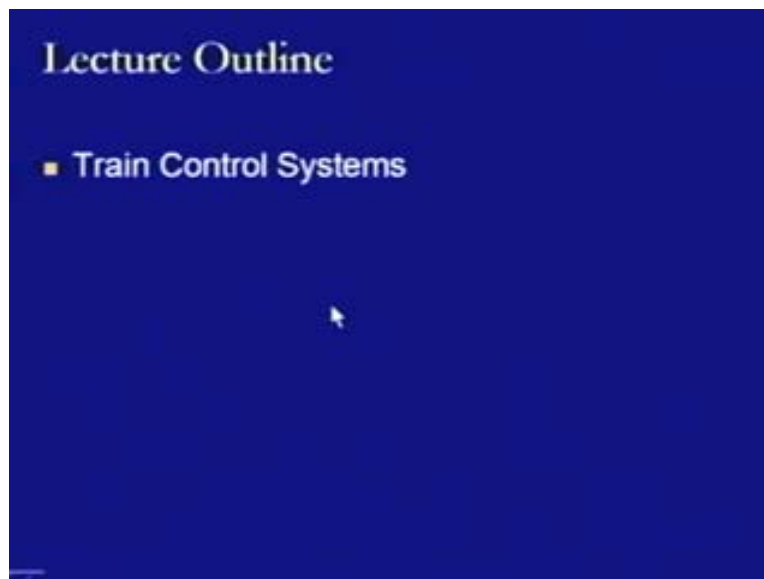


**Transportation Engineering - II**  
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**Department of Civil Engineering**  
**Indian Institute of Technology - Roorkee**

**Lecture – 24**  
**Train control systems**

Dear students, I welcome you back to the lecture series of course material on Transportation Engineering – II. In today's lecture we will be looking at another controlling aspect of the movement of trains on tracks that is train control systems. From the previous two lectures, we have started discussing about this aspect and in the previous two lectures we have discussed about the various types of signals which are used to control the movement of trains on the tracks. So, today's lecture is specifically simply being devoted to only one aspect that is train control systems.

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The single aspect is quite a big one, because it is heart of the overall movement of the trains on the track network and if there is any, at any point mistake is being committed, then this is going to cause serious accident or there will be total disruption of the traffic in any of the direction on which that accident has taken place. So, in the light of that we will be looking at the various types of train control systems which can be there.

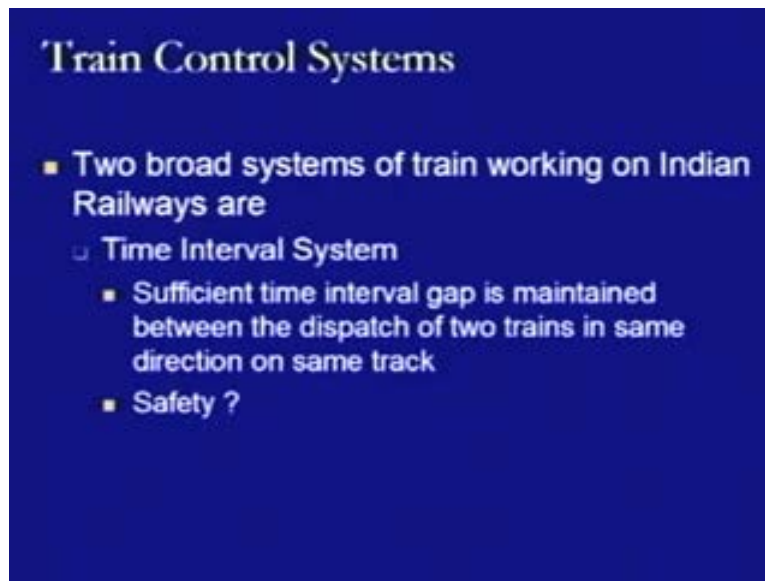
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## Train Control Systems

- Basic objectives of train control system are
  - To allow the operation of trains in either of the both directions
  - To allow the faster trains to overtake the slower trains
  - To ensure full safety of the trains

The basic objective of any of the train control system, whatever is being adopted and implemented on any of the track are: it should allow the operation of trains in either of the both directions, one thing. Second thing is that it should allow the faster trains to overtake the slower trains. Therefore, a mechanism has to be provided wherein the faster trains can approach the slower trains and the slower trains are stopped and the faster trains just over take the slower trains at that place and to ensure full safety of the trains, it is another important thing that is whatever movement is there in terms of their speeds, the one thing which is to be ensured is complete safety of the movement that is the train and the commodities or the passengers who have been moved using that ....

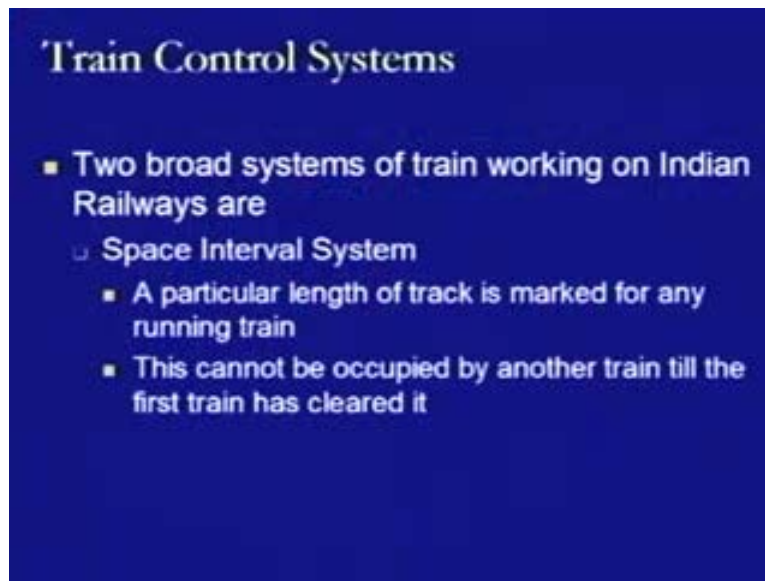
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So, in the light of this thing, then we have to look at what are the various types of systems which can be used so as to operate the trains and the two broad systems which were used for the working of movement of the trains on Indian railways and they are the time interval system. In the case of time interval system a sufficient time is provided or as a gap is provided between the dispatch of the two trains which are moving in the same direction on the same track. So, if one train is being dispatched say for example at 10 a.m, then another train is being dispatched at 11 a.m that is the type of time interval which is being maintained between the movement of the two trains. But then, there is a problem associated with this type of movement depending on the category of the train itself.

If one train which is being dispatched initially is of a slower category and other train which is being dispatched in the following condition is a superfast category, obviously will be having a higher speed as compared with the previous one and then it creates a problem as far as the safety is concerned. Therefore, there is this problem, consideration of safety which has to be given more consideration if you are using time interval system.

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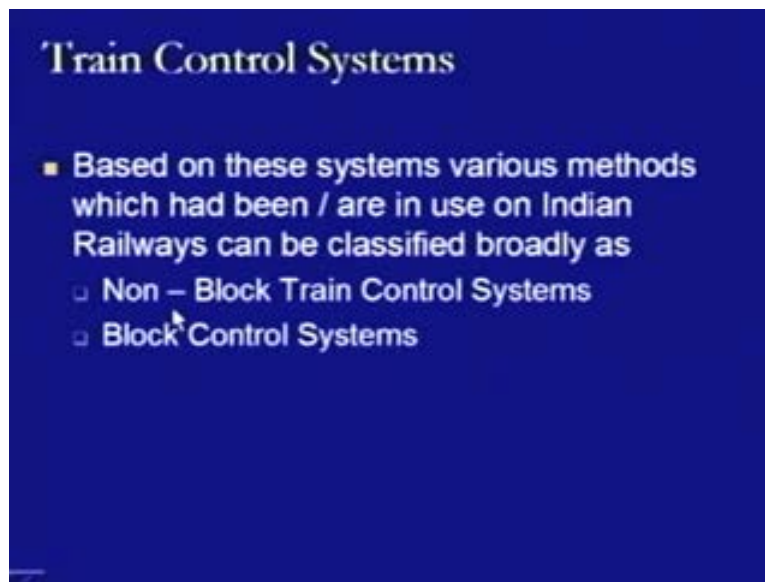


There is another system which we use and that is the space interval system. In the case of a space interval system, a particular length of a track is marked for any running train. So, it is defined that if there is a train which is moving on any track, then the total distance or total length of the track which is devoted for the movement of that train is defined and once it has been defined, then there is no possibility of another train occupying this particular track which is being assigned for another train which is moving in the same direction and the other train which is following the previous train can take that particular section only and only if the previous train has just cleared it and moved into another section.

So, this is what is the space interval system, in which a sufficient space is maintained between the movement of the two trains. In this category again the provisions will be provided so as to overtake the slower category of the train. But then, there are no chances that whatsoever is the condition, whether the train which is following is of superfast or further higher category will not be allowed to come nearer than that particular specified length, which is allowed or which is prescribed as a distance between the movement of the two trains on the same track in the same direction.

So, that is what we have seen is we have two type of systems, broadly. One is the time interval system, another one is the space interval system and now most of the time we are working with the space interval system, though for the convenience of the passengers we have to define that at what times the trains will move. But then, movement of the train at specified time and with the specified speed is decided on the basis of the distance which is to be maintained between the two trains which are moving on the same track. So, therefore as far as the convenience of the passengers is concerned, so that they can understand at what time they are going to have a facility at the railway station that time is prescribed. Otherwise, as far as the intervals are concerned that is space interval system which we are generally working with.

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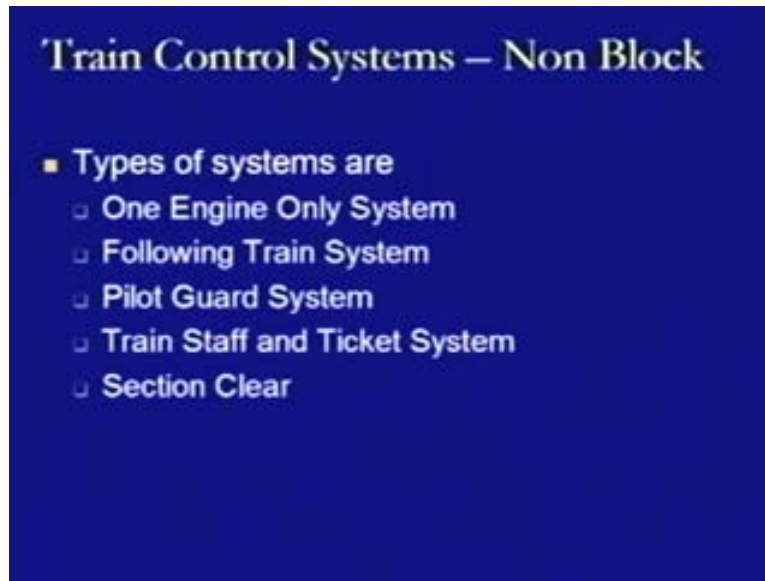


Now, within these cases we are talking about the two types of the interval systems, there are number of methods which can be used and most of all those methods they have been used in Indian railways also and these can be classified broadly as non-block train control systems and the block control systems. These are the two major methods by which we can have the train control systems. So, the difference remains between these two. By the name itself as we can understand that there is something like block and the absence of block in the first case and the provision of block in the next case is the major difference

between these two categories of methods and when we talk about this block, this block is nothing but it is the same space interval which is provided between the movement of the two trains and that is what is termed as block and we will be discussing and understanding that what this block is and how it is utilized in different methods, so that the safe and efficient operation of the trains can be performed.

