

Chapter 2 Railway accident and serious incident investigation

1. Summary of major investigation report

Summaries of five of the 14 investigation reports publicized in 2011 are presented below.

Railway 1 During emergency braking of a freight train, one of the container wagons derailed by the coupling force from the following wagons.
(Derailment, in the Suita signal station, the Tokaido Line, Japan Freight Railway Company)

Full text of the investigation report (Japanese text only):

<http://www.mlit.go.jp/jtsb/railway/rep-acci/RA2011-2-1.pdf>

1. Summary of the accident

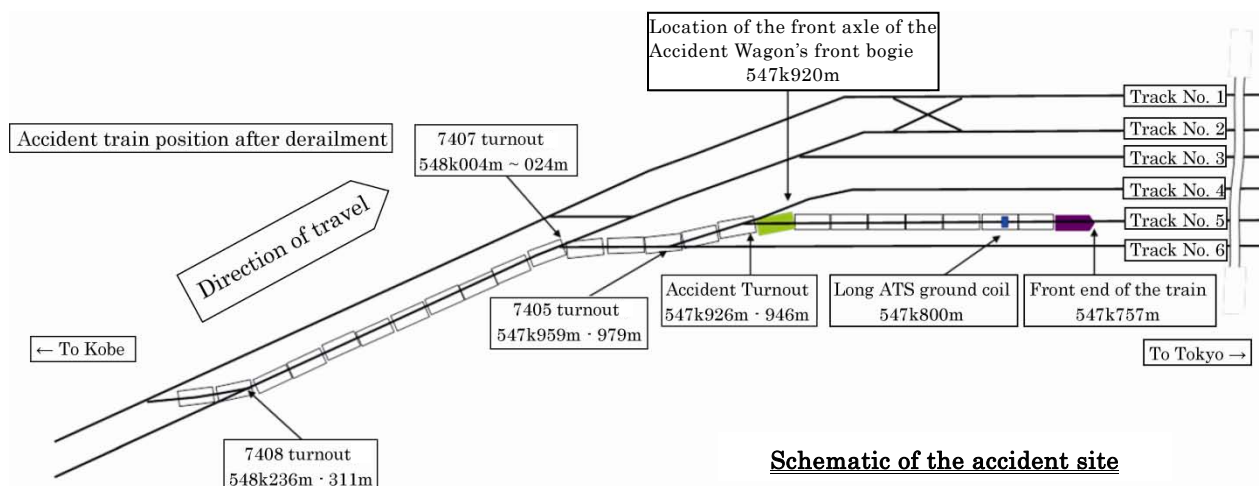
- (1) Date and time: At around 12:03 on September 9 (Wednesday), 2009
- (2) Location: The premises the Suita signal station on the Tokaido Line in Suita City, Osaka Prefecture
- (3) Outline of the accident:

The freight train “B-1076” (consisting of a locomotive and 24 container wagons, from the Fukuoka freight terminal on the Kagoshima Line to the Utsunomiya freight terminal on the Tohoku Line), operated by the Japan Freight Railway Company (the Company), left Higashi-Kakogawa Station on schedule (at 11:01). While the train was powering at about 18 km/h through the Suita signal station, the driver saw a stop signal for the starting signal for Track No. 5. As the driver also heard an acoustic warning by the ATS^{*1}, he took “acknowledgement action.” However, the emergency brake operated and the train stopped.

After the train stopped, it was found that all four wheels of the two-axle front bogie of the 8th wagon (the Accident Wagon) had derailed to the left. The driver was not injured.

*1: ATS is the abbreviation of Automatic Train Stop system, which sound an acoustic alarm and make an emergency brake in operation if the ATS onboard device detects the ATS ground coil installed at before a signal device indicating stop signal.

- (4) Date of publication: February 25, 2011



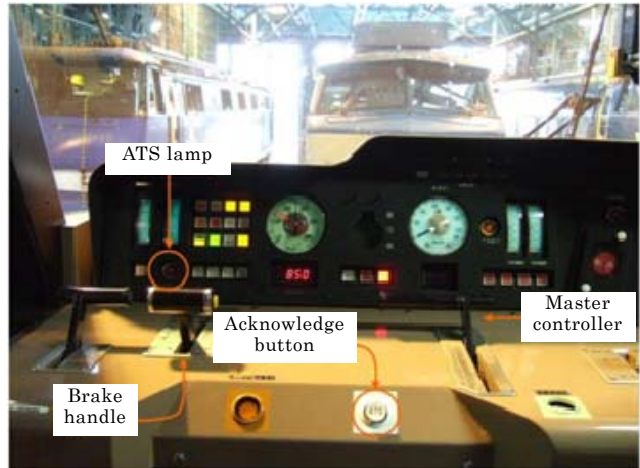
Schematic of the accident site

2. Findings

(1) Analysis of the derailment

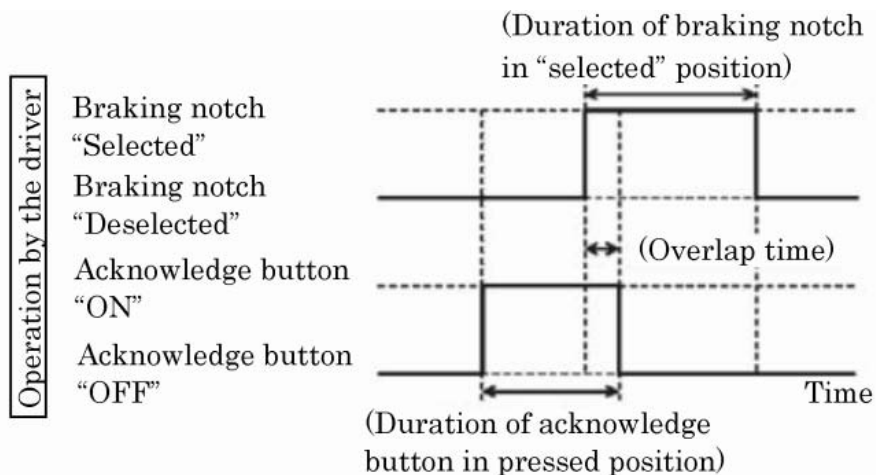
a. Analysis of the action of the emergency braking

The ATS onboard unit is designed in order that the emergency brake will not operate and the train can continue to travel if the driver took “acknowledgement action” within 5 seconds after the ATS acoustic alarm. In this case, if the overlap time when the braking notch is in selected position and acknowledge button is in pressed position, is too short, relay excitation will be insufficient. As a result, the relay ACR (the ACR), which is designed to detect the driver's “acknowledgement action,” will operate instantaneously, failing to activate the relay UR, which prohibits the operation of the emergency brake. As to the reason why the emergency brake operated, it is probable that while the driver took “acknowledgement action”, the overlap time was too short. It is somewhat likely that a contributing factor is that the drivers' operating standards set forth by the Company do not specify the appropriate sequence for operating the braking notch selection and the acknowledge button when the acoustic alarm is ringing. It is therefore necessary that the drivers' operating standards should be reviewed to ensure that the implementing standards are strictly followed, and to ensure a sufficient overlap time between selecting a braking notch and pressing the acknowledge button. In addition, the logic circuit should be revised so that even if the overlap time is too short, the emergency braking will not be activated immediately, and the driver can try pressing the acknowledge button again within 5 seconds after the ATS acoustic alarm.



Taken in the Suita engine depot the day after the accident

Controllers in the cab of the accident locomotive



Overlap time

ACR operation

	ACR operation	Contact "a"	Contact "b"	ATS operation
No acknowledgement action	Does not activate	Stays open	Stays closed	5-second timer completed; emergency braking operates
Acknowledgement action	Activates	Closes	Opens	5-second timer suspended; no emergency braking
Acknowledgement action too short	Activates momentarily, then fails	Stays open	Opens momentarily, then closes	5-second timer suspended; emergency braking operates

b. Analysis of how the derailment occurred

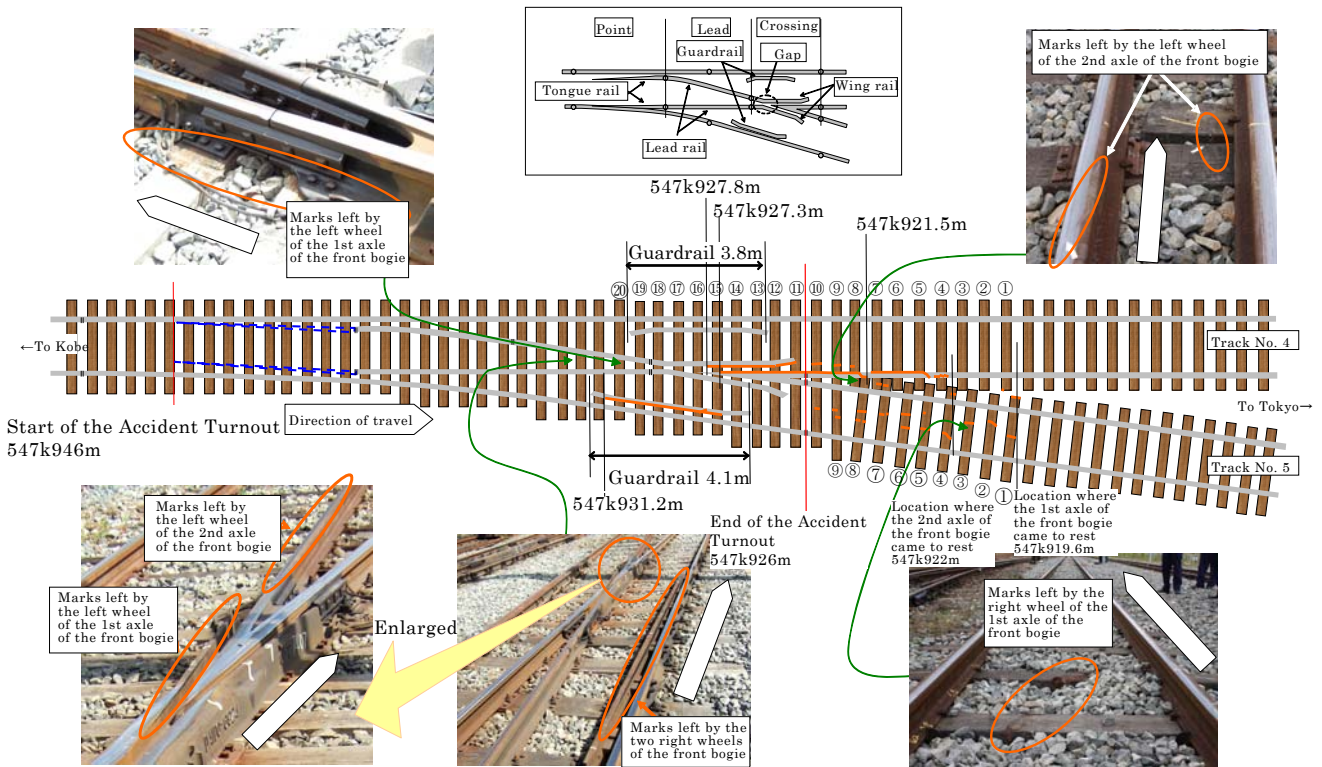
According to the findings of an analysis, which the Company committed to the Railway Technical Research Institute, it is probable that the train experienced lateral buckling*² in the following manner: as the train run through the Accident Turnout for Track No. 5 with the emergency braking applied, and as the 1st axle of the Accident Wagon's front bogie entered the branch line (Track No. 5) at the Accident Turnout and reached a gap in the crossing*³, the backside of the inside wheel rode over a guardrail while at the same time the outside wheel entered through the gap at the crossing into a flangeway of the main line (Track No. 4).

