Standards & Practices: Signalling & Telecommunications

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Telecommunications on Indian Railways
Darlington Stockton, UK: 1825
Golden Quadrilateral
To err is human

To safeguard against that error is Signalling
Why Signalling for Rail Transport?

- Safety in Rail Transport
  - Safety on ground
  - Safety on-board
- Increase line capacity: run more trains on the same tracks
- Operational Benefits through Advanced Signalling

Railway Signalling Systems are required to ensure safe train operations by Reducing human dependence & to make Optimum use of existing line capacity
Design philosophy of Rail Systems: *Failsafe*

- All signalling systems, equipments and components have to be *fail safe*.

- Failure of any signalling equipment or component should either result in *signal displaying most restrictive information* i.e. DANGER or impose a restriction on the movement of trains.
**Track Circuit**: An electric circuit formed along the running rails. Function is to detect **presence** or **absence** of a train on that portion of track.

**Insulation Joints**

**DC Supply**

**Track Not occupied**: Track Relay is Energised.
**Track Circuit**: An electric circuit formed along the running rails. Function is to detect **presence** or **absence** of a train on that portion of track.

**Track Not occupied**: Track Relay is Energised

**Insulation Joints**

**DC Supply**

**Track Relay**

**Track Not occupied**: Track Relay is Energised
TRAIN DETECTION

TRACK CIRCUIT

DC

AFTC (JOINTLESS)

Audio Frequency Track Circuits

AXLE COUNTER

Counts no. of Axles
POINTS: A Mechanism provided on the track to facilitate diversion of trains from one route to another.

(Our Engines do not have steering wheel as available in motor cars)
Different Mechanisms for operating Points
Colour Light Signalling (Multiple-Aspect)

STOP

CAUTION

Be prepared to stop at next Signal

ATTENTION

Be prepared to Pass next Signal at slow speed

PROCEED

Proceed with full permitted speed
So far about 3000 signal aspects have been provided with LED based signals.

**ADVANTAGE:**
- CURRENT CONSUMTION LOW (110mA COMPARED TO 300 mA in Signal Bulbs)
- ELIMINATION OF BULB FUSING
- HIGHER VISIBILITY

**LED Signals**
(Light Emitting Diode)
Development of Signalling

Electronic Signalling

Electrical Signalling

Electro-mechanical Signalling

Mechanical Signalling
SSI is an interlocking system which employs microprocessors and software for interlocking functions.

Advantage of smaller space, power, cabling and maintenance requirements besides fast software based upgradation facility & flexibility to meet changes in yard layouts.

SSIs provide high level of reliability, availability and fail safety.
<table>
<thead>
<tr>
<th>Installation</th>
<th>(in units)</th>
<th>As on 31.12.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Token less Block Working (No. of Block Sections)</td>
<td></td>
<td>1,380</td>
</tr>
<tr>
<td>Automatic Block Signalling (Track kms.)</td>
<td></td>
<td>3,571</td>
</tr>
<tr>
<td>Multiple Aspect Colour Light Signalling (No. of stations)</td>
<td></td>
<td>3,112</td>
</tr>
<tr>
<td>Panel Interlocking (No. of stations)</td>
<td></td>
<td>2740</td>
</tr>
<tr>
<td>Route Relay Interlocking (No. of stations)</td>
<td></td>
<td>204</td>
</tr>
<tr>
<td>Solid State Interlocking (No. of stations)</td>
<td></td>
<td>91</td>
</tr>
</tbody>
</table>
Interlocking Principle

- Complete route for reception of train is unoccupied
- All points are correctly set & locked
- All Conflicting signals are at Danger Position (RED)
- Level Crossing gates (if any) are closed

