



# Detection Procedure, Invasion and On-site Work Protections



Taiwan Railways Administration, MOTC

Engineering Department,

Rail Section Chief Chen, Hong-Guang

2023.6.13

## OVERVIEW

I Railway Detection Procedure

II Invasion Protection

III On-Site Work Safety Protection



# I . Railway Detection Procedure

## 1.1 Track Detection

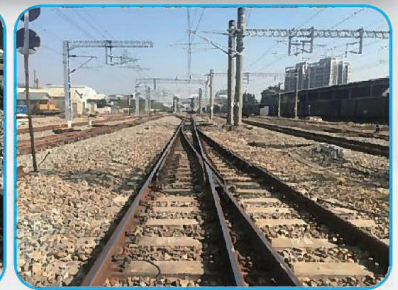
### 1. Method

- By walk
- By track maintenance car
- By train



### 2. Objects

- Roadbed tracks
- Bridges and tunnels
- Equipment along tracks



# I . Railway Detection Procedure

## 3. Malfunction Types & Level Determination

- **11** types: track geometry irregularity, rails, joints, ballasts, turnouts, etc.
- **4** levels and improvement due-dates
- Summarize into detection table

levels	Improvement due-dates
A	Ongoing tracking, improvement schedule
B	Improvement within one month
C	Improvement within one week
D	Improvement during that day or the following day

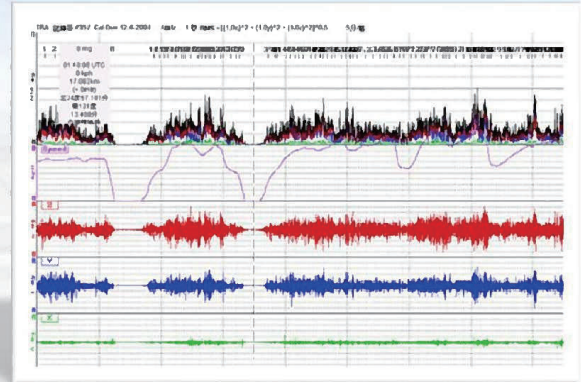




# I . Railway Detection Procedure

## 4. Vibration Detection

- Use **GPS Vibration Indicator**
- Detection on vibration at least once monthly.
- Criteria of regular maintenance:
  - AA and A tracks: **vibration value is 70mg**
  - B track: **vibration value is 80mg**



5

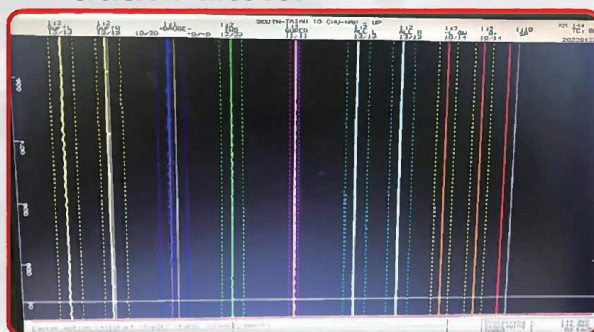
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# I . Railway Detection Procedure

## 1.2 Track Detection

### 1. Type one

Track detection car(EM80,DR2800)  
**Gauge, cross level, longitudinal level, alignment, twist (torsion)**  
Mud-pumping, landscape, track indicator



Detection screen

6

6

# I . Railway Detection Procedure

## Track Levels

**AA and A tracks**

**B track**

**Side track**

## Detection Frequency

**AA at least four times yearly**

**A and B at least once yearly**

## Tolerance Standard of

### Track Geometric

### Irregularity

**Regular maintenance**  
**Emergency maintenance**  
**Extensive repairment/  
 renovation**

標 示 之 檢 別	標 示 之 檢 別			標 示 之 檢 別			標 示 之 檢 別	
	平時養護標準值			緊急整修標準值			大修或更新後之標準值	
	特 甲 級 甲 線	乙 級 線	側 線	特 甲 級 甲 線	乙 級 線	側 線	各等級路線相同	
							一般區段	混凝土道床路段
軌距	+10 -5	(+7) (-4)		直線及曲線半徑600m以上 20 (14) 600m>曲線半徑≥200m 25 (19) 曲線半徑未滿200m 20 (14)			(+1) (-3)	(0) (-3)
水平	11 (7)	12 (8)	13 (9)	依平面性之整修值為基準			(4)	(2)
高低	13 (7)	14 (8)	16 (9)	23 (15)	25 (17)	27 (19)	(4)	(2)
方向	13 (7)	14 (8)	16 (9)	23 (15)	25 (17)	27 (19)	(4)	(2)
平面性				23 (18) 包括超高遞減量			(4) (不包括超高遞減量)	

### Note:

- 1) Measured by highspeed detection car (dynamic unevenness, static unevenness is with bracket)
- 2) Longitudinal level and irregularity are calculated by the length (10m) of chord.
- 3) Flatness is based on the horizontal variation every five meters.
- 4) Tolerances of gauge, level, longitudinal level, and alignment do not include normal widening cant and haversine of curve areas.



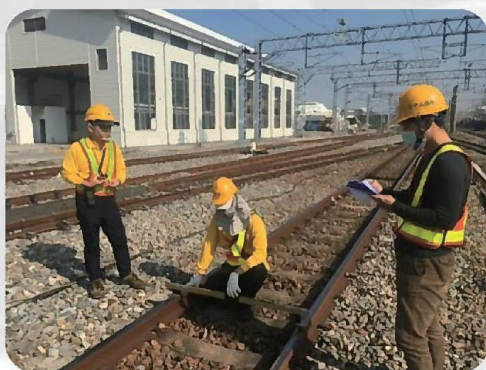
# I . Railway Detection Procedure

## 2. Type 2

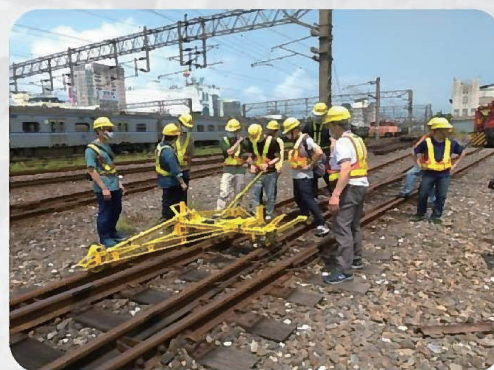
Human detection

Numbered tracks, turnout, joint outside station, expansion joint, side-ditch and weeding, level crossing, tracks of steel bridge, office buildings tidy-up, detection records

Detection Frequencies **All tracks twice a year**



**Gauge level board**



**Mini-sized track detector**





# I . Railway Detection Procedure

## 3. Ultrasonic Flaw Detection

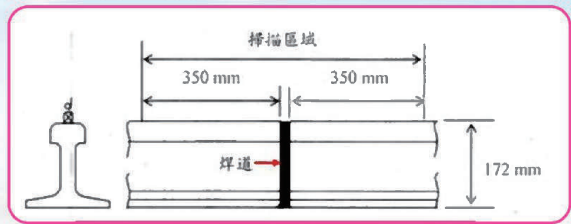
Welded track defects

Welding quality

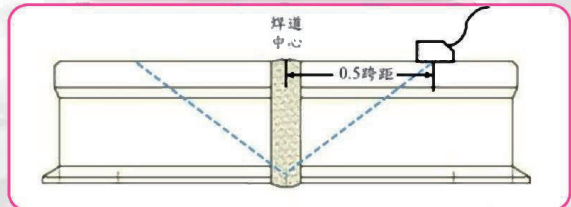


On-site detection

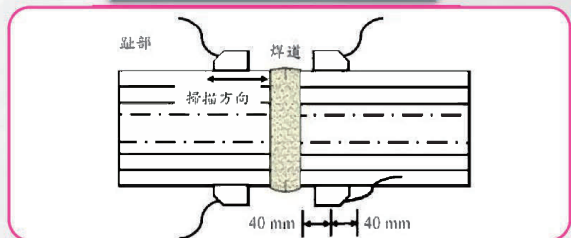
Bottom reflected wave A-Scan



Straight beam method



Angle beam method



Angle beam method on track bottom

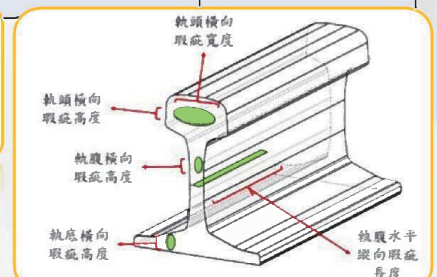
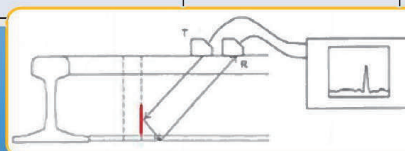