*²: Lateral buckling occurs when massive force is applied in the longitudinal direction of a train, causing the cars to sway laterally at the couplers.

*³: A crossing is where the rails intersect in a turnout.

In addition, (a) the Accident (8th) Wagon and the 9th wagon were not carrying any containers or cargo and therefore were lighter than the leading wagons, (b) no marks were left on the rail immediately on the Kobe side from the gap at the crossing that would indicate the left wheels of the front bogie riding over the rail, and (c) the coupler had longitudinal and lateral dents on its right side. Considering these facts, it is probable that the Accident Wagon was about to enter the Accident Turnout when the driver took "acknowledgement action," which resulted to trigger the emergency braking, causing the following wagons, which had not yet braked, to apply longitudinal force to the coupler of the leading two empty wagons and making the Accident Wagon sway laterally. As a result, it is probable that both axles of the front bogie of the Accident Wagon, which was lighter than the leading wagons, were lifted off the rails and that the coupler force, which was applied in the direction of Track No. 4 (the main line of the turnout), prevented the Accident Wagon from turning right onto Track No. 5 as had been intended, and caused the wagon instead to continue moving straight ahead (in the direction of the main line) as the inner sides of the right wheels of the front bogie slid over the guardrail.

As the train set length is about 507.8 m, it is probable that the 14th, 16th and 21st wagons, which were also empty loaded, were either at the exit of the 7407 turnout or on a straight line with no turnouts when the ATS operated, and that as a result, the longitudinal force from the trailing wagons acted to the leading wagons along the rail.



Details of the derailment

(2) Analysis on how to prevent recurrence

Considering the comment by the driver, “As I was worried that the train had slowed down too much to reach the stop position, I applied additional power and take care to prevent further slowdown,” it is probable that, the driver tried to complete the “acknowledgement action” as quickly as possible within five seconds to prevent the train from stopping on a turnout, noticing that the train was going through a turnout-studded section (accident location).

It is probable that the overlap time for “acknowledgement action” was too short to prevent the emergency braking. As a contributing factor to this, it is somewhat likely that the “acknowledgement action” that the driver took based on the drivers' operating standards was not in line with the implementing standards. Therefore, it is necessary that the drivers' operating standards be revised accordingly and the Company drivers be thoroughly trained on ATS mechanism and the correct procedure to secure sufficient overlap time. In addition, the logic circuit should be revised so that, even if the overlap time is too short, the emergency brake will not activate immediately, and the driver can try pressing the acknowledge button again within 5 seconds. It is probable that longitudinal force applied by trailing wagons, a typical characteristic of the automatic air brake system equipped to the train set, played a role in the derailment. It is therefore desirable that the ongoing work to replace by the automatic electromagnetic air brake equipment to get a no-time-lag braking force on all wagons be given a further push.

3. Probable causes

It is probable that, in this accident, as the locomotive towing 24 container wagons was traveling through several turnouts, the emergency brake operated, caused to act the massive coupling force by the following wagons that were not yet braked, to the empty Accident Wagon at the Accident Turnout, and that the front bogie of the Accident Wagon was then lifted and went over the crossing towards the main line.

As to the reason why the emergency braking was applied, it is probable that the overlap time whereby the braking was set in notch 1 and the acknowledge button was pressed was too short for the emergency braking prevention relay to be activated to form an emergency braking prevention circuit.

Railway 2 While a freight train was running along a 300-m radius curved track at about 60 km/h, both wheelsets of the rear bogie of one of the container wagons derailed.
(Derailment, between Sotaro Station and Ichitana Station (single line), the Nippo Line, Japan Freight Railway Company)

Full text of the investigation report (Japanese text only): <http://www.mlit.go.jp/itsb/railway/rep-acci/RA2011-1-1.pdf>

1. Summary of the accident

- (1) Date and time: At around 13:19 on December 19 (Saturday), 2009
- (2) Location: Between Sotaro Station and Ichitana Station (single line) on the Nippo Line in Nobeoka City, Miyazaki Prefecture
- (3) Outline of the accident:

The freight down train “4075” (11-car train set, from Kitakyushu freight terminal to Minami-Nobeoka Station), operated by Japan Freight Railway Company, passed Sotaro Station on schedule (at 13:12).

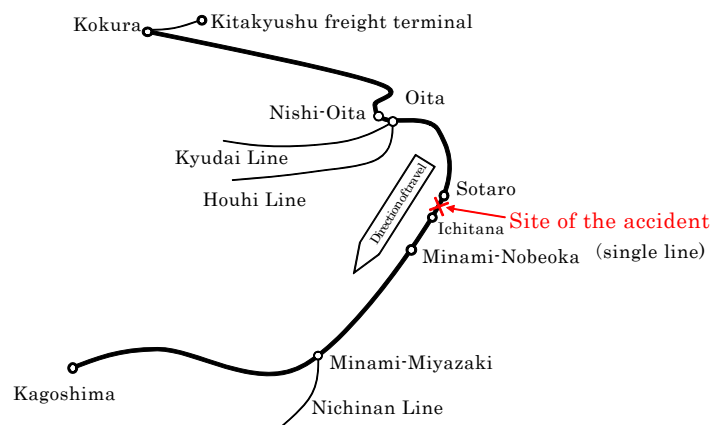
When the driver saw a speed limit indication for the repeating signal for Ichitana Station's down line home signal, he started to slow down the train, which was running at about 60 km/h, to stop it at the station. However,

the train slowed down much faster than it normally would and therefore the driver released up on the brake. Nonetheless, the train stopped about 170 m short of the stop sign.

Both wheelsets of the rear bogie of the 10th wagon were found to have derailed to the left.

The driver, who was the only person on board, was not injured.

- (4) Date of publication: January 28, 2011



Map of Nippo Line

2. Findings

- (1) Analysis on track irregularity

- a. Influence due to alignment^{*1}

At around 237k020m, relatively large alignment is observed which will act in such a way that the curve radius is reduced. Considering this, it is probable that the outside (left) wheel of the 1st wheelset of the Accident Wagon's rear bogie had a large angle of attack^{*2}. It is therefore somewhat likely that the equivalent friction coefficient^{*3} between the wheel flange and the rail also increased.

At around 237k020m, there are rail joints, and some of the bolts and spring clips for the rail fasteners in the area were missing. It is probable that this played a role in increasing the alignment in the area.

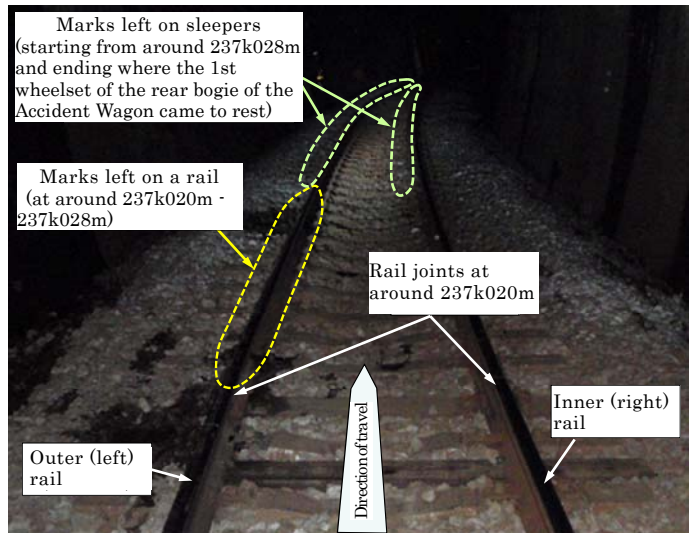
- *1: “Alignment” is the horizontal distance (versine) between the rail and the center of a chord connecting two longitudinally separated points on the rail. The alignment for a curved track is obtained as the horizontal distance between the measured versine and the circular arc of the designed curve radius.
- *2: “Angle of attack” is the relative angle between a rail and a wheel as it is rolling on the rail. As the angle of attack increases, the safety margin against flange climb derailment decreases.
- *3: “Equivalent friction coefficient” is the ratio of lateral force between a wheel flange and a rail to the normal force. It increases as the friction coefficient between a wheel and a rail and the angle of attack increase. The maximum value is the friction coefficient.

b. Influence due to twist*4

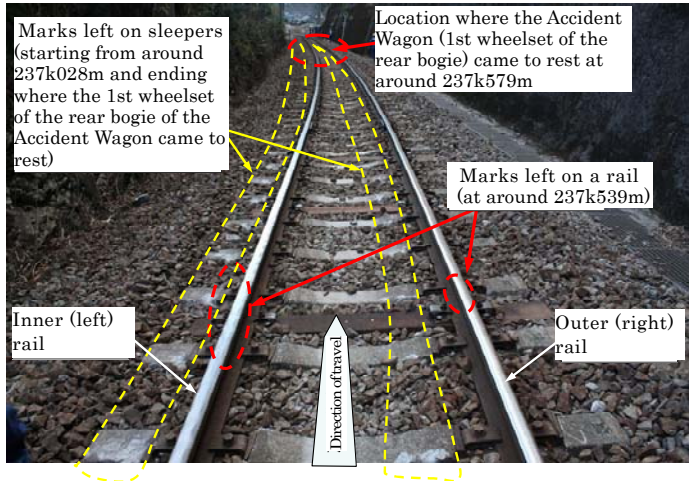
In the last regular inspection prior to the accident, the 5-m twist at around 237k022m was -24 mm (loaded value). In the measurement taken on December 15, 2009, the maximum twist (unloaded value) was -9 mm. In the measurement after the accident, the 5-m twist at around 237k020m was -27 mm (unloaded value), indicating a significant left-frontward down twist.

