

Mining Machinery
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Module - 10
Lecture - 57
Low Profile Dumper

So, we have been discussing about this mine transports and; So, far we have talked about the in surface mining, in underground mining different machinery used for transportations used for hoisting winding.

So, now another thing you know that, in underground mining most of your transport is a transportation with machinery using trucks or just like your the locomotive or your mine this, rope wells all have got a truck. Now, the and another thing is there.

Normally, those are of mine cars of very small height because the gallery or the space is less. But, you know that in metal mining sector and some of the metal mines are under very competent rock. Now, there you can have a higher sizes of gallery and also the floor is strong enough on which this tire mounted vehicle can move easily.

So, under that condition it is useful to have a truck to go underground for working. But these trucks which are to be operated for transportation of minerals they will have to have this, as a ditchers mechanism. So, that we can have to discharge it fully.

So, they will be either just like your surface mining trucks they can be your area ditchers or bottom ditchers or side ditchers trucks now such type of trucks to use underground they will have to have some special design.

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Low Profile Dumper



Objectives:
Application of Truck in Underground Mining



Low profile dumpers are trucks with 4 wheel drive with articulated steering giving excellent traction and maneuverability in underground mining applications

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So, today we will be discussing about how that what type of trucks can be used and these are called your low profile truck low profile dumper or low profile trucks as you can see here in this figure this is a figure from Uranium Corporation of India Limited mine. Where, there is a mine access or mine entry is through decline; that means, there is no there is no shafts in discussing which you have told that there is a decline means there is a path way roadways are made up to the flow up to the pit bottom.

So, this type of material handling system where you can see this is a truck where that is, height is very less you can see that the material is filled over here. So, sometimes this type of this is a truck you can see here a truck with your, the truck body. This body has got up to a low below this even the axial level of here this truck can accommodate material.

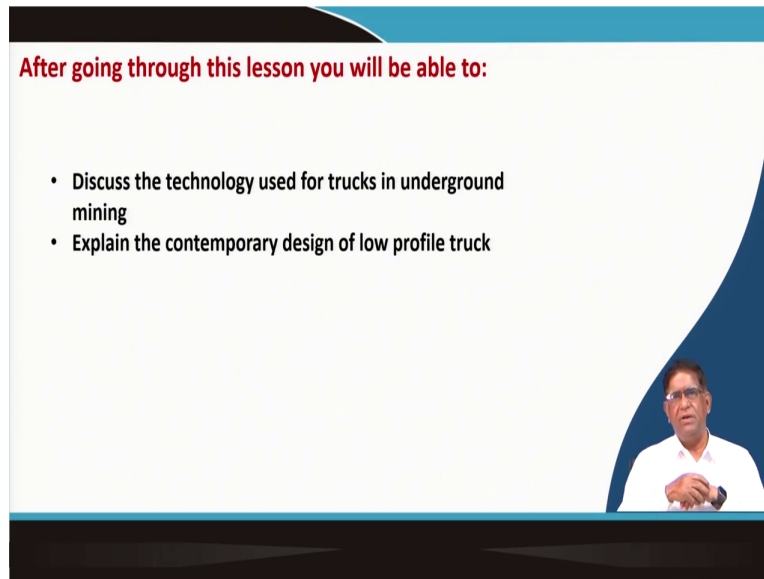
So, that within this short height that required quantity of material up to 20 ton sometimes they carry it. So, these are basically here you can see of course, 6 wheels this is a higher capacity 1, but normally these trucks will be coming with 4 wheels that is and they have got that 4 wheel drive if you are having a 6 wheel there will be a 4 wheel drive 2 rear and 2 front.

That because to negotiate the gradient over there we need to get more power. So, that is why 4 wheel drive and then they have got the articulation articulated truck you have studied in surface mining 4 maneuvering in smaller or restricted space. So, that is why it is an articulated type and then, they should have a proper tractions in underground conditions even in underground mine there will be a lot of seepage of water may be there from the this rocks underground water may seep into the floor.

So, that is why there will have to have a proper traction. So, the tires will have to be of special design should have they have the grip and they can do it over here and for this type of truck it is a low profile or low that is low profile truck.

So, it is clear to you that low profile dumpers are used for underground mining where you do a trackless mining transportation by a truck which is by more or less the same principle same thing is there as a, the as they.

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After going through this lesson you will be able to:

- Discuss the technology used for trucks in underground mining
- Explain the contemporary design of low profile truck

So, after this class you should be able to discuss that, What are the technology used in this trucks? Which are being used in underground? So, I tell you that they could caterpillar that they are latest designs or very very this technology say be very easy to and good to maintain and to get better capacity utilization they are being used. Similarly, Sandvik is a Sandvik has also got a low profile dump truck.

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Caterpillar models



AD22: ENGINE MODEL-CAT® C11
GROSS POWER - SAE J1995 = 242 KW
NOMINAL PAYLOAD CAPACITY = 22000 KG

AD30: ENGINE MODEL-CAT® C15
GROSS POWER - SAE J1995=305 KW
NOMINAL PAYLOAD CAPACITY = 30000 KG

AD45: ENGINE MODEL-CAT® C18
ENGINE GROSS POWER - ISO 14396 =447 KW
NOMINAL PAYLOAD CAPACITY =45000 KG



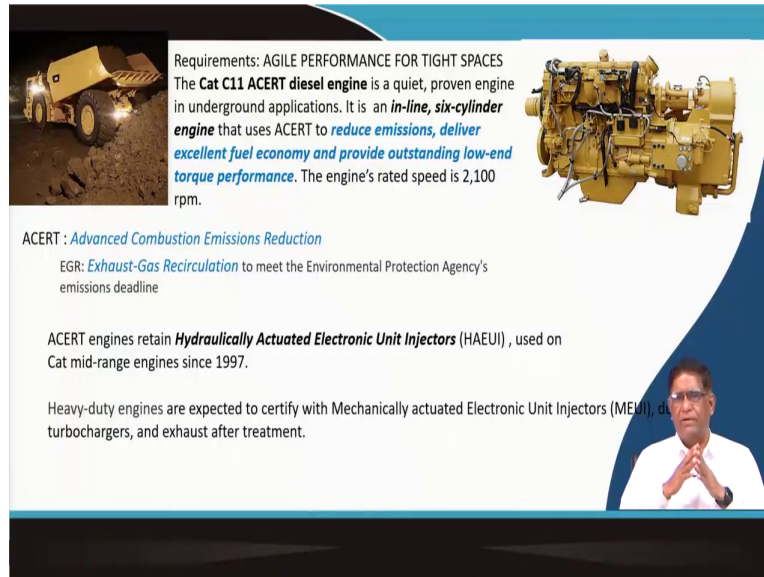
So, those are used in this. So, you can see this caterpillar models they have got this AD22, AD30 and AD45. These are depending on exactly on the capacity. These are the series basically, the technology wise they are more or less same only the selection of the engine and selection of the that size for the size; how the body is made?