# I . Railway Detection Procedure

## Defect Levels

position	defect	A	B	C	D
Rail Head	Lateral defects (width/Altitude)	$W/A < 5 \text{ mm}$	$5\text{mm} \leq W/A < 15 \text{ mm}$	$15 \text{ mm} \leq W/A < 30 \text{ mm}$	$W/A \geq 30 \text{ mm}$
Rail Web	Horizontal longitudinal (Length)	$L < 2 \text{ mm}$	$2\text{mm} \leq L < 6 \text{ mm}$	$6 \text{ mm} \leq L < 10 \text{ mm}$	$L \geq 10 \text{ mm}$
Welded Rail	Lateral defects (Altitude)	-	$A < 5 \text{ mm}$	$5 \text{ mm} \leq A < 10 \text{ mm}$	$AA \geq 10 \text{ mm}$
	Welded poorness	-	Echo height $< 25 \%$	$25 \% \leq \text{echo height} < 50 \%$	Echo height $\geq 50 \%$
Rail Bottom	Lateral Altitude defects	-	-	$A < 3 \text{ mm}$	$A \geq 3 \text{ mm}$

- A : re-inspect/ record once yearly
- B : re-inspect/ record once 6 months
- C : re-weld within two months
- D : re-weld within two days



# I . Railway Detection Procedure

## 4. Temperature Monitor

Avoiding track bending due to high temperature

Set up temperature sensor on near-by tracks

Timely monitoring on rail and atmospheric temperatures



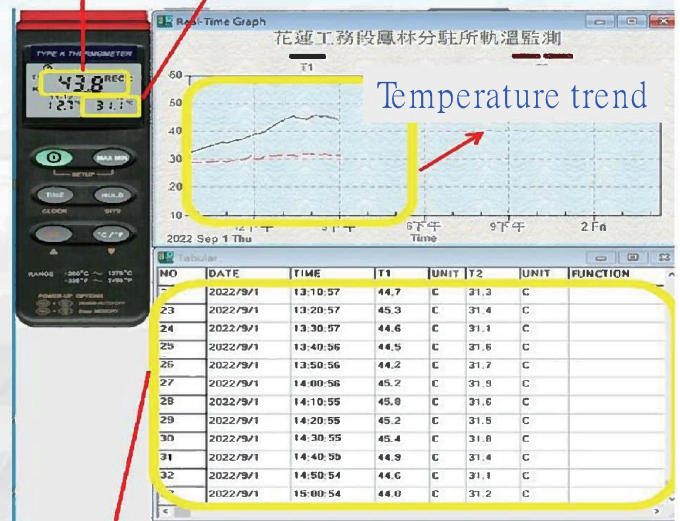
Temperature sensor



Signal transmission



temperature Atmospheric temperature



Recorded Data

# I . Railway Detection Procedure

Make rail temperature standard and step-by-step procedure

Up to 50°C

- Staff pointed to monitor
- Notification to on-site section.
- Not disturb the road-bed.



Up to 55°C

- Staff pointed to monitor
- Staff pointed to detect tracks



Up to 60°C

- Staff pointed to monitor
- Staff pointed to strengthen monitor
- Staff / Equipment stand by





# II . Protection on Track Invasion

## 2.1 Warning System on Rockfall from Side Slope

### 1. Purpose

Areas where exist potential risk factors such as rockfall and debris flow may be difficult to make thorough improvements.

Establishment on rockfall warning system instead **(already 26 spots established)**

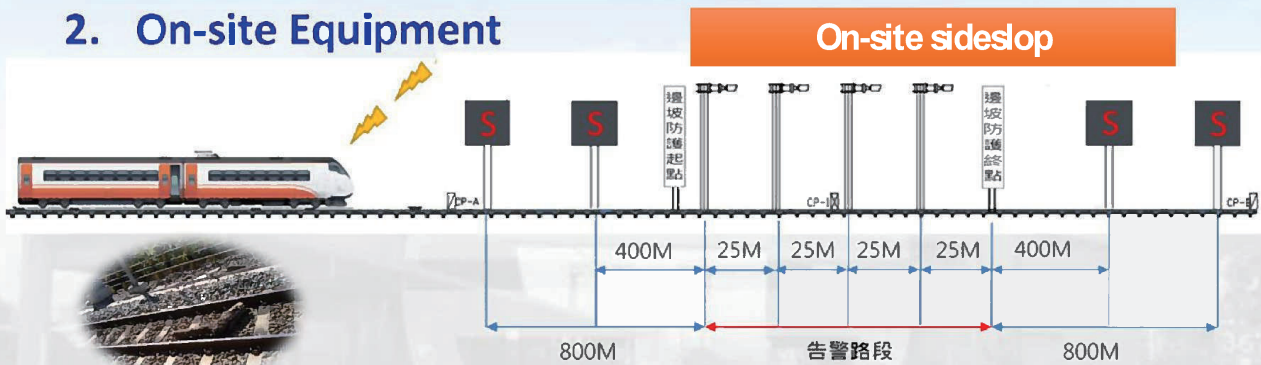
Systems include automatic detection on invasion and alarm device.

Detection system connects with **AI system** through CCTV.



# II . Protection on Track Invasion

## 2. On-site Equipment



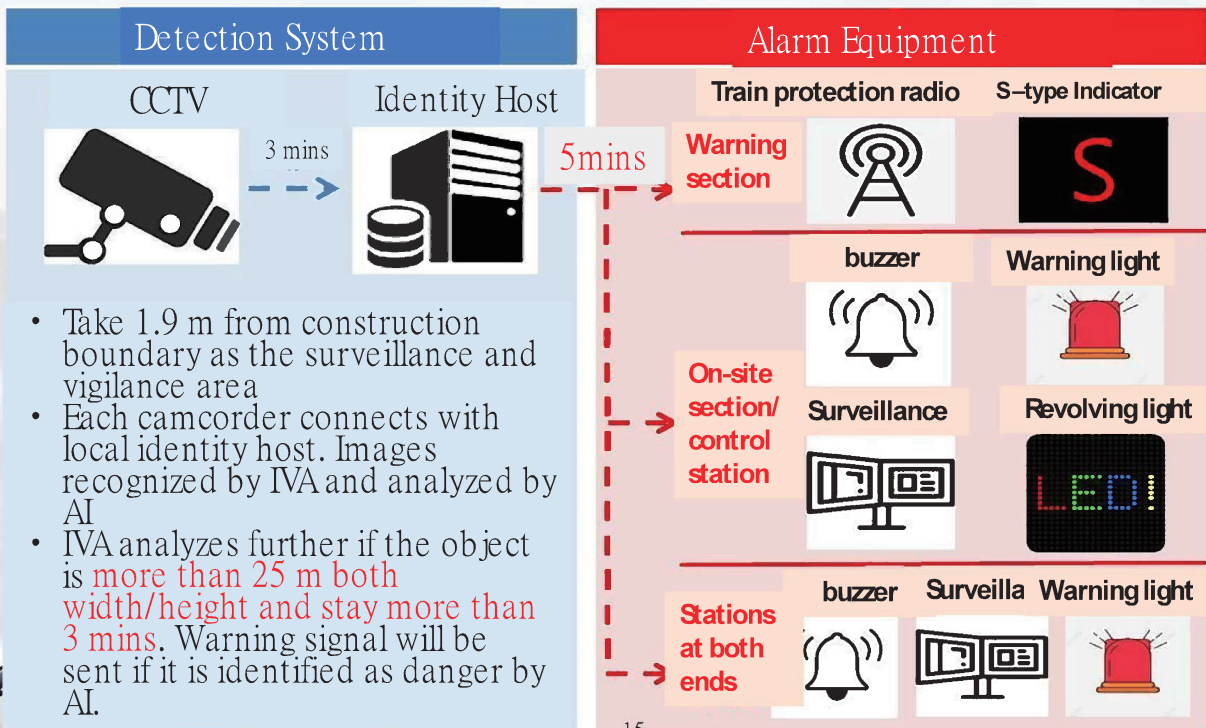
- 1) Camcorders established within warning section **every 25 meters**
- 2) Train protection radio is installed in the center part, with signal coverage at least 800 meters in front and behind the section.
- 3) **S-type warning indicators installed at 400 meter and 800 meter** in front and behind the warning section.
- 4) Signboard (**side slope protection start/end**) at starting point and end point.