CHECK

Till Then

All Clear
## 10.2 Requirements for different standard of Interlocking

<table>
<thead>
<tr>
<th>Type of Equipment / arrangement</th>
<th>Reudimentary Std. 0</th>
<th>Std. I</th>
<th>Std. II</th>
<th>Std. III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Max. speed over the Facing Point unrestricted on the main line in kmph</td>
<td>15</td>
<td>50</td>
<td>75</td>
<td>maximum permissible</td>
</tr>
<tr>
<td>2. Point equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Setting</td>
<td>Local operation</td>
<td>Location operation</td>
<td>Local operation</td>
<td>Central operation</td>
</tr>
<tr>
<td>ii) Locking</td>
<td>Padlocking</td>
<td>Key lock</td>
<td>Hand plunger</td>
<td>Facing point lock or point machine</td>
</tr>
<tr>
<td>iii) Route holding</td>
<td>No arrangement</td>
<td>No arrangement</td>
<td>Lock bar or track circuits</td>
<td></td>
</tr>
<tr>
<td>iv) Detection</td>
<td>No required</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>3) Isolation</td>
<td>do</td>
<td>Not Required</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>4) Interlocking</td>
<td>Indirect</td>
<td>Indirect</td>
<td>Indirect</td>
<td>Direct</td>
</tr>
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</thead>
<tbody>
<tr>
<td>4) Interlocking</td>
<td>Indirect</td>
<td>Indirect</td>
<td>Indirect</td>
<td>Direct</td>
</tr>
<tr>
<td>5) Signals LQ</td>
<td>Outer common Home</td>
<td>Outer bracketed home</td>
<td>Outer bracketed home starter warning</td>
<td>Outer bracketed home starter warning (if necessary)</td>
</tr>
<tr>
<td>MAUQ</td>
<td>Distant home starter</td>
<td>Distant Home starter</td>
<td>Distant Home starter</td>
<td>Distant Home starter (if necessary)</td>
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</table>
Block Instruments: To ensure only one train moves between two stations at a time
ABSOLUTE BLOCK SYSTEM

Station A

Block Instrument

Overhead Wire

Or

UG Cable

Block Instrument

Station B
ABSOLUTE BLOCK SYSTEM

Station A

Block Instrument

Overhead Wire

Or

UG Cable

Station B

Block Instrument
ABSOLUTE BLOCK SYSTEM

Station A

- Overhead Wire
- Or
- UG Cable

Station B

- Block Instrument

Block Instrument
ABSOLUTE BLOCK SYSTEM

Station A

Station B

Overhead Wire

Or

UG Cable

Block Instrument

Block Instrument
ABSOLUTE BLOCK SYSTEM

Station A

Block
Instrument

Overhead Wire
Or
UG Cable

Block
Instrument

Station B
ABSOLUTE BLOCK SYSTEM
Station A

Block Instrument

Overhead Wire
Or
UG Cable

Block Instrument

Station B
ABSOLUTE BLOCK SYSTEM

Station A

Station B

Overhead Wire

Or

Underground Cable

Block Instrument

Block Instrument
Double Distant Signal

Distant Signal: **YY**: Stopping on Main Line; Or Being Recd on Loop Line

Distant Signal: **G**: Being Received on Main Line
AUTOMATIC SIGNALLING
Signal Clearance automatically done by Train Movements

Automatic Signalling
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Automatic Signalling

Available on Suburban Sections
Provides a check of complete arrival of the train and proves block clearance automatically. 488 block sections on IR have so far been covered.
SAFETY AT LEVEL CROSSINGS

Level Crossings : 37345

Manned       : 16,607
Un manned    : 20,738
Telephones  : 15572
Interlocked : 7428

TAWD: 7 a major concern
UNMANNED LEVEL CROSSINGS:-

TRAIN ACTUATED WARNING DEVICE (TAWD)

⇒ Audio-visual warning of approaching train to road users
⇒ Trials conducted in the field.
⇒ Such devices are being provided on 100 Level Crossings in first phase

Alarm Systems at LC gates
USING OPTICAL OBSTRUCTION
(The Japanese Way)
Reducing Human Dependence through Advanced Signalling

*ATP: Automatic Train Protection*

ATP & Mobile Communication, Sweden

Cab Signalling with ATP
(Shinkansen, Japan)
Auxiliary Warning System (AWS)

- Applies Brakes automatically in case Driver disregards a **Red** Signal
- Regulates Train Speed to 15 KMPH on **Yellow** Aspect
- Controls Train speed on **RED** signal


