

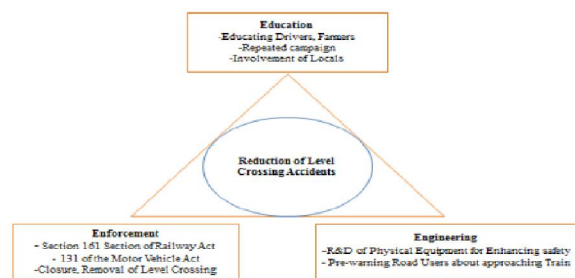
## ***Radio Frequency based Advance Warning System (Radio Based) to Pre-Warn Road User about Approaching Trains at Unmanned Level Crossing Gate***

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### **1.0 Background:**

Level crossings are the most vulnerable location on any Railway system as road and rail levels are at the same level. On Indian Railways there are approximately 32000 level crossing gates, out of which more than 13500 are unmanned level crossing gates. The accidents at level crossing gates contribute for approx. 40% of total accidents on Indian Railways. The fatalities and injuries due to accidents at level crossing gate are very high (i.e approx. 60% of total deaths due to accidents on Indian Railways).

The accidents at unmanned level crossing gates are much severe in terms of human loss since these accidents occurs mostly on account of lack of understanding/misjudgment (errors) and/or deliberate violations by road users, while crossing the level crossing in the face of approaching trains. In a research study from UK market, it has been observed that since level crossing accidents rates encountered by individuals are very low, so people miscalculate the severity of risk. Therefore, Railway administration shall adopt three-dimensional approach (as depicted in figure-1 below) involving Educating road-users about fatal risk, Enforcement of Law and adopting innovative Engineering solutions to warn road-users about approaching train.



**Figure - 1: Three Dimensional Approach for Reduction of Level Crossing Accidents**

According to one UIC study, almost 98% of all accidents at level crossing in Europe are caused by the misuse of road users and pedestrians mainly living or working near level crossings. It is therefore, educating people about severity of risk involved while crossing the Level

Crossings shall be most important factors to reduce the accidents at unmanned level crossings.

The prevailing laws [Section 161 of Railway act and Section 131 of the Motor Vehicle Act) shall be enforced to initiate penal action against those who endanger themselves & others on the Indian Railways. Intensive drive in association with State Law enforcing agencies will be very helpful reduction in fatalities & accidents at level crossings.

The third dimension of this three-dimensional approach focuses on adoption of innovative engineering & technological solutions to pre-warn road user about approaching train at unmanned level crossing. Such systems are only useful for law abiding alert road-users.

RDSO has taken some initiatives to develop Train Actuated Warning System (TAWS) to pre-warn road users about approaching train in past two decades. Different technologies for detection of trains like Seismic Transducers, Open Track Circuit and Axle Counters have been tried. The outcome of these trials have not been found very useful on account of following :

- Vandalism/ outside interference/ frequent theft at Unmanned Locations.
- Poor/ no Availability of reliable power supply at level crossing gates for various electronic systems and audio-visual device.
- Maintenance of system in mid-sections resulting into high downtime.

### **2.0 Details of Radio Frequency based Advance Warning System to Pre-Warn Road users about Approaching Train:**

In this background, Ministry of Railways has advised RDSO in October, 2014 to take appropriate action in mission mode to develop a suitable and viable vandal-proof advanced warning system to pre-warn road users against approaching trains at Unmanned Level Crossings. In December, 2014 Railway Board has directed RDSO to develop suitable device for providing audio-visual Warning to road- users at unmanned Level Crossings (LC) before the arrival

of a train at the LC.

Memorandum of Understanding (MoU) for this project was signed between IIT/Kanpur and RDSO in March 2015. This project has been also mentioned in MR's Budget Speech 2015-16.

RDSO along with IIT Kanpur has undertaken this R&D project for development of suitable & vandal-proof design of Radio Frequency based Advance Warning System to Pre-Warn Road users about Approaching Trains at Unmanned Level Crossing (LC) Gate" at a total cost of Rs. 46.37 Lakhs and completion period of nine months. The Functional Requirement Specification (FRS) & Conceptual design have been finalized and Prototype System for Field Trial has been fabricated by IIT/Kanpur.