It is probable that this significant twist caused the wheel load of the outside (left) wheel of the 1st wheelset of the rear bogie to be reduced as the Accident Wagon passed 237k020m.

The cross level (unloaded value) measured at 237k020m after the replacement of wooden sleepers on October 22, 2009, was 56 mm. The cross level (unloaded value) at 237k020m measured during the regular inspection on October 12, 2009, was 61 mm. The cross level at 237k015m, 5 m in front of 237k020m, was 75 mm. Given this, it is somewhat likely that the 5-m twist at around 237k020m increased by about 5 mm after the replacement of wooden sleepers.



Site of the accident (circular curve A in the Ichitana tunnel (at around 237k020m))



Marks left on sleepers (starting from around 237k539m and ending where the 1st wheelset of the rear bogie of the Accident Wagon came to rest)

- *4: “Twist” is the difference in cross level between two longitudinally separated points on a rail, and indicates the twist of the track relative to a plane. Twist irregularity measured between two points 5 m apart is referred to as 5-m twist irregularity. With the track inspection car, the cross level and twist are measured using different methods and because of this, the two measurements may be slightly different from each other. In this accident report, right-frontward down twist is represented with positive values.

c. Influence due to the combination of alignment and cross levels ^{*5}

The combination of alignment and cross levels at around 237k016m and 231k025m were in the direction to roll the body in clockwise (CW). In contrast, the distance between front and rear bogie center is 8.9m. Then, it is probable that, when the front bogie was passing at around 237k025m, the body rolls in CW caused by the combination of alignment and cross levels of the track, and at the same time, CW rolling force also act to the body from the rear bogie passing at around 237k016m.

It is probable that, due to the above, the load of the outside (left) wheels of the Accident Wagon's rear bogie decreased while the load of the inside (right) wheels increased, causing the inside wheels to push the wheelset to the left, thus increasing the lateral wheelset load of the outside wheels.

*5: "Combination of alignment and cross levels" is one of the parameters of track irregularity maintenance. When a cross level occurs in which the track surface tilts according to alignment of the track, a value 1.5 times the size of the cross level is subtracted from or added to the alignment to increase the absolute value of the combination of alignment and cross levels. As the combination of alignment and cross levels increases, freight wagons can roll or hunt more easily.

(2) Analysis of the derailment

It is probable that at around 237k020m, the derailment coefficient for the outside (left) wheel of the 1st wheelset of the Accident Wagon's rear bogie increased while the critical derailment coefficient^{*6} of the wheel decreased and that the outside (left) wheel started to ride up the outside (left) rail.

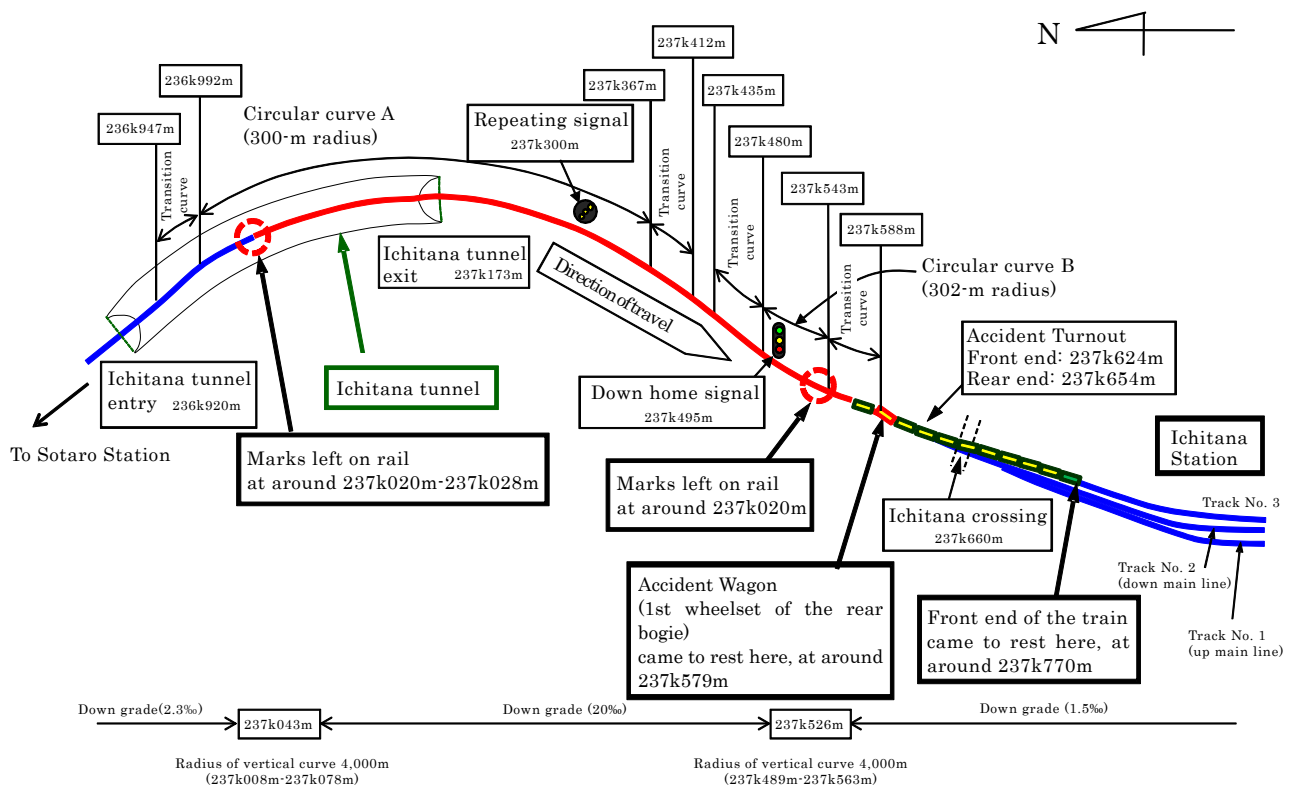
It is probable that the train was subsequently running with the 1st wheelset of the rear bogie derailed and that at around 237k539km in the 302-m-radius circular curve B, the 2nd wheelset of the rear bogie derailed to the left. As to the reason why the 2nd wheelset of the rear bogie derailed in the circular curve B, it is somewhat likely that the relatively large cant in that area and the effect of the derailed 1st wheelset to generate greater leftward force to the rear bogie.

*6: "Critical derailment coefficient" is the limit value of the derailment coefficient (lateral force divided by wheel load) that is obtained using an equation of equilibrium for wheel load and lateral force at the contact of a rail and a wheel flange riding up the rail. As the friction coefficient increases, the critical derailment coefficient decreases. As the angle of contact (wheel flange angle) decreases, the marginal derailment coefficient decreases. Derailment is possible when the derailment coefficient exceeds the critical derailment coefficient.

Judging from the marks left on the right side of the rear coupler of the Accident Wagon and on the left side of the front coupler of the rearmost wagon that in both cases would suggest contact with the centering rod, it is probable that after the 2nd wheelset of the Accident Wagon's rear bogie derailed, the wagon tilted steeply to the left.

Considering the dents left on the underframe and cable conduit near the left wheel of the 2nd wheelset of the Accident Wagon's rear bogie that appeared to have been caused by

the wheel, it is somewhat likely that following the derailment of the 2nd wheelset of the rear bogie, the Accident Wagon sank deeply, allowing its rear coupler to slide down and come off the front coupler of the rearmost wagon. Considering that the damage on the right side of the rear coupler of the Accident Wagon extended upward while the damage on the left side of the front coupler of the rearmost wagon extended downward and that the top surface of the front coupler of the rearmost wagon had marks apparently caused during contact with the underframe, it is somewhat likely that the rear coupler of the Accident Wagon pushed up the front coupler of the rearmost wagon.



Schematic of the accident site

(3) Analysis on how to prevent recurrence

A regular inspection conducted prior to the accident showed track irregularity surpassing the limit specified in the instructions for track maintenance. With this in mind, Kyushu Railway Company, owner and in charge of maintenance of the track of Nippo line, had scheduled track repair in accordance with the facilities maintenance instructions and related details. However, the accident occurred prior to the scheduled repair. The regular inspection conducted on December 11, 2009 found twist and the combination of alignment and cross levels, both exceeding the relevant limits. These parameters significantly affect running safety and must be monitored closely. It is therefore desirable that appropriate action be taken, such as advancing the repair timing, in areas such as those in tunnels subject to a leakage of groundwater where track irregularity may be accelerated.

In track maintenance beyond regular inspection, careful attention must be paid to any change in track irregularity that may occur after maintenance work. This is especially important in cases of large twist in small-radius curved track: post-maintenance check is inevitable even when only one sleeper is replaced.

It is probable that the alignment may be deformed at any area where rail fasteners are missing in a tightly curved track. In such areas, repair must be carried out as soon as possible.

3. Probable causes

In this accident, it is probable that as the Accident Train was running along a 300-m-radius right circular curved track at about 60 km/h, the derailment coefficient increased while the critical derailment coefficient decreased, causing the outside (left) wheel of the 1st wheelset of the Accident Wagon's rear bogie to ride up the outside (left) rail and the wagon to derail.

As to the reason why the derailment coefficient increased, it is somewhat likely that significant left-frontward down twist and rolling of the Accident Wagon caused by the increase of the combination of alignment and cross levels.

As to the decrease in the critical derailment coefficient, it is somewhat likely that contributing factors are that there were relatively large alignment in such a way that the curve radius was reduced, resulting in a large angle of attack of the outside (left) wheel and increasing the equivalent friction coefficient between the wheel flange and the rail.

As to the reason why the twist and the combination of alignment and cross levels increased, it is somewhat likely that the previous track maintenance work failed to sufficiently prevent further deterioration of track irregularity.

Railway 3 A train passed through the work section of the line where the work was initiated despite the day's train operations had not yet ended, and workers were on the site.

(Railway serious incident, between Nishitetsu-Wataze Station and Nishitetsu-Ginsui Station, the Tenjin-Omuta Line, Nishi-Nippon Railroad Co., Ltd.,)

Full text of the investigation report (Japanese text only): <http://www.mlit.go.jp/itsb/railway/rep-inci/RI2011-3-1.pdf>

1. Summary of the serious incident

- (1) Date and time: At around 00:43 on June 17 (Thursday), 2010
- (2) Location: Between Nishitetsu-Wataze Station and Nishitetsu-Ginsui Station on the Tenjin-Omuta Line in Omuta City, Fukuoka Prefecture
- (3) Outline of the serious incident:

At around 00:28, a train dispatcher (in charge of approval of track closing) of Nishi-Nippon Railroad Co., Ltd. (the Company) approved the start of work on the closed track (i.e., work carried out in a specific section of a line, which is closed to prevent entry of operating trains) between Nishitetsu-Wataze Station and Nishitetsu-Ginsui Station (the Work on the Closed Track) after receiving a request for work approval from the chief of the work unit.

