

Feature : Accident investigation activities utilizing domestic and international knowledge at the Japan Transport Safety Board

Since its establishment in October 2008, the Japan Transport Safety Board has been accomplishing appropriate accident and incident investigations which thoroughly unveil the causes of accidents and damages incidental to them, and has also been making efforts to contribute to accident prevention and damage reduction by urging the Minister of Land, Infrastructure, Transport and Tourism or parties relevant to the causes to implement necessary policies and measures based on the results of these investigations.

The investigation of accidents and the preparation of reports are to be chairperson and 12 members (seven full-time members and five part-time members are stipulated by law). Ordinary deliberations are carried out at each committee of the Board by four to five members, mainly members who specialize in their respective fields and the chairperson.

In order to prevent accidents and reduce damage through scientific and fair judgment based on information collected by accident investigators and information provided by accident and other related parties, cooperation with experts from domestic specialized research institutions, universities, etc., and accident investigation organizations in other countries may be essential for investigations.

This feature, the examples of such in Japan and overseas will be introduced.

1. Deliberations utilizing knowledge from various fields

(1) Comprehensive response to serious accidents

~Investigation of Injuries to boarding people caused by the collision of a Hydrofoil and floating objects in the Water.~

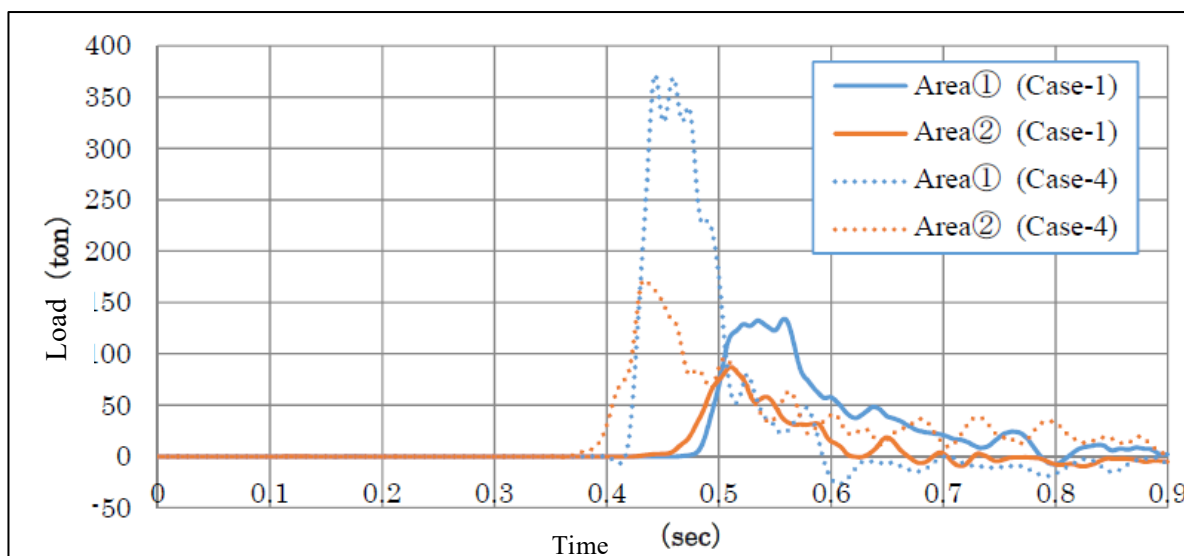
On March 9, 2019, a hydrofoil sailing to Ryotsu Port in Sado City, Niigata Prefecture, collided with floating objects in the water, injuring many people (108 passengers and one crew member).

In accordance with the Rules of Operation of the Japan Transport Safety Board, this accident was designated as a "particularly serious accident" for the first time since the establishment of the Japan Transport Safety Board, and the "General Committee" was held and deliberated by the attendance of not only members in the maritime field but also full-time members in the aviation and railway fields.(See "Major activities in the past year" on page 1 for details.)