Now, we start with the one type of category of train control system which is based on non-block system.

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Within these non-block systems, we have further different type of the systems like one engine only system, following train system, pilot guard system, train staff and ticket system and section clear. These are some of the methods which are termed under the non-block category and look why these are termed under non-block category. Because, here we will not be discussing about maintaining a certain distance between the two trains which are moving in the same direction on the same track.

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## Non Block Train Control Systems

### ■ One Engine (or Train) Only System

- There is only one locomotive being worked at a time in the (single-line) section between two stations, or a single station and a spur section of track with no station at the other end.
- One of the two stations at either end (or the sole station if there is only one) is designated the *base station* for the section.

So, we will be starting with the first method of non-block train control system that is one engine or train only system. Now, in this case of one engine or train only system, there is only one locomotive which is available at a particular station and then it is used on a single line section that is being worked at a time between two stations or a single station and a spur section of track with no station at the other end. So, the same one locomotive which is being available to the station that is going to be used on that single line on which it will be moving to another station or will be moving to some number of small sections or stations up to which it has to ferry down or up to which it has to take or carry the passengers or the freight.

Now, out of the stations at either end of these, one of the two stations or the sole station, if there is no other station as such on the whole of the section, is designated as the base station for the section. It means that this locomotive will belong to this station and it has to come back to this station after performing its work. So, that is what is a base station. So, what happens is that as soon as there is requirement of dispatching certain passengers or commodities in certain direction using that particular track, then that locomotive will be taking that much load with it. That is the number of wagons which will be attached to it and it will go up to the point which it is designated and will return back. Now, till this

particular time period, it is not going to be any other operation, because there is no further locomotive which is available.

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So, the locomotive may be dispatched light or with a vehicle load in either direction at any time. This is one thing which will happen in the case of this one engine only system and the driver carries a metal token as authority to move in certain section, may be, it may be in the form of a wooden baton or it may be given in terms of written authority to that driver, so that the driver can move into that section with the locomotive.

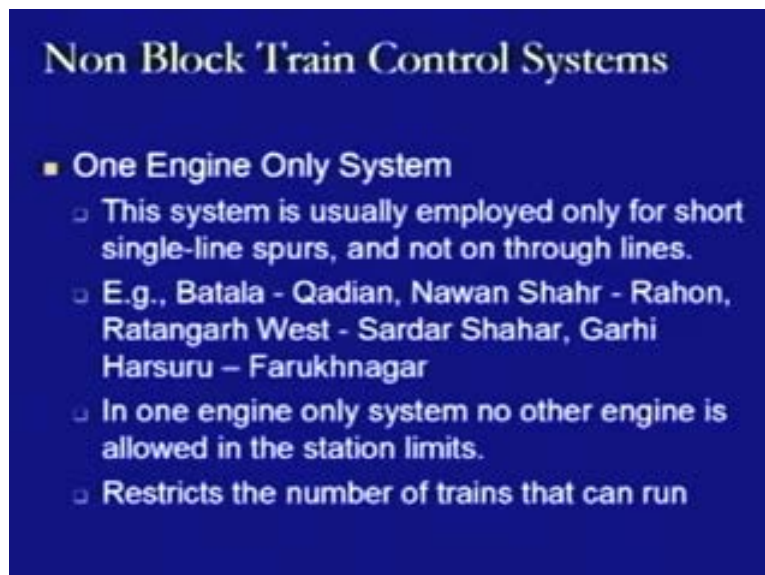


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So, this is case of one engine only system. Generally, what is being done in the case of this one is that it is used for nowadays it is still for some small sections for short single line spurs. Most of the time it is not being used on the through lines, because they are carrying a heavy traffic or heavy loads which needs to be moved between the two big terminal stations. So, that is why this one engine only system is not being utilized for that type of categories

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The sections where still one engine only system is working are like, Batala-Qadian, Nawan Shahar or Rahon, Ratangarh West and Sardar Shahar, Garhi Harsuru and Farukhnagar. These are some of the small sections on which this one engine only system is working and for the time that one engine with a certain load is moving, there is no other train which will be moving from the base station and comes back. So, that is the one type of system which is available and this is under the category of non-block train control system.

So, here what we see is that once one train is being dispatched, then there is nothing like maintaining space in dispatch of another train, because we do not have the flexibility of operating another train, just because there is only one locomotive which is available to the station and which can be used in either of the directions for movement. So, in this one engine only system no other engine is allowed in the station limit. That becomes the crux or in short, the basic thing within the one engine only system, only one engine keeps on moving in any of the direction, to or fro or fro or to and it restricts in this case, the number of trains that can run means, the section will not be having the high traffic handling capacity, because till the engine comes back it is not available for next movement. So, that is why it is reducing the overall capacity which it can haul in that section and it is restricted to generally light traffic sections where the traffic load is very, very less as just I have told in the initial discussion on this one engine only system. So, these remains some of the salient points of one engine only system.

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## Non Block Train Control Systems

### ■ Following Train System

- Modification over previous method
- Also Known as Time interval system
- General time interval kept is 15 minutes
- Trains are supposed to move at a speed of 25 km/hr
- Therefore, there is one train in each 5 km stretch

A modification of this one engine system is following train system and it is also known as time interval system, because just once train is being dispatched, then after some particular period of time like as denoted here, may be 15 minutes or so, another train is dispatched in the same direction. So, they are supposed to move at a specified speed. There cannot be a change in that speed and that is how the category of different type of the trains which can move on different speeds is not a possibility in this form, because if a train which is moving at a higher speed has to overtake, then flexibility is not being provided by the rails, because it is a rigid system where it is a one dimensional movement and there is no two dimensional flexibility being provided within the operation due to which it cannot move in the transverse directions and overtake. So, that is why it is very important, which is another basic thing of following train system is that the trains have to move at a specified speed and there cannot be any change in this.

Therefore, there is one train in each 5 kilometer stretch on the basis of their speed and the time and after which a train has been dispatched, we found out that for a particular section or a stretch that is 5 kilometers, there will be one train. So, that is how we are maintaining the safety of the movement of the trains within same direction.

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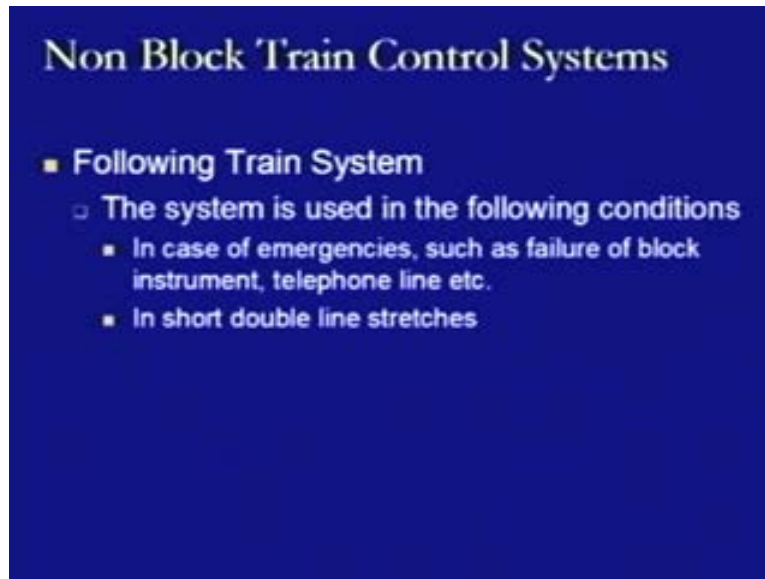
## Non Block Train Control Systems

- **Following Train System**
  - Maximum number of trains simultaneously present in the section is restricted to 4.
  - Driver of the train has to carry written authorization for the section

Then further, in this case, the maximum number of trains simultaneously present in the section is restricted to 4. That is another thing which will happen that there can be 4 trains in a section simultaneously available at all. But then, obviously this is having higher, much higher capacity as compared to the previous methods, where one engine system we have discussed where till the train or the locomotive comes back, there is only one train in the section, whereas now in this case we have 4 trains at a time, at any point of time in the section. So, that is how it is being improved a lot.

The driver of the train has to carry again the written authorization for the section. This remains universally for all the methods whatever methods are there. Some sort of authorization has to be carried by the driver, so that the driver has the permission to enter into the section. Without that no driver can enter or take the train within that section, they have to wait.

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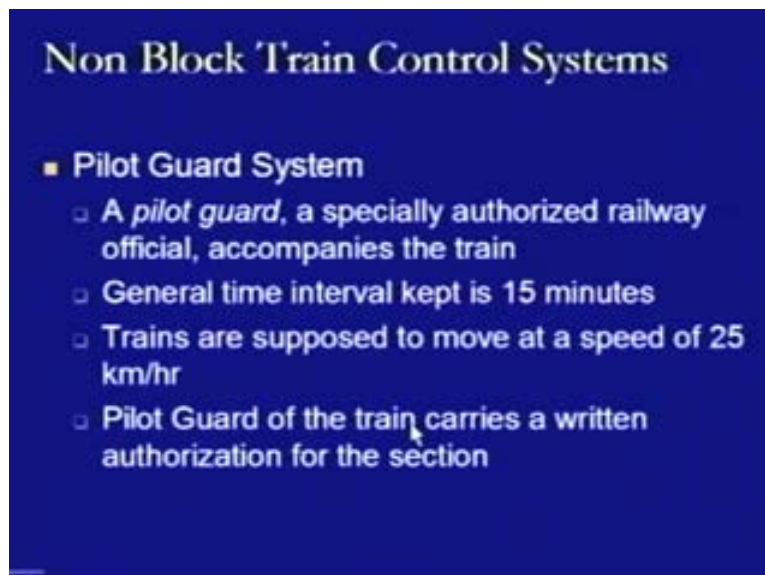


**Non Block Train Control Systems**

- **Following Train System**
  - The system is used in the following conditions
    - In case of emergencies, such as failure of block instrument, telephone line etc.
    - In short double line stretches

This system is being used under certain conditions like there is emergency, such as failure of block instrument or the failure of telephone lines, etc., so as to have a communication between the stations or the sections, find out the movement of the trains and the distances at which the trains are moved within that section. So, if that failure is there, then we can go for the following train system or in short, in double line stretches also this following train system can be utilized.

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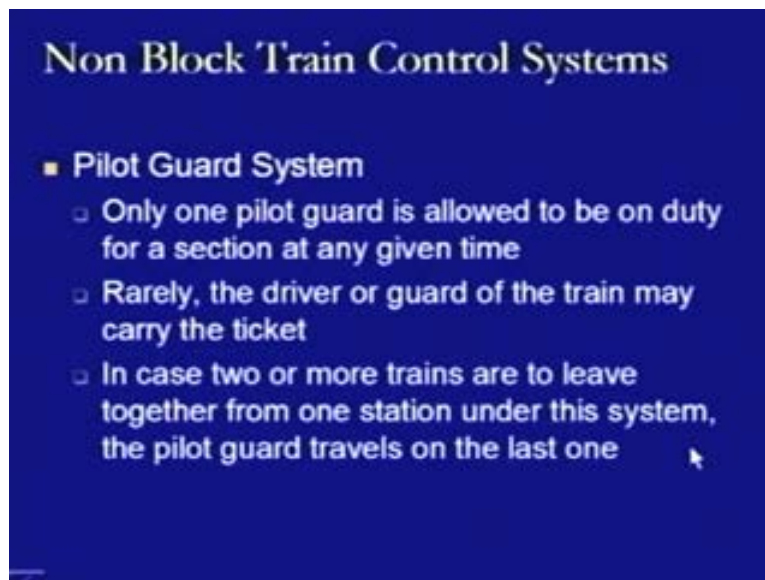
**Non Block Train Control Systems**

- **Pilot Guard System**
  - A *pilot guard*, a specially authorized railway official, accompanies the train
  - General time interval kept is 15 minutes
  - Trains are supposed to move at a speed of 25 km/hr
  - Pilot Guard of the train carries a written authorization for the section

Another further modification within the previous two methods is pilot guard system. This pilot guard system is condition where there is a specifically authorized railway official who accompanies the train. It is like if you take any normal condition of the movement of the train, then there is a driver at the front and the guard at the back, so the guard is authorized to take that train and he has to accompany the train while the train is moving a certain section up to which that guard is being authorized to take the train. So, that is a pilot guard system, there is a driver and a guard combination. So, pilot is, this way it is being defined.