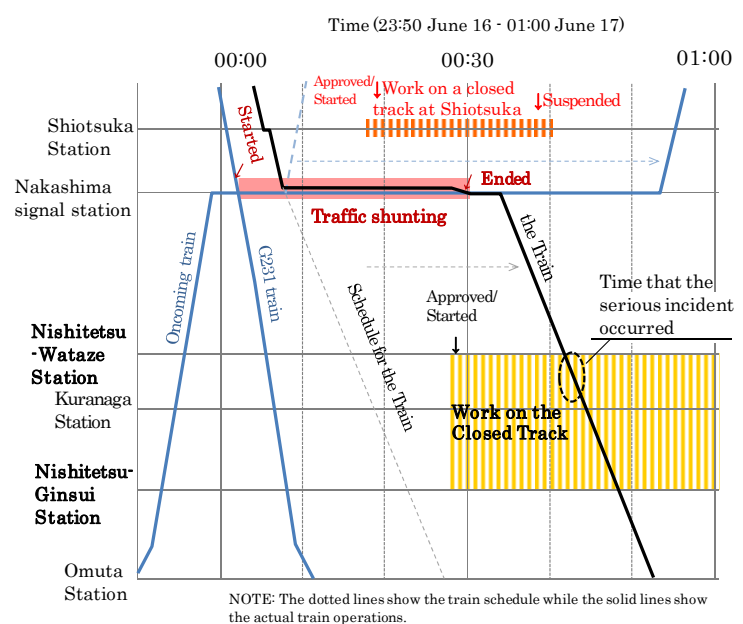
The one-man-operated down local train “7623” (the Train: 2-car train set, from Amagi Station to Omuta Station) departed Nishitetsu-Wataze Station about 26 minutes behind schedule (scheduled to depart at 00:15) due to a transport disorder at Nakashima signal station, and subsequently passed through the section of the Work on the Closed Track where workers had already started working.

- (4) Date of publication: September 30, 2011

2. Findings

- (1) Procedure for approving work on the closed track

While the Company's track closing regulations specify the procedures for not allowing trains, onto the track closed for work, it is probable that in actual application of the regulations, the train dispatchers had been no doubt that a manual operation to indicate stop signal for the signal devices relevant to work on the closed track, because a stop signal is automatically indicated when train operations on the day have ended, by the train operation control

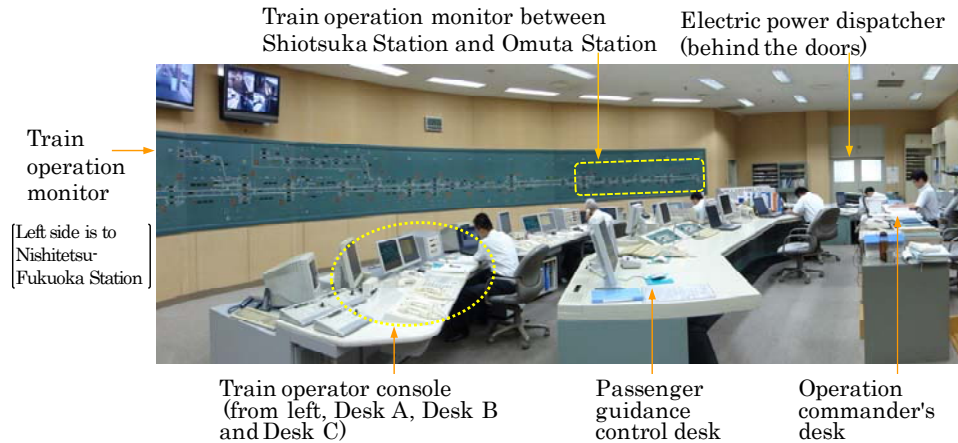


Train schedules for the time around the serious incident

apparatus.

However, it is probable that the train operation control apparatus will indicate green signal if train operations of the day have not yet ended, and it is therefore incomplete and inappropriate in the context of track closing.

It is probable that this on-the-job site interpretation has been taken for granted; with the result that no one had recognized the intrinsic problems with the interpretation.

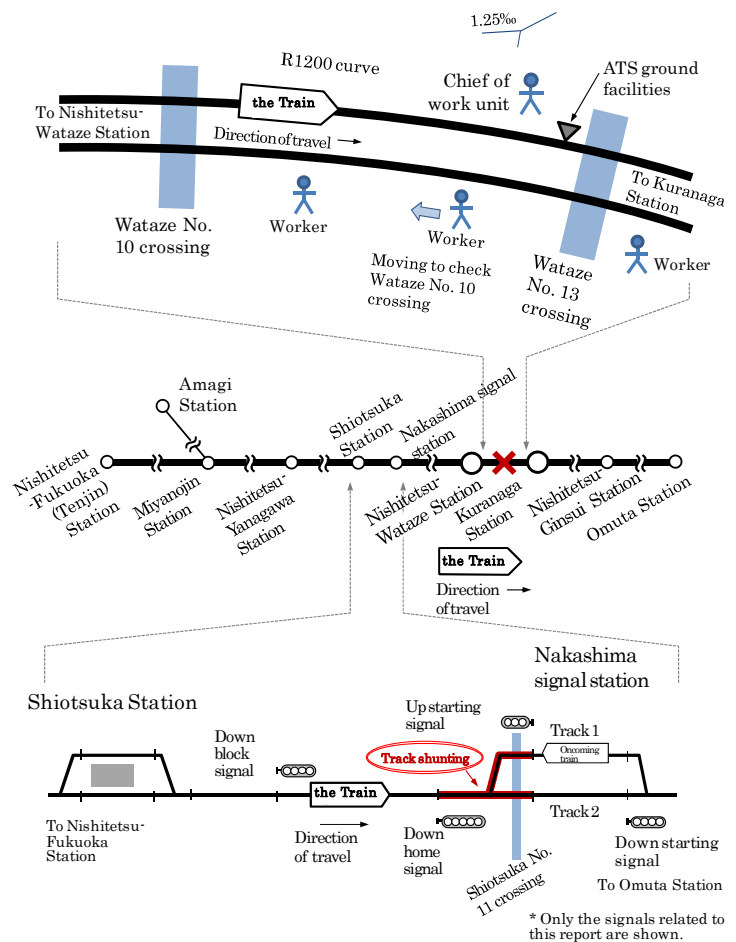


Operation center

(2) How this serious incident occurred

In this serious incident, it is highly probable that approval to start the Work on the Closed Track was issued by the train dispatcher without thorough confirmation of the traffic conditions at that time and without double-checking with other relevant train dispatchers, allowing the work to start even though the day's train operations had not yet ended.

At that time, it is highly probable that, as the Train, the day's last train, had not yet passed the section of the Work on the Closed Track and the train operation control apparatus could indicate entry approval, namely no specific action was taken to prevent the Train from entering the work section.



Facilities related to this serious incident

(3) How to prevent recurrence

It is probable that while the workers, having noticed the alarm of the road warning device (at a level crossing), escaped to safety places to let the Train pass. However, if the road warning device at the crossing been disabled as the work progressed to that stage, the workers would not have been able to notice the approaching Train until the last moment, possibly resulting in a railway accident with casualty. While it is probable that this serious incident was apparently the result of a series of human errors made by the train dispatchers, the root cause was that, despite the specific regulations set forth on how to use hardware for correct issuance of approval to start work on a closed track, in actual application of the regulations, the customary practice that had been followed came with insufficient measures to stop trains, from entering the work section. On prevention of recurrence, it is probable that thorough study should have been done on the validity and the feasibility of not only revised procedures and systems but also of the possible impact on upstream and downstream operations and systems.

Given the above, to prevent the recurrence of similar serious incidents, the Company should establish the following environment without delay to prevent any human errors from developing into a serious event, by not only providing education and training as well as raising awareness among those concerned, but also by putting in place the following measures:

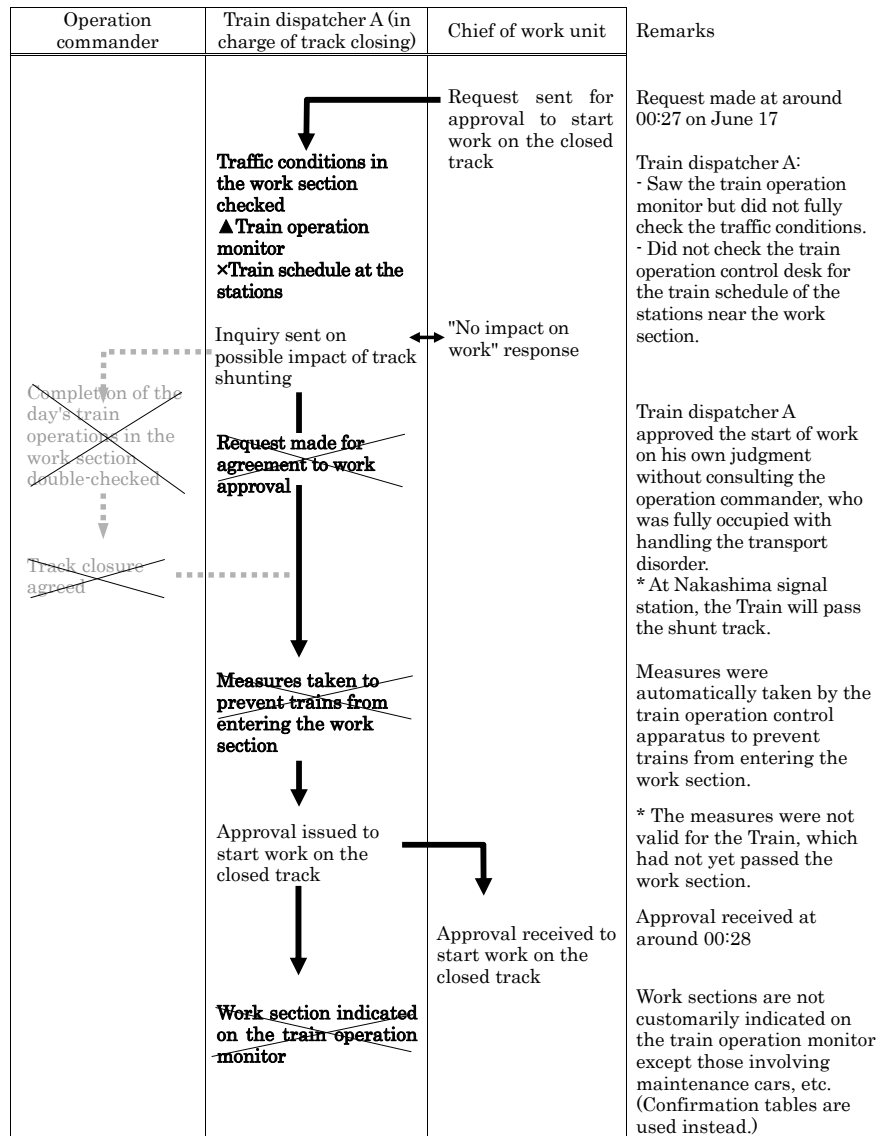
- a. In issuing approval to start work on the closed track, the related regulations, especially the basic rules, must be strictly practiced while paying close attention to the following points, whether during or after completion of the day's train operations.
 - Check on the last train of the day and make sure that the train has passed the work section.
 - Double-check among the train dispatchers.
 - Indicate a stop signal on the relevant signal devices to keep trains, out of the work section of the closed track.
 - Clearly indicate the work section of the closed track after issuing approval so that other train dispatchers will know that work is in progress.
- b. Evaluate the workload on train dispatchers during the hours of the last trains and, based on the results, establish a system that can appropriately handle emergencies and still enable correct approval for starting work on closed tracks. One possible option may be prioritization, if needed, of train dispatcher during unusual circumstance (such as holding the issuance of the approval of works on the closed tracks).
- c. Any discrepancy found between the regulations on procedures for approval to start work on the closed track and the actual application of the regulations must be corrected without delay. More fundamentally, the regulations and related systems currently in place must be thoroughly reviewed against the principles of track closing for possible revision.
- d. The actions put in place as above must be strictly monitored to ensure correct implementation.

