The risk of derailment and collision, and safety systems to prevent the risk

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Introduction

Since our establishment in 1987, we have been working consistently to improve safety as our most important mission. We must prevent derailments and collisions, because passengers may be injured or killed in accidents.

In this paper, we report causes of derailments and collisions that occurred in the past. Next, we report countermeasures for these accidents. In addition, new countermeasures had been suggested after the Fukuchiyama-Line derailment killed 107 people and injured 562 in 2005. We will explain this in view of the law of Japan and changes in risk. And, we report about changes in safety after taking these countermeasures.

1 Causes of derailments and collisions that occurred in the past and countermeasures for these accidents

It is not too much to say that the history of railway safety in Japan is the history of accidents. We have improved the safety level because we must not repeat the accident that occurred in the past. In this chapter, we explain two accidents that were a turning point for our countermeasures.

a) The Mikawashima accident (collision)

This accident, which occurred on May 3, 1962, was a derailment and multiple collisions. In this accident, three accidents occurred one after another.

(The first accident)

A freight train ran through a red signal. Next, the locomotive and freight train derailed on the down main railway track and derailed cars were obstacle to movement on the down main railway track.

(The second accident)

A down passenger train collided with the derailed cars. Next, this down passenger train derailed on the down main railway track and derailed cars were an obstacle to movement on the up main railway track. In this time, protections for trains running in the vicinity were not taken. At the same time, many passengers opened the door and they started walking on the main railway track.

(The third accident)

An up passenger train collided with the derailed down passenger train. Next, this up passenger train derailed. At this time, the up passenger train hit walking passengers on main railway track.

The Mikawashima accident killed 160 people and injured 296 people. This accident occurred about 50 years ago, but it is one of railway accidents in Japan that we must not forget.

The cause of this accident is that a freight train ran through a red signal. If we had been able to prevent running through red signals, this accident would not occur.

At that time, the safety system is the alarm that warns the motorman. This system warned the motorman if the next signal is a red signal, but this system could not stop trains automatically. After the motorman knew the system warning, they must use a train brake by themselves. Therefore, we decided to install “Automatic Train Stop (ATS)”. ATS systems can stop trains automatically independently of motorman’s operation.

The following image is the mechanism of ATS systems. (See Image 1) ATS systems were installed in all JNR* lines in about 4 years . *JNR: Japanese National Railways

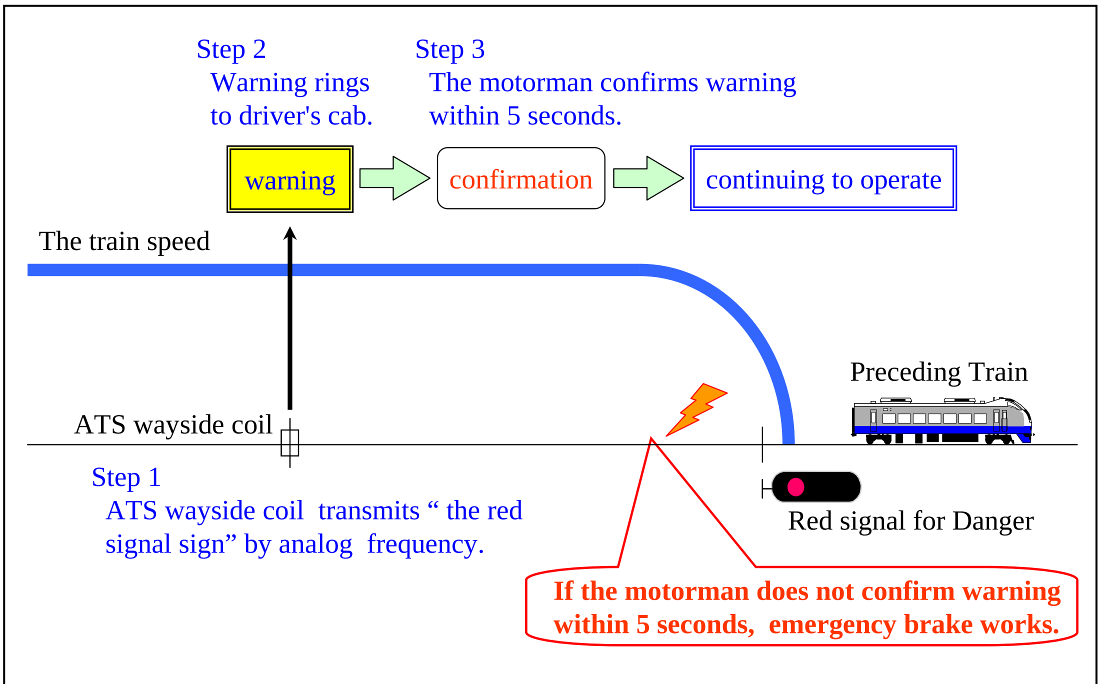

Image 1: The mechanism of ATS

b) The Higashi-Nakano accident (collision)

This accident, which occurred on December 5, 1988, was a collision. An ATS wayside coil transmits "the red signal sign", and warning rings to the motorman's cab. But, after the motorman confirms warning, emergency brake do not work. Therefore, the motorman must pay attention to driving alone.