Signboard

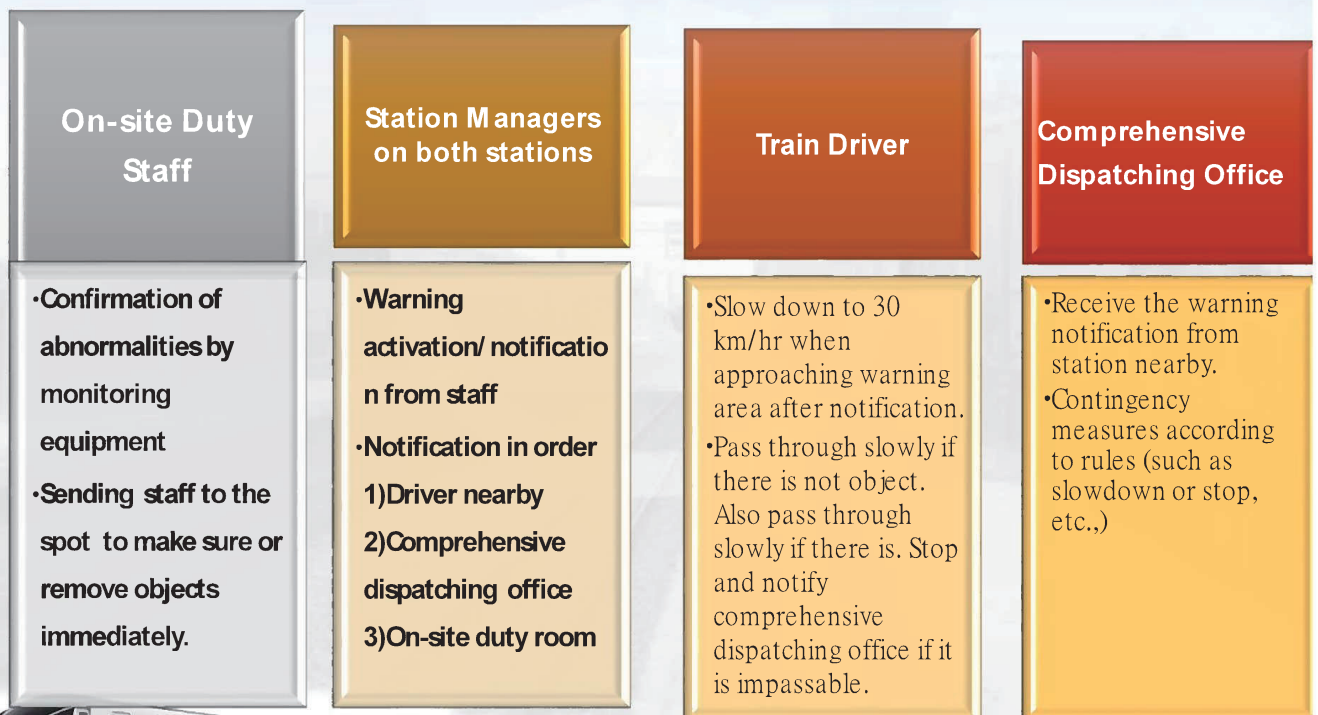
# II . Protection on Track Invasion

## 2.2 Warning Detection System/ Alarm Equipment



# II . Protection on Track Invasion

## 2.3 Notification Procedure(warning activation)

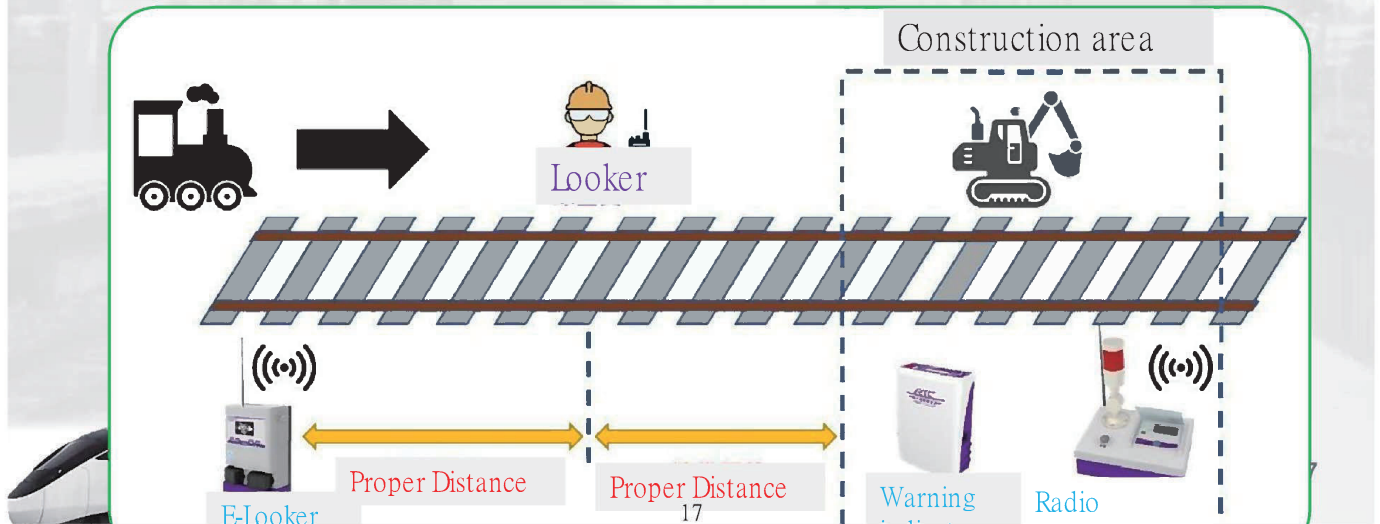
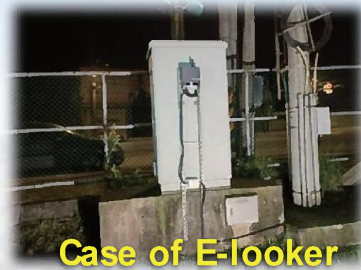