## **2.1 Salient Features of System:**

### **2.1.1 Conceptual design evolved by IIT/Kanpur envisages use of following technologies:**

- (i) Global Positioning System (GPS) Receiver for collecting location information of Locomotive.
- (ii) RFID technology (In addition to GPS information) for collecting location information of Locomotive.
- (iii) Transmission & reception of information so collected in license free band (865 MHz) of Radio Frequency (RF).
- (iv) Low wattage LED Signals (less than 4 watts) & Audio (less than 4 watts) Warning to minimize power consumption at Level Crossing Gate. Total power consumption of the system is less than 20 watts.

### **2.1.2 The prototype developed has following salient feature specially incorporated for pilferage prevention & reduction of down time in case of vandalism:**

- (i) Alerts through GSM network at registered mobile numbers in case of pilferage at LC gate.
- (ii) Provides information at nominated mobile numbers about status of satisfactory working of the system ( i.e Voltage of power supply, RF transmission status etc.).
- (iii) No requirement of Power Supply at remote End from LC Gate. RFID tags being Passive Device.
- (iv) RFID tags placed on track does not have any market value. (Stick / mounted on track in such a manner that once removed from track).
- (v) Least Possible Requirement of Cable. Minimum Requirement of cable and hardware less

venerable to vandalism.

(vi) Following Anti Tamper features has been incorporated in the prototype:

- Use of Tamper/ Vandalism Sensing Devices, Robust Hardware and Specially Designed Pole, Special Type nuts & bolts.
- All Batteries/Solar Panels are tightened by metal rope also. All these metal ropes are connected to device. If any wire gets cut, SMS will go to controlling station & at nominated mobile numbers.
- An Audio alarming message will actuated locally about theft for 10 Seconds. It may be repeated if needed.

## **2.2 Brief Details of System Developed:**

IIT/Kanpur has already developed the prototype model for field trials being undertaken in Lucknow Division of Northern Railway. The system details are as under:

### **2.2.1 The prototype of the system consists of**

- [a] Locomotive Equipment with GPS, RF trans-receiver (Installed on the roof of locomotive) & RFID Reader (mounted at under-frame of locomotive)
- [b] Level Crossing Unit with RF trans-receiver, Solar Power Supply, data-logging & health monitoring, RFID tags.

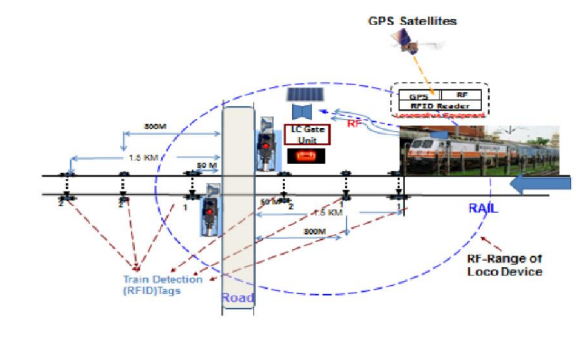
### **2.2.2 The locomotive Equipment consists of**

- (i) Main Unit [SBC (Single Board Computer), GPS receiver, RF (Radio Frequency) Trans-receiver, RFID Reader, SMPS Power Supply, 12 volt Battery] and
- (ii) Auxiliary Unit [GPS receiver, RF (Radio Frequency) Trans-receiver, SMPS Power Supply].

**2.2.3** The GPS Module collects location information of Locomotive and RFID reader of Locomotive Equipment reads the information of RFID Tags (Passive Device) installed on the Track. Location information so received is broadcasted through Radio Frequency (865 Mhz) Trans-receiver from Locomotive. Dual GPS Receiver & Dual RF Trans- receivers to improve availability. Main unit & Aux Unit work independently and takes 110 V DC Power Supply from Locomotive.

**2.2.4** RF Messages (RFID tags information as well as GPS information] are continuously broadcasted by Locomotive Equipment (which contains information like its Location Co-ordinates, Time & Speed) which is received by LC Gate Equipment. The RF Messages are decoded by LC gate unit for generating Audio-Visual Warning for Road Users. This System provides advanced warning

to road-users to pre-warn about approaching trains from a distance of approximately 1.5 Kms. Locomotive equipment also provides information to loco pilot about approaching LC-gate in the form of a buzzer sound through GIS mapping of the LC Gates. The schematic Diagram of the system is given below:



**2.2.5 LC Gate Equipment has Solar Power with Battery back-up as primary source of Power Supply.** LC gate equipment & Locomotive Equipment have a self-diagnostic feature to monitor its health and same is communicated to remote location over GSM platform. Any act of tampering (i.e disconnection) of LC gate equipment/parts i.e. battery, solar panel, hooter, signal unit etc. and the control unit of LC gate equipment generates a SMS alert which is being sent at three designates mobile number over GSM platform.