That is where and the dimensions change, but the basic principle of operations are same. So, you can see here that is when AD45; that means, it can go up to 45000 that is 45 ton capacity trucks whereas, this AD30 means 30 ton capacity trucks AD22 means the smaller one of 22 ton capacity trucks.

So, the power rating also you can see here, that is your from 242 kilo Watt to 447 kilo Watt so; that means, you need to get some very strong engines in these machines. So, now when we see that

this basically this the truck you will have to have the proper agility proper maneuverability and proper strand and the robustness.

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Requirements: AGILE PERFORMANCE FOR TIGHT SPACES
The **Cat C11 ACERT diesel engine** is a quiet, proven engine in underground applications. It is an **in-line, six-cylinder engine** that uses ACERT to **reduce emissions, deliver excellent fuel economy and provide outstanding low-end torque performance**. The engine's rated speed is 2,100 rpm.

ACERT : *Advanced Combustion Emissions Reduction*
EGR: *Exhaust-Gas Recirculation* to meet the Environmental Protection Agency's emissions deadline

ACERT engines retain **Hydraulically Actuated Electronic Unit Injectors (HAEUI)** , used on Cat mid-range engines since 1997.

Heavy-duty engines are expected to certify with Mechanically actuated Electronic Unit Injectors (MEUI), diesel turbochargers, and exhaust after treatment.

As we discussed in our earlier the discussions also that what are the basic characteristics of mining machinery that will have to be there. So, unlike your ordinary truck here, they will have to have a strong power source. So, that strong power source is the engine. So, whenever you think of a truck selecting a truck for your mining operations you will have to first consider that, what type of engine is to be used.

So, this is there for the smaller machines like your AD22 this is a six-cylinder engine and they use this is a advanced technology particularly caterpillar they have developed their engines quite a lot. Exactly they it is 1990's when this engine started getting developed in a totally new directions because this electronics applications came into the applications to serve this engine manufacturer.

So, what is the specialty of this engine they are called as an ACERT engine; Advanced Combustion Emission Reduction. That is you know already that nowadays there are lot of restrictions and you have got this Bharath 2, Bharath 3, Bharath 4 like that Euro 2, Euro 3, Euro 4 this standardizations of the engines basically based on that their engine exhaust that should not have lot of greenhouse gases or this in underground operations it is very very important.

Because in underground you are working with artificial ventilations there is no air. So, in that air the percentage of carbon monoxide, carbon dioxide, nitrous oxides if they increase it will be very unhealthy for the miners.

So, that is why whenever you are going to take a low profile dumper for underground usage your engine will have to be selected. So, that there engine exhaust standards are maintained. So, that they will have to have a reduced emission and at the same time that fuel economy; it is one of the most important thing that is your you are spending this that is a operating costs and we will have to keep it minimized by getting maximum kilometer ton kilometer from the per liter of fuel burnt.

And then, what is the most important thing whenever there is a high gradient or there is a the sensor more rolling resistance at that time it will have to provide a good torque. So, that robust engine for this there is a this new system of advanced combustion emission system this exactly first in 1997 most probably.

This caterpillar introduced this machine in which they introduced this hydraulically activated electronic unit injections. Sometimes they said it is a hydraulically actuated that A is not written. Normally, it is said H E U I HEUI, H E U I that A will not be there that is exactly Hydraulically Actuated Electronic Unit Injector. That is you know in your car or in any ordinary the truck you have seen that there is a fuel injection system.

In the fuel injection system what is there from the crank shafts that you are taking this engines speeds from there you drive a cam and that cam and the cam follower that exactly used to open and close a valve in your study of I C engines you have seen that. But, that does not give you a

control on how much what is the fuel rate and also the for a multi cylinder engines they that your fire firing sequences this is also controlled by your opening and closing of that valves.

So, there in when you are using a cam system like in any ordinary engines it does not give you the freedom that whenever there is a different load you will have to put as much exactly the required fuel. So, that is where exactly the innovators started in 90's.

It is end to the end of 80's people started thinking of that how exactly the fuel injection system can be improved; and that is why, the new technology came in this fuel injection and if you study in your I C engine deeper you say that is your railways system by which that exactly fuel is injected there this hydraulically actuated electronic unit injector type of fuel injection system came.

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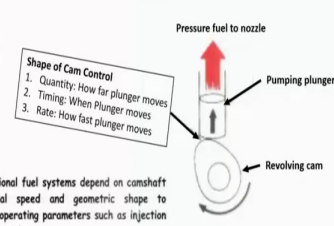
The use of hydraulic force to pressurise fuel for injection in 1990s was invented to make diesel engine more cleaner, powerful and efficient. The **Hydraulically Actuated Electronic Unit Injectors (HEUI)** use highly pressurized engine lubrication oil to drive plungers pressurizing fuel for injection. Prior to this invention fixed geometry camshaft profiles were used for fuel injection. HEUI enabled pressurize fuel independent of engine speed.

HEUI enabled varying injection timing and fuel delivery rate.

For optimal fuel performance and emission quality injection timing and fuel delivery rate must vary with:

- Load
- Coolant and air inlet temperature
- Inlet boost pressure
- Vehicle speed
- Atmospheric pressure

Conventional fuel systems depend on camshaft rotational speed and geometric shape to control operating parameters such as injection pressure and rate.