As the background of this accident, many trains are operated in the Tokyo metropolitan area. Therefore, there are a lot of signals. Warning very often rang in the motorman's cab and the motorman very often confirmed warning, too. As a result, the motorman failed to brake and this accident occurred. The Higashi-Nakano accident killed 2 people and injured 116 people.

The cause of this accident is that the motorman failed to brake. We had installed ATS systems. However, we could not prevent this accident because ATS systems did not support brake failures at that time. After this accident, we installed "Automatic Train Stop Pattern (ATS-P)" ahead of schedule. ATS-P systems are new ATS systems that were developed before this accident.

The following image is the mechanism of ATS-P systems. (See Image 2)

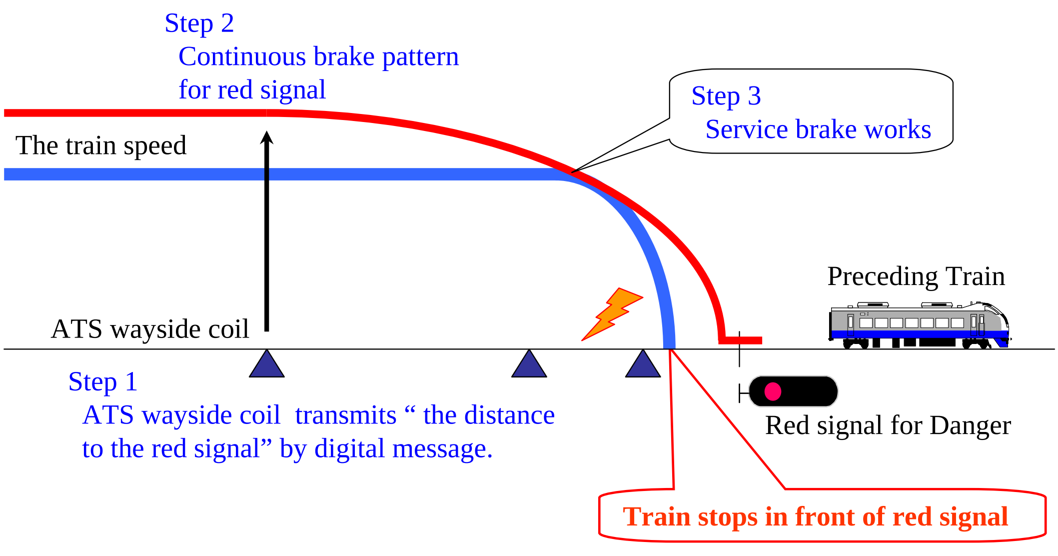

Image 2: The mechanism of ATS-P

The mechanism of ATS-P systems are that an ATS wayside coil transmits the distance to the red signal for trains. Next, the on-board ATS-P device for trains calculates the continuous brake pattern based on the distance to the red signal. If the train speed exceeds the continuous brake pattern, service brake works automatically. Therefore, if the motorman fails to brake, ATS-P systems can stop trains in front of a red signal.

2 The cause of the Fukuchiyama-Line derailment, and new countermeasures for this accident

In this chapter, we explain the Fukuchiyama-Line derailment that occurred on West Japan Railway Company.

2-1 Overview of the accident and its causes

This accident, which occurred on April 25, 2005, was a derailment. The cause of this accident is estimated that the motorman applied the brakes too late as the train entered a 304-meter-radius-curve at 116km/h. As a result, the first car tilted to the left and caused derailment. The following cars from the second to the fifth were derailed. This accident killed 107 people and injured 563 people.

2-2 Differences in risk if an accident occurs

Our present method to prevent serious accidents is mainly to prevent repeating the accidents or events that had happened. We will continue this approach in the future, but there are also events that seem unimportant only because they have not yet caused major damage.

The cause of this accident is estimated as excessive speed. However, before the derailment accident at Fukuchiyama line which killed 106 people, the risk of excessive speed was thought to have low priority. The following figure is the analysis of risk based on result. (See Image 3) In this analysis, the risk could differ if an accident occurs. After the Fukuchiyama line derailment accident, the risk of excessive speed became high priority.