In this accident investigation, we analyzed the drive recorder installed on the ship, the structure of the ship, the turning performance, etc., and measured the behavior of the ship, which is a prerequisite for the analysis of the impact accelerations, etc. Then, we commissioned the National Maritime Research Institute (NMRI) of the National Institute of Maritime, Port and Aviation Technology to conduct an analytical investigation on the effects of the impact accelerations when the ship was hit on the sea surface, on passenger injuries, etc. From this analysis, it became clear that a large impact load was acting on the hull at the stern when the hull hit the sea surface,

generating a large upward acceleration.

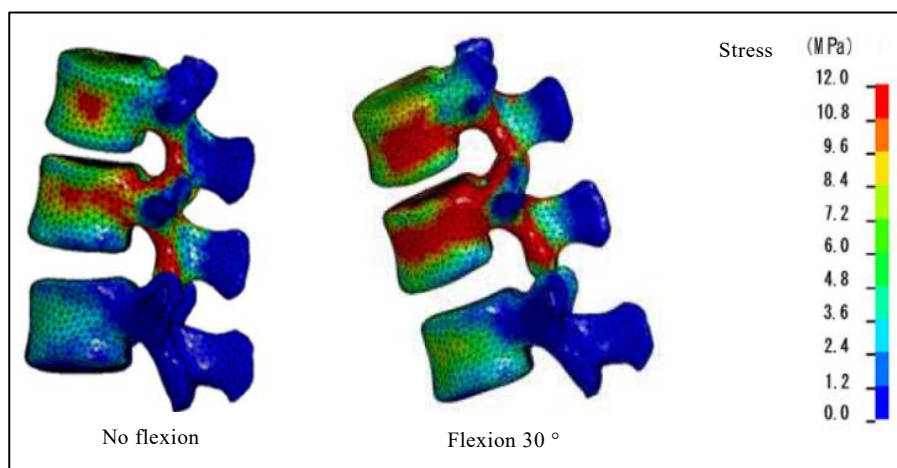
Besides from the viewpoint of confirming the soundness of fuse pins, which are part of the safety devices of the hydrofoil, we commissioned the National Institute for Materials Science (NIMS) to conduct an analysis survey on the fracture surfaces and mutation spots of fuse pins. As a result of the analysis, it was found that the fuse pins were considered to have undergone ductile fracture due to shearing in a sound condition as designed.



Analysis of Time Series of Vertical Impact Force on the bottom of the ship

Moreover, in order to analyze the mechanism leading to lumbar vertebral fracture, Dr. Kei Watanabe, a lecturer at the Department of Orthopedic Surgery, Niigata University Medical & Dental Hospital, participated in the survey as an Expert Adviser, and worked on the analysis of how the load on the lumbar spine differs depending on the posture of passengers.

In addition, a comprehensive analysis was carried out, including information on passenger injuries, measures to avoid collisions of whales, situations of ship operation and lookout, responses after the accident, and similar accident cases, taking into account the knowledge in the aviation