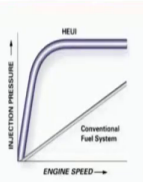
Pressure fuel to nozzle

Pumping plunger

Revolving cam

Shape of Cam Control

1. Quantity: How far plunger moves
2. Timing: When plunger moves
3. Rate: How fast plunger moves



HEUI

Conventional Fuel System

INJECTION PRESSURE

ENGINE SPEED

HEUI fuel systems can develop injection pressures independently of engine speed.

Now, the mechanically actuated that cam system is now removed over, here say as you can see normally what is there is a revolving cam is there which is connected to a cam follower and this ones will be this cam here this is driven taking the drive from the by a you can take by a bell drive or send drive or you can do a cam follower to drive with the from the crank shaft.

Now, this will be when it will be going up here this will this plunger will push this fuel into this one the valve will open and that fuel will go in. But thing is that here, this how that mechanical shape of this cam they determines at how far the plunger will move? Because, this plunger it will be moving say when it started connecting to the plunger from this height and then it has pushed up to here.

So, this plunger motion that will be exactly determining how much fuel will go? And then this shape also will determine that because it will take a rotations over there and after that how much time it will take that will be exactly telling when this plunger will be injecting or how that is your that cam is controlling everything and then the how fast the plunger will move? Depending on that exactly what speed it is coming all these things will determine the rate.

So, now, in a conventional fuel system that depends on this cam shaft rotational speed and geometric shape to control operating parameters for that injection pressure and the rate. Now, this use of this hydraulic force now if we can instead of this mechanical force if we can use hydraulic force to pressurize the fuel injection this what they do? That developed that you can give the diesel engine more cleaner and powerful and efficient.

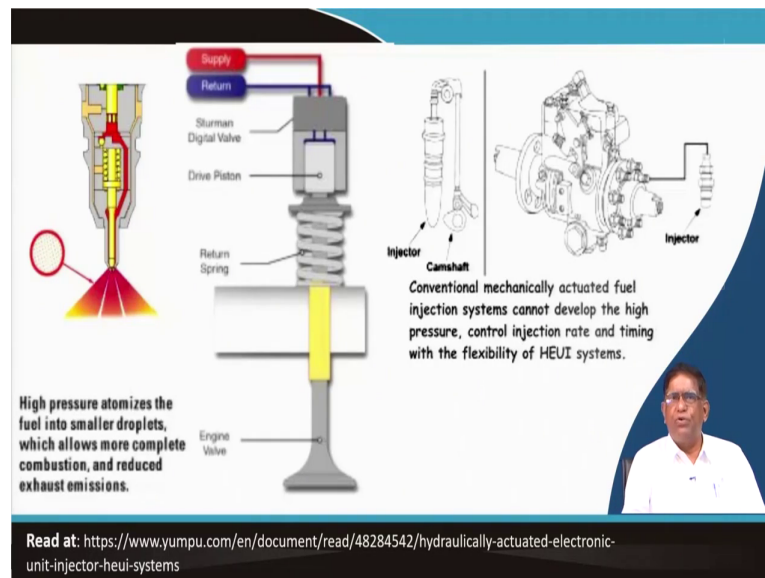
How because you can give that fuel at if the rate you want to if, you can monitor that what type of load is coming if you can have a good electronic system to sense it then you can control this fuel and there came this hydraulically actuated electronic unit injector type of fuel pump came in. And what they do they exactly take the lubrication oil which is there they pressurize it with a that is oil pump and that pressurized fuel is used to exactly push the oil or that pump the oil to the your engine block.

So, that means, all this mechanical system are cam in cam full work will be eliminated, but you can electronically sense what is the load coming what is the coolant and air inlet temperature what is the bush pressures of that air? Which is entering in? What is the vehicle speed at that time? What is the atmospheric pressure under? What condition it is there?

So, that the right amount of fuel at the right time to that is combust with the proper amount of oxygen that can be controlled by properly monitoring and as a result what happens that your engine speed normally your this your injection pressure at which this will be going on it is normally with a speed it increases like this.

And, but with your use of this electronic injector you can do it that pressures you can control and after that it is going that is your steadily. So, this type of arrangements can be made in case of your when you are using this HEUI.

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Now, here another thing is that when this your fuel it is atomized because of this pressure which is coming over there in ordinary when you are having a camshaft from a cam follower it will be operating this valve that this valve will be giving a reciprocating motions here and that injector will release this fuel. But here, what happens because this your with a pressurized fuel you are pumping this at a proper nozzle you can atomize the fuel over there when you atomize it will be giving a better bond.

When better bond means what that is from the same amount of fuel now you get more calorific value that is why the fuel efficient. So, your folder whole work your energy consumption will go less. So, that is why now you are not having in this new system that in low profile dumper or in many modern dumper you will find that there is a instead of this cam follower and all that thing

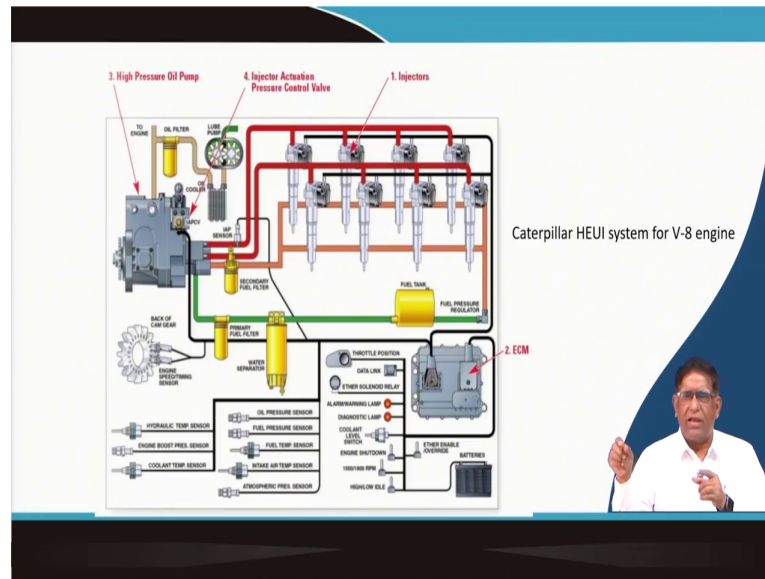
you are having a total hydraulic pump mechanism from here from here there is a oil is injected to that and from there that oil injections takes place.