3. Probable causes

In this serious incident, it is highly probable that approval to start the work on the closed track was issued by the train dispatcher without thorough confirmation of the traffic conditions at that time and without double-checking with other relevant train dispatchers, allowing the Train, which had been running behind schedule due to a transport disorder at a nearby signal station, to pass through the section of track where the work was in progress.

It is probable that a contributing factor to the erroneous issuance of the work approval was that train dispatchers were busily approving a number of work orders on closed tracks during the hours of the last trains, when the abovementioned transport disorder happened, preventing the train dispatcher

in charge of track closing from paying enough attention to follow the correct procedure for approving the start of Work on the Closed Track. It is probable that a contributing factor to the Train being allowed to pass through the work section is that the Company did not realize that the measures currently in place to stop trains from entering work sections were inappropriate and not thorough, and had allowed an unsuitable customary practice to be followed.



NOTE: "×" indicates that action was not taken. "▲" indicates that action was not thoroughly taken.

Procedures for approval to start the Work on the Closed Track

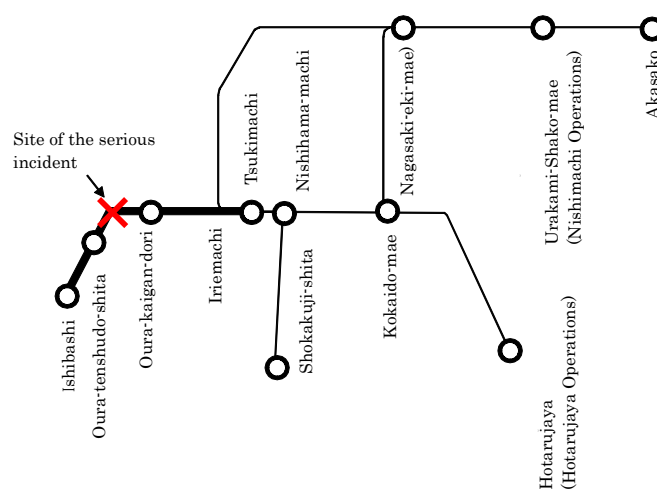
Railway 4 A tram car entered a single track section on which there was already an oncoming tram car, while the tablet and ticket block system was functioning in place of the automatic block system.
(Railway serious incident, between Oura-kaigan-dori Stop and Oura-tenshudo-shita tram Stop, the Oura Branch Line, Nagasaki Electric Tramway Co., Ltd.,)

Full text of the investigation report (Japanese text only): <http://www.mlit.go.jp/jtsb/railway/rep-inci/RI2011-3-2.pdf>

1. Summary of the serious incident

- (1) Date and time: At around 14:15 on October 21 (Thursday), 2010
- (2) Location: Between Oura-kaigan-dori tram Stop and Oura-tenshudo-shita tram Stop (single track) on the Oura Branch Line, in Nagasaki City, Nagasaki Prefecture
- (3) Outline of the railway serious incident:

At around 14:15 on October 21, 2010, the driver of Tram No. 1505 (1-car tram set, from Hotarujaya tram Stop to Ishibashi tram Stop), operated by Nagasaki Electric Tramway Co., Ltd. (the Company), while operating under a tablet and ticket block system*1 on a single track section (between the Oura-kaigan-dori tram Stop and Ishibashi tram Stop) started the tram from the Oura-kaigan-dori



Map of Oura Branch Line

tram Stop (Kaigan-dori tram Stop) after confirming that Tram No. 503 had come out of the single track section. When the driver stopped the tram at the stop line for Ishibashi at the Matsugaebashi intersection, he saw Tram No. 1203 (1-car tram set, from Ishibashi tram Stop to Hotarujaya tram Stop) stopped at the No. 1 stop line at the opposite side of the intersection. The distance at that time between Tram No. 1505 and Tram No. 1203 was about 46 m.

- (4) Date of publication: September 30, 2011

*1: "Tablet and ticket block system" is one of the safety block system for a single track tramway section, and the safety is ensured by allowing only the tram carrying a tablet or ticket, in this case the following car indication panel, to run in the single track section.

2. Findings

- (1) Analysis on the occurrence of this serious incident

It is somewhat likely that the driver of Tram No. 1505 (Driver A) based his decision to depart Kaigan-dori tram Stop not on instructions from the staff who was posted at the Stop to ensure correct implementation of the tablet instrument block system (the Tablet System Staff), but on the number of trams coming out of the single track section. In addition, it is

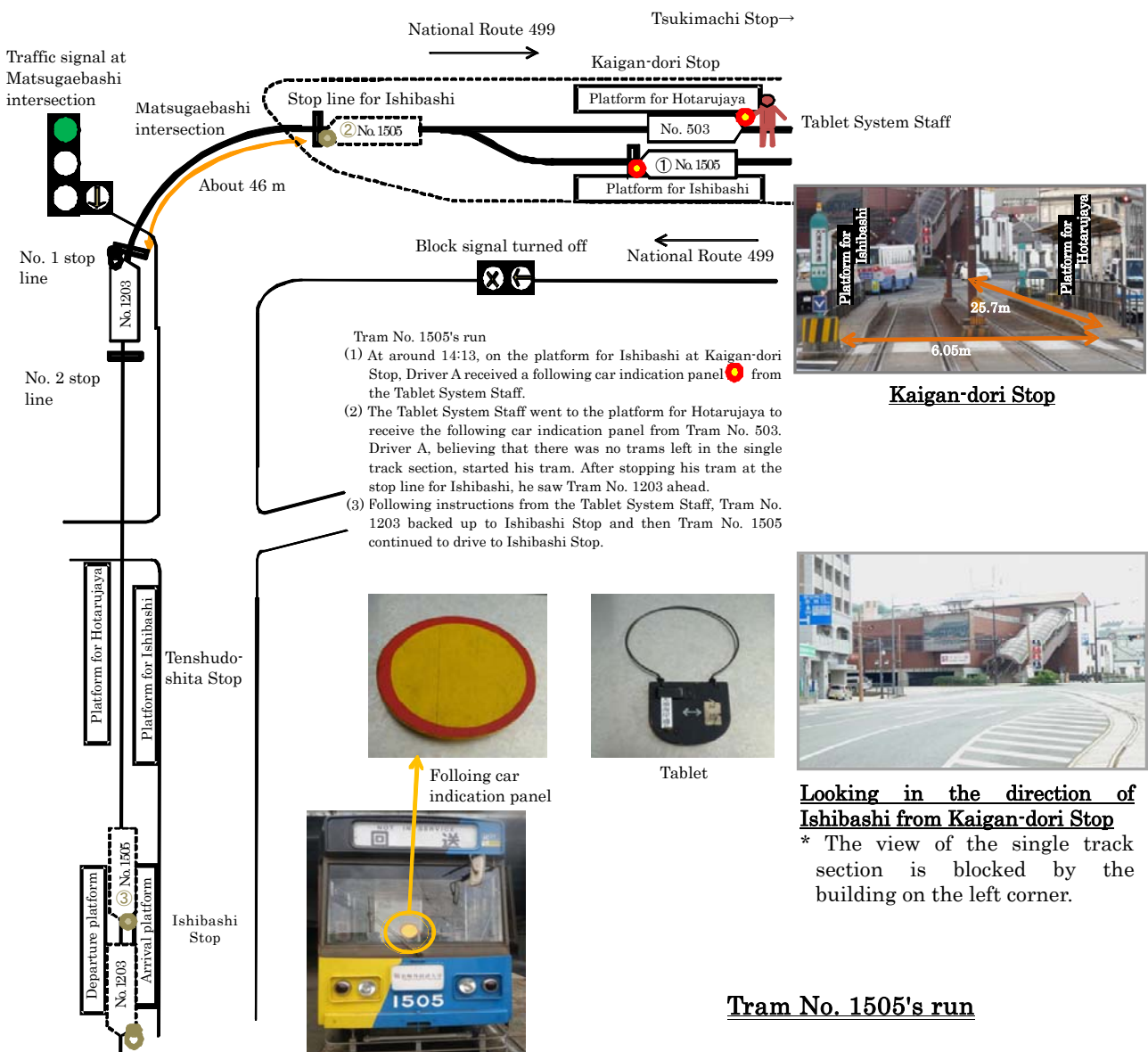
probable that Driver A started his tram believing that two trams had entered the single track section (actually three trams entered) since his tram arrived at Kaigan-dori tram Stop and that, having seen the second tram, Tram No. 503, came out of the single track section, there were now no trams in the single track section.

(2) Analysis on the background contributing to the occurrence of this serious incident

a. Confirmation of the tablet

It is probable that, at the Company, tablet system staffs have customarily posted a ticket, i.e., the following car indication panel, to the tram without checking if its driver possesses a tablet, and that drivers have started their trams without questioning this practice. It is somewhat likely that some of the drivers and tablet system staffs at the Company do not fully understand the procedures stipulated in the operating standards or understand them but have carried out operations differently.