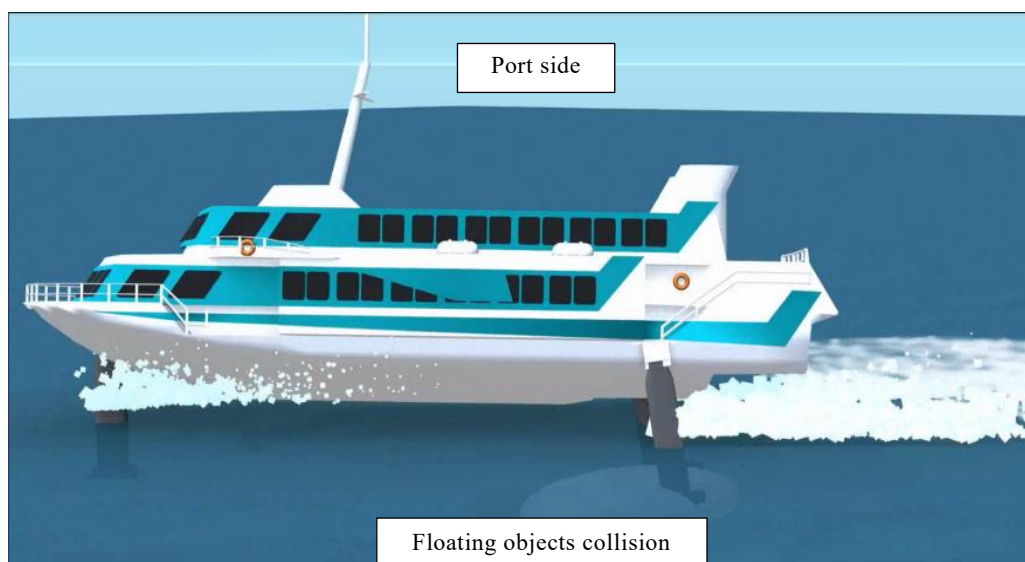


Stresses in the vertebral

and railway fields.

In response to these analyses, the JTSB collated the cause of the accident, which is probable to be caused by a large number of passengers suffering from lumbar vertebral fracture, etc., due to the collision between the floating objects in the water and the aft foil

(hydrofoil) of the ship, and the recommendation, which recommends the Minister of Land, Infrastructure, Transport and Tourism, which is to instruct the owner of the ship to "take measures such as providing seats and seat cushions which are considered to absorb the impact force sufficiently" and "take measures such as attaching cushioning materials to the back of the seats", and the operator to "guide the elderly people to the seats where the impact of the front part of the cabin is relatively small" and "carry out regular training in case of a large number of injured persons", and the JTSB published the Accident Investigation Report on March 26, 2020.



Computer graphic reproduction of ship behavior at the time of accident
(URL: <http://www.mlit.go.jp/jtsb/video/ship/2019tk0008-movie.wmv>)

(2) Participation of Expert Advisers in Deliberations

The Japan Transport Safety Board appoints persons with relevant knowledge and experience as Expert Advisers (part-time) to have them participate in analyses and deliberations in order to investigate specialized matters in more detail when conducting individual accident and incident investigations.

In 2019, the JTSB appointed an Expert Adviser to have them analyze medical information on lumbar vertebral fracture, the mechanism and participate in deliberations in the investigation of injuries to passengers caused by the collision of the passenger ship GINGA (floating objects in the water) mentioned above. As a result of the analysis, it was found that the probability of the occurrence of lumbar vertebral fracture when loaded with an impact load is higher when the passenger is seated in a forward-leaning posture than when the passenger is seated in an upright posture, and it was confirmed that the installation of a 3 point seat belt to maintain the upright posture of the seated passenger is effective in reducing the number of injuries and the severity of injuries at the time of the accident.

We have appointed Expert Advisers to investigate accidents and incidents. For example, we have received the cooperation of expert advisors from the following organizations.

- Japan Aerospace Exploration Agency (JAXA)
 - Investigation of airframe structure and motion
 - Investigation of lithium-ion batteries

- National Institute for Materials Science (NIMS)
 - Investigation on fracture of turbine blades
- National Traffic Safety and Environment Laboratory (NTSEL)
 - Maintenance of diesel engines and the appropriateness of conditions of use
- Railway Technical Research Institute (RTRI)
 - Mechanism of bridge pier sinking
 - Analysis of meteorological disaster prevention, ground disaster prevention, geology, etc.
- The University of Tokyo
 - Analysis of effects of earthquake vibration on vehicle behavior, etc.