So, I think now it is clear to you that how exactly such type of system will work. So, there will be a supply your fuel supply will be coming which will be here, but that there will be that your this oil which will be coming that oil will be a pressurized oil will be coming over here and it will drive this piston which will be exactly pressurizing this is the valve opening to the engine cylinder where the fuel will go.

So, this oil high pressure lubricating oil they will make a circuit over here and this is a they will not get mixed with the fuel oil and then your only the whole thing this when that this pressures is generated over here by that pressurized high pressurized lube oil and they will press the spring; and that spring movement will give you the total pumping things.

Now, as because this is by hydraulic pressure and you know that hydraulic control is the best control there you can exactly that velocity and pressure can be easily very smoothly controlled. So, that is why how much the spring will get pressed depending on that the plungers their velocity that work flow rate and the pressure can be controlled.

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So, this is the way how this fuel injection system comes and if you see in the total truck in that how it is there say there is a 6 cylinder or 8 cylinder in a higher size in a 30 tonner there will be up to a 8 cylinder engine you can see in that 8 cylinder engine how the fuel is being coming from there.

So, you can see here that is your main your, oil pump gear pump is there this is exactly pumping that from a that after through filtering they are giving this oil over here and that oil under pressurized it will be going over here and then that will inject the fuel over here.

So, this is how that circuit it works exactly? And there number of sensors are there you can see here there is a your electronic control module this electronic control module they will be having lot of this engine data get collected.

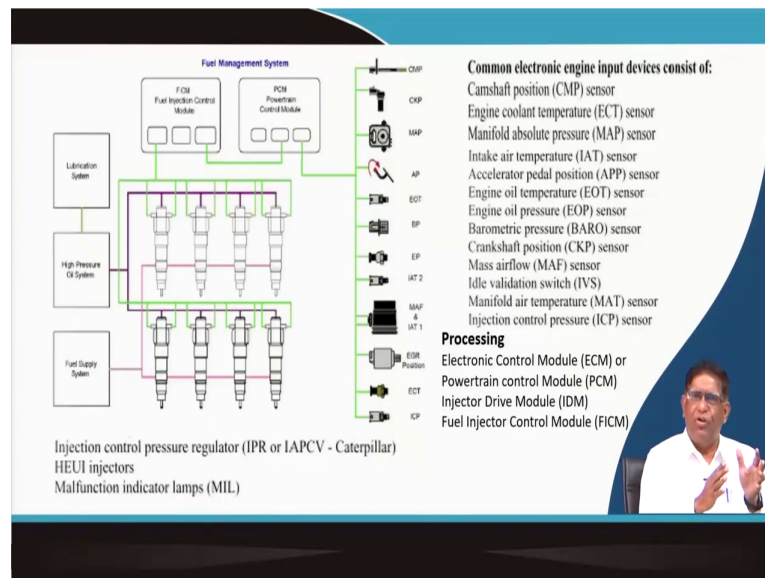
So, that is what will be the total position that how exactly will be fueling that there will be a data link; there will be either solenoid relay that how the relay will be operating their different diagnostic lamps will be there then coolant level engine shut down conditions whether it will be done or not that this levers can be actuated either by manual or by these things.

And then, there will be a hydraulic temperature sensor, there will be engine boost pressure sensor, your coolant temperature sensor, oil pressure sensor, fuel pressure sensor, that fuel temperature sensor, intake air temperature sensor atmospheric pressure sensors all these sensors data that are being brought into this module and then from there it can be transmitted to the manufacturers of that is exactly if it is coming from Japanese machines were working in India. But that truck every truck their whole data can be transferred over there and we can get it how that engine and work.

So, many of you when you are talking about that artificial intelligence you use you want to do a machine learning, but those are exactly how it were done I am telling you in the 90's 80's and 90's. So, do not think that exactly the today's this the computer the world words, those are exactly used in the mining industry and the mining machinery manufacturers in the 80's. When we were student at that time, it itself the studies of this type of systems for mining machinery were being studied and they were implemented.

And now, you can see here this data still in our industry are not taken up by the mine manager for controlling only now with the some of the manufacturers their help it is being done; and exactly this control systems all are not in our curriculum we do not study, but it is high time now that a control of this as well as how this sensors data will have to be used will have to be studied by you.

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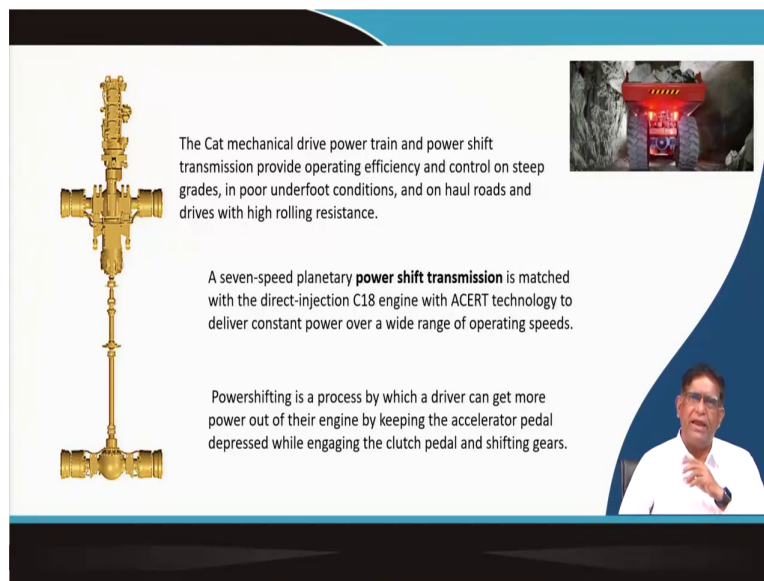


So, that is why I just want to tell you, that this sensors that is our data driven decision making will be very very important for technology management in the mines. So, just to give you an introductions only I have said that as that your injector fuel injectors it has got this tree systems here you can see that lubrication oil at a that a it is coming with a as a high pressure system and there is a fuel supply is coming and then that fuel injections part will be there.

So, that this fuel will be injected over here and then with the high pressure oil system that fuel will be injected that whatever has been said as a technology and you can see what are the different sensors there. So, everyone of you who are doing your B.Tech project or any term paper and all just considering anyone of the sensor how it is data is taken and that how this data is monitored and then or a little bit how all these sensors data can be integrated and then from there how a decision making could be done those exactly.

