RA2007-3-1

Railway Accident Investigation Report
(Excerpt)

Train Derailment Accident between Tsukaguchi and Amagasaki Stations of the Fukuchiyama Line of the West Japan Railway Company

June 28, 2007

Aircraft and Railway Accidents Investigation Commission

Railway Accident Investigation Report

Railway operator:	West Japan Railway Company
Accident type:	Train derailment
Date and time:	Around 9:18, April 25, 2005
Location:	Amagasaki City, Hyogo Prefecture Between Tsukaguchi and Amagasaki Stations of the Fukuchiyama Line (approx. 1,805 m from the Origin at Amagasaki Station)

June 22, 2007

Adopted by the Aircraft and Railway Accidents Investigation Commission

Chairman	Norihiro Goto
Member	Yukio Kusuki
Member	Yasuo Sato
Member	Toshiko Nakagawa
Member	Masayuki Miyamoto
Member	Koichi Yamaguchi
Member	Shinsuke Endoh
Member	Noboru Toyooka
Member	Yuki Shuto
Member	Akiko Matsuo

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1. Process and Progress of the Railway Accident Investigation

1.1. Summary of the Railway Accident

The rapid up train "5418M" (a seven-cars train set) operated by the West Japan Railway Company started from Takarazuka Station bound for Doshisha-mae Station left Itami Station about 10 s past 9:16 a.m., April 25 (Monday), 2005. After passing through Inadera Station, the train passed through Tsukaguchi Station about 22 s past 9:18 a.m. Then, while the train was running along a 304 m-radius rightward curved track located to the south of the Meishin Expressway, the first car of the train fell left and derailed about 54 s past 9:18 a.m. This was followed by derailment of the second to fifth cars. The rearmost car (seventh car) stopped about 4 s past 9:19 a.m.

The first car toppled left to the ground, with the front section of the car collided against the wall of the back of the mechanical parking lot on the first floor of a condominium located to the east of the railway track and the lower part of the rear section of the car colliding against the northwest column of the condominium. The left side of the middle section of the second car collided against the northwest column of the condominium with the body of the second car jackknifed with the rear section of the first car caught in between. The left side of the rear section of the second car collided against the northeast column. Both wheelsets of the third car's front bogie derailed to the left, both wheelsets of the third car's rear bogie derailed to the right, both wheelsets of the fourth car's front and rear bogies derailed to the right, both wheelsets of the fifth car's front bogies derailed to the left, and the left wheels of both wheelsets of the fifth car's rear bogie derailed with the wheels lifted off the rail. The sixth and seventh cars did not derail.

The number of people killed in the accident was 107 (106 passengers and the driver), and the number of people injured was 562 (562 passengers, according to the information provided by the Hyogo Prefectural Police Headquarters).

1.2. Outline of the Accident Investigation

1.2.1. Investigation Organization

On April 25, 2005, the Aircraft and Railway Accidents Investigation Commission (hereinafter referred to as "the Commission") appointed an investigator-in-charge and four other railway accident investigators to investigate the accident. In addition, one, two, two, one, and one additional railway accident investigators were appointed on May 9, June 2, June 13, June 20, and July 19 of the same year, respectively, and one additional railway accident investigator was appointed on February 17, 2006.

The Commission sent the chairman, members, expert adviser, the director-general, railway accident investigators, and other staffs to the accident site and related places.

On April 26, 2005, the Commission appointed Professor Yoshihiro Suda of the Center for Collaborative Research of the University of Tokyo as an expert adviser to investigate the accident in relation to vehicles.

The Kinki Transport Bureau sent its staffs to the accident site to provide support for the investigation of the accident.

For the investigation of the accident, the Commission entrust component analyses of the samples of adhering materials taken from railway facilities, vehicles, etc.; the test to reproduce and measure the shifts of the centers of gravity of the passengers in the individual vehicles; computer simulations of the derailing and swaying of the individual vehicles; the ballast scattering test; the test to measure the brake performance (test using actual trains); and other tests and simulations to the Railway Technical Research Institute (incorporated foundation).

The Commission also entrust the task of analyzing the audio recorded data in the long-time audio recording equipment to Japan Acoustic Lab. and TEAC Corporation and the task of testing

the monitor equipment to Koito Industries Limited.

The Commission obtained information on the accident from the Hyogo Prefectural Police Headquarters, Amagasaki City Fire Department, Kobe City Fire Department, Osaka City Fire Department, and other organizations concerned.

The Commission also obtained the cooperation of passengers, witnesses, and other people concerned.

1.2.2. Implementation of Investigation

On-site survey: April 25 to May 6, 2005, May 17 to 28, 2005, and July 21, 2005

Performance test using actual trains (conducted on the Fukuchiyama Line): June 13 to 16, 2005, October 19 to 21, 2005, and February 3 to 5, 2006

Braking test using actual trains (conducted on the Sanyo Line): October 2 to 28, 2006, and November 12 to 19, 2006

Examinations and tests of railway facilities and vehicles: May 10, 2005, to March 17, 2006

Interviews and questionnaire surveys: April 25, 2005, to May 27, 2007

Ballast scattering test: December 13, 2005, and February 17, 2006

Test to reproduce and measure the shifts of the centers of gravity of the passengers subjected to the centrifugal force in the individual vehicles: November 1, 2005

Simulations of the derailing: December 12, 2005, to March 17, 2006, and June 30, 2006, to August 31, 2006

1.2.3. Interim Report of the Investigation and the Proposals

On September 6, 2005, the Commission submitted an interim report prepared based on the results of the factual investigation conducted up to that day to the Minister of Land, Infrastructure, Transport and Tourism and made the proposals for the improvements to be made in the short term to the Minister (see Attachment 1).

1.2.4. Hearing Public Comments

A “Draft of Reports on Factual Investigation", written in Japanese, was published on December 20, 2006, and a hearing was held on February 1, 2007, in which 13 witnesses were interviewed.

(1) Time and date of the hearing: from 10:00 a.m., February 1 (Thursday), 2007
(2) Location of the hearing: Common Meeting Room A (on the tenth floor of the Central Government Building No. 3, 2-1-3 Kasumigaseki, Chiyoda-ward, Tokyo) of the Ministry of Land, Infrastructure, Transport and Tourism
(3) Chairperson for the hearing: Masato Kakami (director-general of the Commission)
(4) Witnesses

People who were asked by the Commission to be interviewed as witnesses:

Masakazu Iguchi (Professor Emeritus, The University of Tokyo)

Nobukuni Ishii (Adviser, Japan Train Operation Association (an incorporated association))

Isao Kuroda (President, Japan Institute of Human Factors)

People who volunteered to be interviewed as witnesses:

Kazuaki Maruo (Vice President of the West Japan Railway Company and the head and an operating officer of the Railway Headquarters of the West Japan Railway Company)
Hideo Yamanaka (Assistant General Manager, Conduits Department, Nakai Engineering Co., Ltd.)
Kiyomichi Sugihara (Secretary-General, Central Headquarters, West Japan Railway Company Labor Union)
Satoshi Ogura (Subsection Head, REIJINSHA Co., Ltd.)
Yasakazu Asano (President, CKKplan.net)
Kazumitsu Shinohara (Associate Professor, Graduate School of Human Sciences, Osaka University)
Makoto Maekawa (Vice Chairman, Central Headquarters, West Japan Railway Company Labor Union)
Seiji Abe (Professor, Faculty of Commerce, Kansai University)
Shogo Yoshioka (Secretary-General, Western Japan Headquarters, Japan Railways Labor Union)
Kazuhiko Nagase (Professor, Department of Mechanical Engineering, Kanazawa Institute of Technology)

(5) Outline of the hearing and the Commission members who participated in the hearing

Refer to "Proceedings of Hearings for Railway Accidents (Hearing for the Train Derailment Accident on the Fukuchiyama Line of the West Japan Railway Company held in February 2007)," written in Japanese.

1.2.5. Comments from the Parties Relevant to the Cause of the Accident

The Commission held hearing of opinions with parties relevant to the cause of the accident.

4. Probable Causes

It is considered highly probable that the train driver's delay in applying the brake resulted in the entry of the train into a 304 m-radius rightward curved track at a speed of approximately 116 km/h, which was far higher than the specified speed limit of 70 km/h, and the running of the train along the curved track at the high speed caused the first car of the train to fall left and derail, which caused the second to fifth cars to derail.