It is somewhat likely that, tablet system staff and drivers worried about keeping passengers waiting for long time by following the tablet system procedure, they have customarily turned to different procedures.



b. Long-time stop at Kaigan-dori tram Stop

It is somewhat likely that a contributing factor to Driver A not remembering having been told by the Tablet System Staff that there were three trams in the single track section, which is the priority safety information, was that Driver A, who worried about keeping the passengers waiting for long time in the crowded tram, concentrated his attention on the guidance to passengers.

It is somewhat likely that a contributing factor to driver and the tablet system staff not strictly observing the Company's operating standards related to the handling of the tablet and ticket, which was used about 80 days each year, was that their concern about not keeping passengers waiting a long time at traffic signal and others, prompted trams to start early.

c. Education and guidance

It is somewhat likely that tablet system staffs, and drivers with more than 3 years of experience, have been assigned to operations without the Company being fully aware of how much they have learned from the education programs and how well they can put their knowledge into practice.

For the past several years at the Company, the drivers have been instructed not to make judgments by themselves but to contact traffic controllers for instructions and guidance if there is an emergency during operation. However, there are cases when the drivers will need to quickly make the best possible decision based on their knowledge and skills. It is somewhat likely that the sort of company policy mentioned above can make drivers passive and dependent on advisers for resolutions to any emergency that may crop up and is reducing their motivation to improve their knowledge and skills and to be in charge of securing transport safety.

(3) Analysis on safety management

In August 2007, the Company set up a various safety committees on safety in an effort to firmly establish a safety management system. However, it was not long before more incidents occurred one after another. Therefore, it is somewhat likely that there was not enough communication between the head office and those in the field and that a “safety culture” did not fully grow within the Company, such as a corporate environment that keeps close watch on any deviation from the rules and motivation among the staff to maintain a safety record.

3. Probable causes

In this serious incident, it is highly probable that Driver A started moving his tram into the single track section where a tablet and ticket block system was in place, without checking for a tablet despite the fact that Tram No. 1203 was already in the single track section.

As to the reason why Driver A started moving his tram into the single track section, it

is probable that he did not check for a tablet prior to starting as stipulated in the Company's operating standards and that he erroneously believed that there were no trams left in the single track section.

As to the reason why Driver A did not check for a tablet, it is probable that a contributing factor was that the Tablet System Staff handed a ticket to Driver A before he got a tablet from the tram No.1203.

As to the reason why this serious incident occurred, it is probable that the contributing factors were that deviation from the operating standards had been allowed to continue for many years and, more broadly, that the Company failed to properly manage the knowledge level among staff in the field and the procedure in which they actually operated.

As to the background for the above, it is somewhat likely that contributing factors were that the effort by the head office of the Company to establish a safety management system left much to be desired and that those in the field tended to lose their drive to improve their knowledge and skills and be in charge of securing transport safety by themselves.

4. Recommendations

The JTSC recommended to the Company on staff education on the company's regulations and standards, improvement in the safety management system and effective promotion and implementation of measures.

(For the details of the recommendations, refer to "Chapter 2 - 2. Summary of recommendations and opinions" (Page 71).)

5. Remarks

The JTSC expressed its remarks regarding consideration on the prevention of recurrence by facilities improvement, support and cooperation from local public bodies and other relevant government authorities and others.

(For the details of the remarks, refer to "Appendix 15 Remarks made in 2011" (Page 32 in Appendixes).)

Railway 5 A train with a failed ATC system was allowed to continue to operate without the substitute block system applied, and entered a route on which another train had been stopped.

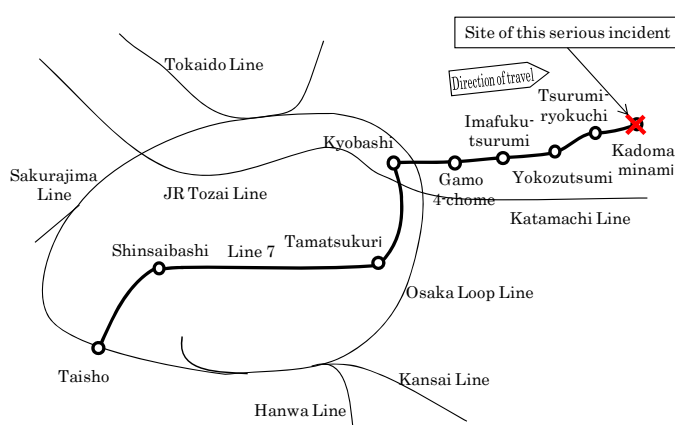
(Railway serious incident, within the Kadoma-minami Station premises, Osaka Municipal Transportation Bureau Subway Line 7 (Nagahori Tsurumi-ryokuchi Line))

Full text of the investigation report (Japanese text only): <http://www.mlit.go.jp/jtsb/railway/rep-inci/RI2011-4-2.pdf>

1. Summary of the serious incident

- (1) Date and time: At around 05:46 on March 15 (Monday), 2010
- (2) Location: Within the Kadoma-minami Station premises of Osaka Municipal Transportation Bureau Subway Line 7 (Nagahori Tsurumi-ryokuchi Line) in Kadoma City, Osaka Prefecture
- (3) Outline of the railway serious incident:

The train “B0504” (Line 7), a 4-car train set, from Taisho Station to Kadoma-minami Station (the Train), operated by the Osaka Municipal Transportation Bureau (the Bureau), departed Kyobashi Station at 05:27. Soon after departure, the ATC*¹ service brake operated, causing the train to stop at about 17 m from where it had started. The driver of the Train disengaged the ATC system as instructed by a train



Site of this serious incident

dispatcher and resumed operation without changing the block system. At Kadoma-minami Station, the Train entered the route to Track No. 2 on which a substitute train, A0504 (the Substitute Train), had been stopped. The driver applied the emergency brake and the Train stopped about 60 m before the Substitute Train.

- (4) Date of publication: October 28, 2011

*1: ATC, abbreviation of the Automatic Train Control, has functions to decelerate trains below the restricted velocity according to information about signal and its position obtained from ground facilities.

2. Findings

- (1) Analysis on the occurrence of this serious incident

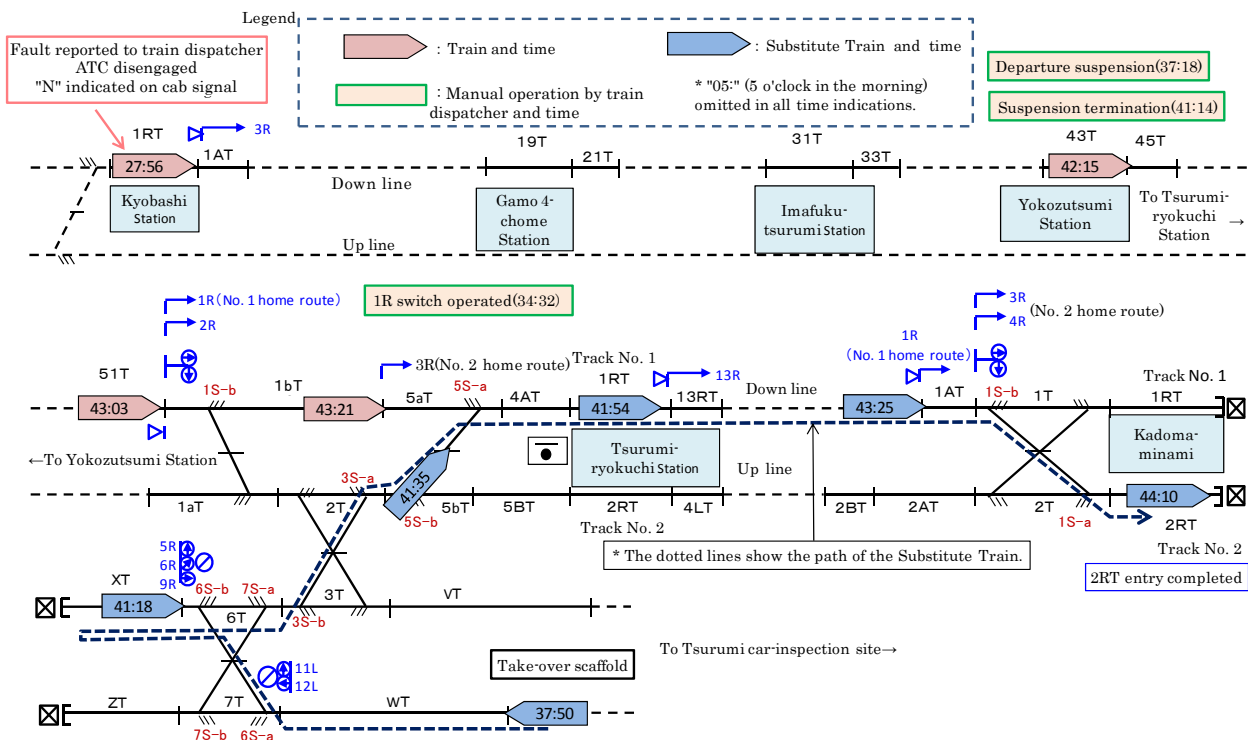
It is probable that the following factors contributed to the Train entering Kadoma-minami Station where blocking had not been completed, and entering a route to Track No. 2 on which the Substitute Train had been stopped.

- a. The Substitute Train had entered Track No. 2 of Kadoma-minami Station prior to the Train and points 1S-a and 1S-b at the station were both open to Track No. 2.
- b. It is probable that as the Train continued to run without the substitute block system

applied, the train dispatcher did not check the route clear status for Kadoma-minami Station.

- c. It is probable that although the Train was running in an abnormal circumstance with the ATC system disengaged and the cab signal showing “N”^{*2}, the driver did not check the opening direction of point 1S-b at Kadoma-minami Station.
- d. The Train lost its train number at Tsurumi-ryokuchi Station and no programmed route control was made at the home signal Kadoma-minami 1R and 3R.

*2: N signal is displayed when the speed limit signal is not being received from the ground. The speed limit then is 0 km/h.



Operations of the Train and the Substitute Train (1)

(2) Background contributing to the occurrence of this serious incident

{1} Analysis on the action of the train dispatcher

- a. Reasons why the substitute block system was not applied after ATC system disengagement

As to the reason why the Train was allowed to run after the ATC system was disengaged without the substitute block system applied, it is probable that the train dispatcher (Train Dispatcher A), although familiar with the substitute block system, was so anxious not to delay the Train, the first train of the day, and to prepare a substitute train as quickly as possible, that he could not think about the need to change the block system for the Train.

