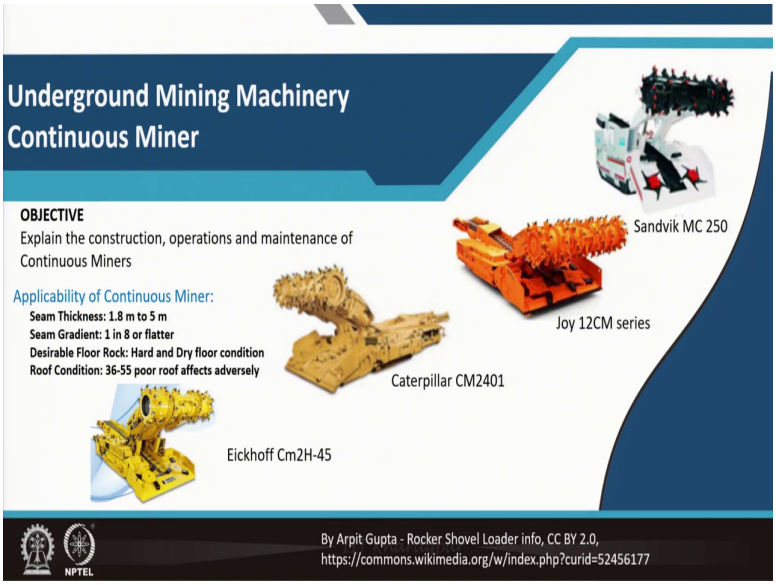
Mining Machinery
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Module - 06
Lecture - 31
Underground Mining Machinery Continuous Miner

Welcome back to our discussions; in today's class, we will be discussing about underground Mining Machinery for coal mining, particularly with Continuous Miner.

(Refer Slide Time: 00:47)



Now, you know that in bord and pillar method, this continuous miner is one of the very important productive machinery for winning coal. There are a large number of a companies which manufacture this continuous miner say, for example, Sandvik, Joy Global, Caterpillar,

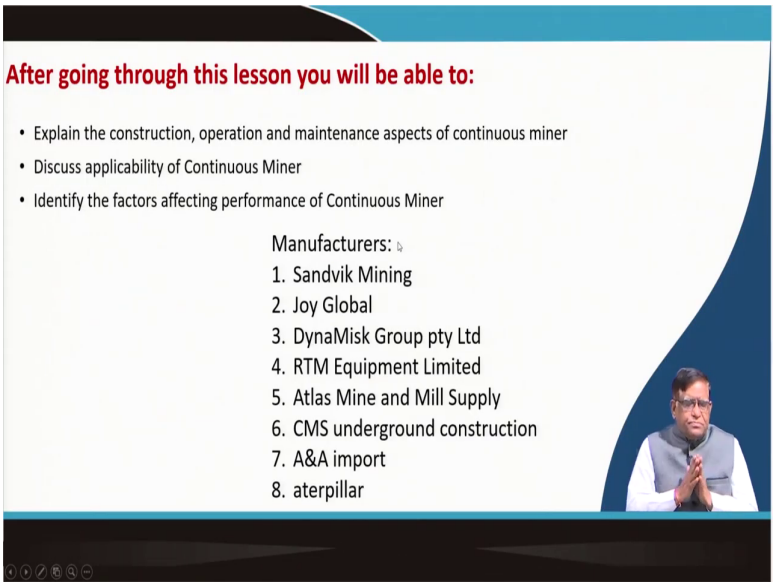
Eickhoff all these machinery manufacturing company, they have provided this continuous miner.

So, in this class, we will be discussing the construction, operation and maintenance aspects of this continuous miner. And you know that this machine is capable of working underground even some thin seams as 1.8 meter to a seam thickness up to 5 meter; then this it can work in a gradient of 1 in 8 or flatter, so not very good for very steep seam.

And then the rock floor, that is the gallery floor, it should be hard and dry for it is best operations. This machine the requires a fairly good roof conditions; so that means these machines can be applied in a in underground coal mine, where thickness is say 1.8 meter to 5 meter and then where the good roof and floor conditions are there.

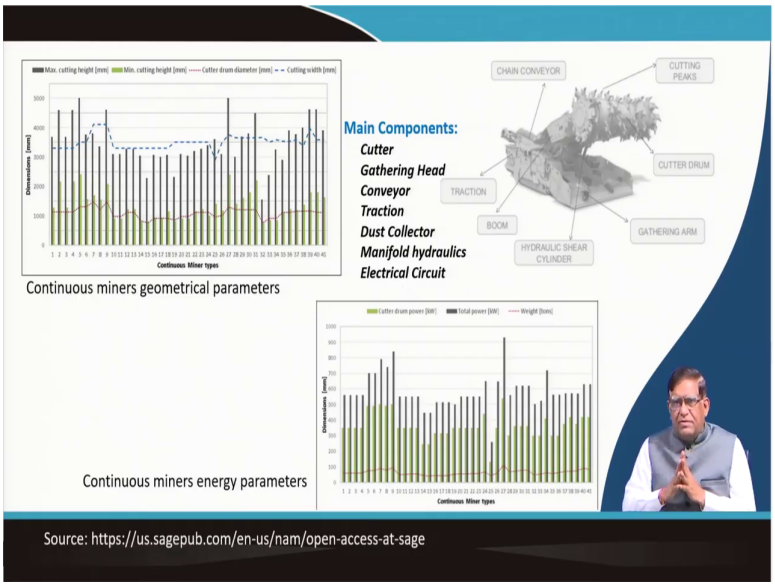
So, this machines normally cut from the face and it does not require your any drilling and blasting. So, you are mechanically breaking the coal and then its load to a shuttle car and the shuttle car takes the coal to the next feeder breaker or to the conveyor belt.

(Refer Slide Time: 02:40)



So, this system is a as I said, it is manufactured by quite a good number of company. But today you will be just learning what are the basic components of this machines and so that you can talk about the applicability and also that safety aspects of this machines.

(Refer Slide Time: 03:01)



So, if you see that to say there is a quite a good number of machines from different manufacturers are available; but structurally if you see, it is comprising of some basic components. That components main is that your a cutter head, that is the cutting the main rock cutting is done by the cutter, where which is having certain cutting peaks or as you can see in this figure, that peaks are on a peak box mounted on the scrolls.

Now, there is a gathering head on which the materials are collected and it is sent to a central conveyor chain conveyor, which gives this to the rear the side chain conveyor from where it is loaded to the your feeder breaker or to the conveyor through the stage loaders. Now, there is a certain systems for the operations; as you know that there will be a mechanical loosening of coal, in that lot of dusts will be generated.

And in the ventilated air, this dust will be airborne and it could be very detrimental to the health of the miner; because it is a coal dust as you all know that it is a source of pneumoconiosis type of lungs diseases.

So, there are the dust collecting system is an important system must be there and also there is a hydraulic systems for controlling various operations of various motors and actuators, we have got the hydraulic system. So, their arrangements will have to be there.

And as such this machine is powered by electrically; so this whole crawler drives and all they have for that that all hydraulic pumps to operate, it has got the electric drive. So, these are the main components. Now, if you see that this your that dimensions of this machine under different working conditions can be tailor made. And then there are certain size dimensions are available from various manufacturers.

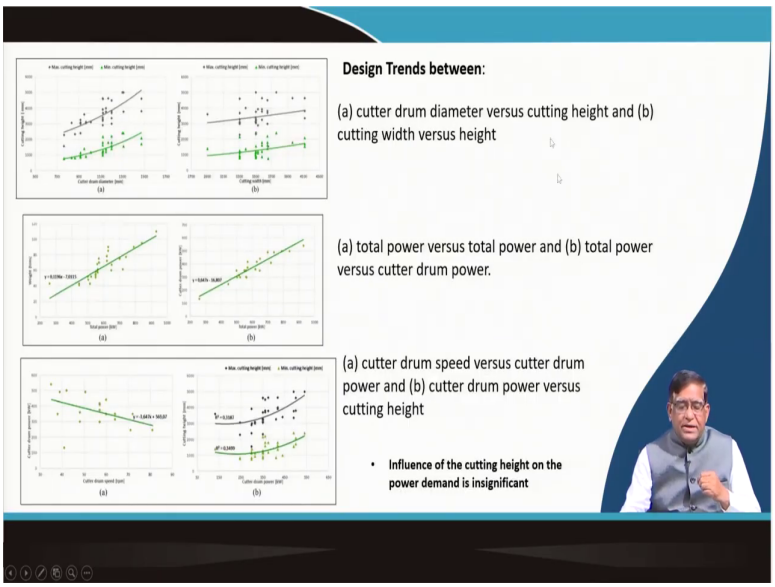
A study they have revealed that, how these are exactly the different types of that is your continuous miners you can see that. The maximum cutting head height if you see this, it goes from 0 to your up to 5000 millimeter of your cutting head height. And at a minimum cutting head height, which is there you can see up to your less than 1000 millimeter; within that range, you can see their combinations of different machine has got different.