# III. Protections for On-site Work

## 3.1 E-Looker(Moveable)

1. Assisting and reminding functions
2. Reminding by vibration and buzzer

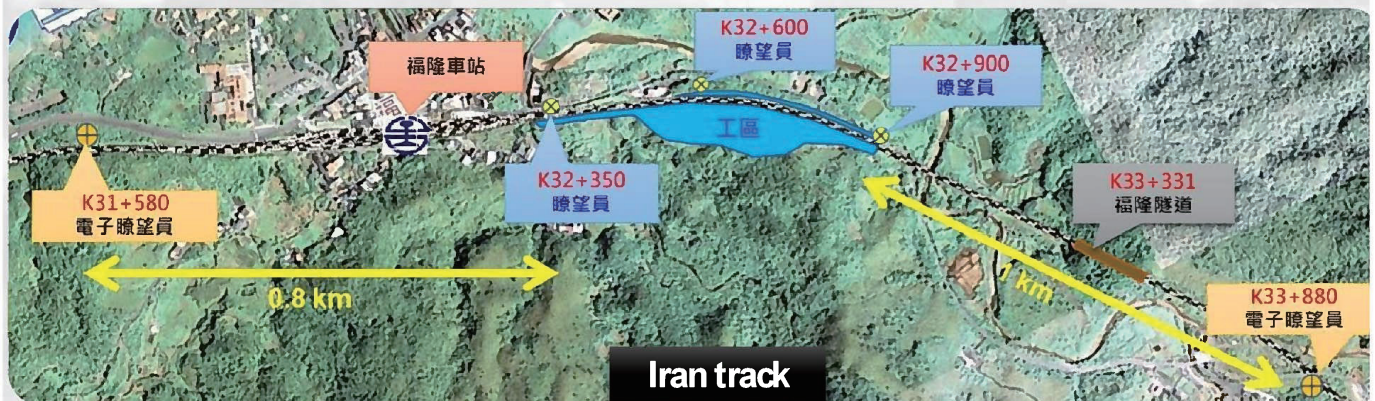


# III. Protection for On-site Rail work

## 3.2 Implementation Sections

1. 7 sections this year
2. Completion of Furon section test the end of 2022

Improvements--Side slope of ground anchor



# Q&A

1. What is the regular detections on traditional rails?  
How to ensure the rail safety?
2. There used to happen track invasion accidents in Taiwan. What are the strategies?
3. Is there any statistic data of track cracks and rail frustration of traditional rails? How to deal with these problems?
4. What are the strategies to avoid rockfalls on slopes?  
How is the establishment of warning system?



19

19



# THANK YOU

安全·準確·服務·創新·團結·榮譽



# The Review and Safety Training after accident occurred in TRA

 Taiwan Railways Administration, MOTC  
Department of Operational Safety  
Executive Tsai, Yi-Chia

2023.6.13



## Content

01

Preface

02

Implementations  
of TRA

03

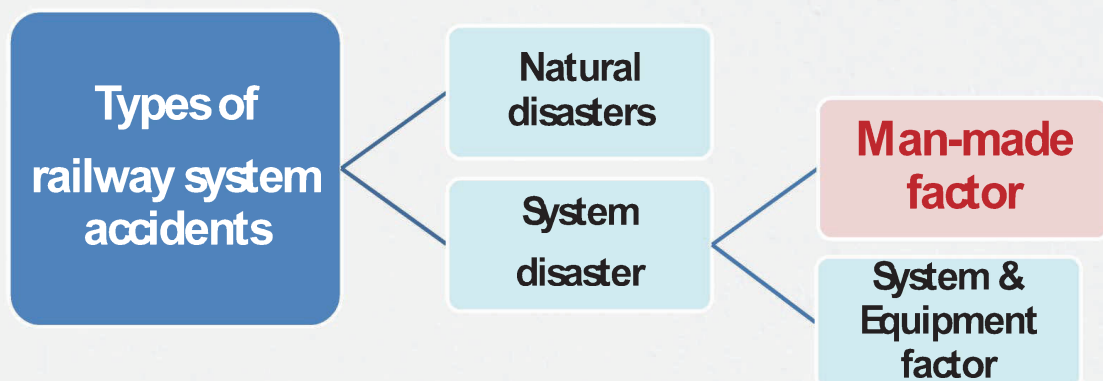
Discussions

# 01 Preface

23

## 1. Preface (1/2)

The types of railway system accidents are divided into two types: natural disasters and system disasters. "System disaster" can be divided into disasters caused by "Man-made factors" and System & Equipment factors. "The damages caused by the former are the most serious."



24



## 1. Preface (2/2)

Therefore, safety education training for the staff members after accidents is essential to prevent recurrences. It may also [improve staff members on safety concepts, knowledge and professional skills, and the ability to handle emergencies](#). The education training improves railroad safety and, as a result, may decrease the occurrence and damage of accidents.

**Strengthen the  
Concept of  
Safety**

**Enhance Security  
knowledge**

**Safety Education  
Training after  
accidents**



**Enhancing Safety  
Skills**

**Emergency  
Handling Ability**

25

## 02 Implementations of TRA

26



## 2、Implementations of TRA(1/10)

### Case1 : 2021.2.23 Staff members hit during turnout maintenance duty at Haiduan station

#### 1 Outline of the Case

One day maintenance staff members were responsible for the regular detection and maintenance (from Haiduan to Guanshan), meanwhile, the other team held a driving training course for electricity maintenance nearby them. Unfortunately, maintenance staff members were hit by the training car when train is crossing the station, with two dead and one seriously injured. It was found that the maintenance staff **did not** comply with the regulations to assign a lookout to pay attention to trains, **nor** did the driver slow down according to the manual.

#### 2 Improvements

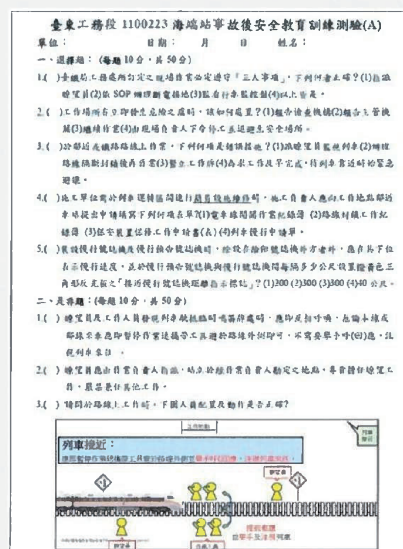
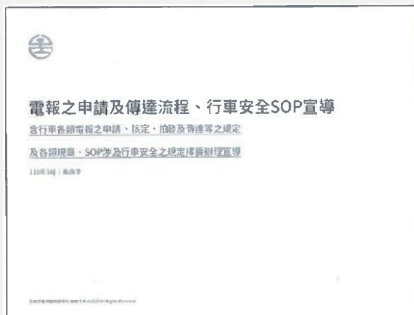
- 1) Intense the management of on-site staff, including self-protection, emergency management, and limiting worktime to only nighttime thus guaranteeing their safety.
- 2) Review the mechanism of horizontal communication to ensure information is transmitted effectively.
- 3) Install a driving recorder on the front part of each vehicle.
- 4) Conduct safety education and training for on-site staff.

27

## 2、Implementations of TRA(2/10)

#### 3 Education Training

Mainly by **classroom lecture**, staffs are asked to make presentations including accident review & prevention of recurrence. The regulations and practices will be explained by lecturers. A written test will be held after each lecture to assess the staff's understanding of training.



28



## 2、Implementations of TRA<sup>(3/10)</sup>

### Case 2 : 2022.8.5 The Derailment of Marshalling Train at Chaozhou Base

#### 1 Outline the Accident

When a marshalling train passing the Chaozhou Base, the staff found that the warning flag and the derailer behind the indicator "Stop and start again" have not yet taken off because of the hinders of road curves and the wire rod. The staff immediately contacts the train driver and make a gesture showing danger. However, the braking distance is too short to stop the train thus a derailment happened. According to the investigation, the driver **did not comply with** slow-down rules and did not stop once before the "stop and start again" indicator. Besides, the malfunction of collaboration within horizontal communications and unfamiliarity with the route also lead to this accident.