**ATP : Automatic Train Protection**
Auxiliary Warning System

Microprocessor based CENTRAL PROCESSING UNIT

DRIVER’S INDICATION PANEL

SPEED-SENSOR

BRAKE CONTROL

SUPERVISORY CH

DATD CH

ENGINE MAGNET

TRACK MAGNET

Opto coupler

Transmits Signal Aspect indications
For Safety in Train Operations

ATP: Automatic Train Protection is a MUST
ACD : Anti Collision Device
(developed by Konkan Railway)

• ACD is a software based equipment comprising of
  – A microprocessor unit
  – A radio-modem for encrypted digital communication
  – A GPS Receiver : to determine the position of a train from GPS satellites.
Transmit $X_1, Y_1$

Transmit $X_2, Y_2$

Compare $X_1, Y_1$ (GPS coordinates)

Compare $X_2, Y_2$ (GPS coordinates)

And Direction

If Inter distance is less than 3 Km apply brakes.
Preventing ‘Head-on Collision’

Train B (on RIGHT TRACK)

Station B

Path followed by Train A (On Wrong Track)

‘Loco ACDs’ of both the trains ‘Approaching’ each other with the same ‘Track ID’ would cause application of brakes
Both ‘Guard’ & ‘Loco’ ACDs of Train A would generate ‘Auto-SOS’ on detection of ‘Train Parting’

Loco ACD of Train B would apply brakes, on receipt of ‘Auto-SOS’ from Train A
After detecting the presence of Loco ACD of Train A on same track (carrying same Track-ID), the Loco ACD of Train B would apply brakes to bring train to a STOP
Anti-Collision Device (ACD)

Hardware
- 486 Industrial PC
- Data Radio
- GPS
- Automatic braking Unit

Software/function
- Operating system: DOS
- Radio protocol: CSMA/CD
- Latitude/Longitude/speed/direction from true north
- Normal braking and emergency braking
Why Telecommunication for Railways?

Needed to ensure safe and efficient train operations

*Failure in communication results in safety hazard & delays to trains*

- Control Communication: for train working
- Block Communication to ensure safety
- Level Crossing Gate Communication
- Emergency Communication: trains held up in section
- Communication for Disaster Management
- Administrative & Data Communication
- Mobile Communication: Trains & Control Centre
- Communication for Passenger Information Systems: IVRS, Train Indicators, Announcing Systems
Railways Telecom Network

- **Optical Fibre**: 35782 Kms
- **MW/UHF**
  - Digital: 5000 kms
  - Analog: 18500 kms
  - Total Towers: > 600
- **Underground RE cable**: 13279 kms
- **Overhead alignment**: 25000 Kms
- **PRS Network**
  (Passenger Reservation System)
  > 600 nodes
- **FOIS Network**
  (Freight Operation & Information System)
  > 300 nodes
- **Railnet**: Connects all Zonal HQs & most of Divisions
RailTel Corporation
formed in Sept 2000

- To expeditiously modernise Railways Operational and Safety systems.
- Create a nationwide broadband telecom and multimedia network to supplement national infrastructure to spur growth of telecom, internet and IT enabled value added services in all parts of the country especially rural, remote and backward areas.
- Significantly contribute to realisation of goals and objectives of New Telecom Policy 1999.
- Generate much needed revenues for implementing Railways developmental projects, safety enhancement and assets replacement programs.
Network Plans

- To create a state of the art OFC based network.

- The network to be based on SDH technology with Core layer of STM 16 for present with DWDM upgradeability, Edge layer of STM 4 and Access layer of STM 1.

- This to be overlaid by an IP layer of voice quality with Gigabit Ethernet connectivity.

- State of the art TDM / IP based switches for Long Distance carriage of traffic.
Present Status

• More than 35000 kms of OFC lit.
• OFC laying progressing at the speed of more than 500 kms per YEAR.
• The core network connecting 4 metro of Delhi, Mumbai, Kolkata, Chennai and 4 mini-metros of Ahmedabad, Pune, Secunderabad and Bangalore made ready.
Mobile Train Radio Communication
MOBILE TRAIN RADIO COMMUNICATION