Now, there is a and then the cutting width, that width is that width of this particular cutter head, that width also varies; but you can see that though there is a changes in the your cutting height and this, but the cutting width are more or less within a, but it in a minimum of say or less than 1500 and at a maximum it is having up to 4000.

So, this is you can see that there is a more or less there is a constancy there; this shows that the gallery width through which it can work, it can go up to say your gallery width is up to 4000 4500 millimeter this machines can work.

Similarly, if you see the cutter drum, that is the kilowatt rating and the total power installed in the machine and compared to the weight of the machine, there is also you can see the behavior. This gives you an idea about how this machine is designed.

(Refer Slide Time: 06:39)

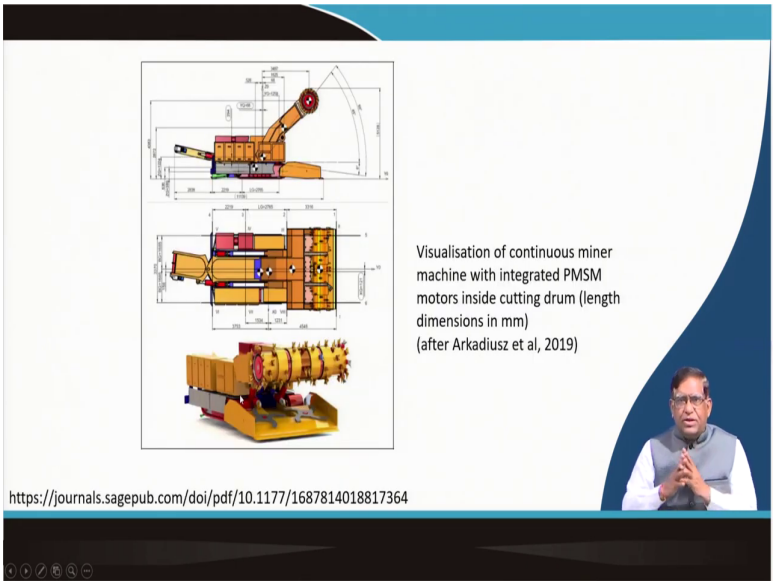


Now, there is a if you see the design trends of this machine, it also shows that this cutter drum diameter; if you see that your this and then cutting height, if you see the cutting height and drum diameter, as your drum diameter increases, the cutting height increases.

So, you can see this different trends. So, to have an idea that all these equipment manufacturers their leaflets are available in a net, you can find from there, plot it and see the sketch and then look at the trends how it is there. So, it is a, if you see the cutter drum power

and the cutter height, that is your power consumptions; then it goes a minimum, but then it increases.

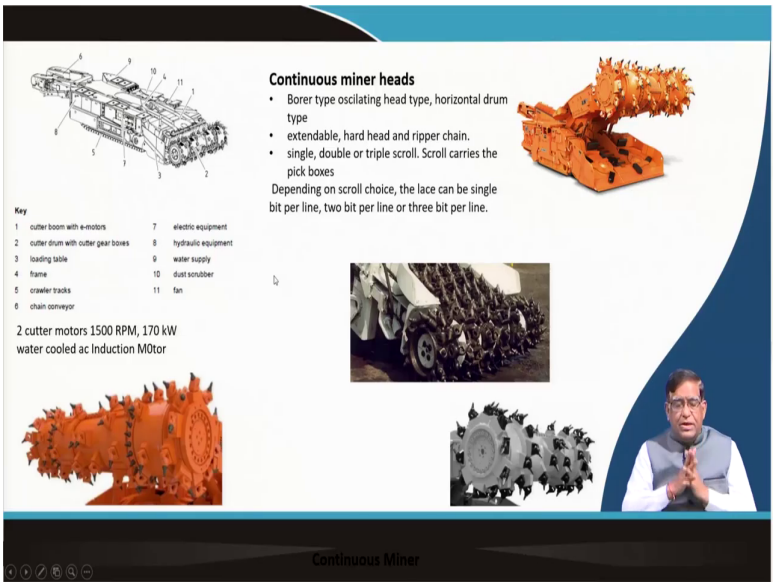
(Refer Slide Time: 07:32)



So, there is a the linear type of relationship is there; though it is just giving an average things, it gives an idea about how the designers they think of. Now, if you see that this dimensionally, this machines how it is look like; is you have said that constructional component wise it has got this drum, that weight.

And there this exactly this head, cutter head it can raise to up to as you say here at the 50 degree and that will be the maximum height to which it will work. So, this as a dimensional thing is important for you to know when you are going to design your underground face.

(Refer Slide Time: 08:09)



So, there is a; this is a visualizations. Now, you can see that how these different types of these machines are there. As a constructional component we have already said, that this machine it is having the front part is a cutter boom.

This is the boom part you can see here, this if you see this boom, this boom is here and this boom part; in front of that, there is exactly the all in that boom only your cutter electric motor is installed. And then you have got the cutter, that is your head drum this on this drum, where there this all the gear boxes are also installed over there.

Then there is the main loading table on which the material will get collected over here and then this is supported on this is the main your frame. And in that you have got the crawler tracks; you can see at the bottom the crawler tracks are here, this the machine is a crawler

driven. And then on that, there is a chain conveyor; you can see here, this chain conveyor is here.

And then there will be the number of electrical equipment these are located here; you can see that this is the location of all electrical equipment will be placed over here. And that by the back side of it, there is the all hydraulic equipments are placed, your hydraulic tank, pump and other things.

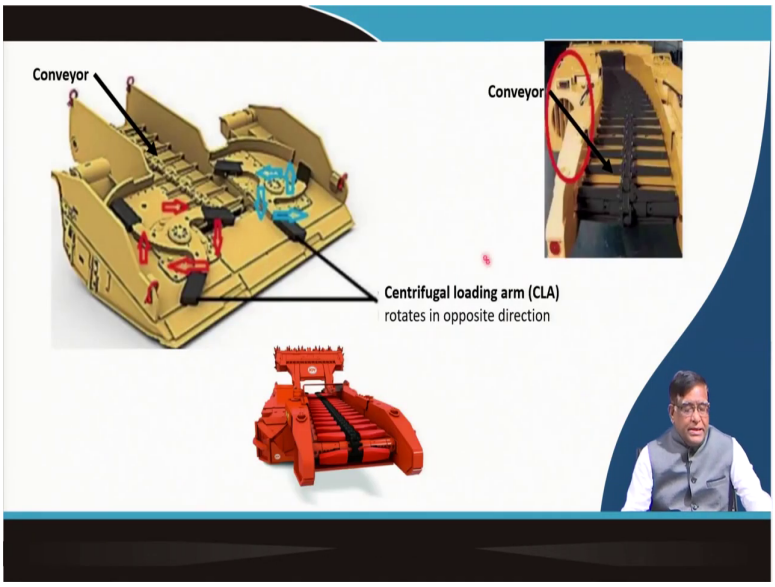
And then with the side of it, there is a this dust collecting system; in the other side of it, here you can see a dust collecting system is there and then the cooling fan all these are available here. So, these machines, these are all in a modular form and brought over there and then it can be. And this cutter head that there could be a different varieties of it; it can cut even as a vertical and horizontal, there are continuous miner, they can give a boring type of vertical cutting.