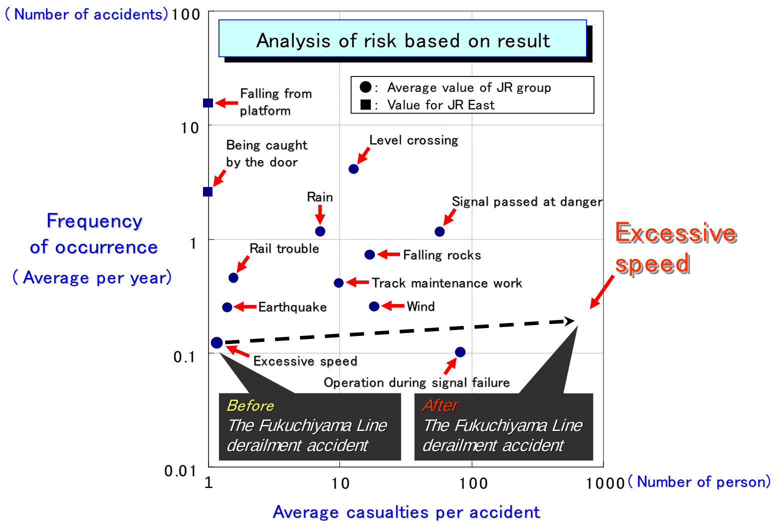

Image 3: Analysis of risk based on result

Therefore, we introduced risk evaluation that takes into consideration the frequency of the events we have experienced in the past, including those with only small damage, and the maximum scale of damage of the events we can imagine. We will give high priority to preventing such accidents by using this evaluation.

The following figure is the analysis of our new risk evaluation. (See image 4) In our risk evaluation, light and shade of the color of the background in the figure shows the priority level. This figure shows that we will take firm countermeasures against accidents leading to major damage, even though their frequencies of occurrence are small. Also, we will take firm countermeasures against accidents or events which occur many times, even though each of them causes only small damage.

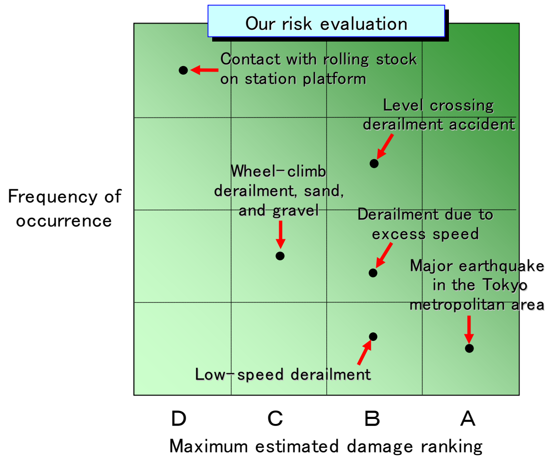

Image 4: Our risk evaluation

2-3 Amendment of the law

After the Fukuchiyama-Line derailment occurred, the Ministry of Land, Infrastructure and Transport revised the technical standards. We must install the systems to prevent excessive speed at curves, junctions, line terminals and so on. These are required to be installed on major rail lines by the end of June 2011 or the end of June 2016, depending on the line’s train speed and frequency.

2-4 Countermeasures taken by JR East

In our company, by the end of March 2010, ATS-P systems had been installed on 2,321.6 km of railway line. ATS-P systems cover 95 percent of JR East’s traffic volume. Since ATS-P systems were installed, the number of collision because trains ran through red signals is only 5 times. Among these was the Higashi-Nakano accident. After the Higashi-Nakano accident in 1988, our company has not caused fatal accidents by the collision.

Next, the following is the progress of countermeasures to prevent excessive speed along with amendment of the law. (See Table 1)

	Target	Installations as of the end of fiscal 2009 (ended March 31, 2010)	Planned completion
Curves	1,470 locations	1,470 locations	Completed (the end of March 2010)
Junctions	1,896 locations	1,083 locations	the end of June 2016
Line terminal	131 locations	105 locations	the end of June 2016

Table 1: The progress of countermeasures

3 Trend in the number of accidents since our establishment

Since our establishment in 1987, the number of railway operating accidents has decreased by about 70 percent in 23 years. (See Image 5)

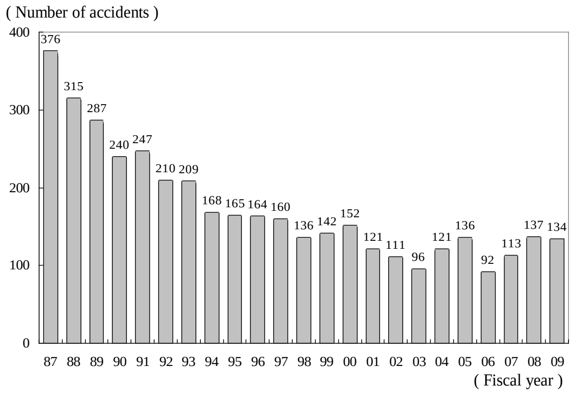

Image 5: Number of Railway Operating Accidents

4 Conclusions

In our company, the average number of trains per day is 12,700. The number of passengers per day is about 16 million. Fortunately, we are not causing serious accidents in recent years due to the running through a red signal or the excessive speed.

We did not allow past accidents to be forgotten from our memory. And furthermore, we have also verified system safety. As a result, we have installed systems that improve the safety. It is not too much to say that our ATS system is exactly the history of the railway system safety

There is no end of safety. Our countermeasures for safety to date had been mainly recurrence prevention countermeasures that respond to past accidents or incidents. We not only take these countermeasures but also try to evaluate and analyze potential risks that can cause very great damage in the future. And furthermore, we take countermeasures for high priority risks. We think that this risk management will improve the railway system safety.