LEVEL CROSSING SAFETY IN ITALY

ILCAD
International Level Crossing Awareness Day

Alberto Mazzola
Responsible of International Government Affairs

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The purpose of the following presentation is to describe what FS Italiane Group does to ensure safety at Crossing Level in terms of

- removing level crossings
- improving technology
- raising awareness
Removing level crossings

Despite everybody knows level crossing environment is very dangerous, there are still accidents and fatalities on such crossing each year:

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<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
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<tbody>
<tr>
<td><strong>Total number of accidents</strong></td>
<td>37</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td>Of which at passive LC</td>
<td>0</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Of which at Active LC</td>
<td>37</td>
<td>35</td>
<td>21</td>
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<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
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<tr>
<td><strong>Total number of fatalities</strong></td>
<td>7</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>of which at passive LC</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>of which at active LC</td>
<td>7</td>
<td>8</td>
<td>5</td>
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Removing level crossings

• Level crossings are outdated because were designed in an era when road and rail traffic was much lighter than today.

• Since the end of the 1980s RFI, the domestic infrastructure manager, aiming at eliminating all existing level crossings through the country, has been carrying out on the current network a massive crossings removal, replacing them, where possible, by subways or bridges.

• The works have been financed by the State through specific funds and are agreed with local authorities.

• Furthermore the new rail networks are building without level crossings.
Removing level crossings

- At the end of the 1980s, there were approximately 16,000 LC along more than 16,700 km of rail network.
- In 2016 on the same lines, there were 4,620 LC
- In 2016 RFI closed around 168 LC around 135 of which assigned to private businesses
- Investment of approximately 60 million euros
- 2017 Program: elimination of 120 level crossings

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<th>2014</th>
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<th>2016</th>
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<tbody>
<tr>
<td>Total number of LC</td>
<td>5010</td>
<td>4840</td>
<td>4620</td>
</tr>
<tr>
<td>Of which passive LC</td>
<td>1076</td>
<td>980</td>
<td>842</td>
</tr>
<tr>
<td>Of which active LC</td>
<td>3934</td>
<td>3860</td>
<td>3778</td>
</tr>
</tbody>
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Improving tecnologies

- Removig LC is a long-term undertaking involving huge costs and relatively long time.
- This is why FS Italiane, is also taking other actions:
  - Investing in technologies
  - Prevention campaigns

The technology systems adopted by RFI to ensure safety at crossing level, include:
- ETCS Application
- PAI-PL Sistem
- Pr-PLp System
- PEPL System
ETCS Baseline 3

- TSI CCS (UE Regulation 216-919) introduces the possibility to manage level crossings with ERTMS/ETCS Baseline 3 specification by means of packet 88.

The occurrence of a not-protected level crossing is reported to the driver by means of a specific icon on the DMI.
ETCS application

- ETCS Level 2 or Level 1 plus Radio Infill will be superimposed to the existing national train protection system (SCMT) along lines belonging to conventional network.

- Level crossings typology on conventional network
  - Level crossings outside station (along the line)
    - Crossing barriers are closed when departure route is made
    - Crossing barriers are closed automatically by the train
  - Level crossings inside station
    - Crossing barriers are closed when arrival/departure route is made

- ETCS trackside system gets information about the status of:
  - Trackside signal used to protect level crossing
  - Each level crossing when the train has passed the trackside signal
In case of level crossing failure the ETCS stops the train at the corresponding trackside main signal.

When signalman activates rescue function (according to the Infrastructure Manager rules), the ETCS allows train to approach not protected level crossing with a Movement Authority in OS mode.

Stopping is required in rear of not protected level crossing.

LX speed restriction is set to 5 Km/h over the LX area.

If there are more than one level crossing protected by the same signal, stopping and LX speed restriction are applied only for the defective LX.
LC outside station (barriers closed automatically by train)

- Departure signal shows proceeding aspect independently by the status of level crossings
- The train orders the closing of level crossing barriers (activating a specific device along the line so that normally the driver sees the advance signal at a proceeding aspect)
- In case of failure, the trackside protection signal shows danger aspect
- ETCS stops the train in rear of trackside protection signal; no rescue function is available
- ETCS checks about the status of level crossing barriers: if they are lowered, MA in OnSight mode is given, otherwise driver has to apply Override procedure according to national rules.
- If there are more than one level crossing protected by the same signal, stopping and LX speed restriction are applied only for the defective LX
LC outside station (barriers closed by departure route command)

