatin containing light-sensitive silver halide crystals such as AgBR and the AgCL. The light-sensitive crystals change shape when exposed to light which are then converted to a dark metallic silver giving us the image generally that we see so at the time of developing some kind of chemical reaction is going on so the material is changing and after that we are getting the exact image over there.

Next one is called the adhesive layer to achieve firm attachment of the emulsion and backing layer with film base. Next one is called the film base to provide support for emulsion layer and to transmit light to view the image itself then backing there to prevent film curling due to swelling of emulsion during processing to prevent reflection of stray light from the film support materials back into the light-sensitive area.

So, you can see if we do the cross-sectional of that particular film we can see the top coat then emulsion then adhesive then film based support materials or maybe the plastic then both sides we are giving the adhesives and another one we are giving the backing. So, when we are holding that film it should not be bent. So, best example is that normally any kind of x-ray film is available in our home so if we hold it or maybe the touch it then we can see these all are the different layers has been put onto that particular film.

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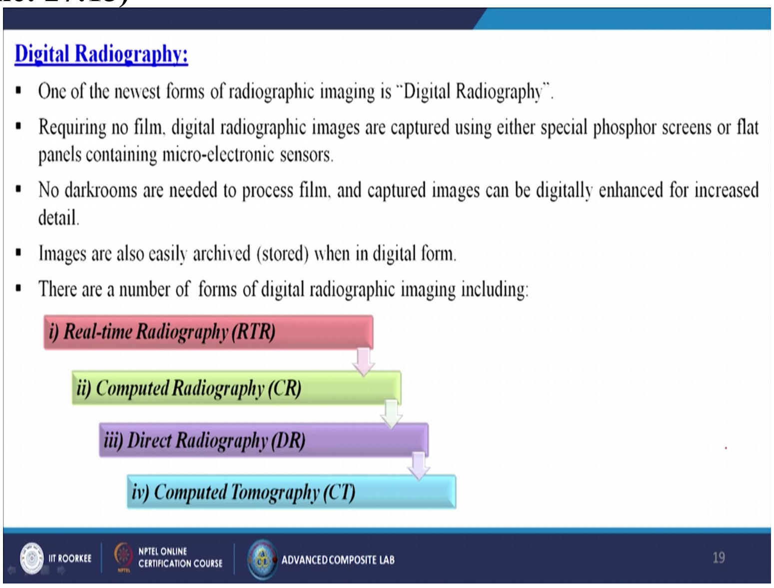

Now come to the digital radiography so it is the one of the newest form as I told already of radiographic imaging is digital radiography requiring no films digital radiographic images are captured using their special phosphor schemes or flat panels containing micro electronic sensors. No dark rooms are needed to process films and captured image can be digitally enhanced for increase the detailing. Images are also easily stored when an digital form.

There are a number of forms of digital radiographic imaging includes real-time radiography or maybe the RTR computed radiography or maybe the CR direct radiography or maybe the DR and the last one is called the computed tomography that is the CT.

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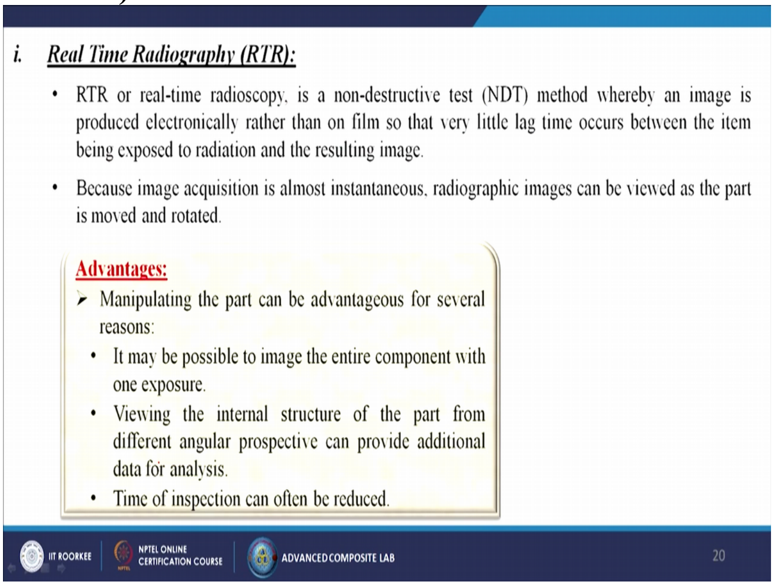

Now first come to the real-time radiography, so RTR or maybe the real-time radioscopy is a non-destructive test method whereby an image is produced electronically rather than on film so that very little lag time occurs between the item being exposed to radiation and the resulting image because after material then it is coming on to the film itself. So, there is some little bit lag time.