It is considered probable that the train driver's delay in applying the brake is attributable to the diversion of his attention from driving the train to (1) listening to the dialogue between the conductor and the train dispatcher by radio communication which was caused by his belief that he had been hung up on by the conductor while he had been talking to the conductor on the intercom to ask him to make a false report and (2) making up an excuse to avoid being put on an "off-the-train" re-training course.

It is considered probable that the West Japan Railway Company's train driver management system in which drivers who caused an incident or a mistake are put on an "off-the-train" re-training course that can be considered as a penalty or are subjected to a disciplinary action and drivers who did not report an incident or a mistake they had caused or made a false report about such an incident or mistake are put on an even harder "off-the-train" re-training course or subjected to an even harder disciplinary action may have (1) caused the driver to make the call to the conductor on the intercom to ask him to make a false report and (2) caused the diversion of the driver's attention from driving the train.

5. Proposals

In view of the result of this accident investigation, the Aircraft and Railway Accidents Investigation Commission make proposals* to the Minister of Land, Infrastructure, Transport and Tourism as follows:

Proposals Based on the Results of the Investigation of the Train Derailment Accident on the Fukuchiyama Line of the West Japan Railway Company

(1) Improvement of procedures to grasp and utilize information about incidents etc.

To allow railway operators to correctly grasp incidents etc., efforts to motivate crewmember to actively report incidents etc., such as efforts to develop a non-punitive reporting system, should be promoted, in addition to promoting the activities and efforts specified in the Commission's Proposals dated September 6, 2005 ("Installation and Utilization of Equipment that Records the Operating Status and Related Data of Trains", written in Japanese).

The Commission has been investigating train accidents etc. and publishing reports on them, but a system should be considered for other events as well in which railway operators etc. perform the necessary analyses and these results are utilized by other railway operators as well.

In addition, research and studies should be conducted on methods and procedures to make a comprehensive analysis of information on a variety of incidents etc. and utilize the analyzed results in an effective manner in consideration of the uniqueness of railway business in the sense that not only crewmember and vehicle but also train traffic control system and infrastructures are centrally managed by transportation operators.

(2) Limitation of using train radio by train driver while train is running.

Use of the train radio by train drivers while they are driving trains should be limited to cases where it is necessary to use the train radio for safety reasons such as the case where braking operation is necessary to stop the train in an emergency situation.

In addition, train drivers should be prohibited from making notes the dialogue exchanged over the train radio while they are driving trains.

For line sections in which trains run frequently and the burden on train drivers of confirming signals is high, a method to reduce the needs of communication using train radio while they are driving trains through the use of equipment that allows train dispatchers to grasp the status of the operation of the trains accurately and in real time, and a method to transmit driving-related instructions, etc., to the onboard device in the form of text information that can be read by the drivers when their trains are not moving, should be considered. In addition, a method to reduce the needs of communication using train radio for train through utilization of conductors to the maximum extent possible should be considered.

(3) Certain notification of the relevant laws and regulations to the related staffs in manufacturers.

Because equipment that is important for safety including vehicle equipment and signal equipment tends to be "black boxes" to railway operators, measures should be taken to ensure that all design, production, and quality control staff members, who are involved in actual design, production, and quality control work, of manufacturers of equipment that is important for safety know and understand the applicable laws and regulations so that sufficient quality control is exercised by such manufacturers.

In addition, because maintenance of vehicle and railway facilities is increasingly being

outsourced, measures should be taken to ensure that all staff members, who are involved in actual maintenance work, of contractors of such maintenance know and understand the applicable laws and regulations.

* The Aircraft and Railway Accidents Investigation Commission may, when it finds it necessary, make proposals on measures which should be taken to prevent aircraft or railway accidents, or to alleviate damage if such accidents take place to the Minister of Land, Infrastructure, Transport and Tourism or the head of the relevant administrative organ based on the Act for Establishment of the Aircraft and Railway Accidents Investigation Commission.

6. Remarks

6.1. Measures that Should Be Taken by the West Japan Railway Company

The West Japan Railway Company should take the following measures:

(1) Improving training on train driving techniques

Training on train driving techniques should be improved and strengthened so that more practical training is provided, for example, by (a) introducing training based on findings on allotment of attention from analyses of information on incidents etc., (b) introducing training that appropriately uses driving simulators and training materials that are easy to understand and imagine, and (c) making train drivers fully aware of dangers associated with exceeding the speed limits.

In addition, "off-the-train" re-training courses, which are considered by some train drivers as a penalty, should also be turned into ones that do not place too much emphasis on spiritual training and are effective in preventing accidents and appropriate to be called "re-training," for example by introducing training on practical train driving techniques mentioned above.

(2) Improving brake equipment

Brake equipment should be improved so that the difference of decelerations for each brake handle position is small regardless of whether the regenerative brake is active or not. This would make it unnecessary for train drivers to pay attention to the status of the regenerative brake as to whether it has been activated or not.

In addition, brake equipment should be improved so that the actual brake deceleration does not exceed the specified standard value by an amount that is larger than necessary to ensure safety, to prevent unnecessary brake activation by ATS.

Furthermore, measures should be taken to solve the problem of non-activation of the brake when the brake handle is located between the service brake's 8-notch position and the emergency position.

Because train drivers may drive many different types of railway cars, brake equipment should be improved so that differences in brake performance between different types of railway cars should be minimized. This would reduce the burden on train drivers and allow them to pay more attention to confirming the safety in front of the train.

(3) Train operation control that gives highest priority to the safety of human lives

Train operation control systems should be improved so that train operation is controlled with highest priority given to the safety of human lives in all situations, for example, by preparing a manual describing the response actions to be taken in the event of a train derailment accident etc., which are considered safest, such as immediate shut off the electric power supply to the accident site and surrounding area as a general rule.

(4) Improving signs

Signs such as curve posts should be improved and enhanced so that they are recognized more easily and reliably.

6.2. Studies on Measures to Improve the Safety Performance of Railway Cars during Accidents

With regard to minimization of damages and injuries caused by accidents, the Commission made "Proposals on Strengthening of Efforts to Improve the Safety Performance of Railway Cars against Collisions" on April 26, 2002, written in Japanese, in response to the train collision accident on the Kagoshima Line of the Kyushu Railway Company on February 22, 2002. The railway operators should conduct studies on measures to improve the safety performance of railway cars, including modifications of railway car structures to ensure that sufficient space for the safety of passengers is retained in passenger cars even in the event of an accident, using the 2002 Proposals as a source of reference.

With regard to equipment in passenger cars, too, the railway operators should conduct studies to improve layouts, shapes, etc., of handrails so that injuries in the event of an accident are minimized.

7. Actions Taken

7.1. Measures that Have Been Taken by the West Japan Railway Company

(1) Development of a Safety Improvement Plan

In response to a direction from the Ministry of Land, Infrastructure, Transport and Tourism, the West Japan Railway Company developed a safety improvement plan on May 31, 2005, that included the provision of the SW curve speed check function and a revision of the train operation plan (see 7.2 (1)).

(2) Improving ATS

The West Japan Railway Company provided curve speed check functions in 1,234 curve sections in accordance with the safety improvement plan, to increase the number of curve sections equipped with curve speed check functions from 105 at the time of the Fukuchiyama Line accident to 1,370 (1,195 curve sections equipped with the ATS-SW curve speed check function, 96 curve sections equipped with the ATS-P curve speed check function, and 79 curve sections equipped with both the ATS-SW curve speed check function and the ATS-P curve speed check function) by the end of FY 2006 (see 1.2.3, Attachment 1, 2.13.8.4, and 7.2 (3)).

The West Japan Railway Company provided turnout speed check functions at 1,017 turnouts in accordance with the safety improvement plan, to increase the number of turnouts equipped with turnout speed check functions from 663 at the time of the Fukuchiyama Line accident to 1,696 (1,385 turnouts equipped with the ATS-SW turnout speed check function, 93 turnouts equipped with the ATS-P turnout speed check function, and 218 turnouts equipped with both the ATS-SW turnout speed check function and the ATS-P turnout speed check function) by the end of FY 2006.

(3) Provision of a backup power supply for the train protection radio equipment, etc.