**2.2.6 The prototype system developed in this project provides following audio-visual warning to road user:**

- (i) Normal aspect of Road Signal will be Flashing Yellow (Flashing reduces power consumption by approx. 50%). and Hooter will be OFF when there are no approaching trains running within aerial distance of 1500 m (Approx.) & +50 m range from the Level Crossing Gate equipment.
- (ii) Audio and Visual (Flashing Red & Hooter

sound) both warning will start as soon as Train with Locomotive Equipment enters within 1500 m (approx.) Ariel distance of LC Gate and approaching towards it.

- (iii) Audio and Visual (both) warning will stop only after locomotive of the train has cleared the Level Crossing by minimum 50 Meter.

- (iv) In the event of two trains are simultaneously approaching level crossing, alarm shall not get switched off till locomotive of later of the two trains has cleared the level crossing by specified distance ( i.e 50 Meter for trail purpose).

- (v) The Audio Alarm should get switched off after 15 seconds and LC gate equipment shall enter in Standby Mode in case locomotive has stopped between Level Crossing Gate & within 1500 m (approx.) Ariel distance of LC Gate. The Audio Warning shall again start once Locomotive approaches towards LC gate

### 3.0 Present Status of Project:

3.1 The LC Gate Equipment has been installed at Level Crossing (LC) Gate number 29C (manned) falling between Sonik & Unnao Station in Lucknow-Kanpur Section of Northern Railway. The RFID Tags have been installed on the sleepers at 1500 Meters, 800 meters and 50 meters away from LC gate on both sides of Up & Down tracks as per clearance received from Track Directorate of RDSO.

3.2 One Electric Locomotive (WAP-4, number 22535, maintained by Kanpur Electric Loco Shed) running with Varuna Express (24227/24228) in Lucknow-Kanpur section has been equipped with Locomotive Equipment along-with RFID reader antennae (at bottom of Locomotive) and GPS & Radio Frequency Antennae (on the roof of Locomotive) as per clearance received from Electric Loco Directorate of RDSO.

Actual photograph of the LC gate installation is as under:



3.3 Field trial on latest version of system (which has evolved after several iterations of software & hardware modifications) has started since 31st October 2015. The performance of the Level Crossing Warning system provided at Level Crossing gate 29-C (manned) has been found satisfactory for last two days. In this system information about approaching LC-gate is also being provided to Loco pilot.

3.4 All the Locomotives/ MEMUs running in the section shall be equipped with locomotive equipment along-with RFID reader antennae (at bottom of Locomotive) and GPS & Radio Frequency Antennae (on the roof of Locomotive)

to provide audio-visual warning to Road users on any particular level crossing gate. Presently, since only one locomotive [WAP-4, number 22535, maintained by Kanpur Electric Loco Shed running with Varuna Express (24227/24228)] has been equipped with locomotive equipment, audio-visual warning is activated at Level Crossing (LC) Gate number 29C (manned) falling between Sonik & Unnao Station in Lucknow-Kanpur Section of Northern Railway, as and when this locomotive approaches this level crossing gate. For all other trains there is no audio-visual warning to road users.

#### 4.0 Conclusion:

The outcome of this proof of concept trials jointly undertaken by RDSO and IIT/Kanpur has been found very encouraging. However, to derive actual benefit all the locomotives running in the section shall be provided with such system. The issues pertaining to Operation & Maintenance of such systems needs to be deliberated before implementation/ adoption. The development and adoption of such solutions are only a small step in direction of Indian Railway's effort for reduction of level crossing accidents.

There is need to give more emphasis on enforcement & education aspects for witnessing better results in terms of reduction of reduction of level crossing accidents. Educating people about severity of risk involved while crossing the Level Crossings shall be most important strategy to reduce the accidents at unmanned level crossings. In this process Schools & Colleges, Print & Social media, Films, Civil societies, NGO, Gram-Panchayats, Law-enforcing agencies shall be involved for educating people about high level of risk involved at level crossing.