#### 2 Implementations

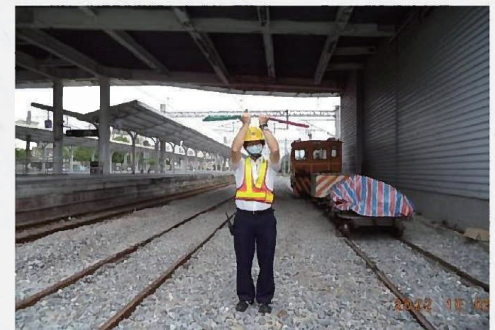
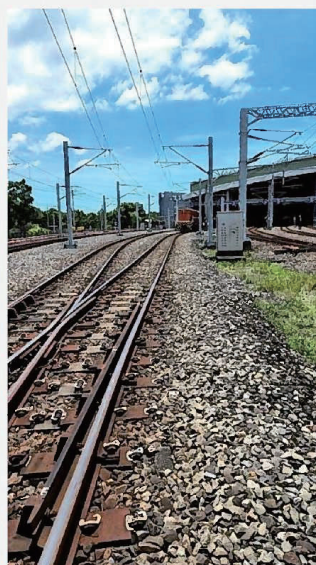
- 1) Remind that when there is a marshalling, the train should stop once before the "stop and start again" indicator in accordance with regulations.
- 2) Strengthen staff's familiarity with the train route.
- 3) Review the horizontal communication mechanism between Electrical & Mechanical or other related units to ensure effective information transmission. Designate a single contact window and complete the "Chaozhou Base Marshalling Work Protocol" together.
- 4) Conduct safety education and training for on-site staff members.

29

## 2、Implementations of TRA<sup>(4/10)</sup>

#### 3 Education Training

Mainly implemented by both lecture/practical training. The lecturer emphasizes safety concept with the explanation of related rules. In addition, staff practices on site to improve the work proficiency.



111年8月5日潮州車輛基地  
運務室A29乙班調車機車出軌  
事故簡報

報告時間:2022.08.18 | 報告人:高雄運務段

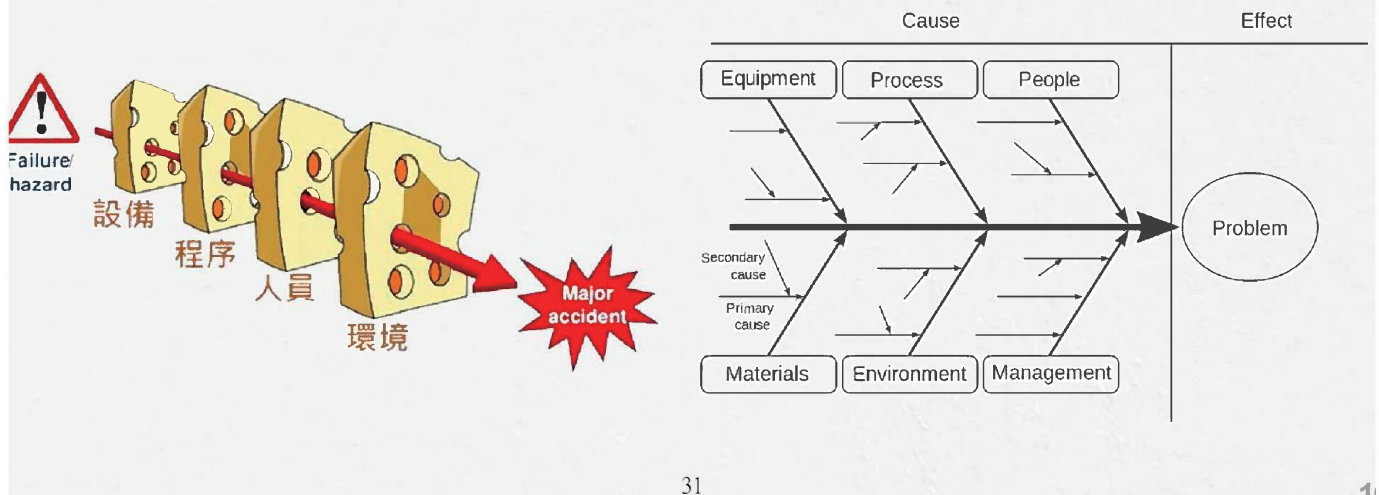


30

## 2、Implementations of TRA (5/10)

### Summary

TRA identifies both direct and indirect causes of the accident. The indirect ones are analyzed by six facets, including **staff members, process, equipment, management, environment, and materials**. Also, **analyze the causes** and **make strategies to improve**.



31

## 2、Implementations of TRA (6/10)

After investigating and analyzing the causes of the accident **that could be attributed**, each department strengthens **staff safety education training** through equipment and regulation/system revision. Tests assess the effectiveness of the improvement measures.

At present, there are mainly two ways of safety education: **lecture training** and **practical training**.



32

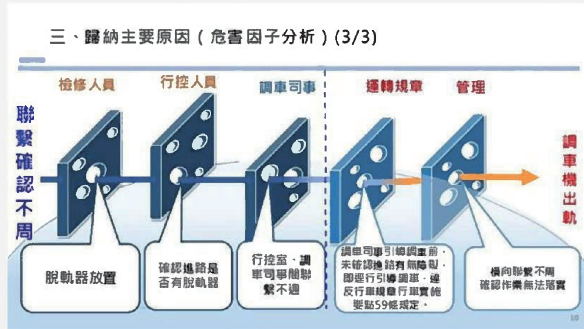


## 2、Implementations of TRA(7/10)

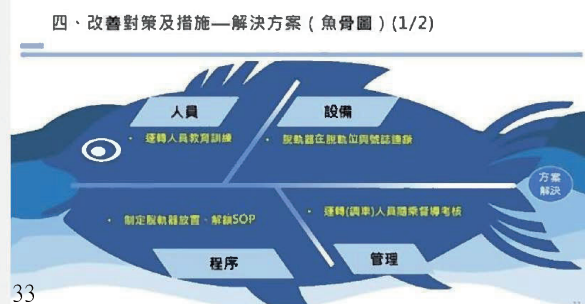
### Lecture Training

#### (1) Produce accident review and prevention strategy report

Use Fishbone Diagram and Swiss Cheese Theory to analyze the detail and let staff identify the causes of the accident.



Improve staff's safety knowledge



33

## 2、Implementations of TRA(8/10)

#### (2) Make Accident Newsletter

The Department of Operational Safety(TRA) makes an accident newsletter and asks all departments to **focus on the education training learned** from this experience. It could prevent similar cases from reoccurrence. Staff must also **read** the newsletter overall and **sign in**.

Strengthen staff's safety concept

事故快報		111年11月15日 鐵安預 第TA-111-19號
事故種類	出軌事故	
發生日期	111年8月5日	
發生地點	潮州基地	
車次	調車機車	
事故概況	11:28 許(車速表資料), 調車機 R34 由到開線往南開, 欲連整備線 2 股連掛第 554 次編組, 接近車庫前時該路線為彎道且有電車線桿阻擋致視距受阻, 調車員司發現停車再開標誌後方紅色險阻標及脫軌器未移除(距離出軌處約 20m), 馬上呼叫司機員停車並手作險阻標誌, 因制制距離不足致衝過脫軌器造成調車機車第 3 軸出軌, 11:30 通報, 12:20 搶修機具出動, 13:30 復軌, 14:09 由單機 R133 將事故車拖離後恢復正常, 無影響出、入基地列車。	
事故原因	一、司機員與調車員司於調車作業時, 未及時制速度, 致使調車機車超過脫軌器, 肇致出軌。 二、脫軌器移除聯繫未周全, 尚未確認拆除即開始調車。	
懲處結果	高雄機務段調車機車司機員申誠1次、高雄運務段調車員司申誠1次。	
改善及防範措施	一、請運務處及機務處督導所屬各調車工作班擬進入車庫調車時, 應依規章於「停車再開標誌」前一度停車, 並在確認進路「禁動牌」已移除及「脫軌器」扳至「不使脫軌之位置」, 方可進入路線調車。 二、請運務處加強調車人員現場調車環境熟悉度及工作安全意識之教育訓練。 三、請運務處於培訓調車管班人力時, 應加強場站環境熟悉及相關調車規定之教育訓練。 四、請運務處及機務處督導所屬高雄運務段及高雄機務段針對潮州基地聯繫調車作業事宜, 應指定單一對接窗口。 五、請運務處及機務處督導所屬高雄運務段及高雄機務段共同完成「潮州基地調車工作規約」。	

\* 發生行車事故未即時通報, 當事人及主管須受處分。  
\* 本公報僅供本局內部參考, 如有外洩, 當追究責任並從嚴核處。

聯繫 再聯繫 再三聯繫!