The West Japan Railway Company provided a backup power supply for the train protection radio equipment in all railway cars (that have a driving cab) by the end of September 2006 and improved the power supply circuits so that the backup power supply will be activated in the event of a failure or disconnection of the normal power supply without the need to operate a power supply switching switch (see 1.2.3 and Attachment 1).

(4) Limiting the use of the train radio by train drivers

The West Japan Railway Company revised the basic section for "Operation" so that train drivers are normally required to refrain from making exchanges over the train radio until their trains arrive at the next station and implemented the revision beginning in May 2007 (see Figure 77).

(5) Improving the accuracy of speed meters of the same model as the speed meter of the first car of the derailed Fukuchiyama Line train

For speed meters of the same model as the speed meter of the first car of the derailed Fukuchiyama Line train, strict error reduction measures etc. had not been taken. For example, if the wheel diameter had been 794 mm, the wheel diameter setting had been set to "80" by rounding up the first place. However, the West Japan Railway Company modified the program by the end of December 2005 to comply with the ministerial ordinance for technical standards (see 1.2.3, Attachment 1, and 2.9.4.1).

(6) Installing EB equipment and TE equipment

The West Japan Railway Company has been installing EB (Emergency Brake) equipment and TE (One Touch Operative Emergency) equipment in railway cars towards the company's goal of installing EB equipment and TE equipment in all railway cars (which have a driving cab and are not a steam locomotive). The EB equipment and TE equipment installation rates as of the end of FY 2006 were 63.5% and 43.4%, respectively.

(7) Improving the train operation plan

Before resuming operation on June 19, 2005, in the line section in which the accident had occurred, the West Japan Railway Company revised their train operation plan. As part of this revision, they extended the minimum stop periods at Nakayamadera and Itami Stations for up-going rapid trains made up of seven 207 Series railway cars to 20 s (a 5-s extension for each station; see 2.14.4).

The revision also included an extension of the regular running time between the Fukuchiyama Line's Takarazuka Station (No. 2 Line) and Amagasaki Station (No. 6 Line) to 16 min and 20 s (a 45-s extension). Because the maximum operation speed for the section was lowered from 120 km/h to 95 km/h and the speed limit for the rightward curve section in which the accident had occurred was lowered from 70 km/h to 60 km/h, the basic "calculated time" increased to 15 min and 52 s (a 45-s increase) (see 2.10.1.2, 2.10.1.9, 2.14.3.1, Figure 51, and 7.2 (2)).

In addition, as a result of the train timetable revision of March 18, 2006, which involved regular running time and stop period changes for railway lines in the Osaka area, the regular running time between the Fukuchiyama Line's Takarazuka Station (No. 2 Line) and Amagasaki Station (No. 6 Line) for rapid trains made up of seven 207 Series railway cars was further extended to 16 min and 25 s (a 5-s extension).

(8) Establishing The Safety Laboratory

The West Japan Railway Company established a "Safety Laboratory" on June 23, 2006. At the laboratory, the West Japan Railway Company's research staff members conduct studies relating to safety-related management systems and human factors.

(9) Establishing safety management regulations in which the responsibilities of top management are clearly defined

The West Japan Railway Company established safety management regulations in which the responsibilities of the president in ensuring transportation safety were clearly defined, and started implementing the regulations on October 1, 2006 (see 7.2 (7)).

7.2. Measures that Have Been Taken by the Ministry of Land, Infrastructure, Transport and Tourism

(1) Directing the West Japan Railway Company to develop a safety improvement plan

On April 28, 2005, the Ministry of Land, Infrastructure, Transport and Tourism directed the West Japan Railway Company to develop a safety improvement plan describing the matters to be improved, the equipment- and management-related improvement measures, the investment plan, etc.

(2) Inspection of the train operation plan

On May 6, 2005, the Ministry of Land, Infrastructure, Transport and Tourism directed railway operators to inspect their train operation plans to check whether they were appropriate ones in which the necessary time margins had been added.

(3) Requiring railway operators to improve functions of ATS etc.

On May 27, 2005, the Ministry of Land, Infrastructure, Transport and Tourism directed the relevant railway operators to install ATS etc. equipped with a curve speed check function. In addition, the Ministry amended the ministerial ordinance for technical standards on March 24, 2006 (implementation date: July 1, 2006) to require the relevant railway operators to install speed-limiting equipment (ATS etc. equipped with a curve speed check function or turnout speed check function). This requirement takes into account the acceleration of trains in the descending sections (see 1.2.3 and Attachment 1).

By the end of FY 2006, ATS devices etc. equipped with curve speed check functions were installed in 2,254 curve sections of the relevant railway operators (47 railway operators).

(4) Reliable execution of train protection actions during and after accidents

On September 6, 2005, the Ministry of Land, Infrastructure, Transport and Tourism directed railway operators to inspect their train protection manuals and repeatedly provide train protection training courses for their train drivers and conductors (see 1.2.3 and Attachment 1).

(5) Securing accuracy of speed meters etc.

On September 6, 2005, the Ministry of Land, Infrastructure, Transport and Tourism directed railway operators to secure accuracy of their speed meters etc. (see 1.2.3 and Attachment 1.)

(6) Installation of equipment that records the traveling of trains and related data

The Ministry of Land, Infrastructure, Transport and Tourism amended the ministerial ordinance for technical standards on March 24, 2006 (implementation date: July 1, 2006) to require railway operators to install equipment that records the traveling of trains (see 1.2.3 and Attachment 1).

(7) Amendment of the Railway Business Act

The Railway Business Act was amended by "the Act for Partial Revision of the Railway Business Act etc. for the Purpose of Improving Transportation Safety" (promulgated on March 31, 2006), to require railway operators to establish safety management regulations and report the content of the regulations and to appoint a Chief Safety Management Officer and report his/her name (implementation date: October 1, 2006). In addition, the Railway Business Act as amended required that a transportation safety management assessment be conducted.

Attachment 1

Proposals Regarding the Train Derailment Accident on the Fukuchiyama Line of the West Japan Railway Company

Nat. Air Com. No. 15
September 6, 2005

To: Kazuo Kitagawa, Minister of Land, Infrastructure, Transport and Tourism

Junzo Sato, Chairman, Aircraft and Railway Accidents Investigation Commission

About Our Proposals Regarding the Train Derailment Accident on the Fukuchiyama Line of the West Japan Railway Company

The Commission is currently conducting, with all its might, the investigation to identify the cause of the train derailment accident that occurred at around 9:18 a.m., April 25, 2005, on the Fukuchiyama Line of the West Japan Railway Company (hereinafter referred to as JR-West). However, it is expected that we will have to continue the investigation for a significant number of days in order for us to draw final conclusions based on the results of multilateral examination of facts and scientific analyses

On the other hand, the accident, in which 107 people were killed and more than 500 people were injured, is the most serious railway accident in the recent railway accident history of Japan, and it is considered that the planning of measures to prevent similar accidents should be started as early as possible. Therefore, we hereby provide and publish an overview of the progress of our investigation to date and make our proposals on measures to be taken pursuant to the provisions of Article 22 of the Act for Establishment of the Aircraft and Railway Accidents Investigation Commission before completion of the investigation of the accident.

Proposals

(Improving function of ATS etc.)

1. As described in the interim report, a record shows that the accident train entered at a speed higher than 110 km/h a curve section that includes the accident site and for which the speed limit is 70 km/h. In addition, a record shows that, prior to the accident, a down-going deadhead train that had been made up of the same railway cars as those of the accident train and driven by the train driver of the accident train (hereinafter referred to as “the deadhead train”) had traveled at a speed higher than 60 km/h on a turnout section for which the speed limit is 40 km/h before arriving at Takarazuka Station.

   Therefore, functions of ATS (automatic train stop) and similar devices should be improved, for example, by adding, taking into consideration the current situations regarding train operation and the current situations surrounding the individual line sections, functions to prevent trains from exceeding the speed limits in curve sections and at turnouts.

(Reliable execution of train protection actions during and after accidents)

2. As described in the interim report, power from the backup power supply would not have been supplied to the train protection radio equipment etc. of the seventh car unless the power supply switching switch had been set to the "Emergency" position. However, according to the confirmation after the accident, the power supply switching switch was set at the "Normal" position, which means that the train protection radio equipment had not functioned. In addition, the fuse of the seventh car had not been used and neither the portable fuse nor the track circuit shunt device had been used.