The general time interval again in this case, it is being kept as 15 minutes and the trains are supposed again to move at a speed of 25 kilometers per hour. So, that is the only difference between this one and the previous method that is the following train system method is that now one more person accompanies the train other than the driver and that is the pilot guard. This pilot guard of the train will be carrying the written authorization for the section. So, in the previous case, it was the driver who was carrying this authorization. Now, it is shifted to the pilot guard.

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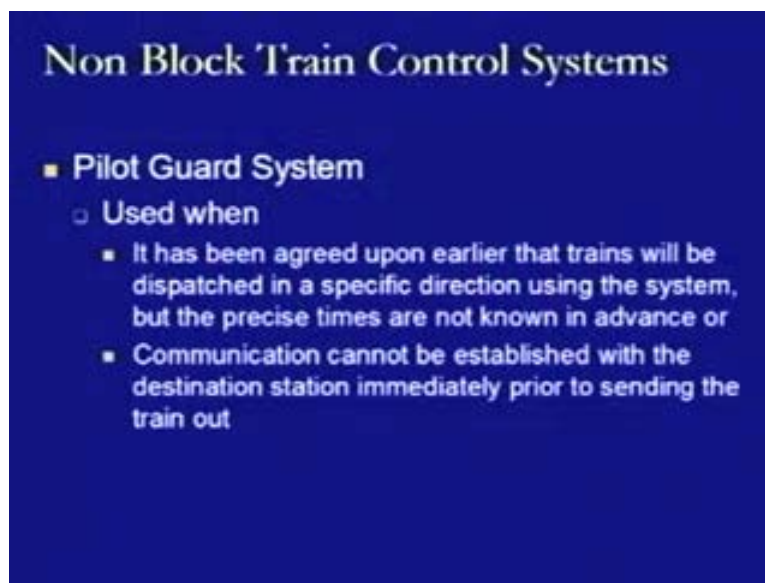
**Non Block Train Control Systems**

- **Pilot Guard System**
  - Only one pilot guard is allowed to be on duty for a section at any given time
  - Rarely, the driver or guard of the train may carry the ticket
  - In case two or more trains are to leave together from one station under this system, the pilot guard travels on the last one

Then, further there is only one pilot guard allowed to be on duty for a section at any given time and rarely the driver or the guard of the train may carry the ticket. So, some features which have been specified here are like this only and in case two or more trains are to leave together from one station, under this system the pilot guard travels on the last one. So, this is another condition now, in this particular specific method where if number of trains are moving in the section, as we have discussed that there can be a train every 15 minutes, so if there are 3 or 4 trains likewise moving in the same direction, then the pilot guard will be moving with the last train which will be entering into this section as such.

So, this is another specific aspect means, now in this case, that pilot guard will be taking or clear off all the 4 trains which have moved and the person will be having the written authority of taking all those trains into the section. Then, there are certain conditions when this type of a system is used.

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One is that it has been agreed upon earlier that trains will be dispatched in a specific direction using the system, but the precise times are not known in advance. So, that is the one condition that you are not knowing at what time the trains are going to be dispatched, so the pilot guard system is used where after certain time intervals we are dispatching the



trains and then the person will be accompanying. Communication cannot be established with the destination station immediately prior to sending the train out. So, this is another problem as we have discussed previously to, in the previous method that if there are emergencies, if there is a failure of communication system and destination station cannot be contacted, then in that case again we are using the pilot guard system and the person will, with the authority will be moving.

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### Non Block Train Control Systems

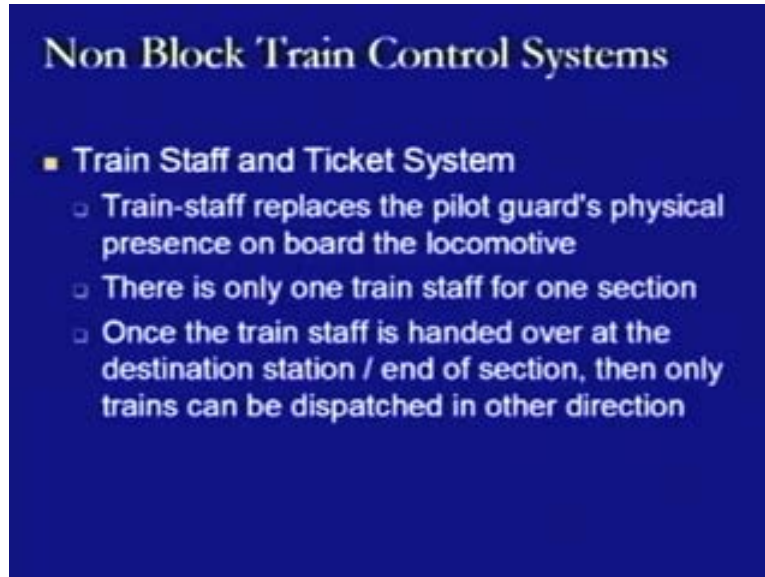
- **Train Staff and Ticket System**
  - This system is used when it is necessary to send trains in both directions between two stations on a single line.
  - A single *train staff* (wooden or ticket) is used, and trains may only be dispatched from the station which has physical possession of the train staff.
  - Trains are dispatched in similar manner as Train Following System

Then, the next method under the non-block train control system is termed as train staff and ticket system. This train staff and ticket system is again the similar sort of a condition like a pilot and guard system with little amount of modification that this system is used when it is necessary to send trains in both directions between two stations on a single line. So, from particular station in both the directions the trains are moving, then we use the train staff and ticket system means there is one person who will be given the ticket. Ticket is another form of authorization of taking the train on a section and that person who is carrying this type of a ticket is known as train staff and a single train staff is used and the trains may not only be dispatched from the station which has physical possession of the train staff. So, the person who will be carrying this type of a ticket which may be in the form of a wooden authority or it may be a sort of again a written form of thing which



is known as a ticket, then that person single train staff will be carrying this and will be taking the train.

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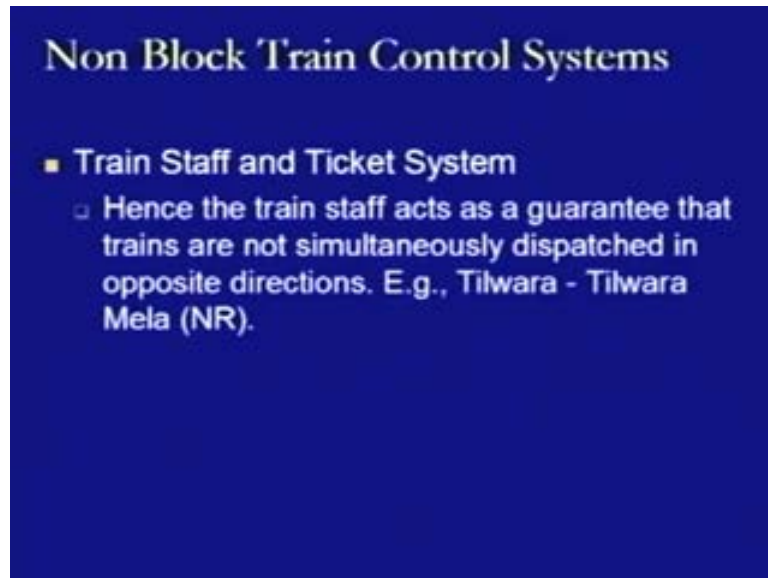


The trains are dispatched in similar manner as we have discussed in the previous case that is the train following system and this train staff replaces the pilot guard's physical presence on board the locomotive. That is a condition here like the pilot guard who has been made to move along or accompany the train probably in this case, it is with the help of this train staff we can just allow the train to move on the section. There is only one train staff for one section. This is one case and this ensures that only one train is moving in one section at a point of a time, because if there are more train staffs, then there will be a possibility of more movement of train within the section, but then it will create a problem as far as the safety of the movement is concerned.

So, so as to ensure that safety, it is being decided in this method that there can be only one train staff for one section and once the train staff is handed over at the destination station or end of the section, then only the trains can be dispatched in other direction. So, what happens is that, once a train is moving between station A and station B and a train staff is being issued at station A, then tell that train staff is being received at station B,

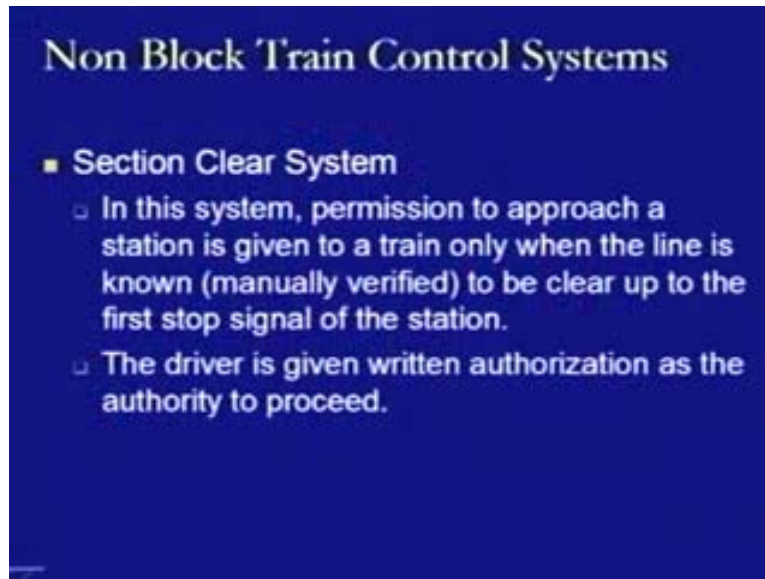
there cannot be any train in other direction. But, as soon as this has reached station B and the driver delivers the train staff to the authority at the station B, then station B can dispatch the train in other direction and that is how this train staff will come back to its original base station.

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Now, hence this train staff acts as a guarantee that trains are not simultaneously dispatched in opposite directions on the same section, because if they are being dispatched simultaneously on the same section, then obviously there are going to be accidents on different such sections. One of the examples of the section which is where this type of method is being used on the Indian Railways is Tilwara - Tilwara mela. This is on the northern railway section.

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Then, the last method under the non-block train control system is the section clear system. In this section clear system, permission to approach a station is given to a train, only when the line is known to be clear up to the first stop signal of the station. So, that is further modification of the method, where from a time control system we are moving towards the space control system and we try to verify that upto what particular distance, which is termed as section, the train has moved away and there is a possibility of now dispatching another train into the section. So, this is how we are trying to maintain certain gap between the two trains in the form of a section.