34

確認 再確認 再三確認!

14

## 2、 Implementations of TRA (9/10)

### (3) Make Education Training Videos

#### A. Steer Marshlling Training

<https://youtu.be/82cNwWWtcNM>



#### B. The SOP of Regular Marshlling Training

<https://youtu.be/YkWKJWGxUqA>

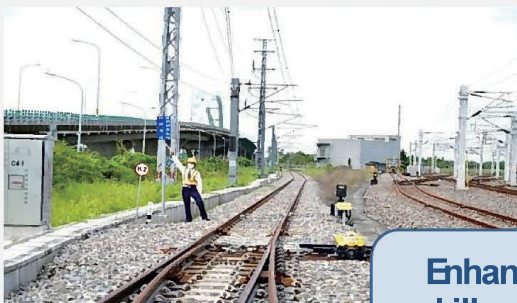


Improve staff's  
safety knowledge

## 2、 Implementations of TRA (10/10)

### Practical Training

To strengthen the knowledge learned from lectures, staff also need to practice on-site work to ensure their practical performances according to the knowledge gained from the lecturer.



Enhance staff safety  
skills and emergency  
handling abilities





# 03 Discussions

37

## 3、Discussions

- 1) How does the Japan Railway manage the accidents caused by the staff's negligence of rules? Is there any safety education training to prevent the reoccurrence of accidents?
- 2) How can the Japanese Railway improve when dealing with repeated cases of the staff not following the regulations?
- 3) What are the difficulties and the solutions when the Japanese Railway implements safety education or takes prevention actions?
- 4) Some suggestions on these two cases, especially the education training from TRA, will be appreciated.

38

1\*



**Thank you for listening.**

**Please do provide your valuable comments.**



# **The Safety Standard of Level Crossing and Equipment Improvement**

**Taiwan Railways Administration, MOTC  
Department of Telecommunications Services**

2023.06.13. | Signal Section Chief Li, Yan-Yi



# OVERVIEW

## I 、 Level Crossing Protection Equipment

- 1.Preface
- 2.Types of level crossing
- 3.Level crossing equipment

## II 、 Improvements on Level Crossing Equipment

1. Large-sized direction indicator, double-sided flashing light and emergency buttons .
2. Automatic detection system on obstacle.

## III 、 Discussion

## 1.Preface

A Level crossing is the most dangerous node in railroad transportation. The more the traffic increases, the more challenging it is in safety protection. Although there has been showing a decreasing trend in traffic accidents occurring in TRA recently, the number of fatalities and injuries that occurred at level crossings has been increasing.

It is essential to disseminate passengers' paying attention when they are crossing. Also, to improve equipment thus strengthening the safety of the railroad is necessary.



## 2. Types of Level Crossing

### Type one

Set up blockers and alarm devices and have a lookout watch day and night.

### Type two

The same as type one but no trains pass through for **more than 6 consecutive hours**.

Equipment is the same as type one, signed lookout during 「Required Time」。

### Type three

Traffic volume is the same as type one with less than 30 train passing during peak traffic hours :

(1)Level crossing goes through less than 4 lanes of the main line.

(2)Sight distance of the alarm flashing is more than 45 meter.

(3)Alarm time is more than 30 seconds

Automatic alarms and automatic blocking machine, no need to have any lookout.

Temporary staff if necessary.

### Type four

Traffic volume does meet the standard, only set up "level crossing "indicators.

## 3.Level Crossing Equipment (1/ 7)

### Basic Equipment (rail side)

- Alarm pole
- Alarm
- Point indicator
- Small-sized route indicator
- Emergency button
- Contact phone
- Monitoring billboard





### 3.Level Crossing Equipment (2/ 7)

#### Train Route Indicator

For small-sized trains

Indicator shows  
"Train Direction Arrow" and  
"Attention Train ", when trains  
approach.

All arrow signals will illuminate when malfunctioning  
happened. The indicator alternately. Signals displays  
"Attention Train" and "Stop Using" every 6 seconds,  
with perspective distance more than 25M.



Large-sized route  
Indicator is installed  
at important intersections  
to warn drivers.



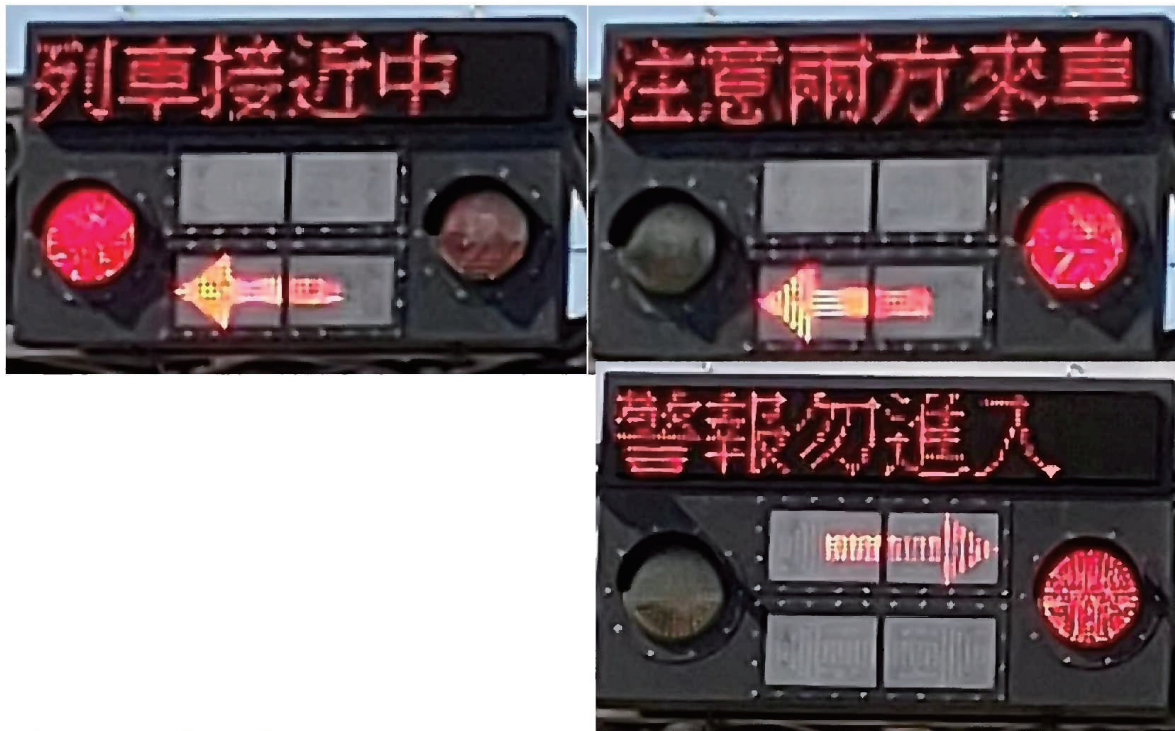
### 3.Level Crossing Equipment (3/ 7)