   On the other hand, there was no provision requiring that the power supply switching switch be set to the "Emergency" position when it is necessary to use the train protection radio equipment when it is not possible to use the normal power supply in the internal regulations of JR-West regarding the response of train conductors during abnormal situations including the "Standard Work Procedures (for the Conventional Lines) for Train Conductors - Standard Work Procedures for Abnormal Situations."

   Against this background, the train driver of Kita Kinki 3, which is the train that had arrived in the accident area from the opposite direction immediately after the accident, had stopped his train in response to the stop signal indication information received by the onboard ATS equipment and taking into consideration other information. However, Kita Kinki 3 did not receive any train protection radio transmission.

   Therefore, efforts should be made to improve the reliability of the train protection radio equipment, enhance ease of operation and further improve the training for train drivers and conductors, so that train protection actions will be executed in a reliable manner during and after accidents and in situations where such actions are required.

(Installation and utilization of equipment that records the traveling of trains and related data)

3. As described in the interim report, the deadhead train had traveled through the turnout at a speed higher than the speed limit before arriving at Takarazuka Station, and had temporarily stopped as a result of the activation of the emergency brake by ATS. In addition, the accident train had run past the stop sign by about 70 m at Itami Station and the train driver had corrected the stop position prior to the accident.

   In addition, there had been a similar incident on June 8, 2004, in which a train driven by the train driver of the accident train had run past the stop sign by about 100 m at Shimokoma Station of the Katamachi Line of JR-West and the driver had corrected the stop position.

   In addition, 46 incidents had occurred in FY 2004 in JR-West's service area in which a train had stopped as a result of the activation of the emergency brake by an ATS-SW-type ground coil (long), according to a report from JR-West.

   Grasping the situations of such incidents etc. accurately, analyzing the situations, and utilizing the analysis results would help prevent accidents.

   Therefore, equipment that records the train position and speed, powering handle position, brake handle position, ATS operation status, etc., should be installed on trains (and on tracks where

necessary) so that incidents etc. can be grasped accurately.

In addition, the efforts described in 4 below to secure the accuracy of speed meters etc. should be made so that incidents etc. can be grasped more accurately using equipment that records the traveling of trains and related data.

(Securing accuracy of speed meters etc.)

4. As described in the interim report, speed values indicated on speed meters of the same type as that of the speed meter of the first car of the accident train may be as low as about 4 km/h below the actual speeds when the train is traveling at a speed of about 120 km/h, according to estimation calculations based on test results.

   Speed meters are instruments that are important for the driving of trains, and inaccurate indication may adversely affect the driving of trains. In particular, indication of speed values on speed meters that are lower than the actual speeds may (1) cause trains to exceed speed limits or run past stop signs, (2) cause emergency brake activation by ATS etc. equipped with an over-speed prevention function, (3) cause incidents that reduce safety, and/or (4) prevent trains from traveling safely. Therefore, measures should be taken to secure the accuracy of speed meters etc.

RA2007-3-2 (separate volume)

Railway Accident Investigation Report (Attachments)

Train Derailment Accident between Tsukaguchi and Amagasaki Stations of the Fukuchiyama Line of the West Japan Railway Company

June 28, 2007

Aircraft and Railway Accidents Investigation Commission

Attachments

Figure 1 – Route Diagram of the Fukuchiyama Line

Fukuchiyama Line (between Amagasaki and Fukuchiyama Stations): 106.5 km(Length of Line)

(Double line (except between Sasayamaguchi and Fukuchiyama Stations, which is a single line))

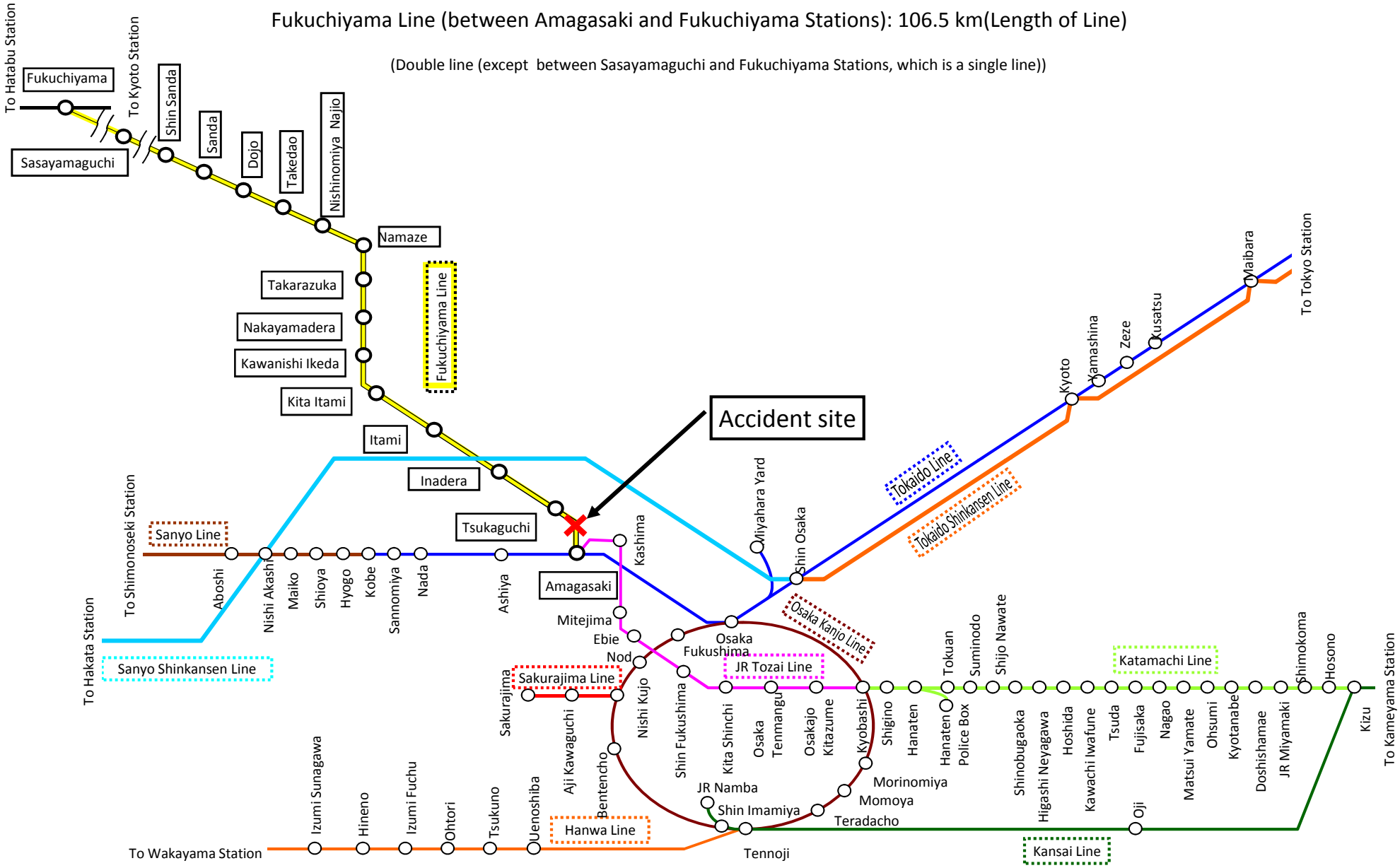
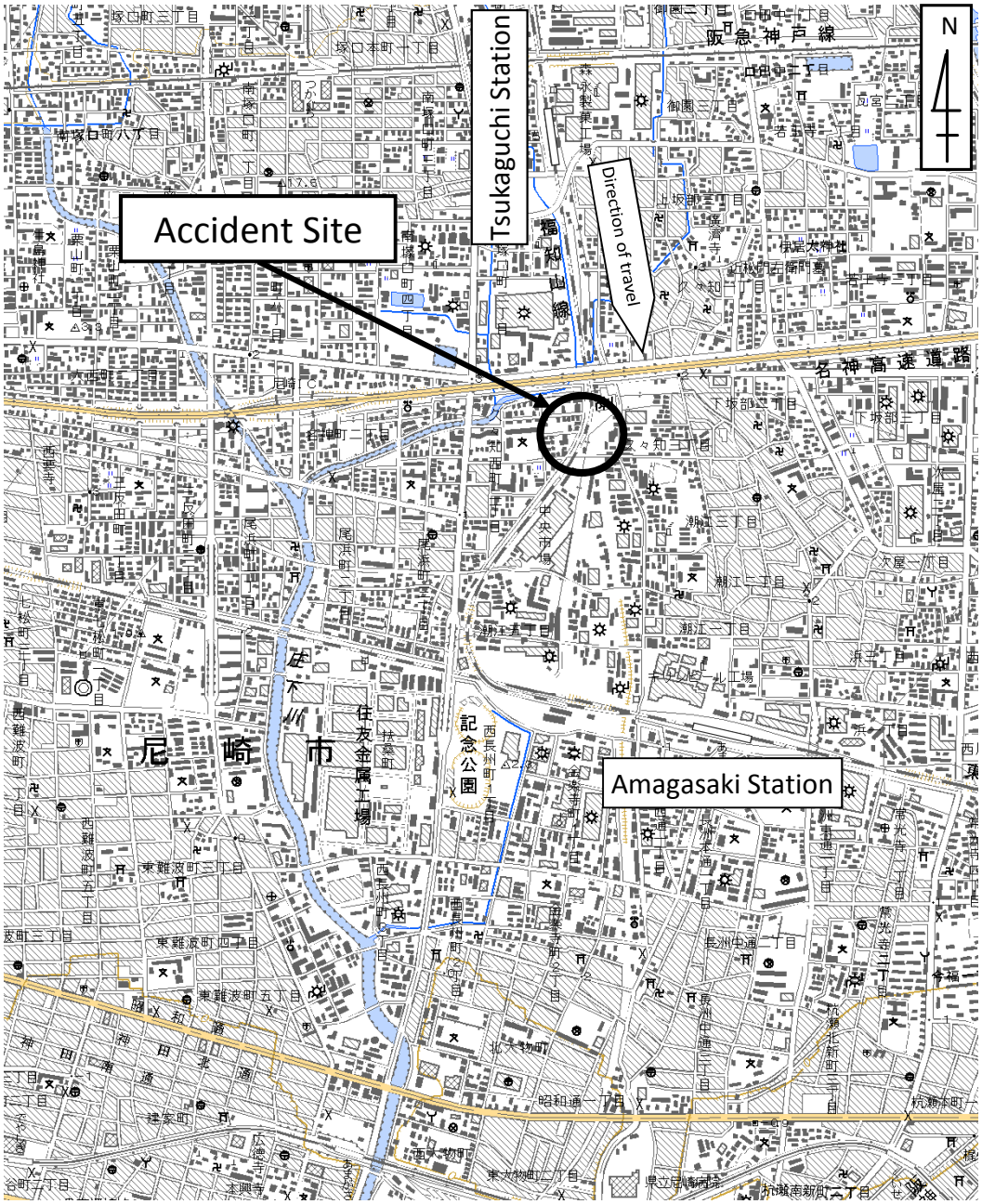