- b. On the response to the illegal track-shunting alert^{*2}

As to the inquiry by an electric power dispatcher about the illegal track-shunting alert,

it is probable that Train Dispatcher A did not understand what was going on. It is probable that the dispatcher's confusion was magnified by the pressure to maintain punctuality and therefore he could not make a proper judgment.

As to the reason why another train dispatcher responded to Train Dispatcher A without confirming the content of the alert, it is somewhat likely that this dispatcher was devoted himself to input control data to set the route for the substitute train into a computer, and stop the irritating alert without careful confirmation.

c. Analysis on the handling of the contingency by train dispatcher

In any contingency, it is necessary to remind the basic concept of the rules and take action in accordance with the rules and regulations. In this abnormal event, however, it is highly probable that, considering that the substitute block system was not applied after the ATC system was disengaged and that appropriate action was not taken to respond the illegal track-shunting alert.

*2: Illegal track-shunting alert indicates non-continuous passing of a train through track circuits or passing of a train through a point set in the incorrect direction.

{2} Analysis on the action of the driver

a. Analysis on why the driver followed the train dispatcher's instructions after disengaging the ATC system

As to the train operations after the ATC system was disengaged, it is somewhat likely that the driver felt doubtful about the instructions of the train dispatcher and it is probable that the driver, while the instructions were not in line with the regulations, did not mention his doubts to the train dispatcher. It is somewhat likely that this was due to the driver's strong belief that he must obey the instructions of train dispatchers even if the ATC system is disengaged.

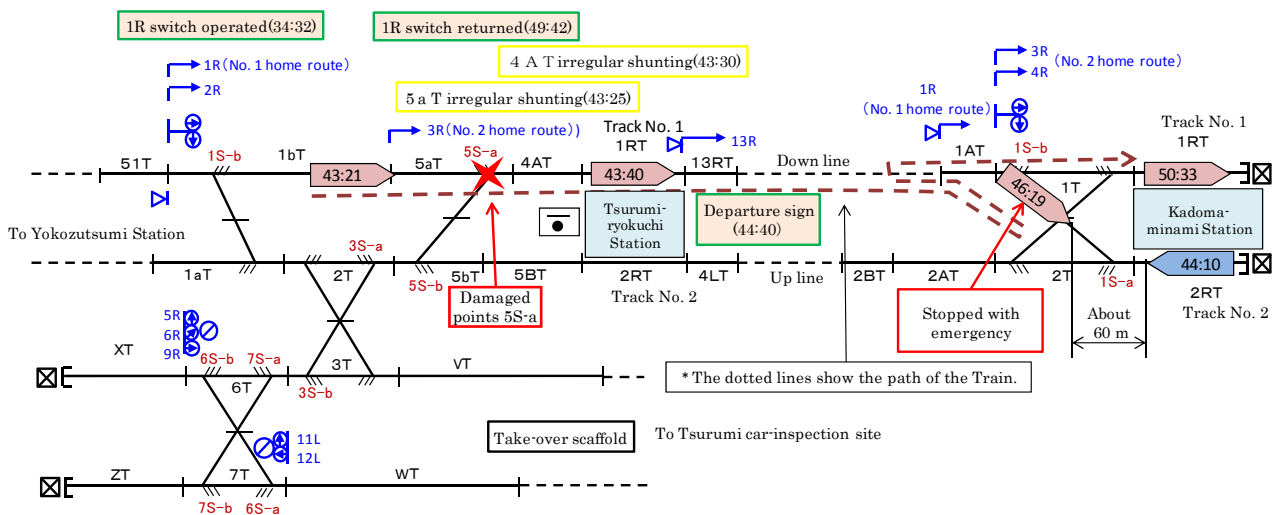
b. Analysis on the train operations and others during the contingency

Considering that before the serious incident occurred, the ATC system was disengaged and the cab signal was showing "N," which indicates an abnormal situation, and that a substitute apparatus for hand signals was not used, although it should have been, it is probable that the driver should have checked the switched status of the point to the correct route. While another two drivers were in the driver's cab of the Train, no one appeared to have been aware of the need to check the switched status of the point to the correct route. It is somewhat likely that all drivers in the cab lost the sense to recognize what they are looking is abnormal, in which the Train is running with the ATC system disengaged and the cab signal showing "N."

It is somewhat likely that some of the drivers at the Bureau have not retained the basic knowledge on train operation in a contingency or are no longer capable of putting that knowledge into practice.

{3} Analysis on the safety management system in the Bureau

It is somewhat likely that the Bureau has failed to maintain a fully effective safety management system among the staff, including how to ensure safety in a contingency and how to retain the knowledge and skills they have learned in training. Especially regarding train dispatchers, it is somewhat likely that they have not been fully trained to make the most basic safety decisions when they are at a loss about what to do. Also for the drivers, it is somewhat likely that they have not been fully trained to enhance their sense of mission to implement safe train operation.



Operations of the Train and the Substitute Train (2)

(3) Analysis on the prevention of recurrence

It is probable that those involved in train operation in this section of the line did not have sufficient knowledge or skills to competently handle any contingency. It is somewhat likely that the Bureau has failed to put in place a safety management system that can thoroughly handle any abnormal circumstances.

Therefore, for the prevention of the recurrence of this type of serious incident, the Bureau should promote measures to maintain and improve staff knowledge and skills and to improve its safety management system for abnormal circumstances.

It is somewhat likely that train dispatcher failed to take some of the most basic actions needed to put safety first in a contingency, meaning that the dispatcher had not been fully trained to make the most basic judgments on safety even when he cannot recognize the current situation. It is therefore necessary for dispatchers to be thoroughly trained on issuing appropriate instructions for train operation during any abnormal circumstances.

It is necessary for the drivers to be given training to maintain and improve their basic knowledge and skills on train operation in abnormal circumstances and to go through programs to enhance their awareness of safety and commitment to ensuring the safe operation of their train.

In its effort to improve its safety management system for emergencies as recommended above, the Bureau should also pay attention to the following:

- a. Reeducation of train dispatchers and drivers on the rules and regulations regarding train operation and instructions during a failure in the onboard ATC system and have them strictly obey the rules and regulations.
- b. Improvement of the training programs for train dispatchers and drivers covering a range of abnormal cases including train failures requiring train replacement and failures from complex causes.
- c. Reeducation of train dispatchers on the input of train numbers*³ into the Programmed Traffic Control (PTC) system, issuing of warnings, the use of switches for controlling signals, points and other relevant subjects.
- d. Improvement of communication and information sharing among train dispatchers.
- e. It is probable that as the Train was instructed to run in reverse at Kadoma-minami Station, there was no prior check on the traffic conditions in the direction the Train was going (reversing). Therefore, the Bureau must consider appropriate ways for train operation in similar contingencies in the future.
- f. It is probable that the cab signal failure of the Train was caused by damage due to aging of the electrolytic capacitor of the detector in the ATC receiver. Therefore, the Bureau must pay closer attention to aging when conducting future maintenance on its fleet.
- g. In the event of a failure in the PTC, the train dispatcher and the driver may have to change to manual operation. Therefore, they must be regularly trained on possible failures and appropriate handling of these failures.

*3: Train numbers must be inputted into the PTC system for traffic control.

3. Probable causes

In this serious incident, it is probable that the Train with a failed ATC system and without the substitute block system applied, was then allowed to enter Kadoma-minami Station without any check of the station's blocking status, so that the driver of the Train, on which the ATC system had been disengaged and the cab signal was showing an abnormal indication, did not check the point change to the correct route before entering the station, and that as a result, the Train was allowed to enter a course on which the Substitute Train had been stopped.

As to the reason why the Train was allowed to run without the substitute block system applied, it is probable that the train dispatcher, although familiar with the substitute block system, was so anxious not to delay the Train, the first train of the day, and to prepare a substitute train as quickly as possible, that he could not think about the need to change the block system for the Train.

As to the reason why the driver did not check the status of the point indication, it is somewhat likely that he had lost the sense to identify what is abnormal, which in this case is

the Train running with the ATC system disengaged and the cab signal showing an abnormal sign.

As to the background of this, it is somewhat likely that the Bureau has failed to maintain a fully effective safety management system among the staff, including how to ensure safety in a contingency and to retain the knowledge and skills they have learned in training.

4. Remarks

The JTSB expressed its remarks to the Osaka Municipal Transportation Bureau regarding the need to improve its safety management system for abnormal circumstances including training programs to ensure that everyone involved in train operation is capable of taking appropriate actions in any contingency.

(For the details of the remarks, refer to “Appendix 15 Remarks made in 2011” (Page 33 in Appendixes).)

2. Summary of recommendations and opinions

There was one recommendation in 2011, which is summarized below:

(1) Recommendations (one case)

• Based on the results of the investigation into the serious incident on the Oura Branch Line of Nagasaki Electric Tramway Co., Ltd., the following recommendations were made to the company on September 30, 2011.

1. Staff education on the company's regulations and standards

- (1) Nagasaki Electric Tramway should verify whether the current operations standards, etc., related to the implementation of the safety system (safety blocks) are appropriate and in line with the reality including the competency of those directly involved in train operation.
- (2) Appropriate education and training should be provided to the relevant employees in ways that ensure that what they have learned can be fully put into practice and that their knowledge and skills level should be monitored regularly.
- (3) The relevant employees should understand the relevant laws, the company regulations and standards, etc., and strictly observe these rules.

2. Improvement of the company's safety management system and effective promotion of related measures

- (1) The current safety management measures should be reviewed for their effectiveness and those systems and measures that are found to be dysfunctional should be abolished or reviewed for improvement.
- (2) The top-down, head-office-led safety management system should be reviewed so as to end up with measures that can help the field personnel address any issues seriously and proactively improve their capabilities.

3. Statistics of investigations of railway accidents and serious incidents

The JTSB carried out investigations of railway accidents and serious incidents in 2011 as follows:

Regarding accident, 10 cases were carried over from 2010, and there were 14 cases newly launched in 2011. Of the total number, investigation reports for eight cases were published and 16 investigations were carried over to 2012.

Regarding serious incident, six cases were carried over from 2010, and there were two cases newly launched in 2011. Of the total number, investigation reports for six cases were published and two investigations were carried over to 2012.

Among the publicized reports of 14 cases, one included recommendations and two included remarks.