And then this can be, there could be a extendable, that may a little bit of telescopic boom can be provided over there. Then there is could be a chain type of, this cutters are with a drum there could be a some chain type of thing Dintheader and all those machines were manufactured, where instead of this cut; there could be a chain which will be going on cutting over there.

So, these are the scrolls, where you can see they are carrying and this could be a single or here you can see three scrolls on which this cutters and the peaks are placed. So, now, depending on this the choice that how you are doing, you can get this the matrices of, if you take just a, if you develop this drum and see a rectangular plan; how these peaks are placed that will be having a relationship in how exactly the hardness of the coal and how you are being cutting.

So, depending on the coal properties, you will be deciding this peaks, just like in any other cutter.

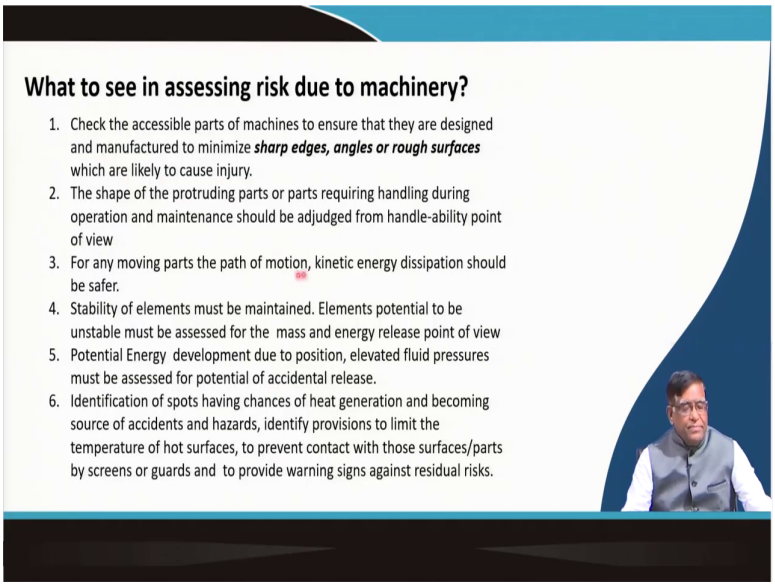
(Refer Slide Time: 11:09)



So, if you see here as a constructional component wise that, this part you which you have seen here; that is in your the gathering part, here it is exactly we are having two centrifugal loading arm is there. You can see that they are rotating in the opposite direction, this is rotating in this directions and then this is rotating in this directions by which the material are brought over here in front.

And this is you can see a single, single chain with the flights both sides; there could be it is a here, this is your chain conveyor, where these horizontal members are called flights. And then there is this you can see the fan that is there is electric fan, that is also working over there and the dust collecting systems are also working over here. And in some designs there could be even two chains, but mostly that single chain type of things are there. So, these are the way the material is collected from there.

(Refer Slide Time: 12:11)



Now, what most important thing is you need to work with this machines in underground. When you are working with any machines in an underground coal mining, you need to be very careful about that to avoid accidents and then avoid mishaps.

For that this is exactly some of the general precautions that, whenever you are working with this type of machinery; you will have to see that the operations are risk free. And for that, wherever there is sharp edge or angle of rough surfaces, those things need to be looked and avoided. So, there is a there may be if anywhere, anything is stuck up or having a protruding portions, you need to remove it off.

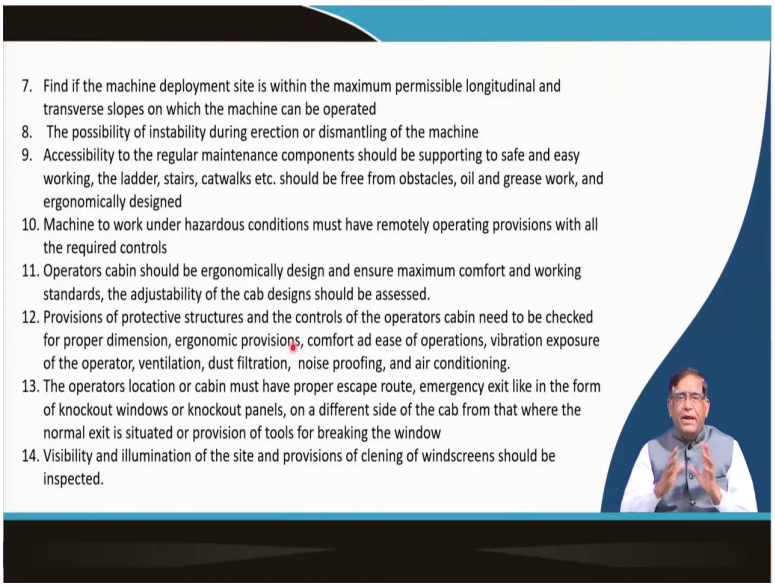
So, then this is exactly, this machine should be working underground; wherever it is moving that around it, the space should be properly clear. Then this the floor on which it is moving

and that machines whether it is your lateral and that your transverse position should be such that, the stability is maximum.

And anywhere you in operating with a machines, your potential energy development should be avoided, so that anything whether you can fall or that type of potential energy accumulation should not be given.

So, you need to identify all the spots, where there could be some problem of this risk is may be coming.

(Refer Slide Time: 13:29)



So, it is a the machine when you are going to deploy in there, you will have to see the slopes; that is your the gallery, whether it is your transverse slope as well as the that your along the line slopes is very very important.

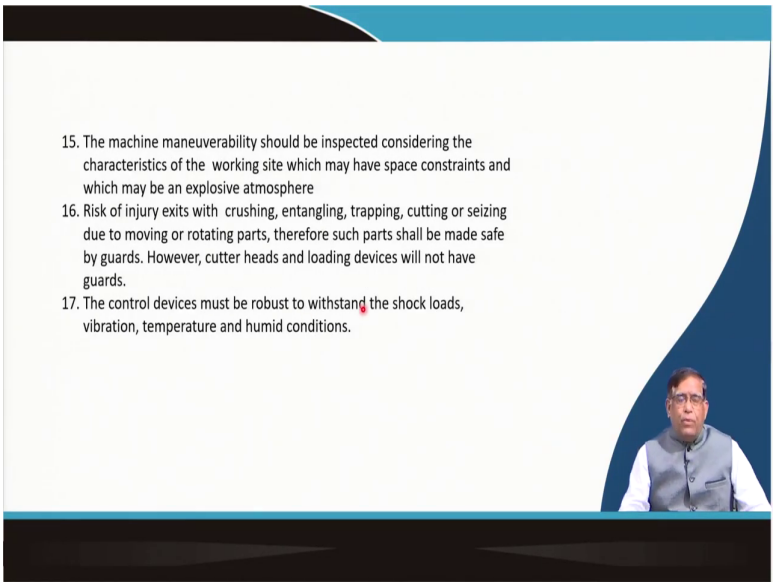
Then this so that in any case wherever this is moving, your instability should not be there; the crawler track which on which it is mounted, need to be seen that it is properly its tensions should be proper, otherwise there could be while moving, if the there is the collar pins if they break and then there could be more problems of maintenance and then there will be loss lose of time.

So, that is why for the operational risk will be reduced, if your all the hazardous conditions must be monitored and removed. The operators cabin, this is very very important, where the operator is placed, his maximum safety is to be maintained, so that any rollover or the roof fall or any type of things should be protecting him.

At the same time this is a low height machines, in that you will have to provide the operator; if you want to keep the operator on the machines or if you have to keep it operate remotely, there should be adequate space from which he can control. So, that is the risk point, that is another anything happens; if the sudden roof fall or any collapse or any gas in just comes and things like that, the operator must be able to escape from the machine.

So, for that also the freeness should be there; it should not be that exactly the operator we need cannot come out quickly, that type of system should be avoided. And the most important thing is the visibility and illumination must be kept proper.

(Refer Slide Time: 15:22)



So, this is general thing which you must know while ever working with any underground machinery. Moreover the maneuverability, sometimes this machine will have to be positioned for maintenance; it will have to just see that adjust for the if any side wall fall or anything takes place. So, that is why the maneuverability of the machine, so that you can steer properly within that limited space need to be seen.