Figure 2 Topographical Map of the Area Surrounding the Accident Site

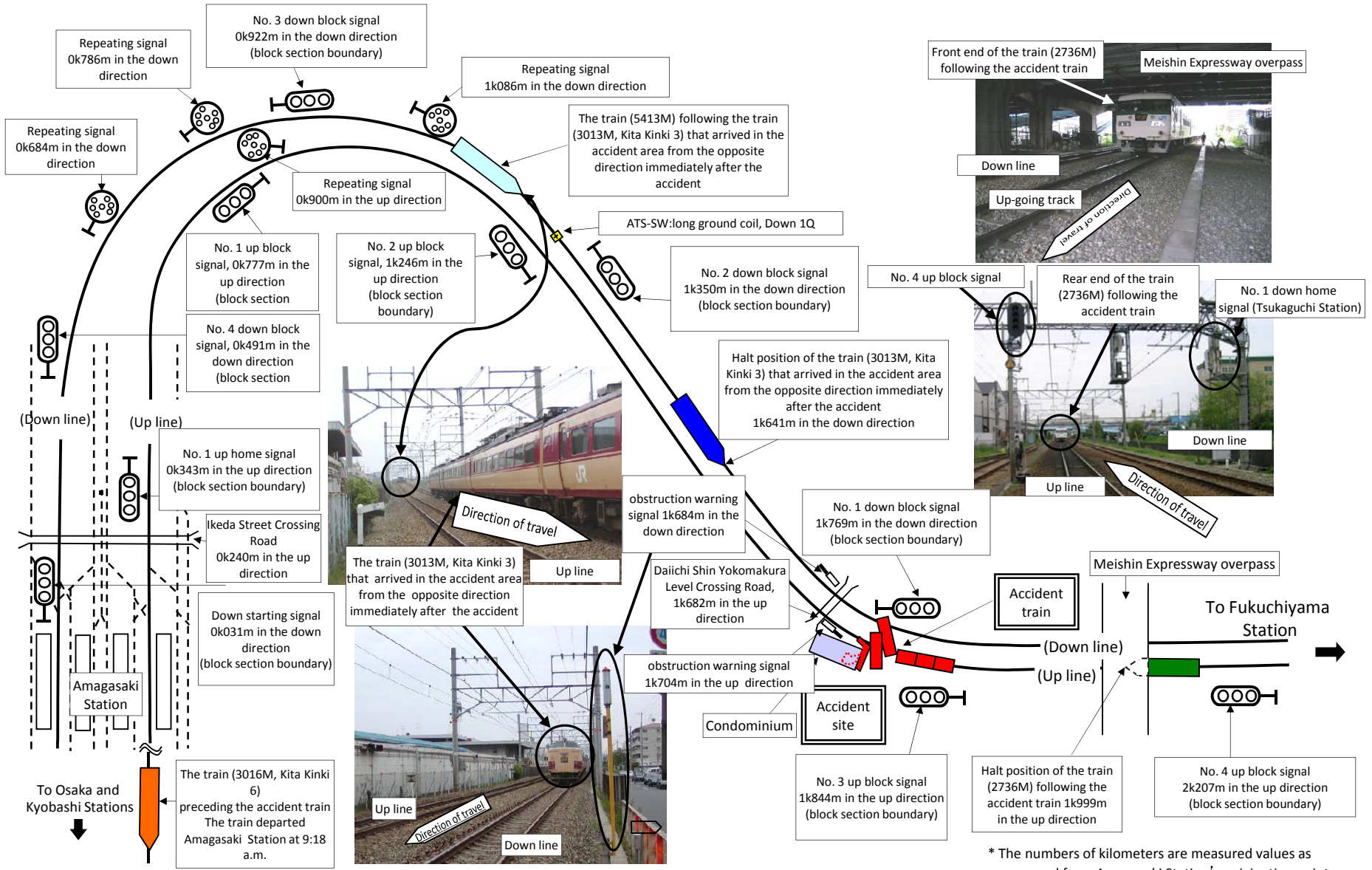


1:25,000 Northwestern Part of Osaka

500 m 0 500 1000 1500

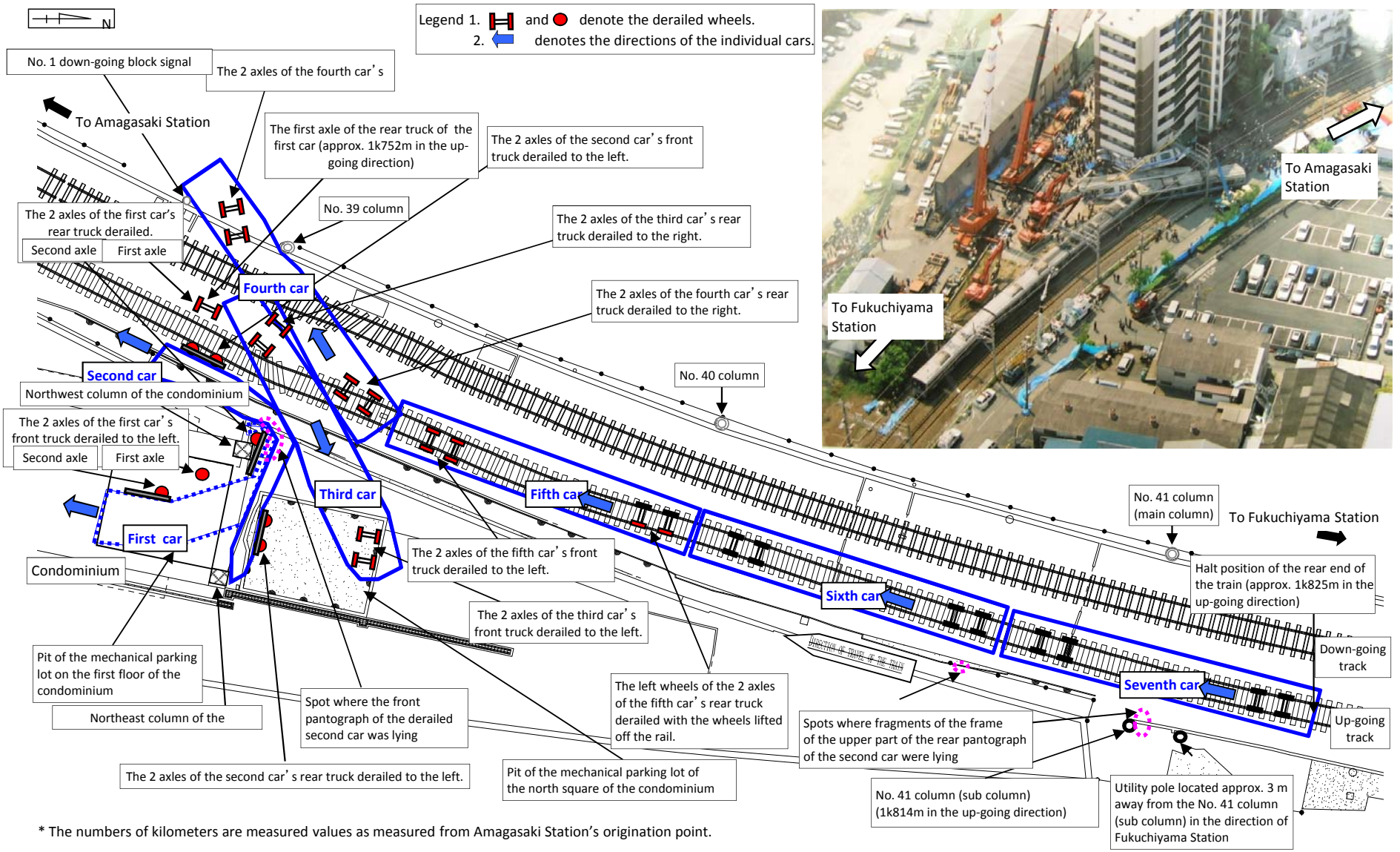
A map created by editing a 1/25,000 topographic map published by the Geospatial Information Authority of Japan

Figure 6 – Simplified Diagram of the Spatial Relationships between the Trains Involved



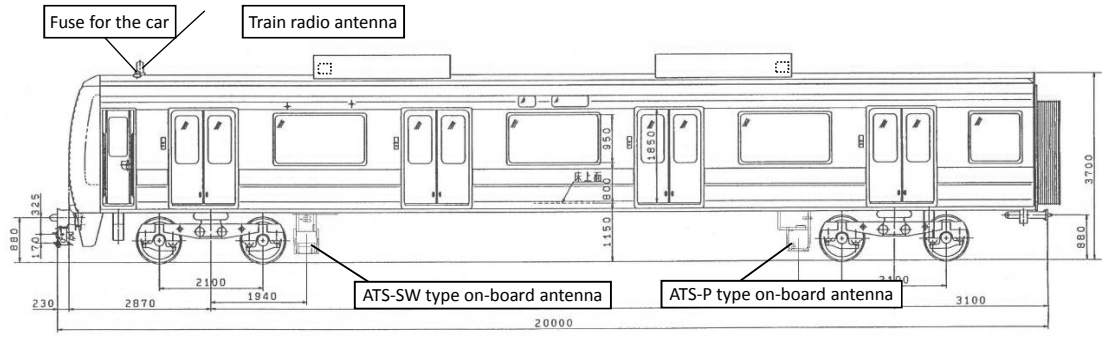