So, when the electrons is heating your materials and when the electron after passing it is heating your film so there is a time gap in between these two occurrence. Because image acquisition is almost instantaneous radiographic image can be viewed as the part is moved and rotated what are the advantages manipulating the part can be advantageous for several reasons first is that it may be possible to image the entire component with one exposure.

Second viewing the internal structure of the part from different angular prospective can provide additional data for analysis and the last one is that time of inspection can often be reduced. So, very quickly we are getting the image of our material.

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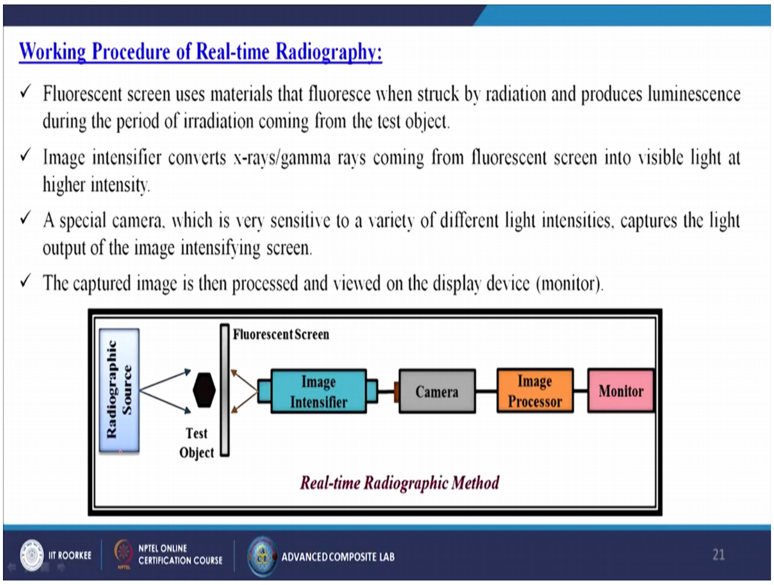

It is working procedure of the real-time radiography so generally the fluorescent screen uses materials that fluorescents when struck by radiation and produces luminescence during the period of irritation coming from the test object itself. Image intensifier converts x-rays and gamma rays coming from fluorescent screen into visible light at higher intensity. A special camera which is very sensitive to a variety of different light intensities captures the light output of the image intensifying screen.

The captured image is then processed and viewed on that display device or maybe the monitor. So, here we are having that radiographic source now we are having that samples, now we are having that fluorescent screen over there now we are having that image intensifier camera image processor and the monitor. So, that means a very small image is coming over there and now just we are enhancing its size so that we can clearly see the image of that particular cracks or pores or maybe the defects.

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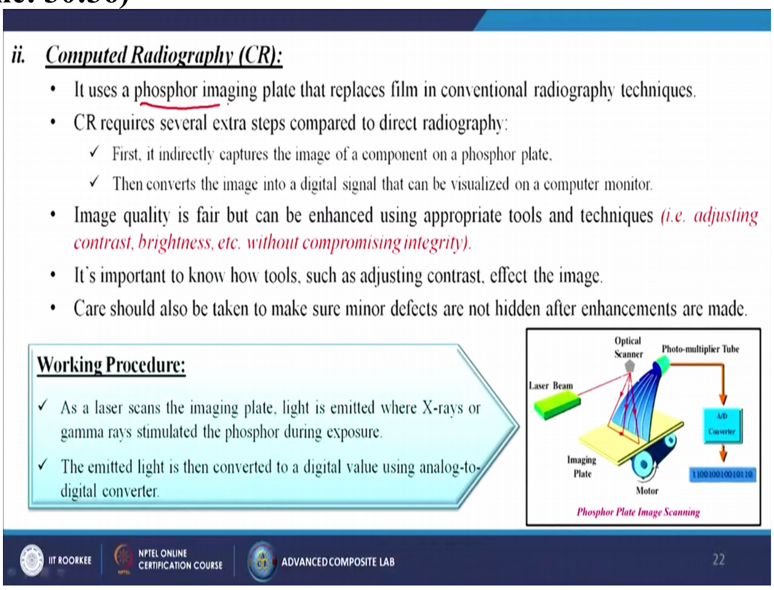

Next one is called the computed radiography or maybe the CR it uses a phosphor imaging plate that replaces film in conventional radiography techniques. CR requires several extra steps compared to the direct radiography first it indirectly captures the image of a component on a phosphor plate and the second then converts the image into a digital signal that can be visualized on a computer monitor.