So, this is governed by the position of stop signals on the stations. The stop signals which we have seen in the previous lecture that is the semaphore type of signals or the colour aspect signals. The location of those semaphore type of signals or colour aspect signals govern this type of a movement. The driver is again given the written authorization as the authority to proceed in this section. So, this is what we have seen is that there are different type of non-block train control systems by which the trains are still being operated on Indian railways on different small sections, but not the through sections or the big sections for which these methods have been utilized.

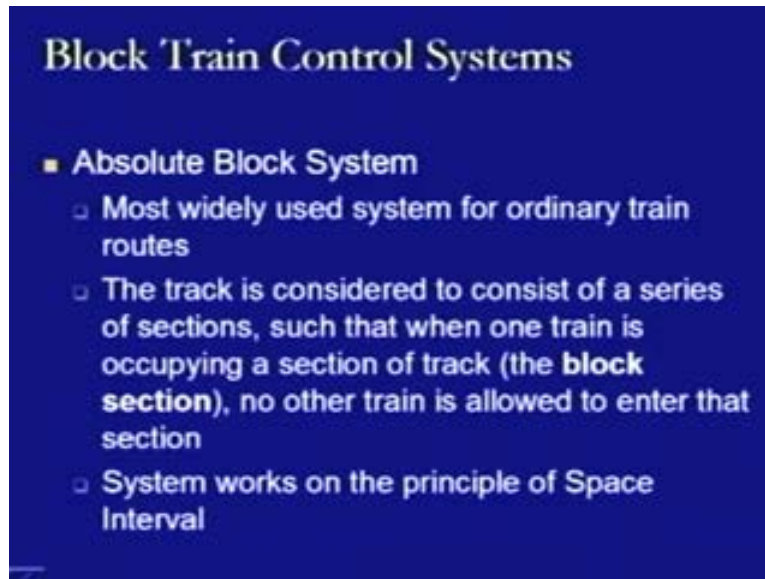
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In the case of the big sections or the through sections or the sections where the heavy loads need to be moved on, there are certain other train control systems which are termed as the block train control systems and these block train control systems, then again we have some categories like the absolute block system, the automatic block system, the centralized traffic control system and automatic train control system. These are the major types of the systems which have been in use or are used in different sections of Indian railways at present. There are some more methods of the block train control system .... still and they are like the absolute permissive block system or the moving block system.

We will try to look at these types of different systems and differentiation between all these types of the different train control systems.

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So, within this block train control systems, we start with the first one that is absolute block system. In the case of this absolute block system this is one of the systems which is most widely used for ordinary train routes. That is a differentiation, where for ordinary train routes we are using this type of a system. The track is considered to consist of a series of sections. Sections mean the length of the track being designated as section, so that length of the track is available. It consists of a series of sections such that one train is occupying a section of track and this is what is being termed as the block section and no other train is allowed to enter that section.

So, this is how the whole of the section starting from station A to station B which are the major controlling stations on the track, now, the smaller stations which are on the way, the whole of the section will be divided into number of parts and those parts are termed as block sections. They are of some distance and then the train, once the train is moving in one particular block section, then there is no other train which is allowed to move in that block system and that is what is the basis of absolute block system. The system works on the principle of space interval instead of time interval.

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## Block Train Control Systems

### ■ Absolute Block System

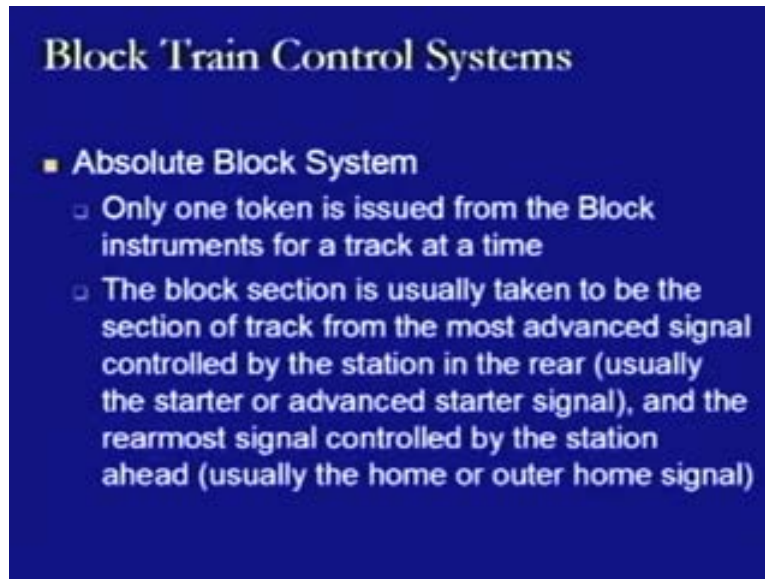
- The block section is a section between two stations having block instruments.
- Block instruments of adjoining stations are connected together and operates simultaneously in coordination with each other
- The permission to enter the block may be in the form of a physical token carried by the train crew

That is what will be there, because we are talking about maintaining the certain blocks within the two trains which are moving on the same track in the same direction. The block section is a section between two stations having block instruments and this is another specific thing in this one is that wherever the controlling agency of that block section is there, then that controlling agency will be having one instrument which is termed as block instrument and this block instrument basically provides the authority for any train to move into a section. So, the block instruments of adjoining stations are connected together and they are operated simultaneously in coordination with each other that is what we have seen in the previous condition too, where we talked about the train staff system where the staff has gone up to the second point and then, till it returns back with the train which is coming in the opposite direction, then only after that section will become again available for movement in the previous direction.

So, it is the similar sort of condition here where we have a block instrument and this block instrument is provided on the two ends of the block section and the instrument has to be operated in consultation as well as in coordination with each other and once that is being operated, then the permission to enter the block will be given by this instrument in

the form of a physical token and this token will be given to the train crew to be taken as an authority to move on to the section.

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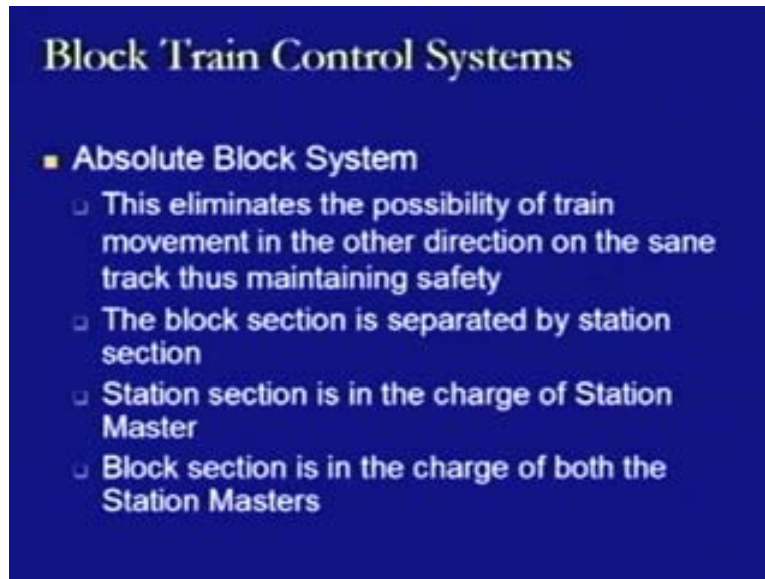


At a particular point of time, when the two block instruments provided in the two stations are coordinated and operated, then only one token will be issued from the block instruments for a track at a time. It means it is trying to ensure that there can be only one train at a point of time on that block section. So, this block section is usually taken to be the section of track for the most advanced signal controlled by the station in the rear. Usually, the starter or advance starter signal and the rearmost signal controlled by the station ahead usually the home, usually the home or outer home signal.

So, here what we can understand is that if this block section can be defined in the form of like, the starter it starts from the starter or advanced starter signal provided at station A and it is up to the home or outer home signal provided at station B, so subjective we are moving in the direction from A to B and these types of signals we have already seen in the previous lectures where we discussed about signals.



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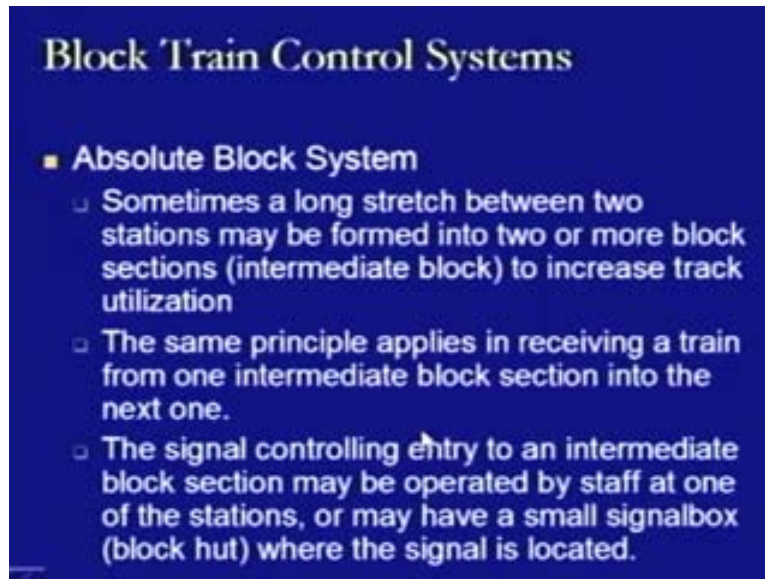


So, this is what is a block section and with this block section, then how we are working is that it eliminates the possibility of train movement in the other direction on the same track thus maintaining the safety. So, this is important aspect of this absolute block system and the block section is separated by, further by station sections that is within two block sections there will be one station section and this one station section will be having the limits from the outer signal of the station to the advance starter signal of that same station and the station section is in the charge of station master at particular station section whatever it is and he is going to control the operations of the trains into any block section.

So, the block section is in the charge of both the station masters who are there on the either of the end of that block section.



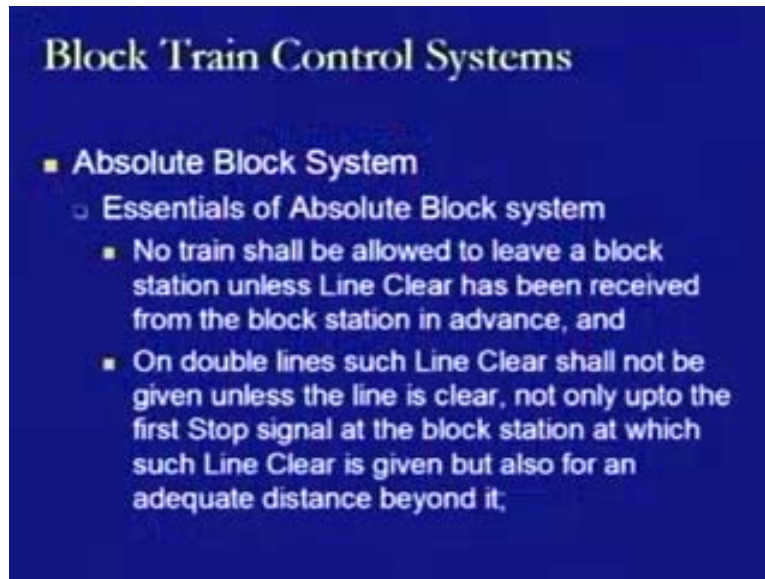
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Further, within the absolute block system, sometimes a long stretch between two stations may be formed into two or more block sections where this is termed as intermediate block to increase the track utilization, because if suppose it is going up to large many kilometers and then in that sense if only one train is moving within that whole of the section, then it is going to reduce the efficiency as well as the load taking capacity of that section. Therefore, what we do is we just increase the number of block sections within that 1 by 4 mean some other station.