* The numbers of kilometers are measured values as measured from Amagasaki Station's origination point.

Figure 12 – Schematic Diagram of the Derailment of the Train

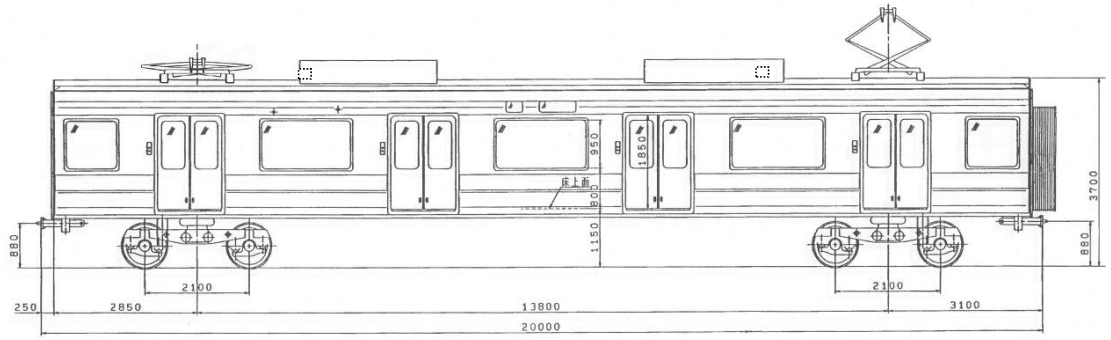


* The numbers of kilometers are measured values as measured from Amagasaki Station's origination point.

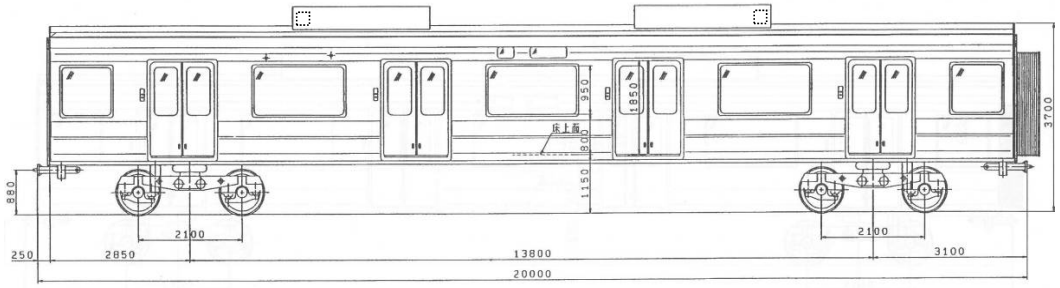
Figure 14 – Railway Car Types (1/3)



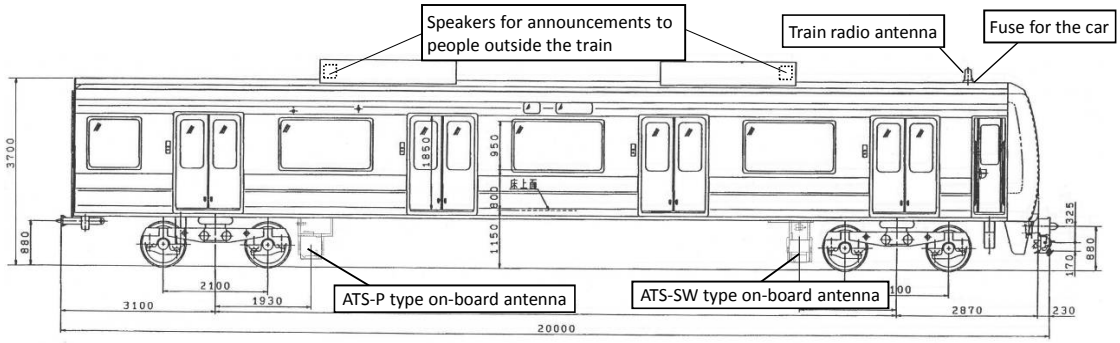
First car (KUHA207-17)



Second car (MOHA207-31)