Investigations of railway accidents and serious incidents in 2011

(Cases)

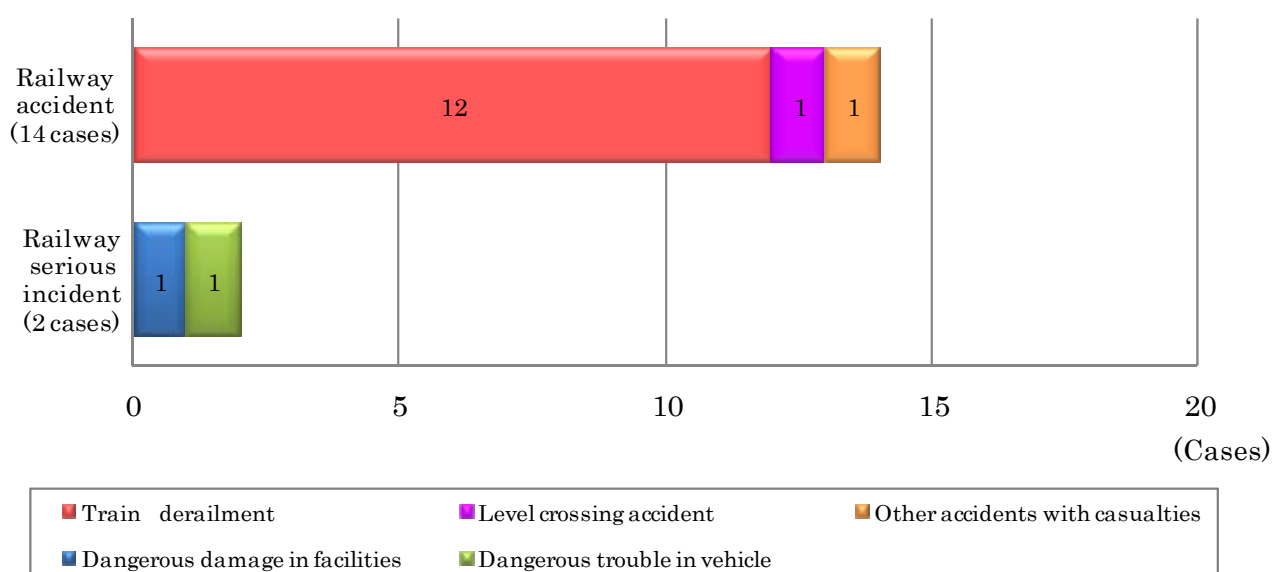
Category	Carried over from 2010	Launched in 2011	Total	Publication of investigation report	Recommendations	Safety recommendations	Opinions	Remarks	Carried over to 2012
Railway accident	10	14	24	8	0	0	0	0	16
Railway serious incident	6	2	8	6	1	0	2	0	2

4. Statistics of investigations launched in 2011

The investigations launched in 2011 included 14 accidents, up five cases from nine cases for the previous year, and two serious incidents, down five cases from seven cases for the previous year.

With regard to railway accident cases, there were 12 cases of train derailment (including due to two accidents of level crossing), one case of level crossing accident and one case of other accidents with casualties. With regard to railway serious incidents, there were one case of dangerous damage in facilities and one case of dangerous trouble in vehicle.

Number of railway accidents and serious incidents by Type



In the 14 railway accidents, the number of casualties is 86, consisting of one death and 85 injured persons. These accidents include one accident killing the driver of the vehicle in February 2011, in which a crossing rod that had been stuck in the lowered position was raised by an employee of the railway company, leading to a train colliding with a vehicle that had entered into the crossing, and another accident injuring passengers and crewmembers while escaping on foot in May 2011, in which white smoke billowed from a train that had stopped in a tunnel.

Number of casualties (railway accidents)

2011							(Person)
Category	Dead			Injured			Total
	Crew	Passenger	Others	Crew	Passenger	Others	
Casualties	0	0	1	2	83	0	86
Total	1			85			

5. Publication of investigation reports

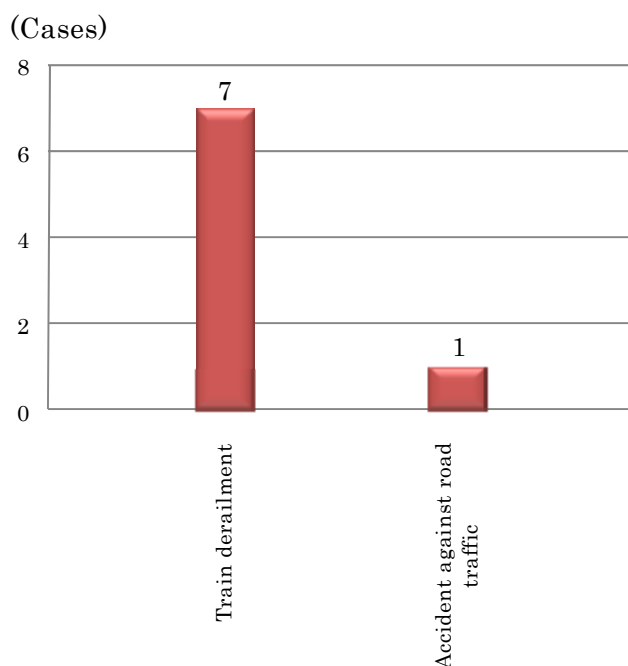
The number of investigation reports of railway accidents and serious incidents publicized in 2011 is 14: eight accidents and six serious incidents.

Looking those accidents and serious incidents by type, there were seven cases of train derailment (including due to two accidents of level crossing) and one case of accident against road traffic in railway accidents. Whereas in serious incidents, there were one case of incorrect

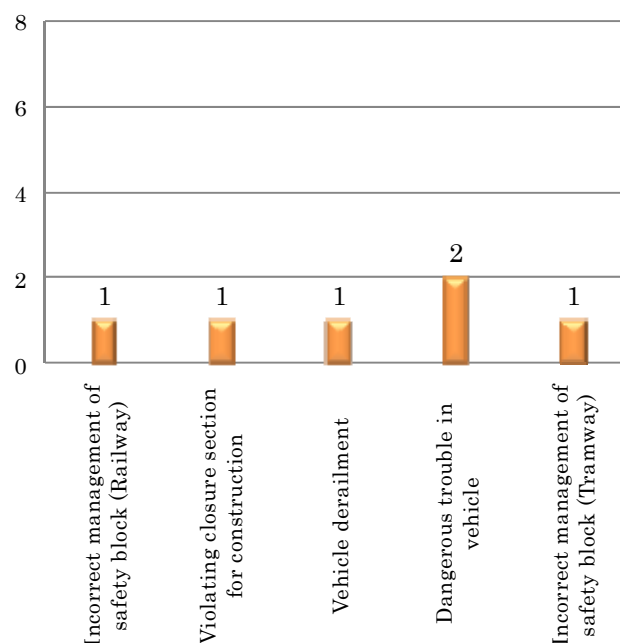
management of safety block (Railway), one case of violating closure section for construction, one case of vehicle derailment, two cases of dangerous trouble in vehicle and one case of incorrect management of safety block (Tramway).

In the eight accidents, the number of casualties is 57, consisting of one death and 56 injured persons.

**Railway accidents (eight cases):
reports publicized in 2011**



**Railway serious incidents (six cases):
reports publicized in 2011**



The investigation reports of railway accidents and serious incidents publicized in 2011 are summarized as follows:

List of publicized investigation reports on railway accidents (2011)

No.	Date of publication	Date and location	Operator	Type	Deaths/Injuries
1	Jan. 28, 2011	Dec. 19, 2009 Between Sotaro Station and Ichitana Station, Nippo Line, Miyazaki Prefecture	Japan Freight Railway Company	Train derailment	None
2	Feb. 25, 2011	Sept. 9, 2009 In Suita signal station premises, Tokaido Line, Osaka Prefecture	Japan Freight Railway Company	Train derailment	None
3	Mar. 25, 2011	Jan. 17, 2010 Between Echigo-kawaguchi Station and Ojiya Station, Joetsu Line, Niigata Prefecture	East Japan Railway Company	Train derailment	None

No.	Date of publication	Date and location	Operator	Type	Deaths/Injuries
4	Mar. 25, 2011	Jan. 29, 2010 Between Fukagawa Station and Moseushi Station, Hakodate Line, Hokkaido	Hokkaido Railway Company	Train derailment (Level crossing accidents)	44 slightly injured (42 passengers, a conductor and a dump truck driver) and one seriously injured (a train driver)
5	May 27, 2011	Dec. 9, 2010 Between Zasshonokuma Station and Kasugabaru Station, Tenjin-Omuta Line, Fukuoka Prefecture	Nishi-Nippon Railroad Co., Ltd.	Train derailment (Level crossing accidents)	One dead (an automobile driver)
6	Sept. 30, 2011	May 21, 2010 Between Kumanomae Stop and Miyanomae Stop, Toei Streetcar Arakawa Line, Tokyo	Bureau of Transportation, Tokyo Metropolitan Government	Accident against road traffic	6 slightly injured (3 passengers, the driver and 2 passengers of a truck)
7	Sept. 30, 2011	June 19, 2010 In Higashi-mizushima Station premises, Koto Line, Okayama Prefecture	Mizushima Rinkai Railway	Train derailment	None
8	Dec. 16, 2011	July 31, 2010 Between Oshikado Station and Iwate-Okawa Station, Iwaizumi Line, Iwate Prefecture	East Japan Railway Company	Train derailment	One seriously injured (a passenger) and 4 slightly injured (2 passengers and 2 crewmembers)

List of publicized investigation reports on railway serious incidents (2011)

No.	Date of publication	Date and location	Operator	Type
1	Apr. 22, 2011	June 29, 2010 In Tomida Station premises, Sangi Line, Mie Prefecture	Sangi Railway Co., Ltd.	Vehicle derailment
2	June 24, 2011	May 29, 2010 Between Inazumi-koen Station and Teine Station, Hakodate Line, Hokkaido	Hokkaido Railway Company	Dangerous trouble in vehicle
3	Sept. 30, 2011	June 17, 2010 Between Nishitetsu-Wataze Station and Nishitetsu-Ginsui Station, Tenjin-Omuta Line, Fukuoka Prefecture	Nishi-Nippon Railroad Co., Ltd.	Violating closure section for construction
4	Sept. 30, 2011	Oct. 21, 2010 Between Oura-kaigan-dori Stop and Oura-tenshudo-shita Stop, Oura Branch Line, Nagasaki Prefecture	Nagasaki Electric Tramway Co., Ltd.	Incorrect management of safety block
5	Oct. 28, 2011	Oct. 29, 2010 Between Yaga Station and Hesaka Station, Geibi Line, Hiroshima Prefecture	Nishi-Nippon Railroad Co., Ltd.	Dangerous trouble in vehicle
6	Oct. 28, 2011	Mar. 15, 2010 Kadoma-minami Station premises, Subway Line 7 (Nagahori Tsurumi-ryokuchi Line), Osaka Prefecture	Osaka Municipal Transportation Bureau	Incorrect management of safety block