The same principle applies in receiving a train from one intermediate block section into the next one that is what we have been discussing. The signal controlling entry to an intermediate block section may be operated by staff at one of the stations or may have a small signal box which is termed as block hut where the signal is located and from where it is operated. So, that is the condition as far as the signal controlling is concerned.

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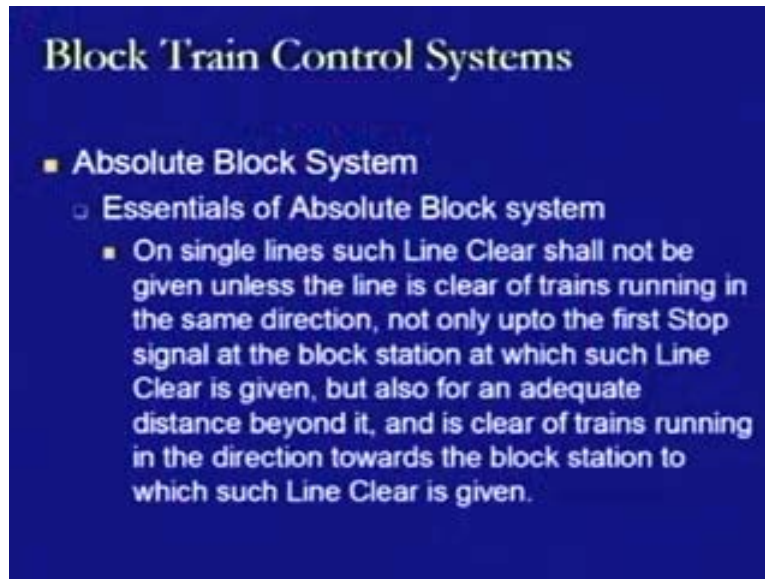


## Block Train Control Systems

- **Absolute Block System**
  - **Essentials of Absolute Block system**
    - No train shall be allowed to leave a block station unless Line Clear has been received from the block station in advance, and
    - On double lines such Line Clear shall not be given unless the line is clear, not only upto the first Stop signal at the block station at which such Line Clear is given but also for an adequate distance beyond it,

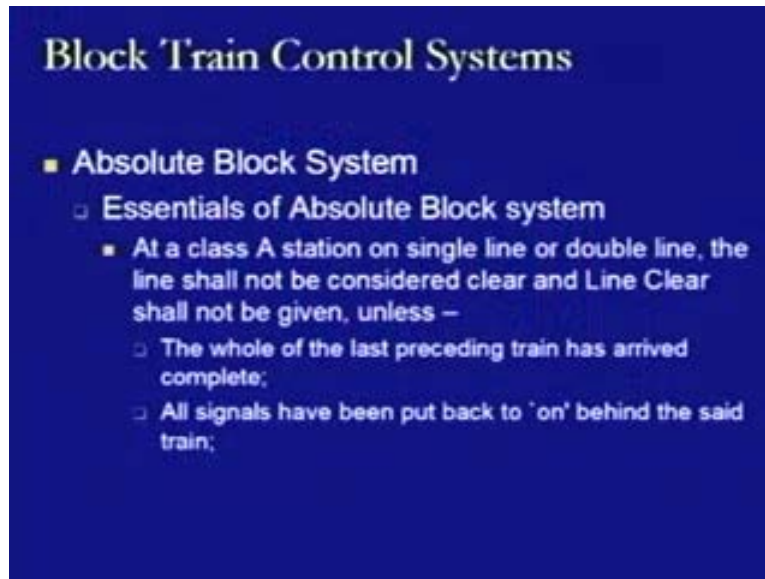
Then, some of the important things which are related to the absolute block systems are that no train shall be allowed to leave a block station unless line clear has been received from the block station in advance that is from station A, the train can start only and only if station B says that the line is clear and they can receive a train. In the case of double lines, such line clear shall not be given unless the line is clear not only up to the first stop signal at the block station at which such line clear is given, but also for an adequate distance beyond it. That is the condition that it has to be seen that the line should not be clear only up to the block station, but it should also be clear away from it, so that the train can also be dispatched once it is being received at the block station.

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Then, on a single line, such line clear shall not be given unless the line is clear of trains running in the same direction not only up to the first stop signal at the block station at which such line clear is given, but also for an adequate distance beyond it and it is clear of trains running in the direction towards the block station to which such line clear is given. So, that is again the same sort of a condition that is it has to be given only those conditions where we have not only before, but after the block station the line is available as a clear line on which the trains can be dispatched after receiving and then it should be clear of running of the direction towards the block station to which such line clear is being given.

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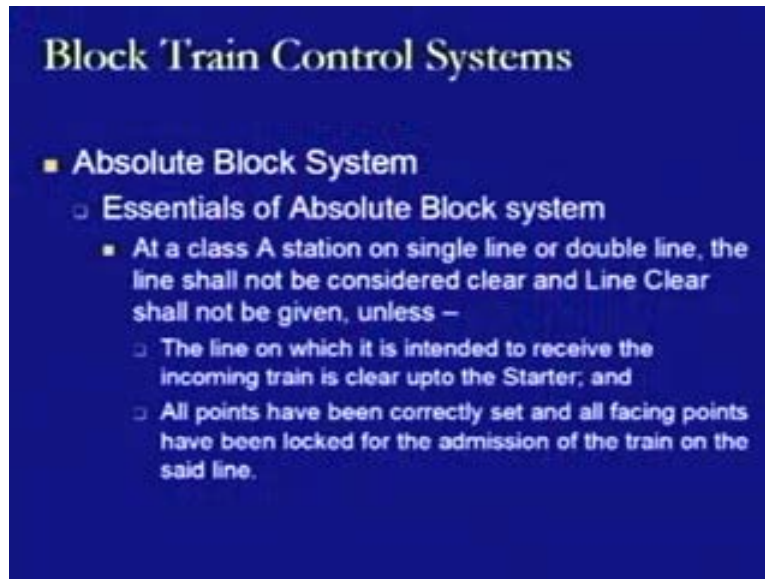


## Block Train Control Systems

- **Absolute Block System**
  - **Essentials of Absolute Block system**
    - At a class A station on single line or double line, the line shall not be considered clear and Line Clear shall not be given, unless –
      - The whole of the last preceding train has arrived complete;
      - All signals have been put back to 'on' behind the said train;

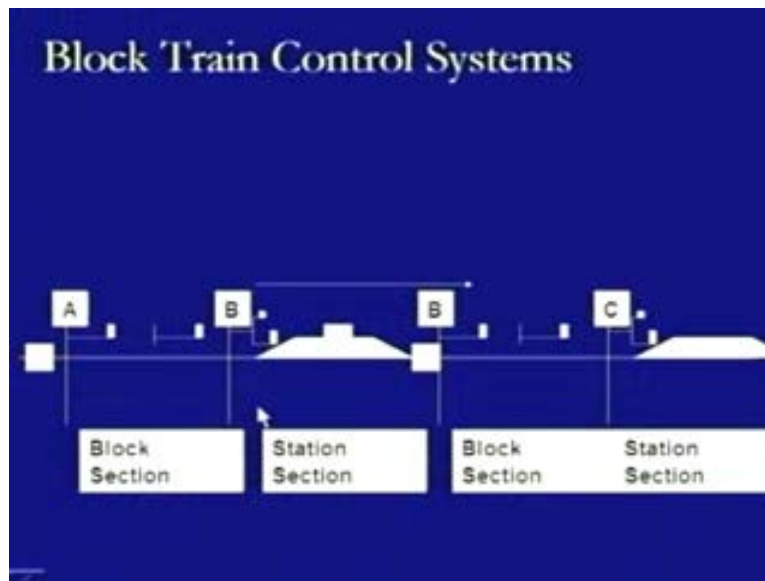
Then further, at any class A station on a single line or double line, the line shall not be considered clear and line clear shall not be given unless the whole of the last preceding train has arrived completely. This is one thing that the line clearing can be given in the case that the whole of the previous preceding train has completely arrived and it is being received in the second station that is the station B and all signals have been put back to 'on' behind the said train. This is another condition that whatever the signals are there behind the movement of the train, they have been placed to 'on' position.

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Then, at any class station A on a single line or a double line, the line shall not be considered clear and line clear shall not be given unless the line on which it is intended to receive the incoming train is clear up to the starter signal and all points have been correctly set. Points mean those locations from where the train is making a change of direction and all facing points have been locked. Whatever the points which are going to come in the direction of the movement of the train they have been allowed, so that there is no possibility of a danger or hazardous condition while the train moves in the forward direction for the admission of the train on the said line. So, that is the two conditions which needs to be met before giving a line clear statement from station B to station A.

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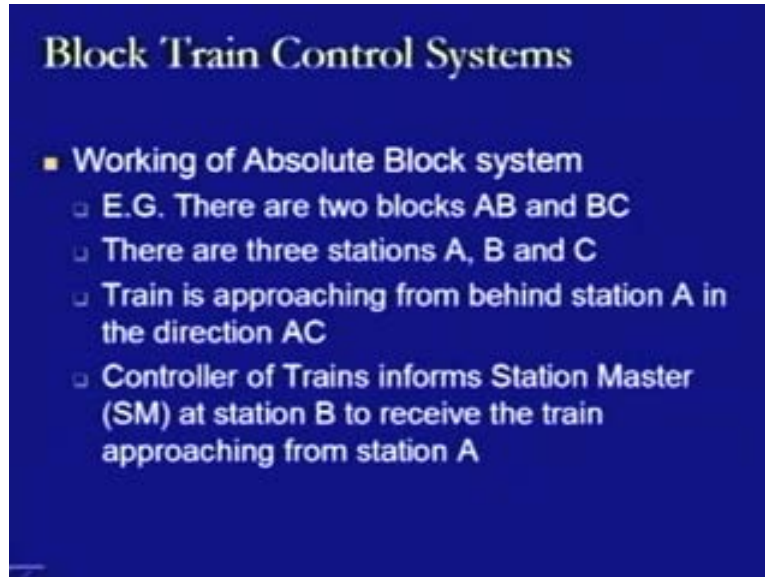


This is the diagram which is trying to define the absolute block system where we have, this is one station, then we have another station here, then another station here. So, this station is having a station section like shown here, where there is one signal, this is the outer signal and then there is a signal that is the advance starter signal. So, between this outer and advance starter signal we have this station section and then between this advance starter of the station A and the outer signal of station B, there is a block section. In between these there can be signals.

So, a train is supposed to move within this section only if the station master at station B gives the line clear statement to the station master at station A and once it is being received here and then only the train will be given the authority to move it in this section. Now, while giving this statement at station B, the station master of station B has to see that this particular section which is ahead of the station section is also clear, so that if the train is to be dispatched, then there is a possibility of dispatching the train without any delay. So, this is, these are the conditions which are generally seen by these two persons and another thing is that as we were discussing about the block instrument, then the block instrument will be available at this location as well as this location and based on the direction of movement, we term them as West cabin or East cabin, which will be having

these blocks sections. So, this is what is the working of absolute block system being defined in this diagram.