Now, today's operation research will be having a different directions with the sensor driven. So that, that data analytics part will be coming. So, it is just the real analysis will be there with your technology knowledge only, but if you are just telling therefore, the calculation and statistical purposes if you know are or any other thing that will be helpful.

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The Cat mechanical drive power train and power shift transmission provide operating efficiency and control on steep grades, in poor underfoot conditions, and on haul roads and drives with high rolling resistance.

A seven-speed planetary **power shift transmission** is matched with the direct-injection C18 engine with ACERT technology to deliver constant power over a wide range of operating speeds.

Powershifting is a process by which a driver can get more power out of their engine by keeping the accelerator pedal depressed while engaging the clutch pedal and shifting gears.

But, your that technology part must be understood. So, now, we have seen here also another truck you can see this is a Sandvik truck. I am just showing this figure to see that this is the trades that is your the this dumper the this dumpers tire that is very very important.

When you are using in underground and with the type of grip will be coming I have told you in the discussion with the dump truck and that tires that this it itself also a area where a detailed study and a very the specific study need to be carried out, but one thing is there this particular thing I

have discussed in your in other machines here only just you recapitulate. What is called your power transmission?

Now, here you can see that the differential and then from here it will be going to the final drive where here, you are having this whole transmission part transmission systems over here with a your propeller shaft material is coming over here.

So, this mechanical drive power train or it is a power shift transmission. This word I think is also know to you power shift transmissions; it is exactly your with the fuel injection systems your things are moving and then, how exactly you are engaging the gear box that clutching and declutching; that is what is done by a power shift transmissions? That exactly when you are putting your accelerators down at that time how you are changing the gear from one to the another.

This power shift it is a process by which the driver can get more power out of their engine by keeping the accelerator pedal depressed while engaging the clutch pedal and shifting gears. Now, this is what is done and manually in a mechanically done your this power shifting transmissions with the sensor driven you what is read about this automatic transmissions you have got the modification of it.

I am just telling you, that these are don't think that these are very high and that uncontrollable that technology there are of course, that detailed design and now we will be taking lot of time the mechanical engineers do it. But, there is a no bar that a mining engineer cannot go and investigate and study it for the better use in the mining industry.

In fact, some of you that as a mining engineer you should study this in detail. So, that new technology can be applied in a better way into the mining industry.

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Advantage of Low Profile Trucks

- Narrow size enables operation in headings as small as 3x3 meters
- Excellent payload capacity reduces the need for additional trucks
- Ground-level daily maintenance enables safer servicing
- Optional ejector box for tight backfill haulage

Sandvik

All Sandvik underground mining trucks are designed to operate fully loaded and at high speeds on long spiral haulage ways with up to 20% gradients.

Technical data	
Dimension (L-W-H)	9.1 x 2.2 x 2.4 m
Capacity	20 metric ton
Weight (operating)	22,600 kg
Engine power	240 kW
Speed (loaded)	28 km/h



Now, why this low profile trucks are used that their main advantage is they are exactly narrow size enable operators in heading as small as 3 by 3 meters small gallery size they can work and they have got excellent payload capacity and reduces the need of additional truck is not needed here.

They can be instead of your mine cars and all if you are bringing in locomotive lot of other things are there lot of operational arrangements are there and flexibility is not there, but if you use a truck you can go drive and take it out and then this maintenance and all can be done very easily at your surface maintenance stations.

And then, in the that your truck that there could be a ejector type of hydraulic arrangements for evacuating the things can be there. So, just like that you can see it is a it this is only by that a rear

ditches dump truck that is Sandvik's model in which there up to 20 ton 20 ton 20 ton capacity trucks are used over here.

So, engine also you can see here 240 Kilowatt engines using and you can achieve up to 24 28 Kilo meter per hour can be obtained.

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BRAKING SYSTEM

The oil-cooled braking system delivers reliable performance and control in the most extreme underground mining conditions. The integrated system combines the service, secondary, parking brake and retarding functions in the same robust system for optimum braking efficiency.

OIL-COOLED MULTIPLE DISC BRAKES

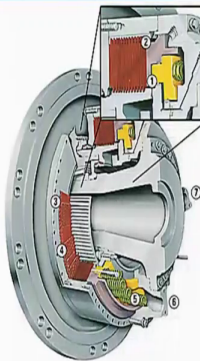
Four-wheel, forced oil-cooled, multiple disc service brakes are continuously cooled by a water-to-oil heat exchangers for non-fade braking and retarding performance. They are also completely enclosed to prevent contamination and reduce maintenance.

AUTOMATIC RETARDER CONTROL (ARC)


Electronically controls retarding on grade to maintain optimum engine RPM and oil cooling. Additional braking may be applied using the manual retarder or the brake pedal. ARC also allows the operator to maintain optimum engine speeds for faster downhill hauls and greater productivity. The ARC automatically activates when engine speed exceeds factory preset levels.

SUPERIOR CONTROL

Automatic brake modulation offers a smoother ride and greater control, allowing the operator to concentrate on driving.



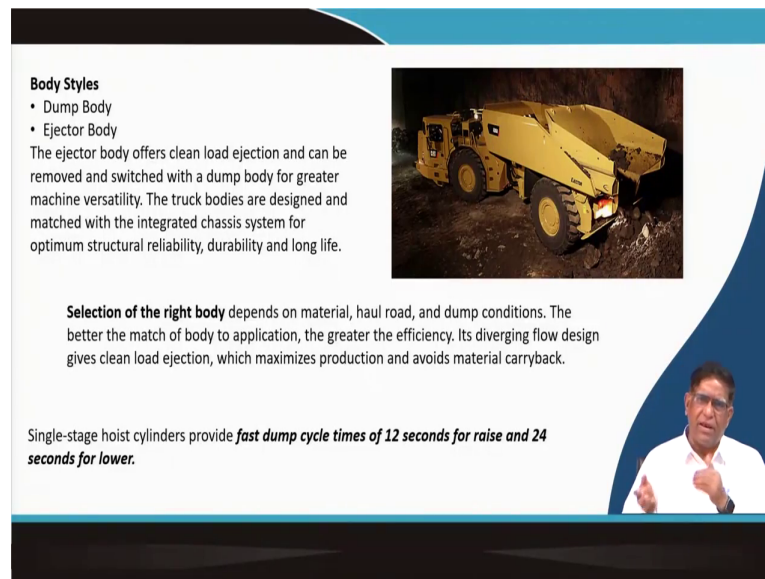
1 Parking/Secondary Piston
2 Service/Retarding Piston
3 Friction Discs
4 Steel Plates
5 Actuating Springs
6 Cooling Oil In
7 Cooling Oil Out



Now, in such type of machines when it will be working in a gradient working in underground and then where movement is where that your braking system should be very very good and there you can say that there are different type of brakes are there your mainly a parking brake and then your operational brake and that the how that brake is operated you have studied these things in our machine elements class.