- Departure signal shows proceeding aspect when the level crossings protected by the signal are OK
- In case of failure departure signal remains at danger aspect
- When signalman activates rescue function (according to the Infrastructure Manager rules), the departure signal becomes at proceeding aspect and ETCS allows train to proceed with a Movement Authority in FS (the defective level crossing is outside the station).
- Stopping is required in rear of not protected level crossing; RBC/RIU sends MA in OS mode to overpass the LX area (level crossing barriers have to be lowered)
- LX speed restriction is set to 5 Km/h over the LX area
- If there are more than one level crossing protected by the same signal, stopping and LX speed restriction are applied only for the defective LX

Signalman activates rescue function. Departure signal becomes at a proceeding aspect

RBC(L2) / RIU (L1) verifies the status of crossing barriers of the defective LX; if they are lowered then MA in OS mode is given
In 2013 the RFI started a Program of Interventions aimed at increasing security levels on PL railway infrastructure.

Every 6 months is drafted a report sent to the Ministry of infrastructure and transport and the National Agency of Rail Transport (ANSF).

The PAI-PL System must verify the freedom from road vehicles of rail crossing equipped with complete barriers.
PAI-PL SYSTEM

The PAI-PL System consists of a “Monitoring Subsystem” and “Processing Subsystem”

In case of obstacle the signal is not set free and the national train control system activates the braking

Processing subsystem handles interfacing with signaling facilities. Each Monitoring Subsystem sends the information of the monitored area to the Processing Subsystem which determines whether there is an obstacle and in free area conditions it allows the train to be freed.

The senses of monitoring Subsystem can be realized with different technologies:
- Microwave barriers
- Radar systems at 10GHz, 24GHz, 76GHz
- Laser Scanner 2D or LIDAR 3D
- Inductive Loop

Among the various interventions, the most significant is the introduction of a new system PAI-PL
In 2013, thanks to new technologies on the market, RFI has decided to develop a new system analysis. The study developed by RFI originates from the European Regulation N.1302 DEL 18-11-2014.

In paragraph 4.2.2.5. Passive safety defines the scenarios from which to protect themselves:
- impact of the unit with a large road vehicle at a level crossing,
- impact of the unit into a low obstacle (eg car on a lift).

The reference object of the first scenario is defined by the UNI EN 15227 as a deformable barrier of 15 tons.
Another case for European standards do not define precisely the object of reference in order to define a minimum hurdle of reference that the system must ensure PAI-PL detection is necessary to refer to the vehicle's minimum size that it can be assumed represented by:

- a box placed on the floor with the following dimensions
  - 2.2 m in length
  - 1.1 m wide
  - 1.3 m in height

The size of the casing represented from the vehicle must be at least compatible with a person sitting

RFI decided to establish a precautionary level as an obstacle sample an object smaller than that defined above. To check the execution of the test you were chosen a cube of one meter side.

In addition, the new specification imposes further improvements:

- use of a limited number of sensors (maximum 2 sensors)
- god ease configuration
- internal planning for the installation
The system includes a laser head that scans the area to be monitored. Laser radar emits a laser pulse to an object, and measures the time that it takes for reflected laser to return to the radar (time-of-flight method) to acquire a distance to that object.

The laser radar head processes laser pulses through polygon and swing mirrors to make the laser pulse scan the entire area of a crossing in horizontal and vertical directions twice every second.

A controller processes the detection of obstacles. The hardware that executes detection processing tasks is made duplex.
The Unit Detection acquires the image of the monitored area. Unit Detection using a scanning optical system with distance measurement (LIDAR) to derive the geometric profile of the area.

The Unit Detection scans the area through polygon and swing mirrors which deflect the beam of measurement of a distance sensor.

The processing logic Detection Unit is built according to safety composite architecture equipped with all the necessary self-diagnostic.

The model “Background of Reference” provides the information on the monitored area free of encumbrances, against which
The Radar System operates as SIRIO sensor range - azimuth with cancellation of stationary targets using the "Remove the background."

The measurement range is effected by waveform LFMCW (Linear Frequency Modulation Continuous Wave) and the measurement is carried out by scanning in azimuth of 20 pairs of channels.

The Radar System is formed by an array of basic elements to form 20 pairs of channels TX-RX. It is constituted by two identical modules and one used for the transmission of the signal and one for receiving the echo of the targets.
The obstacle detection is performed using 2 FMCW radar operating in the W-band (76GHz). Radar antenna transceiver provides the transmission signal modulated in frequency and the result in base band (IF) of the scan control electronics.

The sensor subsystem is realized with an architecture of fail-safe type, where the control logic periodically monitors the correct functioning of all the sensor.