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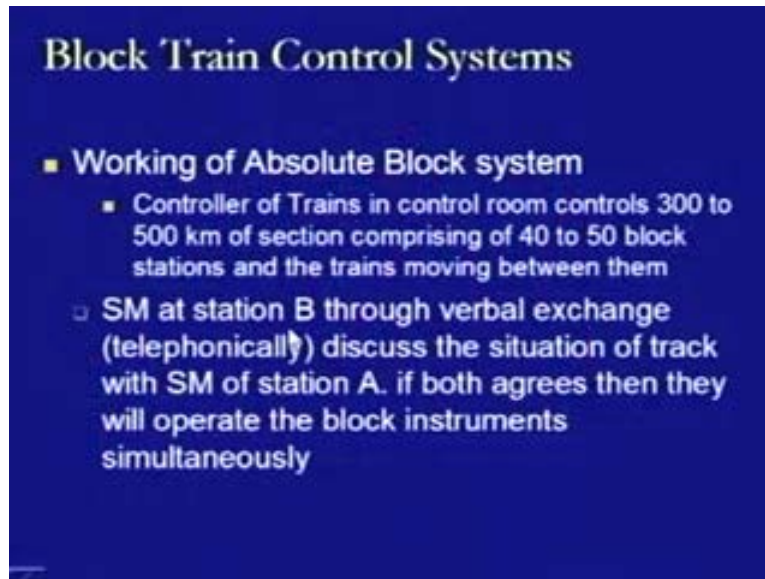


Now, looking at the same thing, what we are, we will be looking is that in this example or the diagram what we have seen is there are two blocks A B, between station A and B and block B C between station B and C. So, we have three stations A B and C. The train is approaching from behind the station that is station A and it is running in the direction AC. The controller of trains informs station master that is in short we can write as SM at station B to receive the train that is coming or approaching from station A.

So, there is a controller of trains who is controlling the bigger section than the total block section and that person is keeping the information of the movement of the train and informs accordingly the station master of station B to receive the train.



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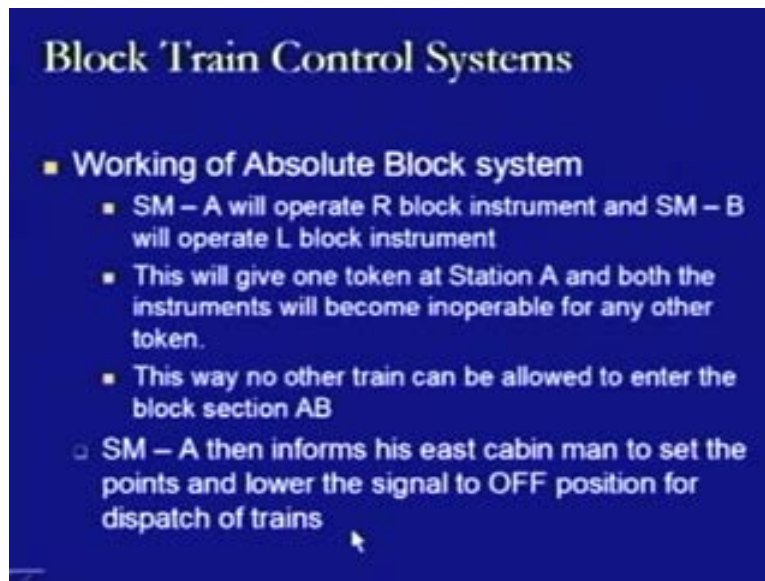


Now, once this is received, then the controller of train in control room controls as I was speaking that the person is controlling a very big section and it may be of the length of around 300 to 500 kilometers and it may comprise of 40 to 50 block stations and the train moving between them. So, this is the total amount of the movement which is being controlled by a single person who is known as the controller of trains and that person keeps sitting at one particular location with one big dash board on which overall network of the tracks is being shown and the train movement are also located in terms of the movement of small red dots which keep on moving on those tracks in different directions.

So, the station master at station B, through verbal exchange that is telephonically will discuss the situation of the track with the station master at station A. Now, if both agree then they will operate the block instruments simultaneously.



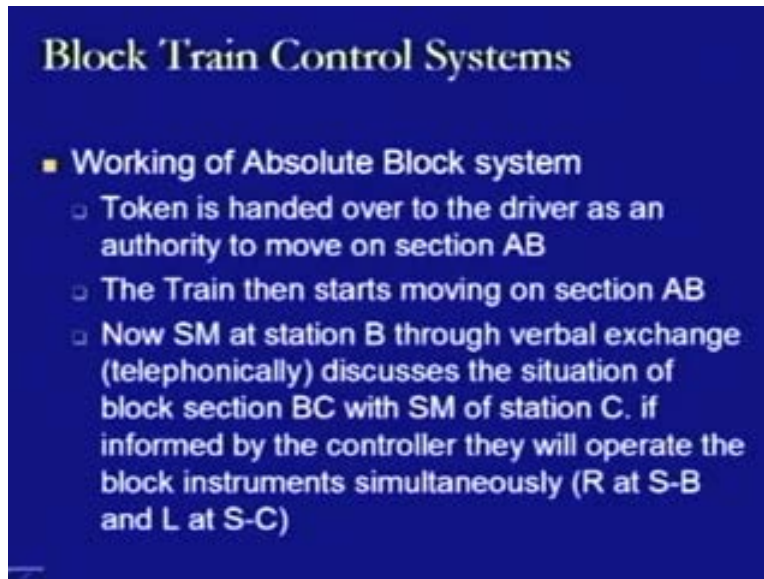
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So, what they will be doing is that the station master at A will operate the R block instrument that is the right hand side block instrument and the station master at station B will operate the L block instrument that is the left hand side block instrument and this will be done simultaneously. So, this will give one token at station **A** and both the instruments will become inoperable for any other token. So, once one token comes out, then both the block instruments will become locked and no other token can be issued from these block instruments. This way no other train can be allowed to enter the block section A B. So, that is how the block instruments are used to get the authority.

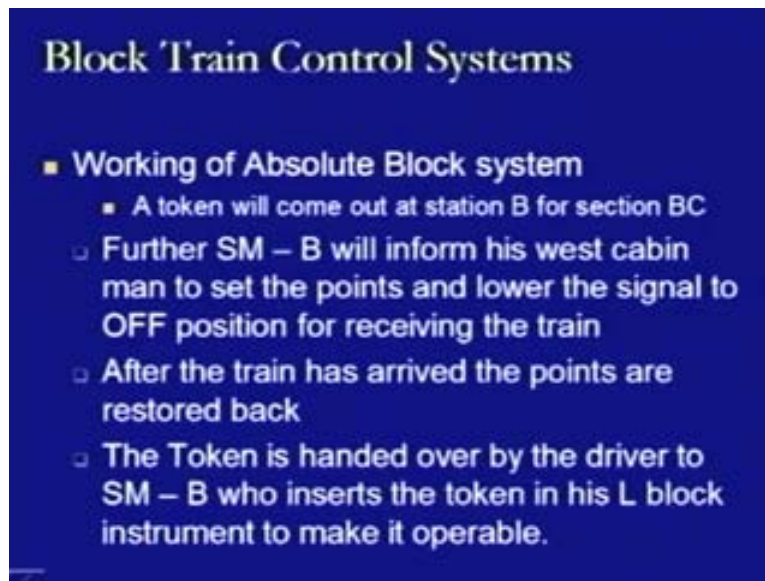
Now, station master A then informs East cabin man to set the points and lower the signal to OFF position for dispatch of trains. So, this is what will be done at station A.

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Then, the token is handed over to the driver as an authority to move on section AB. The train then starts moving on section AB. Now, the stationmaster at station B through verbal exchange that is again with telephonically discusses the situation of block section BC with the station master of section, station C and if informed by the controller, they will operate the block instruments simultaneously that is between station B and station C and in this case, it will be the right hand block instrument at station B and left hand block instrument at station C.

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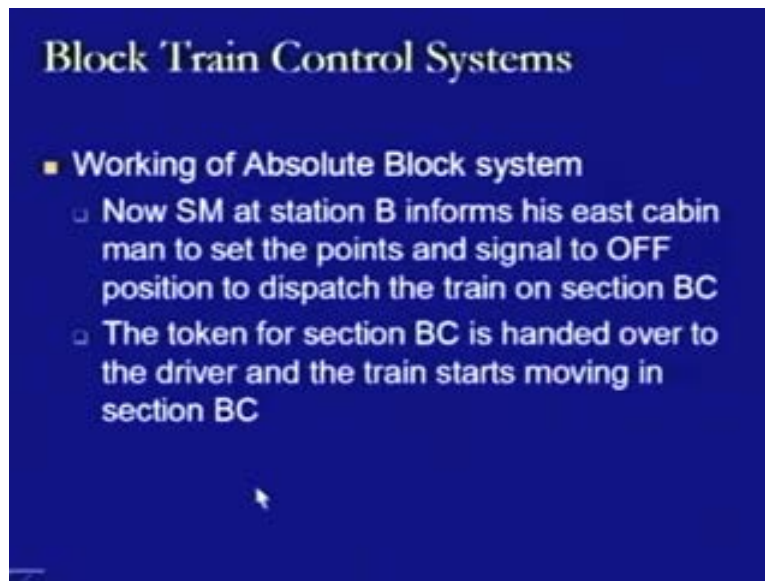
### Block Train Control Systems

- Working of Absolute Block system
  - A token will come out at station B for section BC
  - Further SM – B will inform his west cabin man to set the points and lower the signal to OFF position for receiving the train
  - After the train has arrived the points are restored back
  - The Token is handed over by the driver to SM – B who inserts the token in his L block instrument to make it operable.

So, again a token will come out at station B for section BC. Further, the station master at B will inform his west cabin man to set the points and lower the signal to OFF position for receiving the train on station B. Once the train has arrived, the points are restored back means they will put back to their normal condition. So, that is how they are again made available for the next movement on the behind condition. The token is handed over by the driver to station master B. Once the train reaches here, then the token will be handed over and this token will be inserted into the left hand side of the block instrument and as soon as it is inserted in this one, now this block instrument as well as the block instrument available at station A on the right hand block instrument, they both will become operable means now another token can be issued by the same block instruments.

Now, this is what is the condition in this one and not necessarily that the train has to come back and with the token in this case, as we have seen in the case of train staff method of non-block systems. Here, there may be other tokens which can be made available and can be issued with the operation of block instrument as we have seen during the discussion.

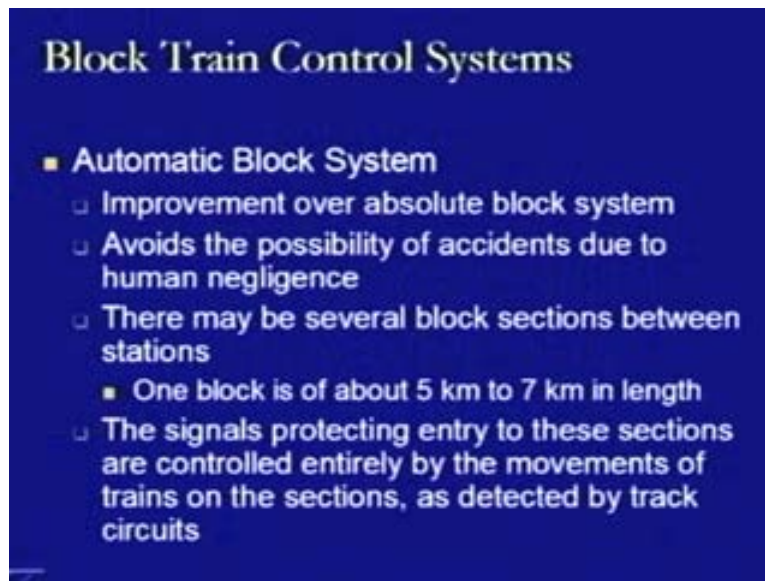
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Now, in the same operation condition, now the stationmaster at station B will inform his east cabin man to set the points and set the signals to OFF position to dispatch the train on section BC. The token for section BC is handed over to the driver and the train starts moving in section BC. So, this is what is the overall working of the absolute block system. That is how between station A, B and C the train is moved using the block instruments and the token given as an authority for that movement. Now, that is what is the absolute block system.