Then there should be exactly the risk of injury exists for the crushing, entangling, trapping, cutting, seizing due to the different moving parts. In the machines, the main moving parts will be your drum will be rotating, your chain conveyor will be moving, your arms will be moving, your crawlers can be moved.

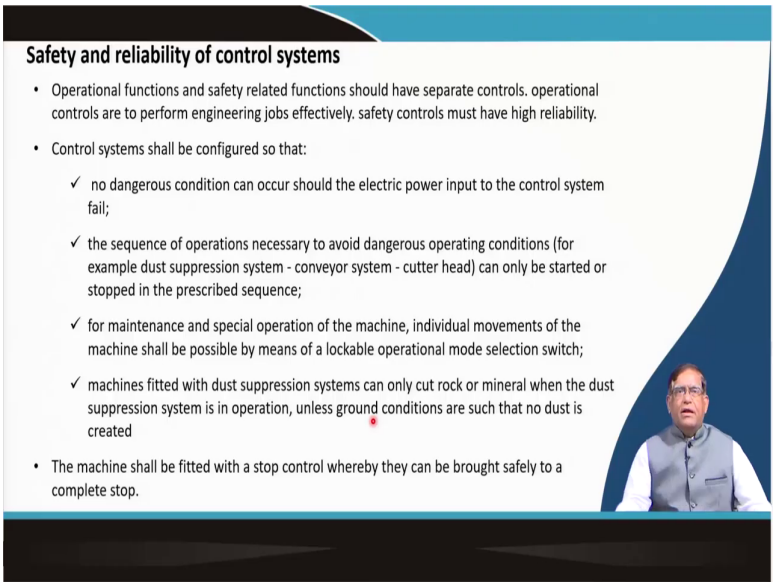
So, wherever there are motions, you know that in machines in a very early introduction of the machines I told you; you need to be careful about what are the powered functions, wherever

there is a powered functions, there is a possibility that you can get entanglement with that motions. So, that point is to be avoided.

So, that whenever you are asked to do a risk assessment of the place where that machine is deployed, you will have to see those powered functions and their control. So, that the control must be robust, at any time you should be able to switch. So, whenever you want to study these machines, go and find out what are the control switches from where also you can stop the machines, if you observe anything going wrong in the machine.

So, that there should not be, the machines also should have certain capability; it can absorb certain shock loads, certain vibrations, certain temperatures and humid conditions. Now, this when it goes beyond, there should be sufficient warning, so that the machine can be stopped. Now, in the machines, there would be certain automatic safety devices, automatic control to shut up the power. So, those issues need to be carefully observed.

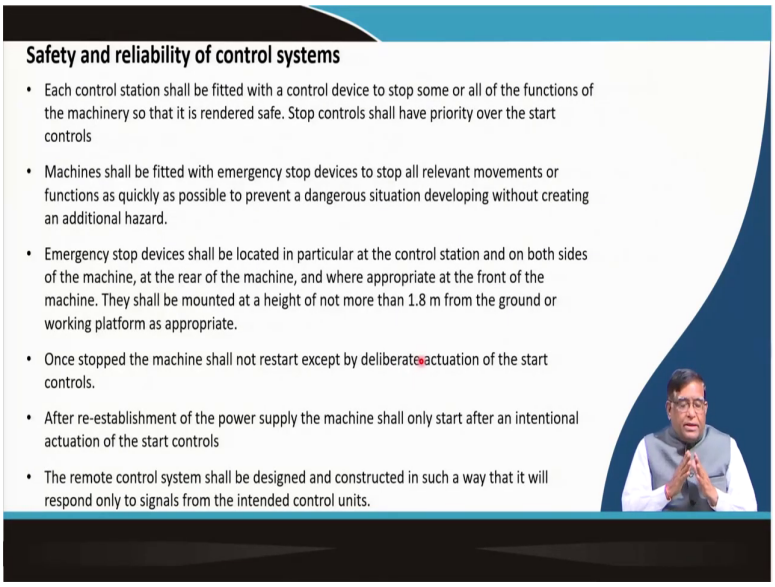
(Refer Slide Time: 17:16)



So, the safety and reliability of the control systems, exactly it is you will have to see that there is no dangerous conditions can occur. And sequence of operations in which way it will start and which it will a it will have to be close; to shutting down and starting sequences as prescribed by the your operators manual need to be maintained.

The maintenance schedule as given by the manufacturers must be followed and it must see that, the dust suppression system, illumination system which are working in the machine are properly adjusted.

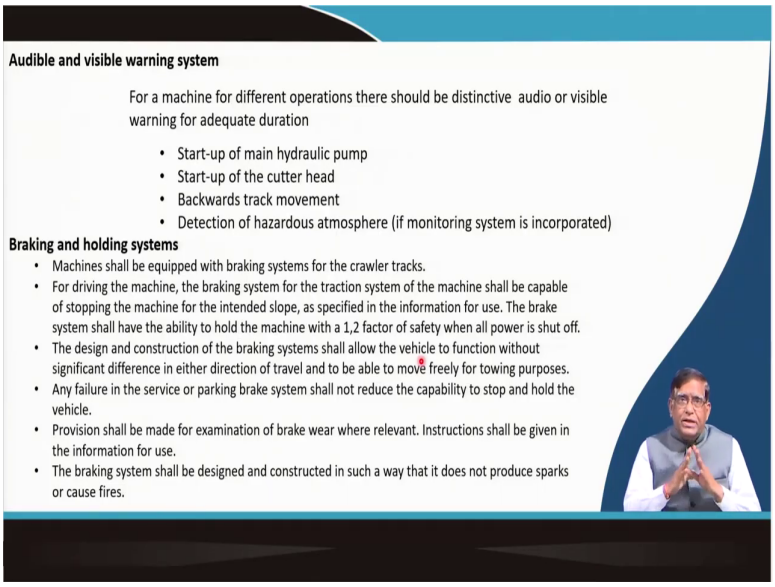
(Refer Slide Time: 17:54)



So, this the control stations should be there in the machines from where all the operations can be monitored; then it must be fitted with the emergency stop. As I said that is if you see that something is wrong, some fall is coming up, there you are apprehending that the machine may get jam or stuck or it can get unstable; at that time, there should be a button from which exactly emergency stop you can operate with, ok.

So, wherever you have operated, at that time you will have to see that this your when you are working, you will have to restart the machines after a stoppage; you should see that you do not bypass the safety devices, but you take care of the problems and then only you restart. So, there is a power supply when you will have to re-establish; it will have to become an properly seen that no accidents takes place.

(Refer Slide Time: 18:55)



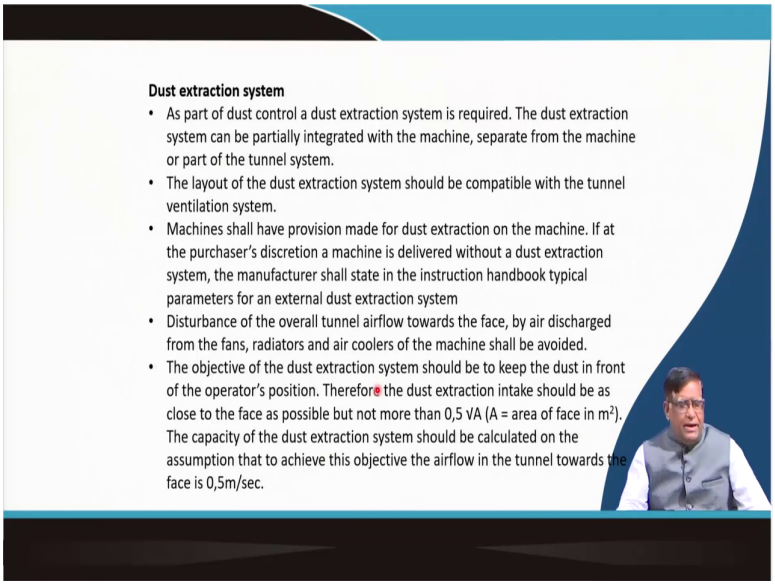
So, then your there will be the warning systems. So, particularly in this machine, the warnings are given for the startup for the main hydraulic pump is working or not startup of the cutter head; then your backward or track movement, if you are moving in a reverse motion or if you see any dangerous situations coming in all these cases, there should be a sufficient warning that could be a audible or a visible warning could be provided.