I request you that please once again go there and read those items that what is a how the oil cooled multiple disc brake work. So, there is a automatic retarder control is there in all low profile trucks and then ultimately the brake operations is to give a very good operational control and as I was telling you about the dump body you can see here this body can be pushed why and then it can be take that is a ejector type of dump body is there.

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Body Styles

- Dump Body
- Ejector Body

The ejector body offers clean load ejection and can be removed and switched with a dump body for greater machine versatility. The truck bodies are designed and matched with the integrated chassis system for optimum structural reliability, durability and long life.

Selection of the right body depends on material, haul road, and dump conditions. The better the match of body to application, the greater the efficiency. Its diverging flow design gives clean load ejection, which maximizes production and avoids material carryback.

Single-stage hoist cylinders provide **fast dump cycle times of 12 seconds for raise and 24 seconds for lower.**

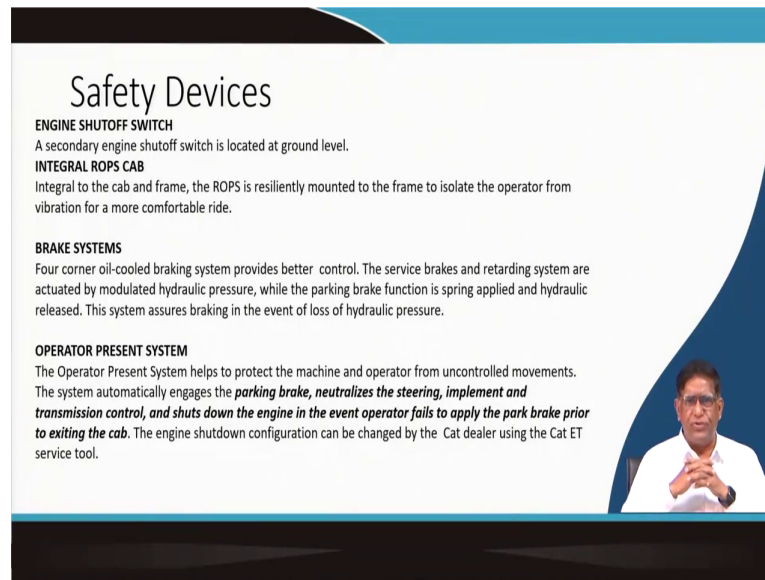


So, this 2 types of one is your just dumping by the rear ditchers and another is by ejector type of things are there and then for a operations you will have to select the body depending on the density of the material how much will be taken over there; and then, this exactly the that how it will be evacuating on the basis of that it is cycle time will also depend.

That depending on the capacity what type of loader you are using front end loader or this your load haul dump whatever is exactly loading this equipment. And then at the time of evacuation all these

things is required to calculate the cycle time which exactly, determines the your factor of that your capacity or productivity utilizations.

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Safety Devices

ENGINE SHUTOFF SWITCH
A secondary engine shutoff switch is located at ground level.

INTEGRAL ROPS CAB
Integral to the cab and frame, the ROPS is resiliently mounted to the frame to isolate the operator from vibration for a more comfortable ride.

BRAKE SYSTEMS
Four corner oil-cooled braking system provides better control. The service brakes and retarding system are actuated by modulated hydraulic pressure, while the parking brake function is spring applied and hydraulic released. This system assures braking in the event of loss of hydraulic pressure.

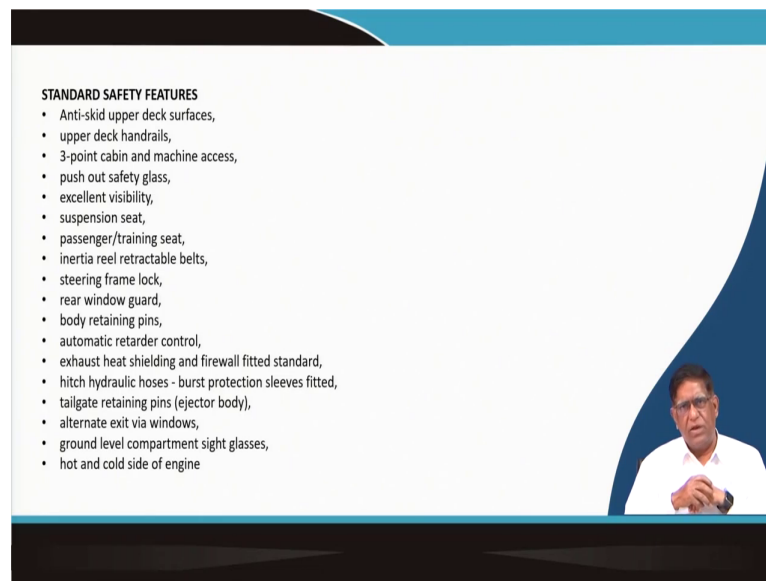
OPERATOR PRESENT SYSTEM
The Operator Present System helps to protect the machine and operator from uncontrolled movements. The system automatically engages the *parking brake, neutralizes the steering, implement and transmission control, and shuts down the engine in the event operator fails to apply the park brake prior to exiting the cab.* The engine shutdown configuration can be changed by the Cat dealer using the Cat ET service tool.

Then the safety devices there are different type of safety devices available here that is for the engine shutoff switch that is exactly that is a secondary engine shutoff when if it is not (Refer Time: 28:12) at the time of when you need to control. Then there will be the ROPS they say that is your that is your roll over protections structures.