Now, we are looking at the further modification of that system which is termed as automatic block system.

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So, this automatic block system is an improvement over absolute block system. It avoids the possibility of accidents due to human negligence, because when we are issuing the tokens, when we are setting the points in the east cabin or the west cabin or we are operating the signals, then in that condition there are all chances that because of any human negligence the accident can take place. But, here in this case it is total automatic system and therefore, the negligence or human negligence can be eliminated or reduced to minimum.

So, in this case how it works is that there can be several block sections between the stations and in this case, the block is of 5 kilometer to 7 kilometer in length instead of bigger length of the block section as we have seen in the previous absolute block system. So, the overall section which is available between the two major stations is further divided into number of blocks and these blocks are only 5 kilometers to 7 kilometers in length. It means at one point of time, a large number of trains can be made operational in the same direction on the same track and the signals protecting entry to these sections are controlled entirely by the movement of the trains on the sections as detected by train circuiting.

So, this is, track circuiting is one another important aspect of automatic block system, where the circuits are provided which connects all these block sections with each other and the signals are controlled by these track circuits or they will be made operational on the basis of the track circuit or the current available in the track circuit. We will be looking at further that how it is going to work.

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What happens is as soon as the train enters the block, the electric current puts the signal at danger position until the train has moved ahead by adequate distance, because what happens is that as soon as the train enters the block, there will be a short circuiting condition in the electric current being provided within the circuit and that will bring the signal to the OFF condition means what we have seen is the ON position, where it will come to the danger or the stop condition and that is how the rest of the train will start moving ahead in this particular block.

Now, there are certain characteristics of automatic block system.



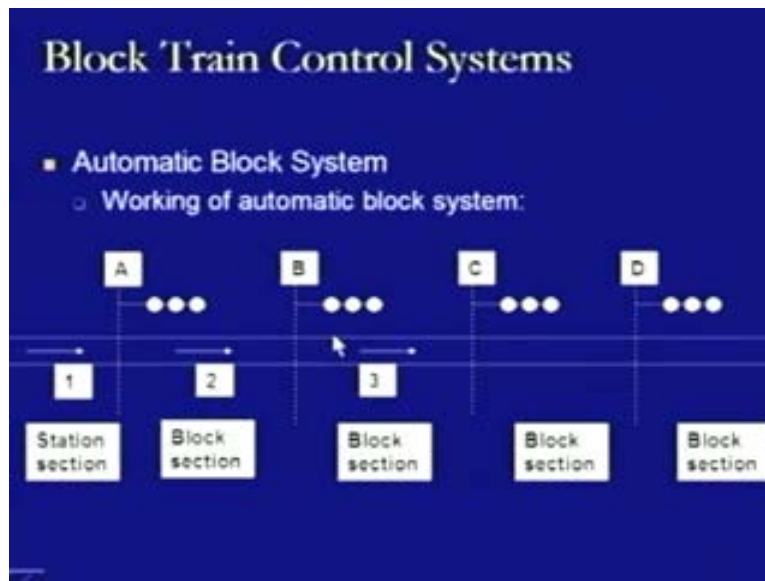
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The movement of train is controlled by stop signals which are operated automatically by the passage of train past the signal and this is governed by the track circuits. No automatic signal assumes OFF, unless the line is clear not only to the stop signal ahead, but also an adequate distance beyond it. So, that is an important specific feature in this case, because in the previous cases as well as the semaphore signal have been used, we have seen that they are the conditions where there are many ON positions means the danger condition.

Here it is a different condition, where the signal remains in the OFF condition speaking that the track is available showing the green light for the movement and it comes to the ON condition or danger condition only and only if the train occupies the section. The line is track-circuited throughout its length and it is divided into a series of automatic signaling sections or blocks, which, each of which is governed by an automatic stop signal. So, wherever there is changeover from one block to the other, an automatic stop signal is provided. Now, this is how it works.

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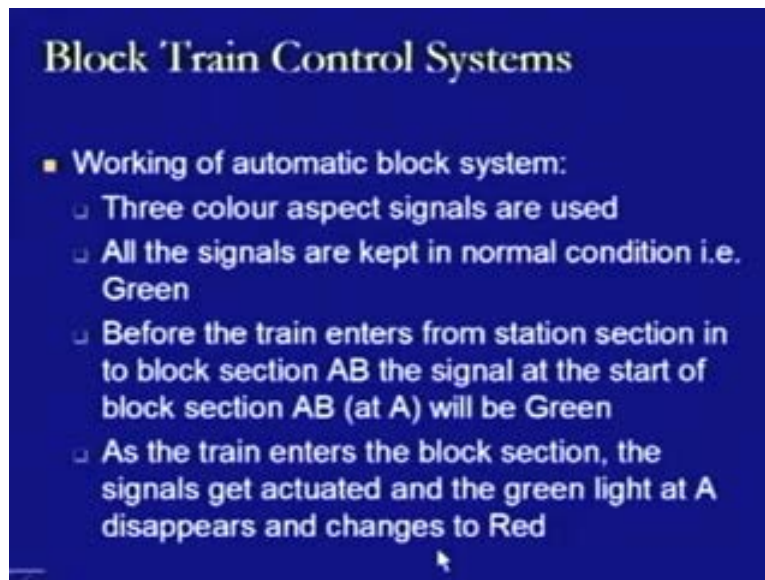
We have the stations like A B C and D. They are the locations where we have the signals and we have the station section here as, designated as 1 and then after that we have number of block sections as 2, 3, 4, 5, 6. So, here this is three aspect signal being provided at location A, location B, location C that is wherever there is a change-over. A train has to move from this location to further location and we have to see that these all are automatically controlled by circuits. But, so far the train is here at location 1, all these signals provided at A B C and D are green.

So, they show the green color that is they are allowing the train to move into the section. But, as soon as the train comes to the location B, then this, this signal at location A will turn to the ON condition that is danger condition; it will switch over and it will show the red light instead and all the B C and D will still show the green light. Now, when this train occupies further the section 3 that is it comes to this location, then B will turn to the red colour and A will turn to the yellow colour and that is how it keeps on moving. So, if the train comes to further next condition, then C will be red, B will be yellow and A will again become green.



It means there is a distance of two blocks sections between the movement of the two trains. So, if the train is here then there is a possibility of train at this location also with the gap of two block sections. This is what is the basic concept of automatic block system. So, this diagram shows the working of automatic block system.

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So, in this case of automatic block system, as we have seen it has three colour aspect signals and all signals are kept in normal condition as green and before the train enters the station section to block section A B, the signal at the start of block section A B will be green. That is what I have already defined that how it works from A to B to C and it enters the block section. Then the signal gets actuated and the green light at A disappears and changes to red. So, that shows that it is being occupied.

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## Block Train Control Systems

- Working of Automatic Block System
  - It prohibits the entry of train in section AB
  - When the train enters block section BC, the signal at B becomes Red and the signal at A turns to Yellow light
    - This indicates that no train can now enter block section BC but a train can enter block section AB with cautious speed
  - Further when the train enters block section CD, the Green light at C will turn to Red and Red light at B will turn to Yellow. Similarly the Yellow light at A will turn to Green

Then, it prohibits the entry of train in section AB, so no other train can move in. When the train enters the block section BC the signal at B will become red, whereas the signal at A will turn to yellow light. This indicates that there is no train, can now enter block section BC. But, a train can enter block section AB with cautious speed, but not with normal speed. Further, when the train enters further block section CD, the green light at C will turn to red, red light at B will turn to yellow and yellow light at A will turn to green.

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## Block Train Control Systems

- Working of automatic block system:
  - It means that a train can enter section AB with full speed, section BC with cautious speed but no train can enter section CD
  - It indicates that a distance of two block sections is maintained between the two trains moving with full speed.

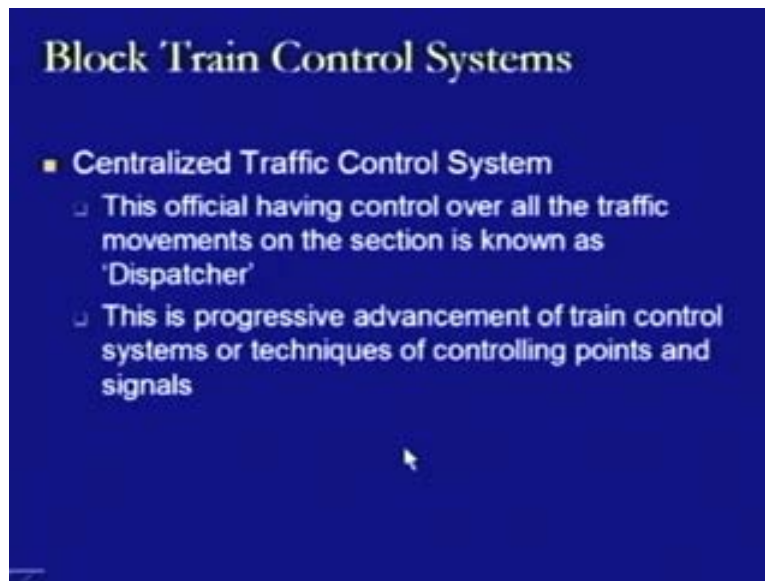
So, that is how in continuation the lights keep on changing and they allow the movement of other trains within the block. It means that a train can enter section AB with full speed, section BC with cautious speed, but no train can enter section CD. That is how we are trying to maintain the gap between the trains. Further, it indicates that a distance of two block sections is maintained between the two trains which are moving with full speed. So, this is how the distance or the space control system is there in, within the automatic block system.

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There are certain advantages of automatic block system. The human error is eliminated, there is greater safety and efficiency, there are less personals required, there is no requirement of automatic block instruments or simple block instruments, less operating cost and capital cost in the system, there is an increase in the traffic density, because we can handle more of the traffic because of the higher number of block sections and less number of locomotives and carriages are required in this form.

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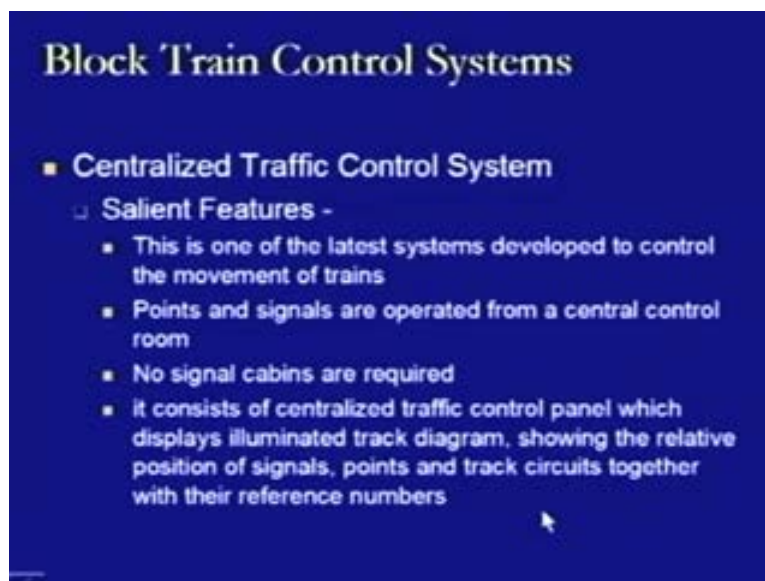
Now we come to the next method that is the centralized traffic control system. It means centralization of operations of all the points and signals at the various stations on a section at one single location. So, that is from one single location we are trying to control overall points and signal and it concentrates the control over all the points and signal indications into the hands of a single official and this single official is basically known as the dispatcher and so the official having control over all the traffic movements of the section is known as dispatcher. This is the progressive advancement of train control systems or techniques of controlling points and signals from absolute automatic to now this particular system.