Now, there is a there will be a breaking system of this machine must be having, that is whenever you are having; if it working on any that is your gradient, if it is getting a control, losses control on speeds and all, you should be able to break it. Now, they it must have this your all the control, it should be, it is to be commensurate with the proper dimensions and its weight.

So, designing of the braking system, which will be in compatible with the type of drive motor selected. So, these are done in the type of whenever you are going to do the, that the designers take care of it. So, as a result what is the thing in the operational as a manager of the mind, you must see in the logbook; whether the machine operator or the maintenance people, they have inspected that or not.

Because the braking system, steering systems, power drive systems, control systems these are very very important and vital photo machines. So, you should always keep a track of the log book that and how their maintenance schedule or their conditions are being monitored.

(Refer Slide Time: 20:37)

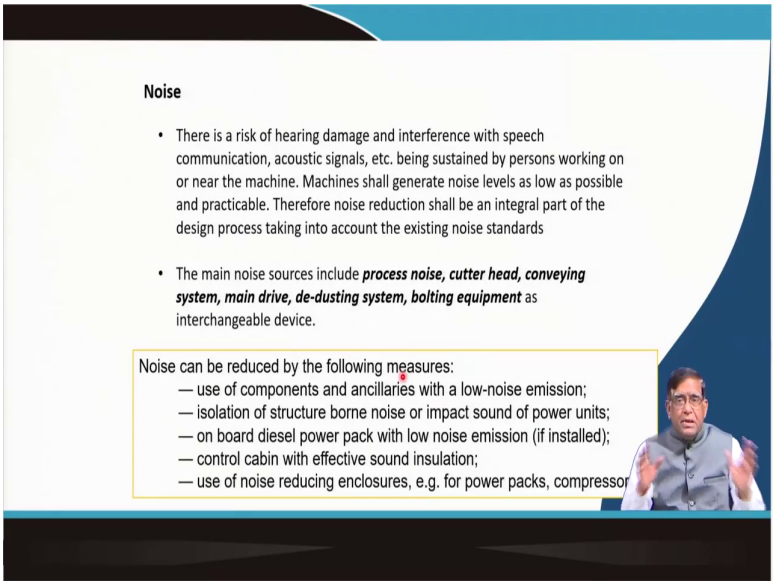


Similarly, the dust extraction system is very very important; because as I said this coal mining dust is can it can generate pneumoconiosis amongst the miner. So, for the dust collections, we

have got a properly that it is a your air is a ventilated air which is coming from there, it will be entering into.

Then when it is cutting and then while going out, it will be going through a dust suppression system and they collecting And then the whatever the air will be coming out of this, they will be coming without any this, dust will be minimized to an extent that the persons working at the rear of the machine, they do not get exposed to a high dust.

(Refer Slide Time: 21:22)

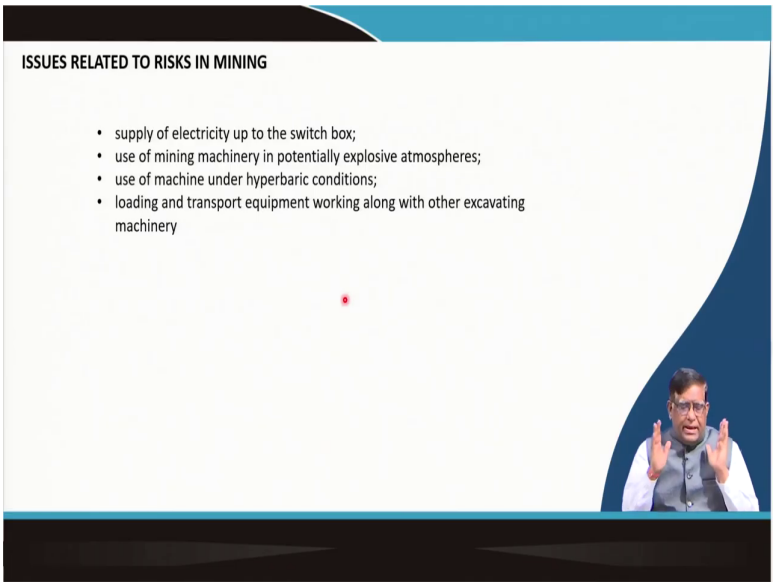


So, will be another problem is this noise, because it is a mechanical loosening of coal, while cutting that the overcoming this cutting resistance. The basic principle of shearing, where there will be a lot of noise generated; moreover the machines also can vibrate, because of the machines different parts vibrating, a lot of noise will be coming.

So, the personal protective equipment, that is your ear plug and that ear mufflers must be used. And noise can be reduced by using the components in a proper low noise emission system, design could be there and then the isolation structures; wherever there will be vibrations of one component should not get transmitted to the vibration of the other.

So, there could be a isolator of vibrations. And then there is a will have to have the operators cabin; it can be given even a active noise control. In the active noise control you generate that, you observe that whatever the vibration is coming and then you generate the reverse vibrations. So, that by superimposing the total overall vibrations in the air to give your noise sensations will not come. So, that is active noise controllers can be provided in the operators cabin.

(Refer Slide Time: 22:41)

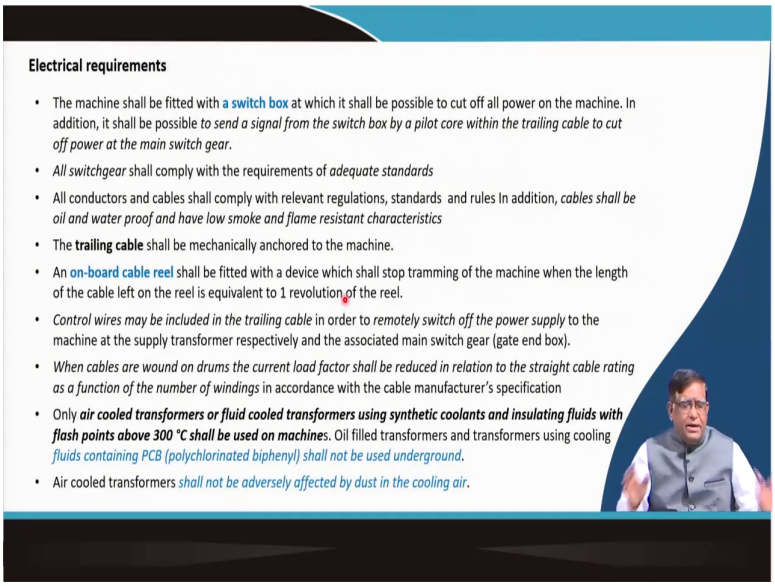


Now, there are different issues related to the risks in the mining that supply of electricity, then use of the machinery with in an explosive atmosphere; because there could be firedom that methane can be emerging while cutting your coal that methane and air mixtures can become an explosive.

At that time that your whatever the electric motors being used, if they are not FLP struts that is enclosure, that is flame proof enclosures and all the circuits will have to be intrinsically safe. So, it must be following the DCMS circular as per our mines act and mines regulations. Please go through the conditions how that is exactly approval from DCMS will have to be taken for the flame proofness of the all electrical enclosures and the circuit must be intrinsically safe.

And then there should be, while you need to see that they fall; that is why loading and unloading at that places, there should not be any dangerous.

(Refer Slide Time: 23:48)



Similarly, there will be certain your electrical requirements, where will be the switchbox from where the power will be coming; the power will be coming through a cable, then that trailing cable how it will be handled.