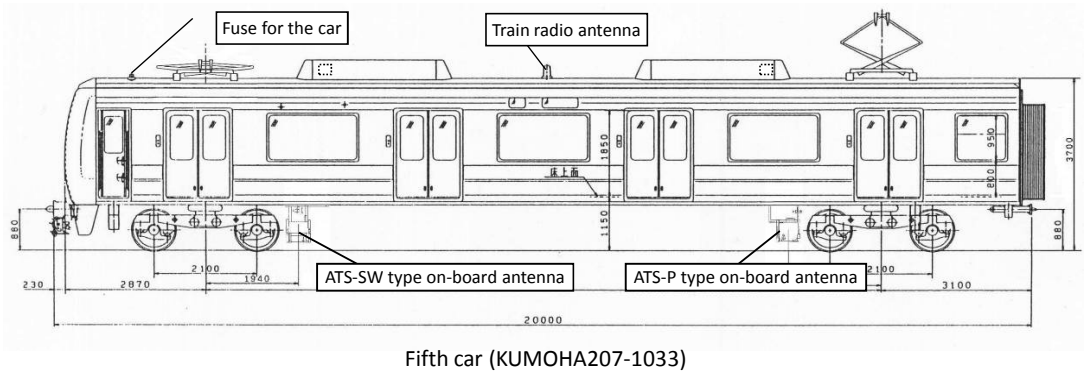
Third car (MOHA206-17)



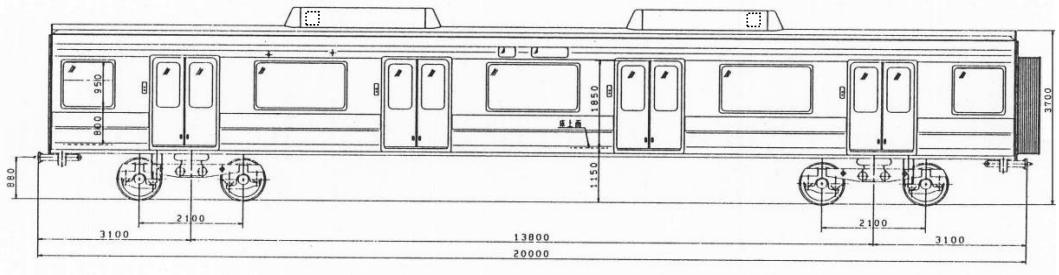
Fourth car (KUHA206-129)

* The locations of the speakers for announcements to people outside the train are the same on all cars.

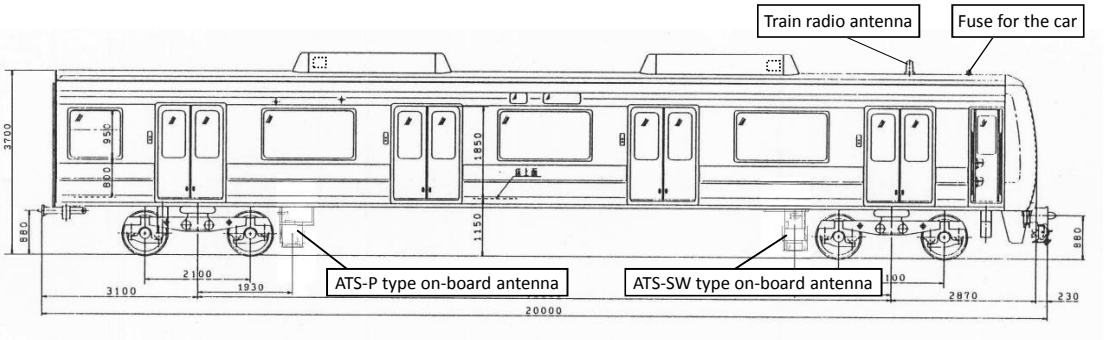
Figure 14 – Railway Car Types (2/3)



Fifth car (KUMOHA207-1033)



Sixth car (SAHA207-1019)



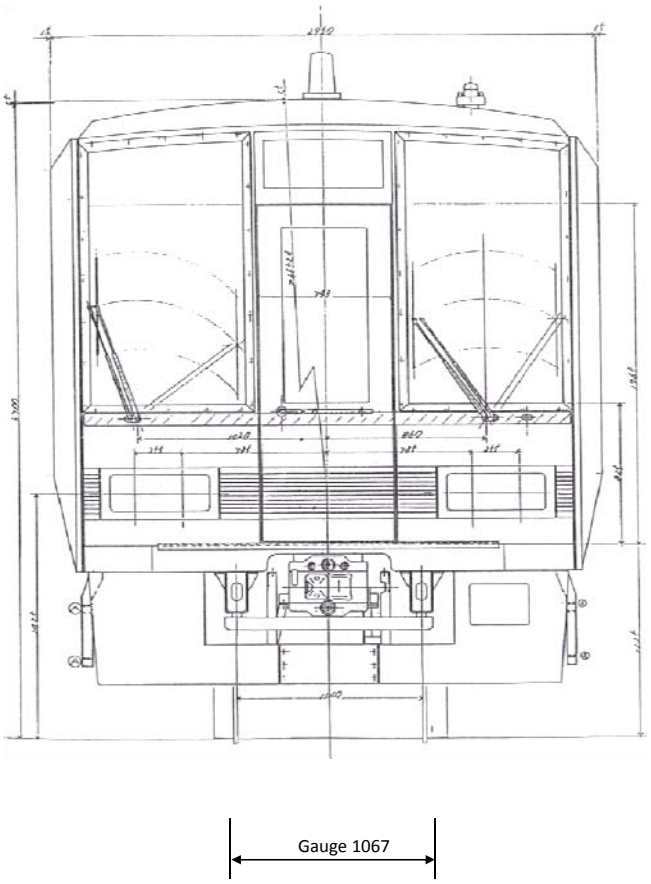
Seventh car (KUHA206-1033)

Main Specifications

Car position in the train	First car	Second car	Third car	Fourth car	Fifth car	Sixth car	Seventh car
Identification number	KUHA207-17	MOHA207-31	MOHA206-17	KUHA206-129	KUMOHA207-1033	SAHA207-1019	KUHA206-1033
Month and year of manufacture	Feb-92	Feb-92	Feb-92	Feb-92	Mar-95	Mar-95	Mar-95
Tare (t)	26.3	35.2	32.2	26.3	37.4	24.8	27.8
Passenger capacity (number of persons)	150	163	163	150	150	163	150
Car length (m)	20.000						
Roof height (m)	3.700						
Car body width (m)	2.950						
Monitor equipment	Old type	Old type	Old type	Old type	New type	New type	New type
EB equipment	Not equipped	—	—	Not equipped	Equipped	—	Equipped
TE equipment	Not equipped	—	—	Not equipped	Equipped	—	Equipped
Backup power supply for the train radio equipment	Switching is necessary.	—	—	Switching is necessary.	Switching is necessary.	—	Switching is necessary.
Backup power supply for the train protection radio equipment	Switching is not necessary.	—	—	Switching is not necessary.	Switching is necessary.	—	Switching is necessary.

Figure 14 – Railway Car Types (3/3)

Front View (KUHA207-17)



Cross Section of the Ordinary Part (KUHA207-17)