That operators cabin it should be that is ROPS and then ROPS the 2 types of that protections on the that operators cabin should be there the brake system is on safety devices then sometimes that is exactly the machine will automatically get stopped if there diagnosis that the operator is not there on the seat.

If, the operators stand then, automatically the machine engine is shutoff that is how a operator present system is there. So, it is the they apply the parking brake then utilize the steering system that you cannot do a steering and that whole thing that exactly the if, the that is if the operator is not there is accidental movement of the that machines or the vehicle will be stopped.

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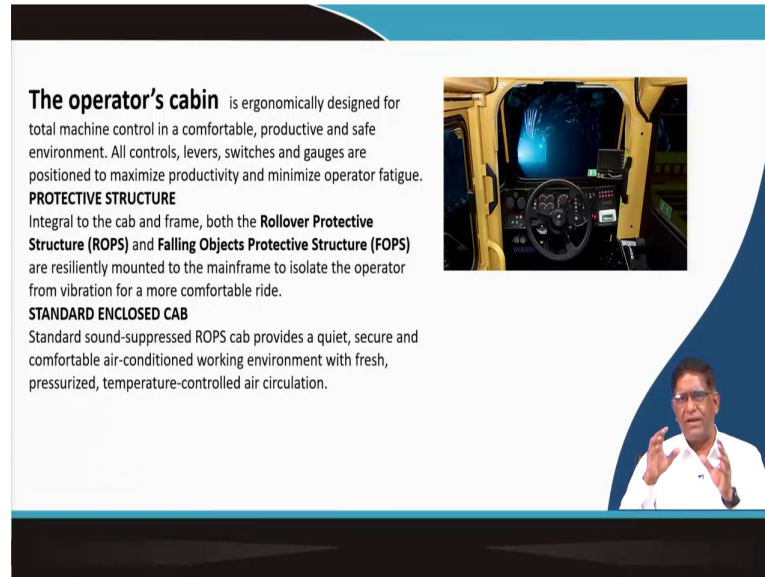


So, this type of safety devices are there other standard safety features like anti skid upper deck surfaces upper deck handrails 3-point cabin machine access then push out safety glass excellent visibility suspension of seat that your passenger training seat inertia reel penetrable belts all those features are there

So, normally what I request you, please go through the this, manufacturers leaflet us and then identify particular word and then on that you make a detailed study and prepare a your own study note. So, that here also a tailgate retaining pins. Now, what is a tailgate that is again; that means,

while you are going in a up the gradient material should not slide down and fall from the truck that is why at the back of it there will be a tailgate system.



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The operator's cabin is ergonomically designed for total machine control in a comfortable, productive and safe environment. All controls, levers, switches and gauges are positioned to maximize productivity and minimize operator fatigue.

PROTECTIVE STRUCTURE
Integral to the cab and frame, both the **Rollover Protective Structure (ROPS)** and **Falling Objects Protective Structure (FOPS)** are resiliently mounted to the mainframe to isolate the operator from vibration for a more comfortable ride.

STANDARD ENCLOSED CAB
Standard sound-suppressed ROPS cab provides a quiet, secure and comfortable air-conditioned working environment with fresh, pressurized, temperature-controlled air circulation.



So, that the material is retained within the truck body. So, that type of safety systems are there the operator's cabin as it said your roll over protective structures ROPS and falling object protective structures. These two are given and that operator cabin is high pressurized. So, that there should not be acoustically treated. So, you will not because in underground metal mine when there are lot of drills and all will be working it will be very noisy.

So, that is why the operators cabin is made acoustically sound there is a active noise controller there inside the equipment that operator's cabin a it senses the noise and depending on the what type of noise wave is coming; it is opposite wave is created and so, that the super imposing you get a neutral noise zone that is created inside the cabin.

Now, there is a all these are standardized by international standard expected standard for this. So, high visibility is there you can see that the glass and all it is maintained in such a way that with underground light and all that system there is a proper visibility of the area.

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COMFORT AIR SUSPENSION SEAT
Ergonomic, fully adjustable suspension seat provides optimal operator comfort. Designed to minimize vertical and lateral motion of the operator. Thick cushions reduce pressure on lower back and thighs. Wide, retractable seat belts provide a secure, comfortable restraint.

STEERING COLUMN
Comfort wheel with tilt steering provides a comfortable driving position, secure grip and greater control.

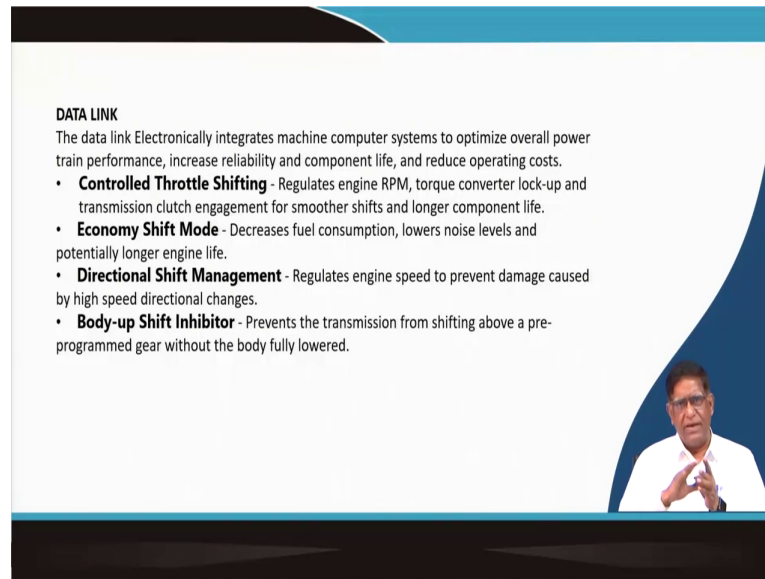
MONITORING SYSTEM
In Cat trucks the Cat Electronic Monitoring System (Cat EMS) continuously provides critical machine data to keep the machine performing at top production levels. Displays are backlit for easy viewing.