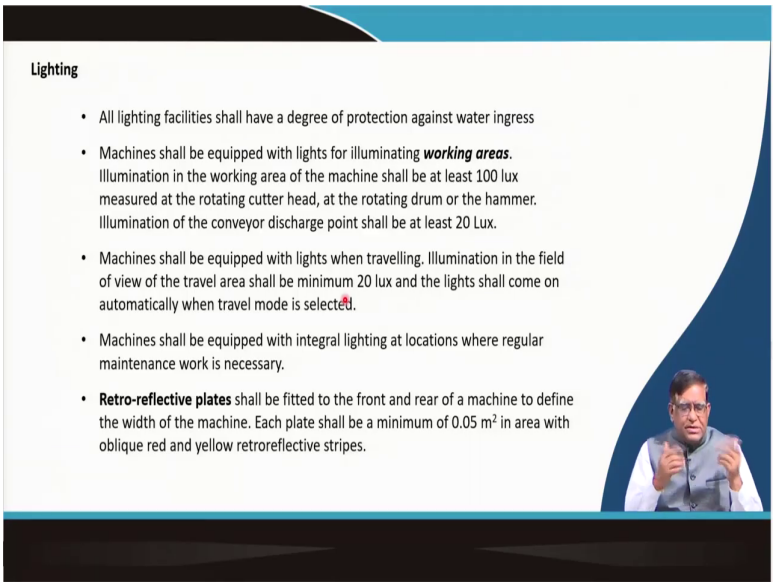
If the trailing cable will have to be reeled on a reel, then at that time whether you have got automatically tensions tension sensed automatic cable drilling is there or not that need to be seen. Then there is a your the conditions that is your the atmospheric conditions need to be monitored that is; if the machines motor electrical system they may go wrong, then that will be giving signal.

Say for example, if the electric motors temperature is increasing, at that time it will have to be taken care of that the cooling system is proper or not and then whether why that thing is

happening that can be investigated. So, that with your, while you are using the electrical system, you follow the instructions very strictly.

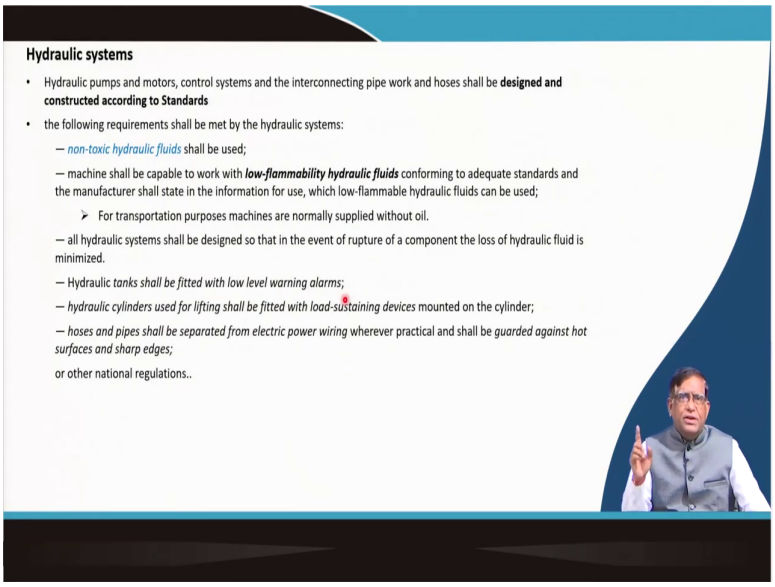
And there is a that particularly there are this transformers, motors and the joints couples that controls need to be properly looked into.

(Refer Slide Time: 24:46)



Similarly, all the lighting facilities shall be also it will be protected against water ingress, because this water if it is coming in the circuit and there could be a problems coming in. So, your type of illuminations as also in our DCMS circular, they prescribe the particular level of illuminations, it will have to have there. And that is why the retro reflective plates which are given, exactly it is not like a mirror reflector that is your; that it should be fitted at the rear side and the front side, so that it can be properly illuminating the sides.

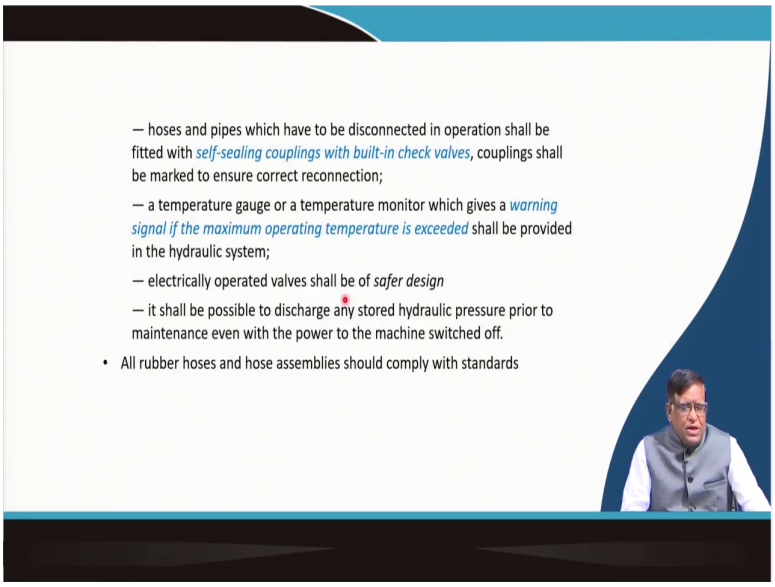
(Refer Slide Time: 25:35)



Similarly, the machines you have got a lot of hydraulic systems, because there are that is your hydraulically controlled that is your motor as well as different actuators are there. So, for that the fluid, it should not be a toxic type or an inflammable type; then the pressure generated, it should be that your all the host pipes should be with the proper specification, so that the under operating pressures and temperature no leak generates and it will be there.

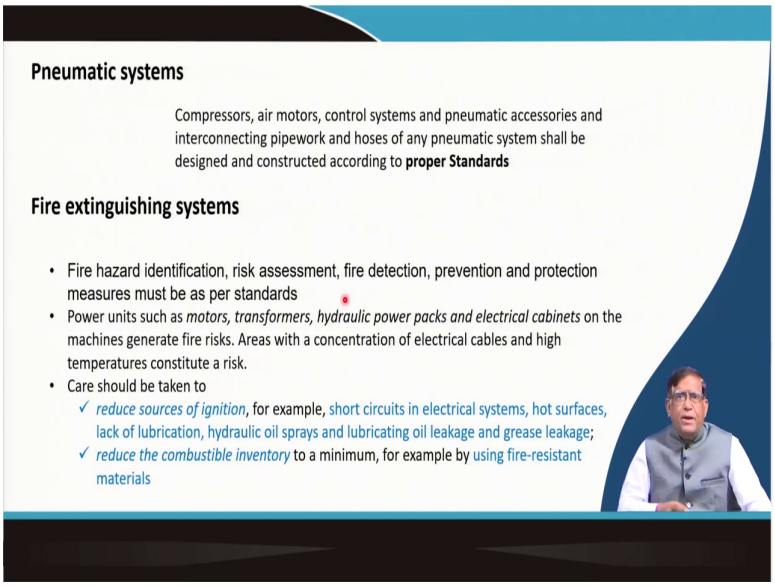
So, all the valves, they need to be also periodically inspected and set, so that they it is a setting type that pressure and a operations it get in a proper manner. So, these hydraulic systems will have to be properly set.

(Refer Slide Time: 26:19)



And then there are the couplings, then the your different gearboxes; how it is connected to the motors this need to be checked.

(Refer Slide Time: 26:34)

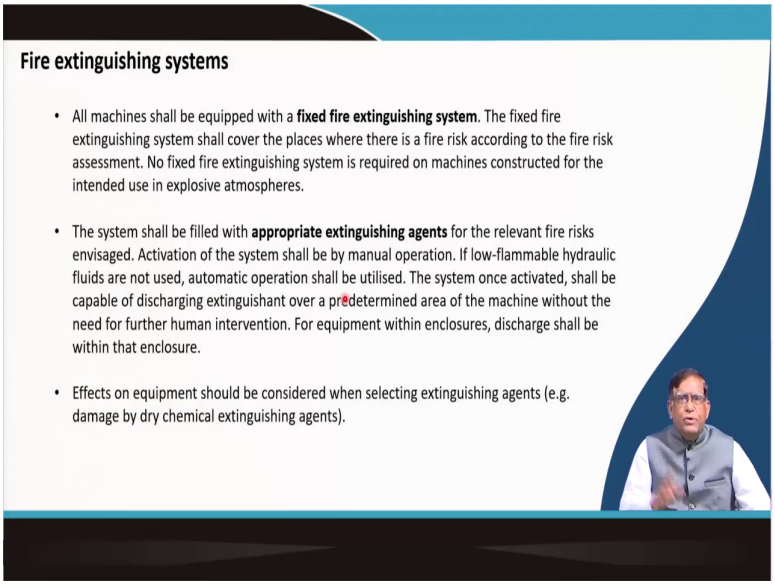


So, that means that safety can be ascertained only by inspecting and operating each and every system properly. Like the hydraulic system there are the pneumatic systems also in this machines, where there are compressors, air motors and control systems. Now, this pneumatic accessories wherever it is used, you need to be seen; because these manufacturers are from different countries, we must see that whether they are following that our Indian standards or not. So, that proper standards must be ensured.