Train route indicator(information changeable)---Alert  
is not activated



### 3.Level Crossing Equipment (4/ 7)

Train route indicator(information changeable)---Alert is activated



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8

47

### 3.Level Crossing Equipment (5/ 7)

Rail Barriers(controller and breakout bar)



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9

48



### 3.Level Crossing Equipment (6/ 7)

#### Emergency Button and Signaling System



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### 3.Level Crossing Equipment (7/ 7)

#### Automatic sensor for obstacle (infrared line)



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## II 、 Improvements on Level Crossing Equipment(1/ 7)

Add large-sized route indicators and double-sided flash indicators  
,improvements on the emergency button

Add large-sized route indicators

Double-Sided flash indicators

Emergency button (add the new one on the exit side)



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12

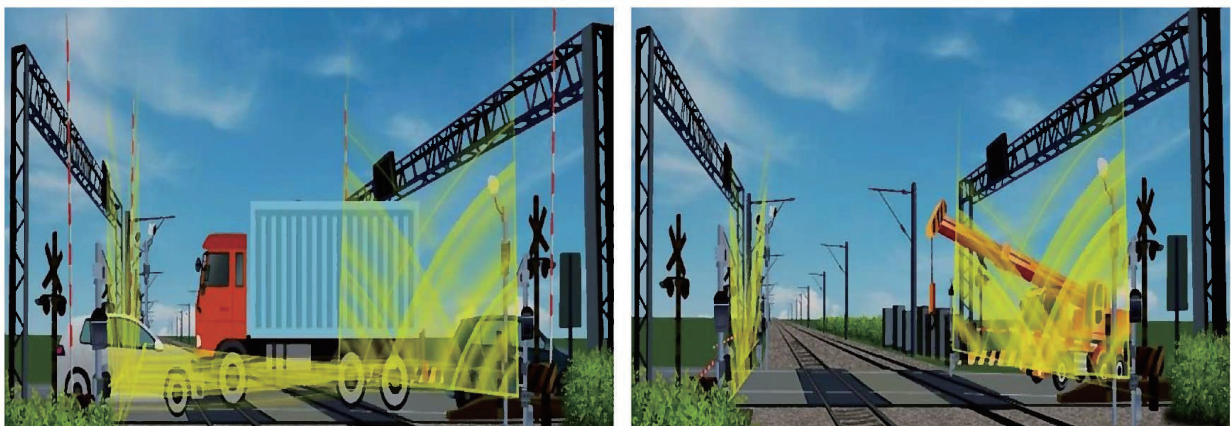
51

## II 、 Improvements on Level Crossing Equipment(2/ 7)

### Automatic Detection System

Use thermal and radar detection systems. The detection area changes from 75cm-150cm to 30cm-300cm by comparison with the old one using point-to-point scanning by infrared laser light. Once the obstacle is detected, the recorder will feed back to the driver via radio for early response and thus reduce the occurrence of accidents.

Has been applied to 257 level crossings since June of 2022.



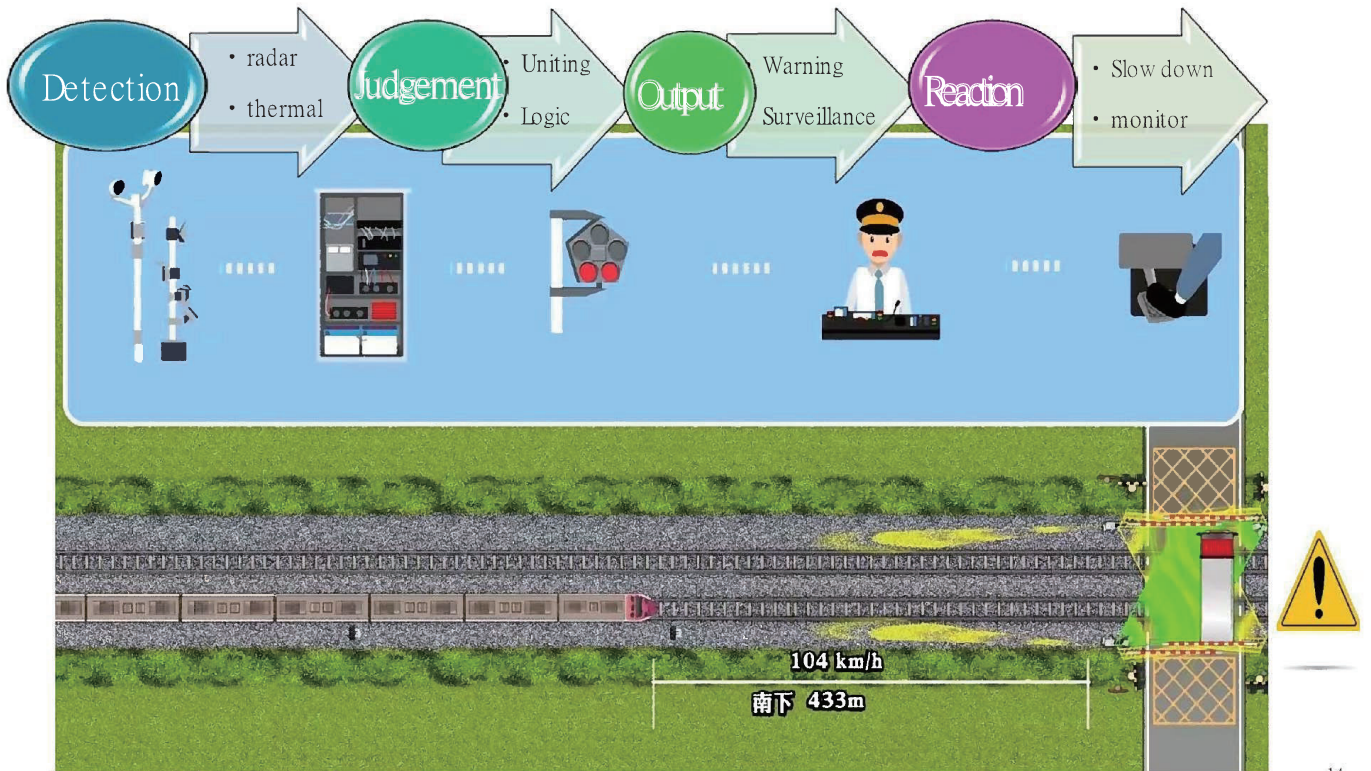
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13