CAT MONITORING SYSTEM

Controls serve to comfort

So, it is the comfort air suspension seat steering column and monitoring system all these are very well maintained. So, that means, the in a caterpillar trucks all the monitoring systems are done and it is controlled from the operator's cabin in such a way that while operator is easy to work and he gets warning for his safety as well as operational movement.

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DATA LINK
The data link Electronically integrates machine computer systems to optimize overall power train performance, increase reliability and component life, and reduce operating costs.

- **Controlled Throttle Shifting** - Regulates engine RPM, torque converter lock-up and transmission clutch engagement for smoother shifts and longer component life.
- **Economy Shift Mode** - Decreases fuel consumption, lowers noise levels and potentially longer engine life.
- **Directional Shift Management** - Regulates engine speed to prevent damage caused by high speed directional changes.
- **Body-up Shift Inhibitor** - Prevents the transmission from shifting above a pre-programmed gear without the body fully lowered.

Video inset: A man in a white shirt speaking.

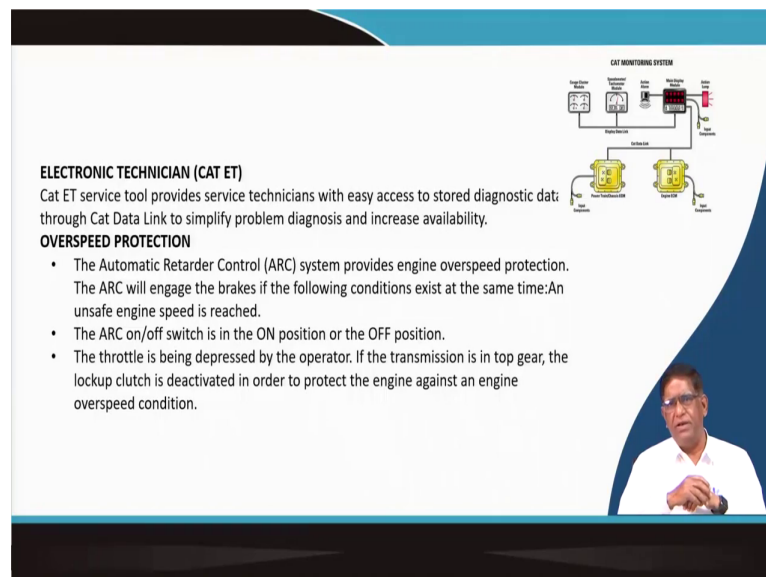
And that is what exactly in a modern truck your all this data link as I showed in from previous figure that is, your data acquisitions system by different sensors are very very important. So, I request you to make a little bit of additional study to find out that what is this controller throttle shifting what is that how economic shift mode; that means, how the fuel efficiency can be obtained by getting the engine data properly and then what will be controlled exactly the how the fuel injection rate is that their pressures and flow rate is controlled by controlling the that your pump up that is pressurizing which pressurizes the loop well to operate the injector.

So, that whole mechanism is not your you need not go to the details of it, but you must appreciate that these are possible. Now, normally that we standardize an operators that manufacturers support team.

They train the people and many a times they take the even the AMC and they do the maintenance, but here is a possibility that we need to go and then developing our efficiency this will be bringing a lot of start up for doing a maintenance operations in the country there will be more than 50,000 55,000 surface mining truck and about 100 to 200 underground truck will be working in India.

And if, there this engine system is to be maintained by a per day it will be having a multimillion dollar business is there for the maintenance and capacity utilization of these machines.

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CAT MONITORING SYSTEM

ELECTRONIC TECHNICIAN (CAT ET)
Cat ET service tool provides service technicians with easy access to stored diagnostic data through Cat Data Link to simplify problem diagnosis and increase availability.

OVERSPEED PROTECTION

- The Automatic Retarder Control (ARC) system provides engine overspeed protection. The ARC will engage the brakes if the following conditions exist at the same time: An unsafe engine speed is reached.
- The ARC on/off switch is in the ON position or the OFF position.
- The throttle is being depressed by the operator. If the transmission is in top gear, the lockup clutch is deactivated in order to protect the engine against an engine overspeed condition.

The slide includes a schematic diagram of the CAT Monitoring System showing components like the Engine Control Module (ECM), Retarder Control Module (RCM), and various sensors. A small inset video in the bottom right corner shows a man in a white shirt speaking.

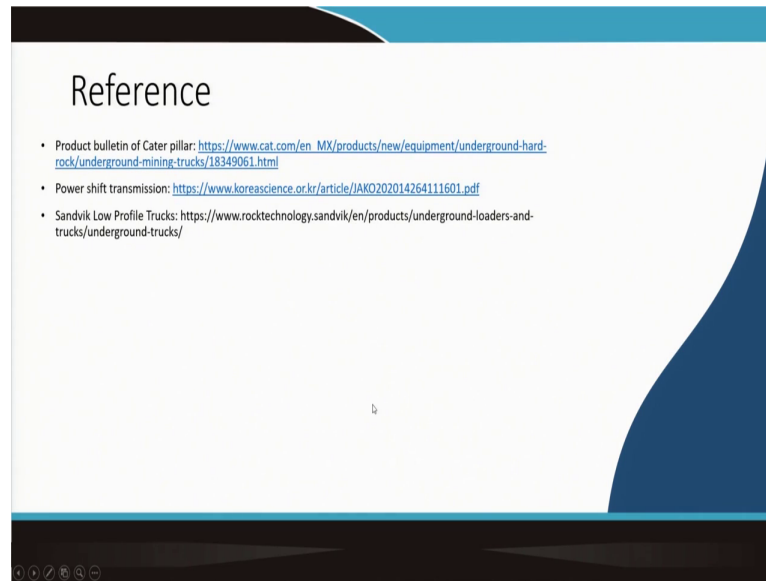
So, that is why then and that maintenance cannot be done without knowing this how the data acquired and then how those components are to be repaired maintained and controlled.

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So, that is another area another aspects which you will have to know. So, in a nutshell today, I have told you about this low profile dump truck and then there you can explain that is as a just like if you know the truck operations here most important thing is the engine and the electronic control mechanism which is coming rest of the things as a mechanical means all things are they are available. So, in metal mining this these trucks are being used. So, if you (Refer Time: 33:56) to see UCIL or Hindustan zinc you can see such type of dump trucks in our mines working.

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Thank you very much.