Then in all machines, because they are working in a different situations and under different conditions; if any fire takes place that, then the fire extinguishing systems also should be there. You must take proper care to reduce the source of ignitions; there should not be short circuit or there should not be any hot surfaces, which may be lubricants and all may get spread.

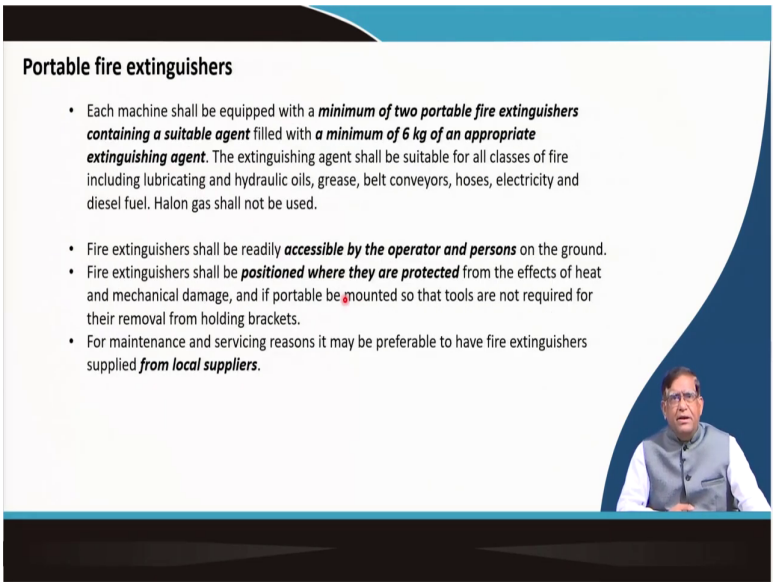
So, that is it's a temperature should not go above the flash points, that need to be very much seen. And also you should see that the machine does not have many combustible inventory; combustible inventory like that the that your the operators seat, it may be having that foam and that leather or plastic type of covers and all that thing, those are. Like that you see in the machine what are the inflammable materials and you must ensure that this inflammable material do not come very close to the sources of heat and fire.

(Refer Slide Time: 28:03)



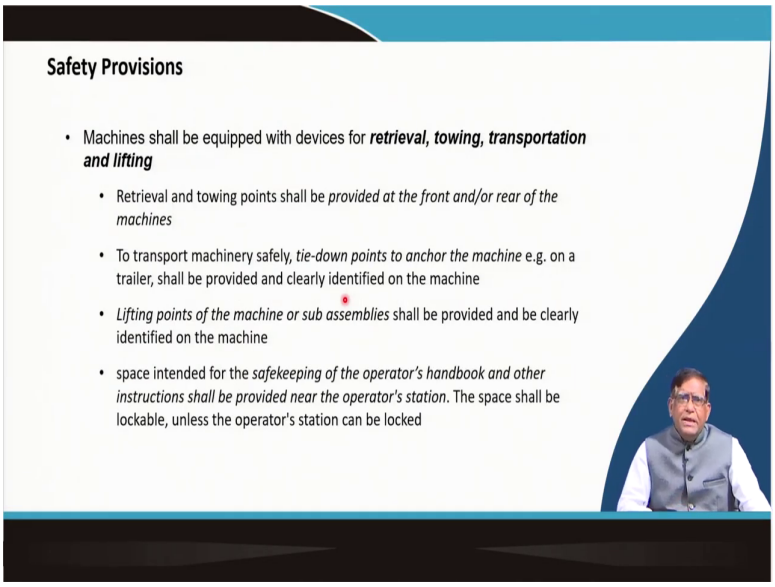
So, and so after ascertaining that, you will have to develop and give some fire extinguishing system, that could be a fixed type of fire extinguishing system. But and that what type of agent you use; that is whether for electrical fire or for the gas fire, you will have to get the fire extinguisher with the proper fire extinguishing as it should be there in the machines.

(Refer Slide Time: 28:25)



Like that you have got the, you can keep some portable fire extinguishers also in the face, so that in any case if the machines any part gets any flame, it can be put.

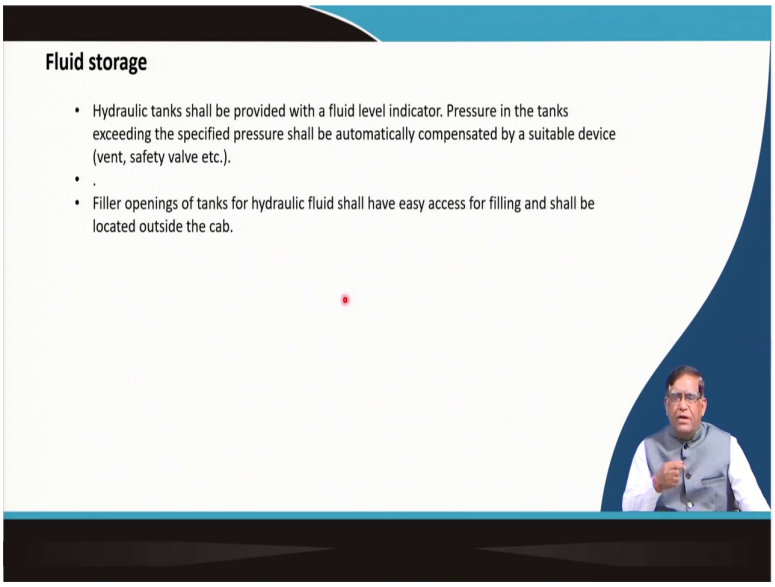
(Refer Slide Time: 28:36)



Similarly, the there are number of other this safety provisions, some devices are there; because if you will have to take the machines away, so there should be proper that lifting. For lifting purposes, there should be the anything how the workers will be carrying these things, so that for connecting rope, for pulling, for towing all that arrangement should be provided in the designing.

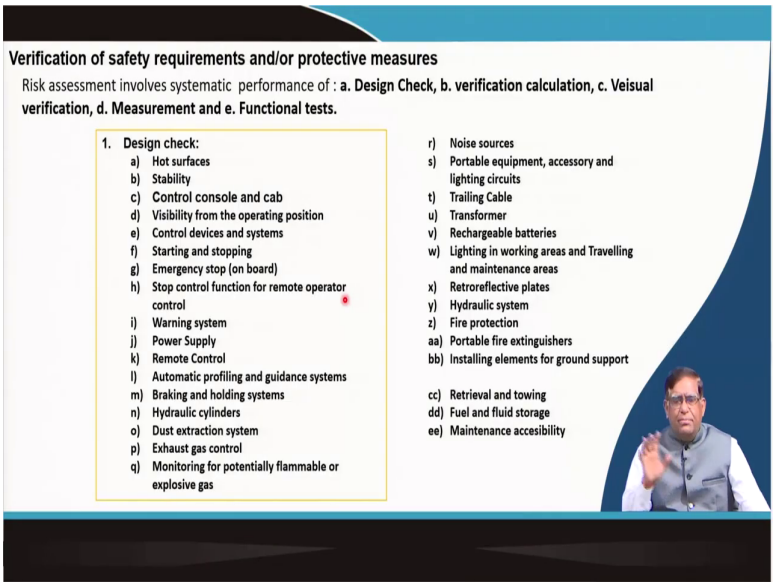
So, that the lifting positions; you will have to see that you can tie in such a way that, the center of gravity is properly maintained, balancing is properly maintained and it can be carried. Because this all will be coming in a modular form, each module will have to be transported to the underground. So, for that, the design must look into those provisions for itss towing transportations or lifting are given over there.