Image quality is fair but can be enhanced using appropriate tools and the techniques that is the adjusting the contrast brightness without compromising the integrity or maybe without compromising the image quality. It is important to know how tools such as adjusting contrast affect the image. Care should be also be taken to make sure minor defects are not hidden after enhancements are made.

Sometimes it may happen that we are increasing the contrast or maybe the brightness so and what will happen maybe a very hairline cracks we cannot see by just giving the extra contrast or maybe the brightness so that we have to adjust so that we can get the whole image very clearly and sharply. What is the working procedure? As a laser scans the imaging plate light is emitted where x-rays or gamma rays stimulated the phosphor during exposure the emitted light is then converted to a digital value using analog to digital converter.

So, in this particular case you can see that here we are having that laser beam so we are having that optical scanner over there so it is heating and then we are having that imaging plate over there. So, on top of that it is creating the image and then we are having that photomultiplier tube and through a analog to digital converter and then directly it is coming as some digit or may be directly that means one computer only understands 0 and one value.

So, when there is some signal some sorts of signals are coming then the computer is converting that signals into some images and we are getting the information.

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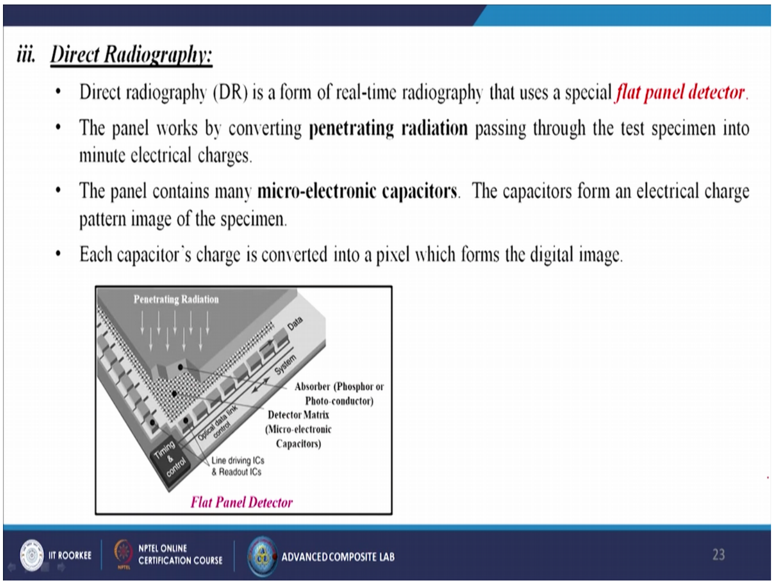

Next is called the direct radiography so generally the direct radiography is a form of real-time radiography that uses a spatial flat-panel detector. The panel works by converting penetrating radiations passing through the test specimens into minute electrical charges. The panel contains many microelectronic capacitors the capacitors form an electrical charge pattern image of the specimen itself.

Each capacitors charge is converted into a pixel which from the digital image over there. So, now here the simple is that electronically we are capturing the image of our defects or maybe of our samples.

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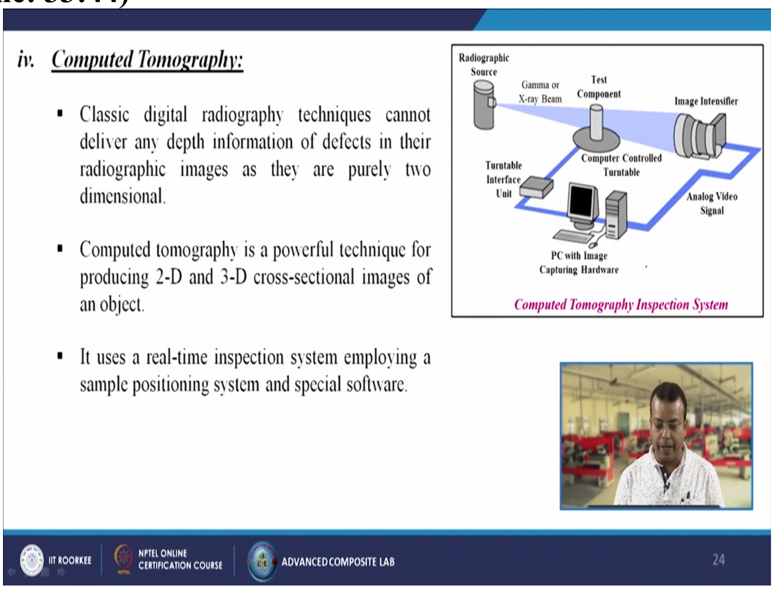