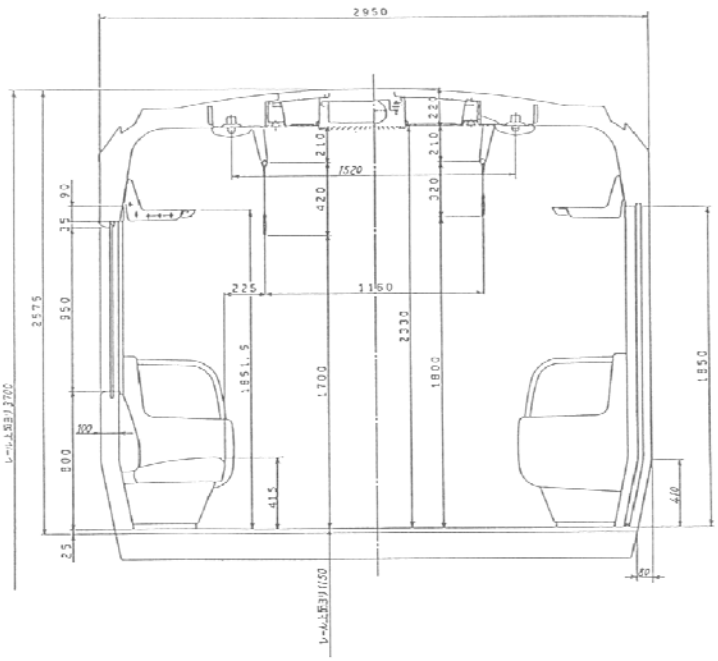
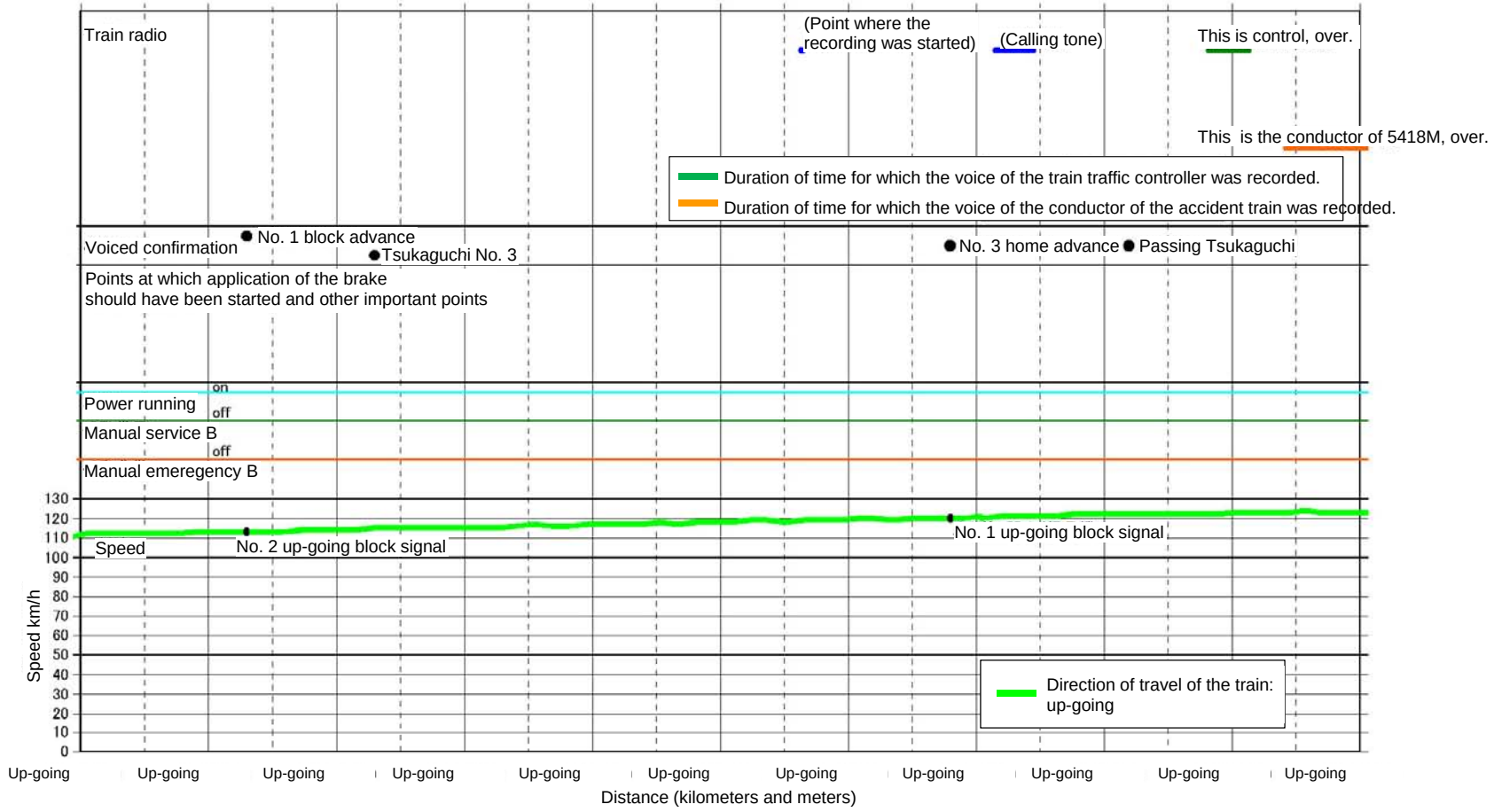


Figure 25 - (Distance-based) Record of Train Operation (in the Vicinity of the Accident Site) 1/3



* Because there is no record of voiced confirmation by the train driver of the accident train, main ones of the voiced confirmation events specified in "Operation" are shown (the same applies in the following sheets).
* Distance (in kilometers) to the (point where the recording was started) was calculated from the recording start time of the radio exchange record "204T092140a" saved in the long-time recording device, with corrections made to the startin

Figure 25 - (Distance-based) Record of Train Operation (in the Vicinity of the Accident Site) 2/3

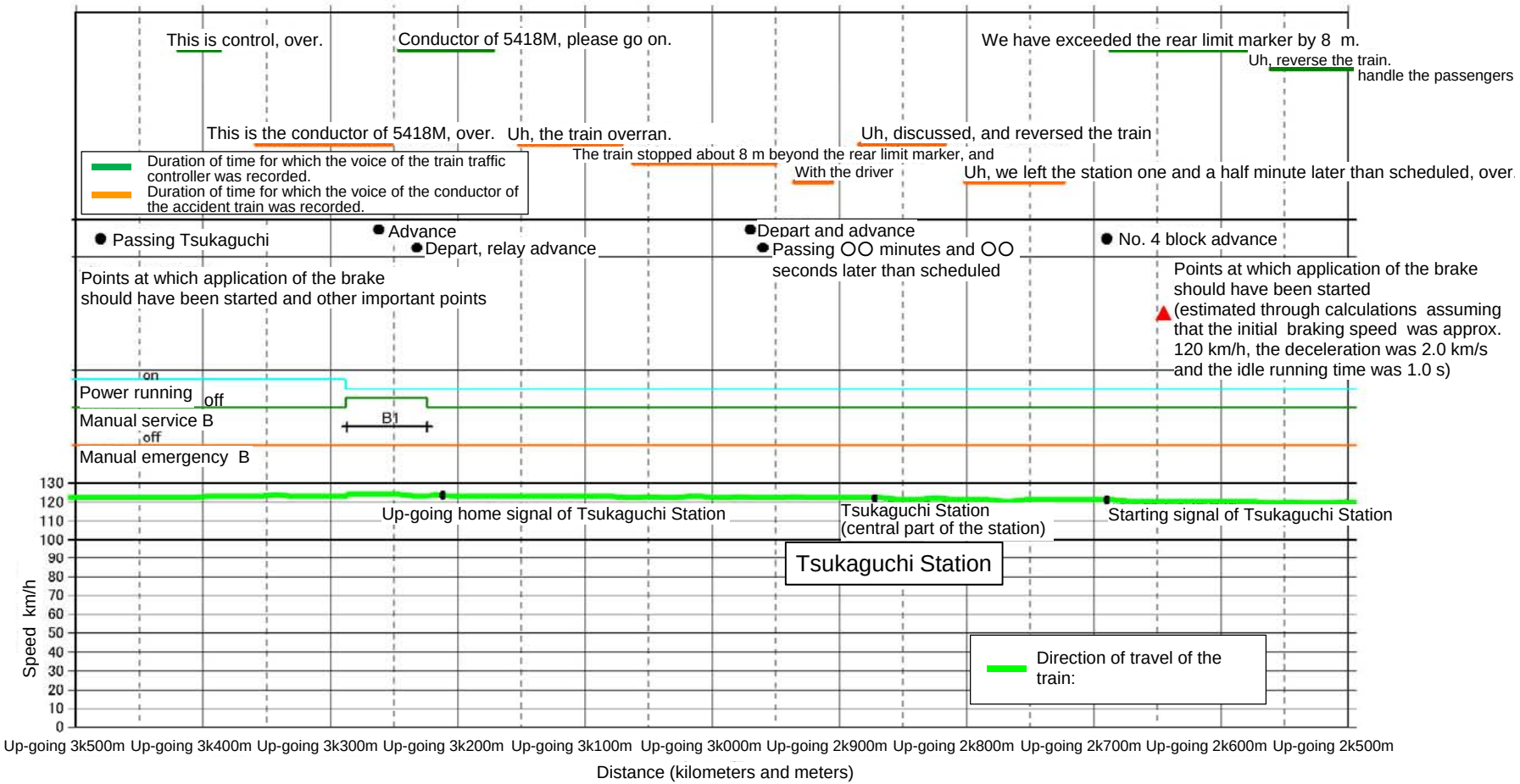


Figure 25 - (Distance-based) Record of Train Operation (in the Vicinity of the Accident Site) 3/3