(Refer Slide Time: 29:24)



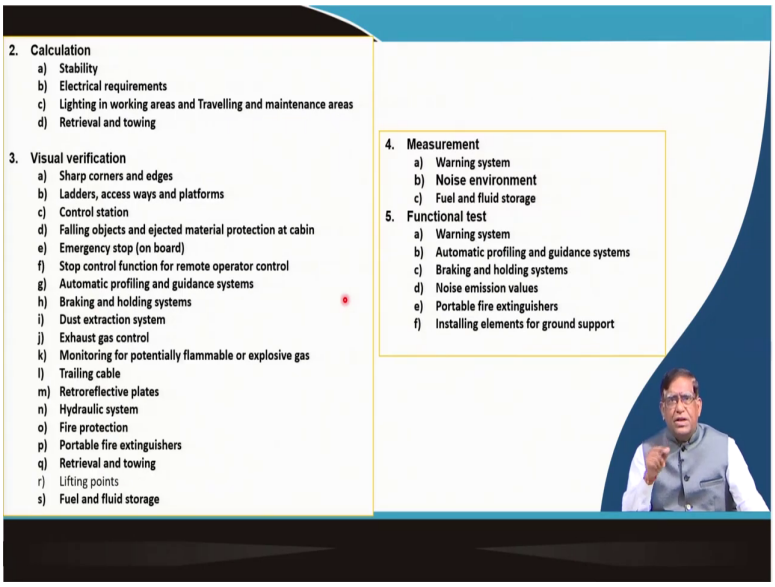
So, there will be this hydraulic fluids and all, so they need to be properly stored in the machines.

(Refer Slide Time: 29:29)



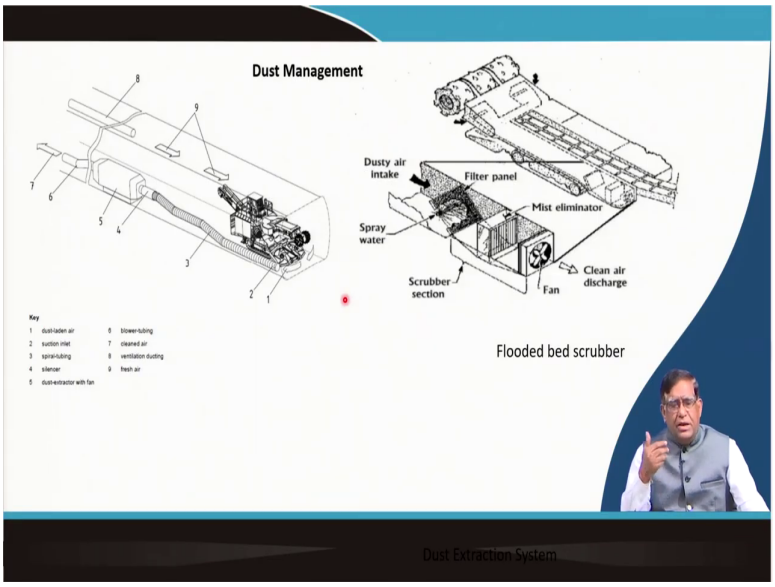
So, whenever you go that the protective measures, there are number of checks need to be there. So, whenever you are going to inspect this machines, make a checklist for that what are the design checks will be doing; like that whether the hot surfaces stability, all the points which I have just said are listed over there. You please make this list and so that you can make a have a point; that if you are going underground to inspect a machines, what are the things to be looked into.

(Refer Slide Time: 29:56)



And then after these verifications, what type of measurements and all how you will be keeping them logged and how you will make a study report that need to be seen.

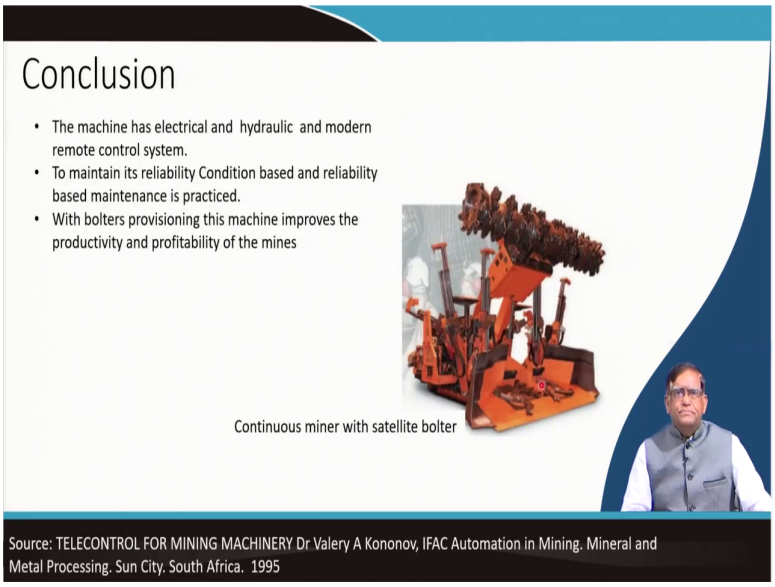
(Refer Slide Time: 30:07)



So, that is what exactly in a machines, most important thing is that dust management. You can see here these two type of dust management over there, that is your the from the dust, flood, and air when it is coming from the front of it; it is going through the suction inlet and then it is going to the spiral that you are tubing, then it goes to a silencers and then it is going to a dust extraction fan.

And then ultimately with that your spiral tubing, it is given to the air; then it is going into the return air, going outside the mines. You can see in these other designs, that is your dust air intake when it is coming over here; a filter panel is there, the water is spread and then there will be a scrubber sections, where this dust flood and dust is collected over here and from the fan that clean air is released. So, this type of arrangements are there in this machine.

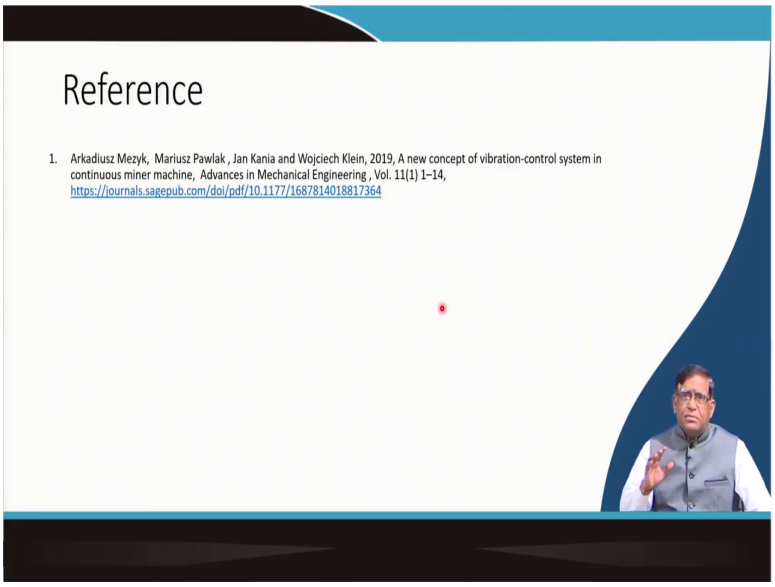
(Refer Slide Time: 31:00)



So, to conclude that this machine has electrical, hydraulic and modern remote control systems; to maintain its reliability conditions, you will have to that all the maintenance and the monitoring should be done in properly as prescribed. And as you can see in this photograph given over here that, machines can be provided with number of roof bolter.

So, that means, that from the machine itself, you can do the roof bolting for the supporting purposes. So, these are the red advances coming up; nowadays the modern advance is coming, how a automated without a operator also these machines can be working.

(Refer Slide Time: 31:39)



So, that you can get a lot of information's about these machines from the different literature; but what is important is to know that, how a continuous miners will have to be selected for deploying in a particular mines, which will have to be compatible with the coal seam, its gradient, its that is thickness, and its cutting properties.

And then you will have to make the total logistics of your hydraulic system, pneumatic system, and that electrical system and then operational control, with that only you can achieve the full out of this machine.

Thank you.