Next come to the computed tomography so classical digital radiography techniques cannot deliver any depth information of defects in their radiographic images at they are purely two-dimensional as I told already. It will give you the two-dimensional image but when you are talking about the three-dimensional image we are coming to the computed tomography that is why if you see the CT scan it is giving you the 3d view of our skeletons or maybe of our body parts.

So, computer tomography is a powerful technique for producing the 2d and 3d cross-sectional images of an object itself it uses a real-time inspection system employing a sample positioning system and the spatial software. So, in this particular case you can see that we are having that radiographic source so either gamma or maybe the x-ray beam are generating then we are having that test component over there and we are having that image intensifier.

So, now analog and video signals is coming directly to the computer and here we are having one turntable interface unit also so in that particular case the sample is rotating into the different angle or maybe the directions and through that we are getting a real-time inspections or 2d or maybe the 3d image directly into the computer itself.

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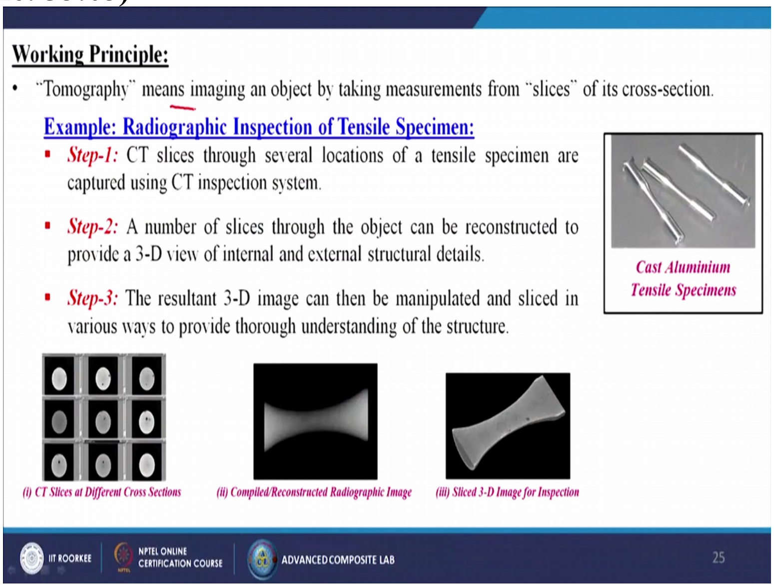

Now what is the working principle generally tomography means imaging an object by taking measurements from slices of its cross section. Example radiographic inspection of tensile specimen step 1 CT slices through several locations of potential specimens are captured using the CT inspection tables. So, in this case you can see CT slices at different cross sections. Now come to the step 2 a number of slices through the object can be reconstructed to provide a 3d view of internal and external structural details.

So, compiled or may be the reconstructed radiographic images and step 3 the resultant 3d image can then be manipulated and sliced in various ways to provide through understanding of the structures itself. So, this is the slide 3d image for inspections. So, first it is taking suppose you are having one object now it is dividing your object slice by slice and then each slice it is taking the image then automatically after adding all the slice it is creating a 3d image and then after that it is giving a clear inspections or with the clear results of our test specimen.