** TO ESTABLISH INSTANT COMMUNICATION IN DUPLEX MODE BETWEEN:

## DRIVER & GUARD OF THE SAME TRAIN.

## DRIVER & GUARD AND A TRAIN CONTROLLER.

## TRAIN CREW & CONTROL CENTRE TO HANDLE EMERGENCIES, TECHNICAL & LOGISTIC PROBLEMS.

## MOBILE TRAINS.

## MOBILE & FIXED LOCATION SUBSCRIBERS.
WHY MTRC? (Mobile Train Radio Communication)

- **CONVENTIONAL MODE OF COMMUNICATION WITH THE MOVING TRAIN IS AVAILABLE IN STATION AREA ONLY, THROUGH FIXED SIGNALS IN STATION LIMITS AND HAND / LAMP SIGNALS, WHICH COULD BE DISPLAYED BY STATION STAFF TO CONVEY GROUND SITUATION TO THE DRIVER/GUARD OF THE MOVING TRAIN.**

- **WALKIE-TALKIE SETS PROVIDED RECENTLY DO NOT CATER FOR AVAILABILITY OF ALL-TIME & CONTINUOUS COMMUNICATION BETWEEN DRIVER/GUARD AND STATION/CONTROLLER.**

- **UEC SYSTEMS HAVE ALSO NOT PROVED FULLY EFFECTIVE & USEFUL ON HEAVY DENSITY ROUTES.**

  - * SIMPLEX MODE OF WORKING – REQUIRES DISCIPLINE IN USE.
  - * NOISY FREQUENCY BAND.
  - * ALL USERS ON ONE FREQUENCY – CREATES CONFUSION & MAY NOT BE AVAILABLE WHEN NEEDED MOST.

- **WITH INCREASE IN SPEED & NUMBER OF TRAINS, RELIABLE & INSTANT COMMUNICATION WITH FAST CALL SET-UP TIME BETWEEN DRIVER & GUARD AND DRIVER/GUARD AND CONTROLLER IS ESSENTIAL.**
MTRC

- ENHANCES SAFETY:
  * CAN ELIMINATE FATAL ACCIDENTS IN CERTAIN SITUATIONS.

- PROVIDES INSTANT COMMUNICATION:
  * TO CONTROL FROM SITE OF ACCIDENTS.
  * TO DRIVER IN THE VICINITY OF AFFECTED TRAIN TO AVERT ACCIDENTS.

- IMPROVES OPERATIONAL EFFECTIVENESS & EFFICIENCY:
  * IMPROVES TRAIN RUNNING THROUGH BETTER MONITORING.
  * CUTS DOWN ON DURATION OF BLOCKS – ENGINEERING & POWER.
  * HELPS IN TROUBLESHOOTING AND SENDS TIMELY INFORMATION TO CONTROL ON LOCO FAILURES, C & W DEFECTS, AND LAW & ORDER PROBLEMS.
AIDS IN RELIEF OPERATIONS DURING ACCIDENT SITUATIONS:

* CONSTANT FLOW OF TWO – WAY INFORMATION FOR DIRECTIVES FROM CONTROL AND ASSISTANCE NEEDED AT ACCIDENT SITE.

IMPROVES CORPORATE IMAGE:

* PROVIDES POSITIVE SIGNALS TO PUBLIC AT LARGE FOR MEASURES TAKEN ON IR IN SAFETY MATTERS.

PROVIDES POTENTIAL FOR COMMERCIAL EXPLOITATION:

* MOBILE PHONES TO TRAVELLING PASSENGERS.
* RURAL COMMUNICATION IN A REASONABLY WIDE CORRIDOR ALONG THE TRACK.
Induction of Modern Signalling & Telecom in Rail Transport paving way for higher levels of Safety, Management of Rail Operations and Passenger Comforts.
Before TMS, Our Traffic Controllers were managing train operations in the old fashioned way…

- Static yard layouts
- Time Table
- Manual Control Chart
- No communication with Trains
Induction of Modern Signalling & Telecom in Rail Transport paving way for higher levels of Safety, Management of Rail Operations and Passenger Comforts.

TRAIN MANAGEMENT SYSTEM

On Churchgate Virar Mumbai Suburban Section
TMS Project on Western Railway

Real Time Train Arrival Status for Commuters with automatic announcements

Real Time Train Movements and Live Signalling Indications for Rail Operations

Mobile Communication
Thank You!

.....competing with Nature’s beauty......