The control logic performs a spectral elaboration of the samples acquired from each sensor, and verifies the presence of an object within the area by comparing the energy level of the acquired signals with that of a reference.
Fifth: Inductive Loop

The magnetic field created by the loop results in electron movement in the conductive material.

For Lenz law, these electric currents induced on the conductive material are such as to create a induced magnetic field.

The inductance of the loop installed in the ground is tuned and through a suitable circuit it is possible to measure the transmitted power that the reflected power.
Comparing Systems

- **Microwave Barriers**: The system is not flexible. A lot numerous of false alarms. A lot number of antennas. Installation complex.

- **Radar Systems 10GHz**: Good resistance to weather condition and RCS obstacle rather stable with the angle of exposure. These frequencies allow for more complex processing: developing a coherent processing system with phase achieves good resolutions and low false alarm.

- **Radar Systems 24GHz**: The systems allow higher resolutions than at 10GHz while still maintaining a decent immunity to weather condition and angle of exposure of the object.

- **Radar Systems 76GHz**: Excellent resolution, it is hardly possible to develop a system with a complex signal processing. The system is susceptible to weather condition and RCS is affected by the angle of exposure of the obstacle.

- **3D Laser Scanner**: Almost immune to shape and material of the object to be detected. Great flexibility. The operation of the system is critical with weather condition.

- **Inductive Loops**: Only detects metal obstacle. Immune to weather condition. The process installative is rather complex.
Approval Process

The process of approval of the system consists of three phases:

- The first phase is finalized with the certification of prototype. To obtain such a certification system had to overcome a series of tests tracked by RFI. Test of functional requirements and environmental conditions (such as rain or fog).

- The second phase is finalized with the certification of the product. This phase is a detailed analysis of all documentation, both on the part of RFI and VIS, in order to ensure the achievement of the degrees of SIL4 safety system.

- The third phase is finalized with the approval of the product. In this phase it is carried out the experiments in the field of the system. A first stage OFF line of 4 systems for three months and then other putting into operation.
New Pr-PLp system (1/3)

Normally Private Access (PLp) Level Passes are not protected by signals and security is mandated to the single private user who must check the freedom of the line prior to crossing.

PLps are allocated on private land and access is only guaranteed to people authorized by one or more padlocks. All responsibility for the user was provided, which had only visual information. The opening is performed by the user under his direct and exclusive responsibility. The level crossing used by private users have the barriers normally locked. Immediately after the user closes the barriers

*Today, RFI also seeks to manage this type of PL safely and transforms them into 'normally closed PLs open on request'. Therefore, a PLP protection system is required to ensure that trains are traversed.*
New Pr-PLp system (2/3)

With the new Pr-PLp technology management system, barriers are open, conditioned to trains, only when demand is made by road users.

"PLp normally closed and opened on request" are protected by signals and have the status of permanent consent throughout the termination period.

The new Pr-PLp system designed by RFI to protect the PLP includes:

At the PLp:
- Establish a system with a magnetic card reader capable of sending the opening request to the DM / DCO;
- Realize electro-locks to enable locking and unlocking of barrier;
- Provide each authorized user with a uniquely identifiable magnetic card to perform on that request.
New Pr-PLp system (3/3)

At the designated station, create a system designed to:

- Acquire and record opening requests;
- Verify the validity of the request automatically;
- Submit the valid opening request to DM / DCO;
- Verify automatically the conditions of the line and the IS equipment (local and corresponding station);
- Obtain the permission granted by DM / DCO;
- Broaden the consensus on the PLP.
The passage of the train at the control pedal activates the PL lock closing maneuver. After crossing the first axis, the train occupies the release pedal leading to the maneuver in opening. If the train stops before crossing completely, then the PL may complete the opening with the train present on the crossing level.

This risk is defined in the standard UNI 11117 and it’s solved by the system PEPL.

PEPL System plans to install a track loop over the crossing level. In this way, release of the release pedal allows reopening of the barriers only if the track loop is free.
Raising awareness and education of public users are others key components of FS Italiane commitment to improve level crossing safety and to reduce accidents. Level crossing accidents are rarely attributable to the railway system. Almost all collision are due to users behavior because of a non – respect of the Highway Code, distraction, habit, stress of being late.

FS Italiane Group strongly support ILCAD initiative and every year organises an information awareness campaign to make people understand that accident could be avoided if they obey the traffic rules and are aware of the danger of risky behaviors at level crossing.

Tutti, ma proprio tutti, si fermano al passaggio a livello
Thank you!