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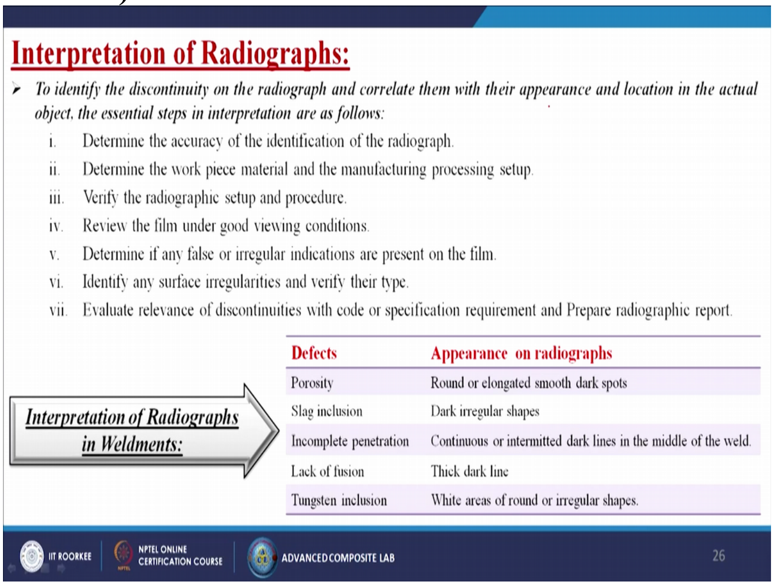

Now how to interpret the radiographs to identify the discontinuity on the radiograph and correlate them with their appearance and locations in the actual object the essential steps in interpretations are as follows sometimes it may happen that maybe pores or tracks are almost looking like same or maybe some holes or maybe the pores are looking like same. Now you need a trained operator or maybe trained person who can judge properly that whether it this image is exactly for the cracks or maybe the pores or maybe the holes or maybe some other else.

Now to determine the accuracy of the identifications of the radiograph determine the workpiece material and the manufacturing processing setup, verify the radiographic setup and procedure, review the film under good viewing conditions, determine if any faults or irregular indications are present on the film, identify any surface irregularities and verify their type evaluate relevance of discontinuities with code or specification requirement and prepare the radiographic report.

So, generally the interpretation of radiographs in the weldments so I am giving an example so for defects like porosity round or elongated smooth dark spots will come unto the film itself or maybe into the image. If it is slag inclusion dark irregular ships incomplete penetration continuous or intermediate dark lines in the middle of the weld. If it is tungsten inclusions white areas of round or irregular ships if it is lack of fusions thick that line.

Now the thing is that at a first instance we cannot predict the exact thing what is going on inside or maybe what is present inside the materials a really, really highly trained operator or maybe that scientist can say that what is the cracks are present inside the material from their experience.

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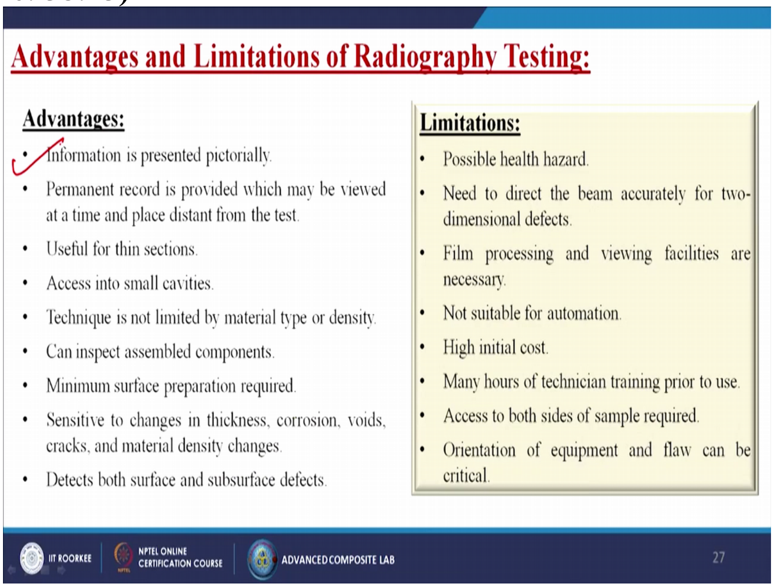

Now what are the advantages and limitations of the radiography testing if we talk about the advantages first one is that information's is presented pictorially? Permanent record is provided which may be viewed at a time and place distant from the test useful for thin sections access into small cavities technique is not limited by material type or density can inspect assembled components minimum surface preparations required, sensitive to change in thickness corrosion voids cracks and the material density changes and detects both surface and the subsurface defects.

Of course there is certain limitations what are those possible health hazard, need to direct the beam accurately for two-dimensional defects, film processing and viewing facilities are necessary, not suitable for automation, high initial cost, many hours of technician training, try to use access to both sides of samples required for getting the exact information orientation of equipment and flaw can be critical.