52

## II 、 Improvements on Level Crossing Equipment(3/ 7)

### The Activation Mechanism of Detection



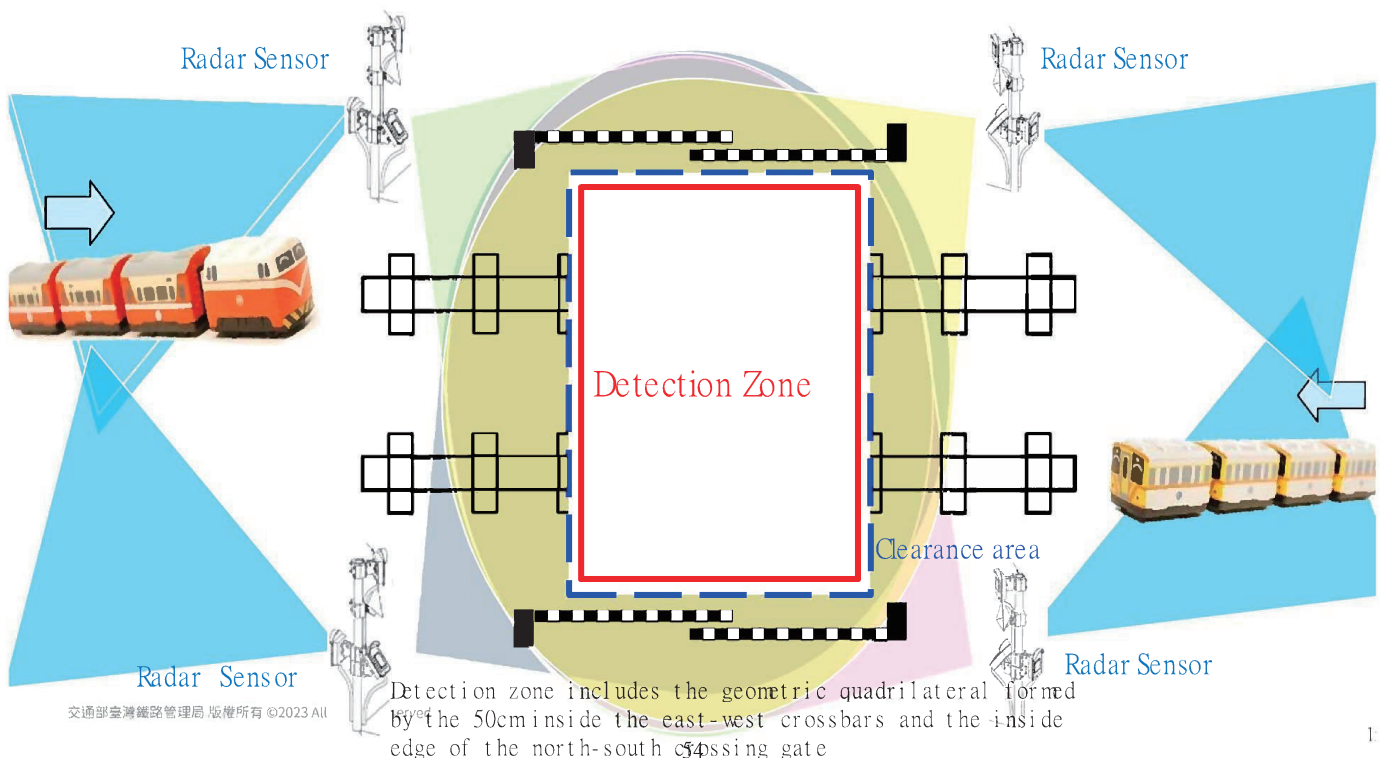
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14

53

## II 、 Improvements on Level Crossing Equipment(4/ 7)

### Radar sensor and train detect equipment



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1




## II 、Improvements on Level Crossing Equipment (5/ 7)



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### Train Detect Radar



Positive detection for tracks.  
Judgement on directions and train speed.  
As the basis to estimate the entry/departure time of train.

### Horizon/Vertical detect Radar



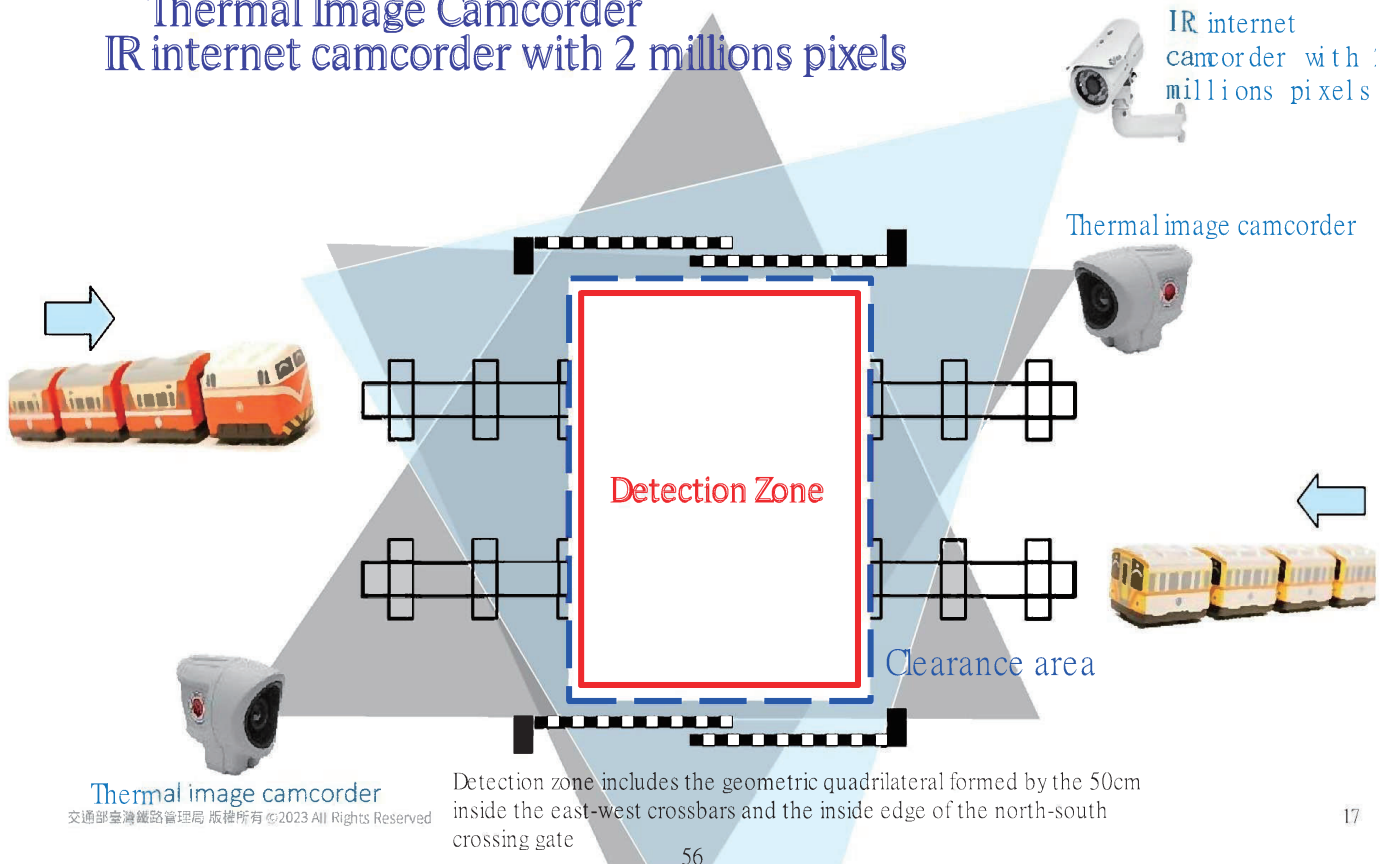
Horizon detect  
Vertical detect  
As the judgement of whether there is obstacle

55

1

## II 、Improvements on Level Crossing Equipment(6/ 7)

Thermal Image Camcorder  
IR internet camcorder with 2 millions pixels



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56

17

## II 、 Improvements on Level Crossing Equipment(7/ 7)

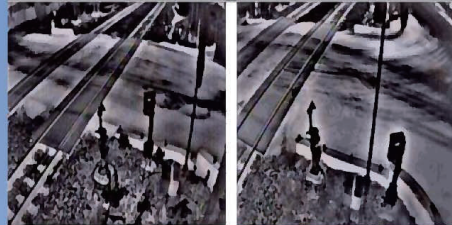


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57

### Thermal Image Camcorder

Not easy affected by weather  
Timely Compare/Calculate



### IR Network camcorder with 2 millions pixels

Including total clearance area  
of level crossing  
Image preservation as an  
evidence



18

## III 、 Discussion

Does the Japanese Railroad have an automatic system for level-crossing obstacle detection? What types are they?

Is there any requirement that the width of the level crossing need to completely cover the width of roads without any gaps? Do staff need to be responsible for any accidents caused by those who neglect these gaps?

Is there any protection when the break bar is raised and is immediately putting down caused by trains intersecting frequently?

How could you protect plenty of cables established along with the level crossing? Is there any cable trunk installed to store these cables?

What are the penalties for those who break through level crossings in Japan?

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58

19



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