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In this case, the advancement is as follows. It is from the non-interlocked to the multiple cabin, from multiple cabin to single cabin, from single cabin to remote control of points and finally centralized control of points and signals over the entire section. This is what is the overall advancement as we have discussed; from the non-block to block to absolute to automatic to centralized traffic control system, this is how it can be defined.

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Then, the salient features of the system are that this is one of the latest systems developed to control the movement of trains. The points and signals are operated from a central control room. No signal cabins are required and it consists of centralized traffic control panel which displays illuminated track diagram showing the relative position of signals points and track circuits together with their reference numbers, so that they can be operated using those reference numbers.

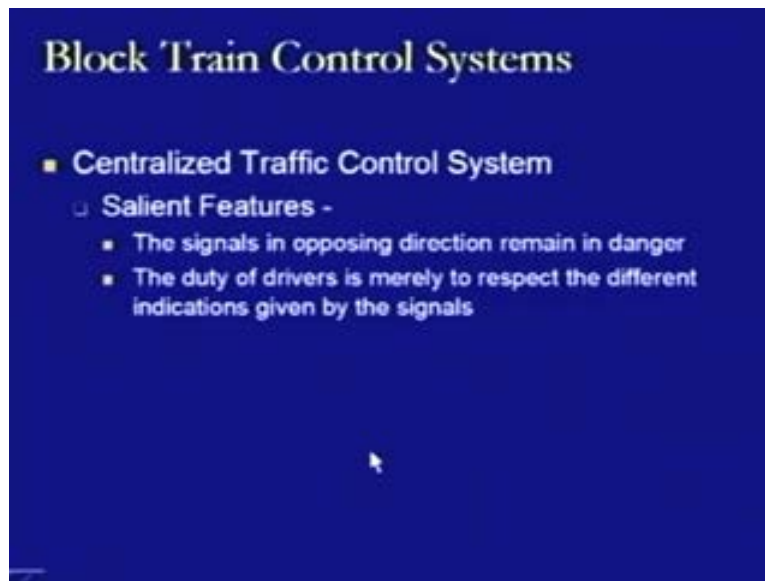
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Further, the arrangement is made to display stop signals automatically in advance and bring the train to a rest to avoid a collision. The number of thumb switches are placed below the illuminated track diagram for the control of points. So, using these thumb switches we can control the points. It is a very easy system as far as the control is concerned. Immediately below the point thumb switches the signal thumb switches are mounted. So, once we operate a point switch, then the signal switch associated with that can also be operated within the same location and the switch is also provided to determine the direction of movement of train.

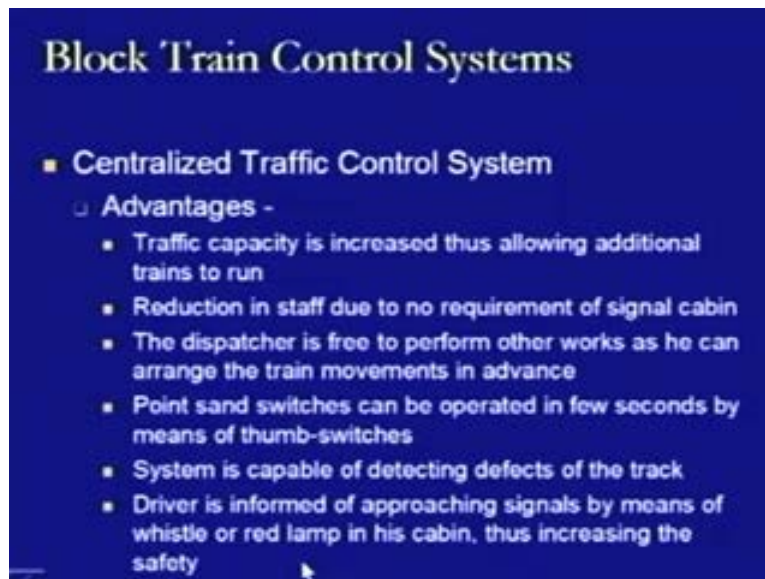


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This is what I said that it looks like a movement of a red dot on the track. The signal in opposing direction remains danger and the duty of the driver is merely to respect the different indications which are given by the signals.

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So, no other thing is to be done by the drivers on a centralized traffic control system and it has a lot many advantages like the traffic capacity increases a lot, reduction in staff is there because there is no requirement of signal cabin, the dispatcher is free to perform other works, the points and switches can be operated in few seconds, the system is capable of detecting defects of the track and the driver is informed of approaching signals by means of whistle or red lamp in his cabin, which is directly controlled by the control system of centralized cabin.

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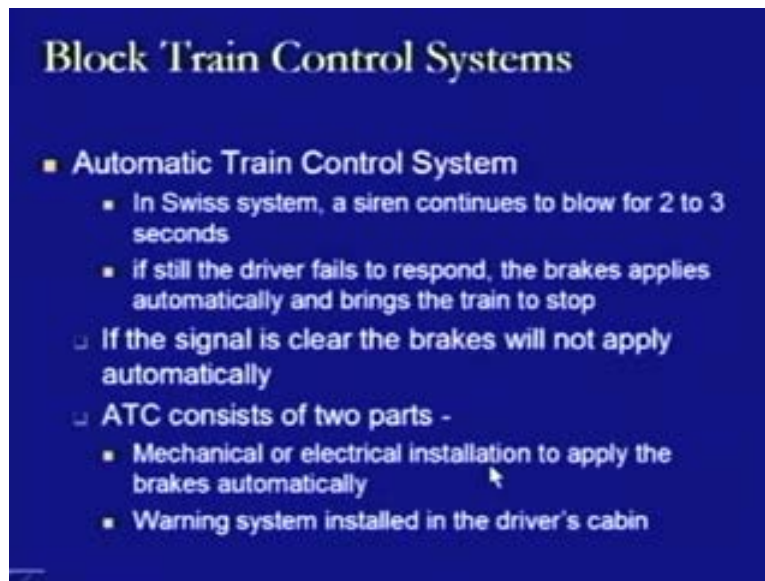


### Block Train Control Systems

- Automatic Train Control System
  - This system is in use in America, Japan, Switzerland, etc
  - It consists of electrically circuited track and electrical fittings at the wheel brakes of locomotives
  - These helps in stopping the train when the driver fails to obey the signal at danger position
  - It works in different ways -
    - In Japanese system a red light continues to lit and bell keeps ringing in the drivers cabin for 5 seconds to warn the driver

So, this system is in use in number of advanced countries or developed countries like America, Japan, Switzerland, etc. It consists of electrically circuited track and electrical fittings at the wheel brakes of locomotives. That is an added condition in this one with respect to the previous one and these help in stopping the train when the driver fails to obey the signal at danger position and it works in different ways. In Japanese system, a red light continues to lit and the bell keeps ringing in the drivers cabin for 5 seconds to warn the driver and in Swiss system a siren continues to blow for 2 to 3 seconds.

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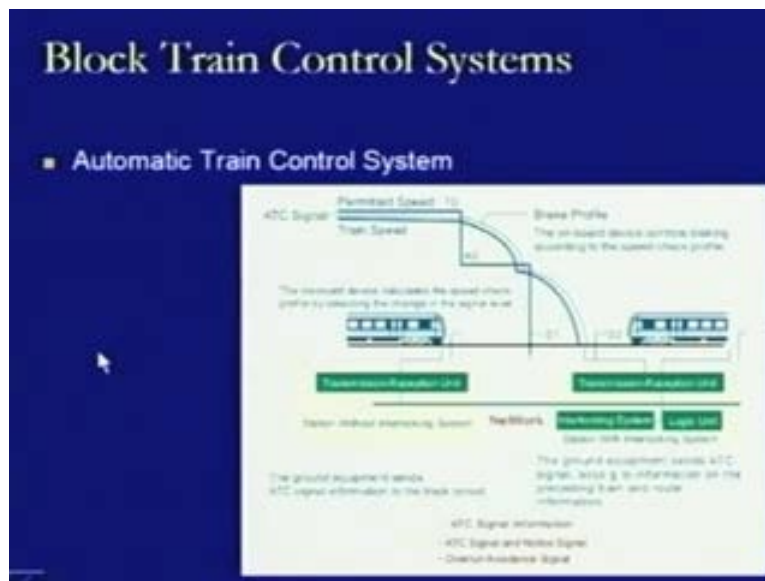
If still the driver fails to respond, the brakes apply automatically and bring the train to a stop condition. If the signal is clear, the brakes will not apply automatically and it consists of two parts. The mechanical or the electrical installation to apply the brakes automatically and the warning system which is installed in the driver's cabin and this is how it looks like.

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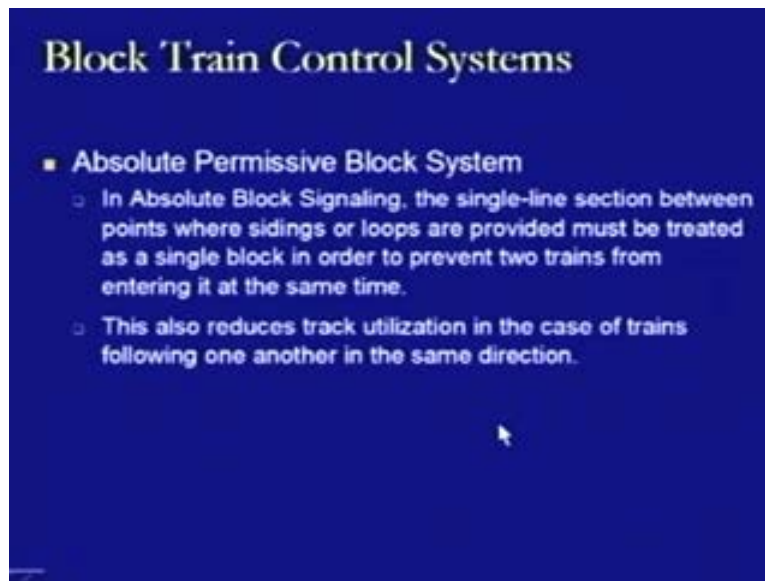
This is the track, illuminated track which is being provided. The controlling systems are available here. Whatever the points and switches are there, they are being located with the crossovers between the different locations and then the switches are provided here, by which all these signals and points can be controlled and this is another diagram of, showing the working of the ATC signal.

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That is how it works. This is automatic train control system by which we can control the number of trains.

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Then, lastly we have the absolute permissive block system where in this system absolute block signal line section between two points where sidings or loops are provided must be treated as a single block in order to prevent two trains from entering it at the same time and this also reduces track utilization in the case of trains following one another in the same direction.

So, what we have discussed today is the various types of train control systems, which are available worldwide and in fact, are also being used in Indian railways. In this series then, we have seen the systems which are non-block operated systems and block operated systems and then we have also seen some of the advanced systems which are in use on heavy traffic corridor routes. With this we stop as far as the train control system is there at this part point of time and we will be looking at one more aspect related to the controlling and operations of signals in the next lecture.

Till then, bye.