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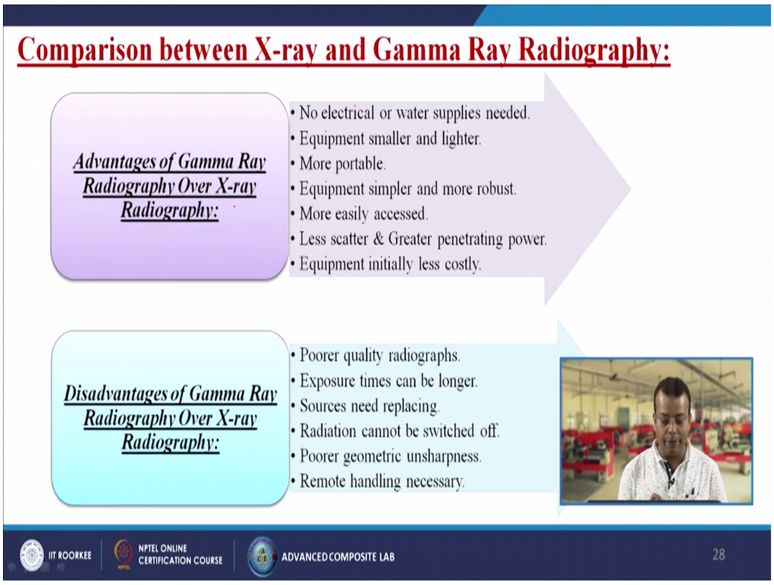

Now if we just make a comparison in between the x-rays and gamma-rays radiography so what are the advantages of the gamma ray radiography over x-ray radiography? First is that no electrical or water supplies needed equipment smaller and lighter more portable equipment simple and more robust, more easily accessed, less scatter and greater penetrating power, equipment initially less costly.

But when you are talking about the disadvantages of the gamma ray over x-ray so it is poorer quality radiographs exposure times can be longer sources need replacing, radiation cannot be switched off, poorer geometric and sharpness, remote handling necessary. So, these are the drawbacks of gamma rays over x-rays.

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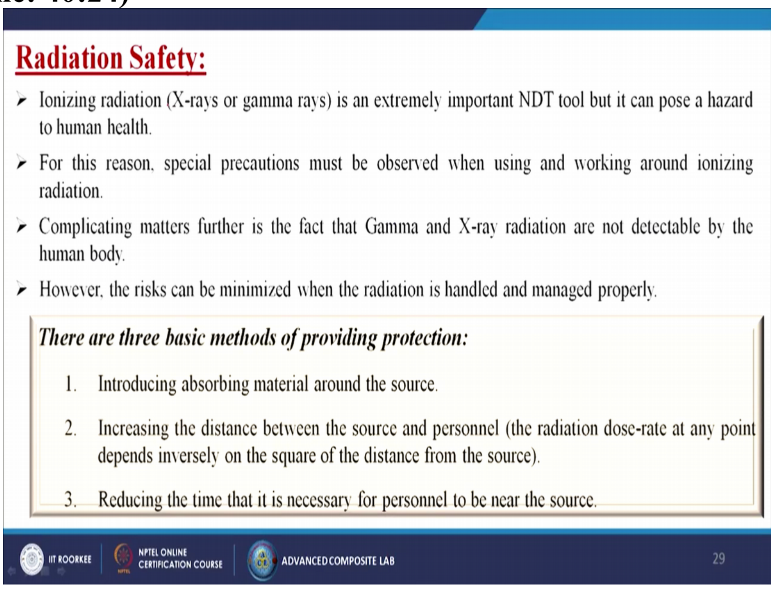

And last is called the radiation safety so now ionization radiations whatever may be whether it may be the x-rays or maybe the gamma rays is an extremely important non-destructive testing tool but it can pose a hazard to human health. For this reason special precautions must be observed when using and working around ionizing radiation. Complicating matters further is the fact that gamma and x-ray radiation are not detectable by the human body.

However the risk can be minimized when the radiation is handled and managed properly. There are three basic methods of providing the protections first one is that introducing the absorbing materials around the source. Maybe some electrons which will not pass through the materials it will scatter or maybe it will be reflected from the material itself. So, we have to take some kind of protection so that that is reflected electrons can be absorbed by some other material.

Second increasing the distance between the source and the personal the radiation dose rate at any point depends inversely on the square of the distance from the source itself. So, we have to maintain the keep safe distance third reducing the time that is necessary for personal to be near the source itself so, reducing the time.

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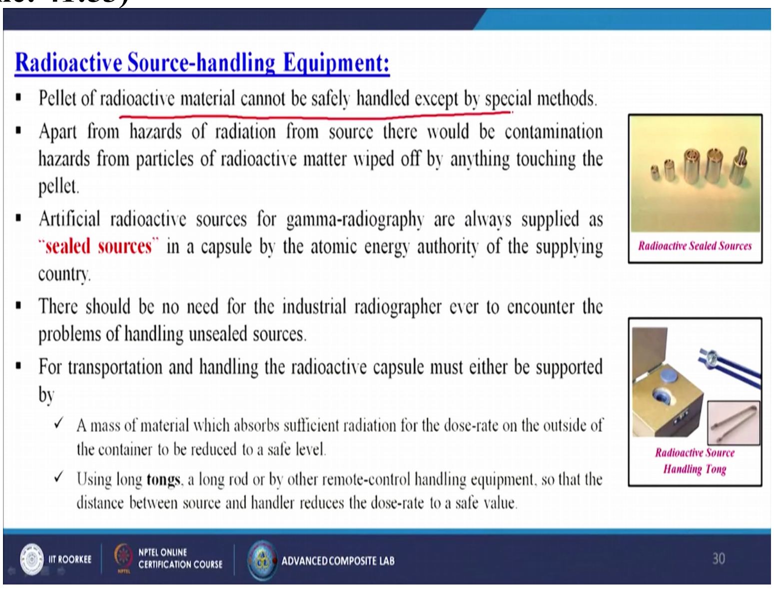

Now radioactive source handling equipment pellet of radioactive material cannot be safely handled except by the special methods. Apart from hazards of radiation from source there would be contamination hazards from particles of radioactive matter wiped up by anything touching the pallet. Artificial radioactive source for gamma radiography are always supplied as sealed sources in a capsule by the Atomic Energy Authority of the supplying country. Because these all are the some kind of health hazards materials and environmental hazard materials so we are going to keep that material or may be transferring that materials with a very high security and safety. There should be no need for the industrial radiographer ever to encounter the problems of handling unsealed sources. For transportation handling the radioactive capsules must that be supported by a mass of material which absorbs sufficient radiations for the dose rate on the outside of the container to be reduced to a safe level using long tongues a long rod or by other remote control handling equipment so that the distance between the source and handler reduces the dose rate to a safe value.

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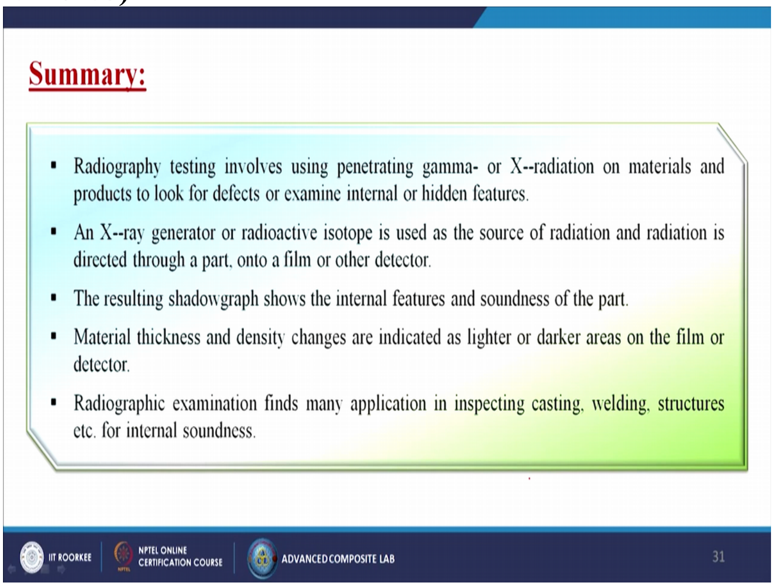

Now we have come to the last part or maybe the last slide of this particular lecture. So, now if we summarize the whole lecture so in this particular lecture we have talked about the radiographic inspections which is nothing but the taking the image of that particular materials so either we can do it by two methods one is called the x-rays another one is called the gamma rays. An extra generator or radioactive isotope is used as the source of radiations and radiation is directed through a part onto a film or maybe some other detector.

Material thickness and density changes are indicated as lighter or darker areas on the film or maybe the detector. Radiographic on examination finds many applications like casting, welding, structures for internal soundness. So, there are in number of applications nowadays we are using this kind of rays over there even if for the biomedical applications too. Thank you.