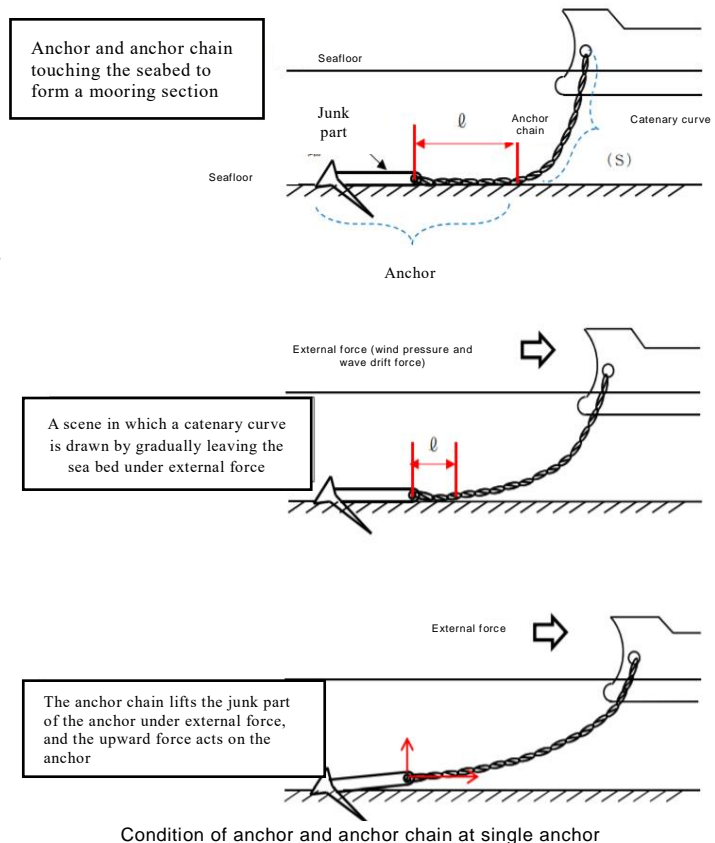
Besides, the Japan Transport Safety Board has improved equipment and software for analysis necessary for investigating the causes of accidents, etc., and has established a system to conduct investigations efficiently and promptly. Moreover, when advanced analysis or detailed analysis is required for a particular case, we commission analyses to an external specialized research institution.

In 2019, these analyses were commissioned to the National Institute of the National Maritime Research Institute, the National Institute for Materials Science, the Railway Technical Research Institute, and the Japan Electric Cable Technology Center. The following are examples of initiatives that utilize the expertise of specialized research institutions.

(3) Cooperation with domestic research institutes in the field of ships

In the accident investigation (see page 2 of "Major Activities in the Past Year") in which the oil tanker collided with Kansai International Airport Access Bridge, which was published on April 25, 2019, the National Maritime Research Institute (NMRI) of the National Institute of Maritime, Port and Aviation Technology analyzed the mooring power of the concerned oil tanker and the ship anchored in Osaka Bay, as well as the wind pressure during the anchoring, by our request.

As a result of this analysis, the mechanism of anchor dragging (that the ship is carried away with the anchor thrown) was explained in an easy-to-understand manner. It also led to recommendations for safety measures (see page 21), such as ensuring sufficient mooring power with anchors and anchor chains and using the main engine on a continuous basis, in order to prevent recurrence of similar



accidents and reduce damage during extremely strong typhoons.

(4) Cooperation with Domestic Research Institutes in the Aviation Field

In the field of aviation, Japan Aerospace Exploration Agency (JAXA) has participated in a number of specialized surveys and analyses, including surveys on the structure and motion of aircraft and lithium-ion batteries.

The Electronic Navigation Research Institute (ENRI) of the National Institute of Maritime, Port and Aviation Technology is participating in specialized surveys and analyses related to air traffic management and aeronautical systems, including those related to the transmission and reception of radio waves.

Besides, in the investigation of the serious incident that the engine of a passenger aircraft (Boeing 777-300ER) was damaged (see page 53), which was published in the report on October 31, 2019, the National Institute for Materials Science (NIMS) analyzed the openings generated in the turbine rear frame, which is a structural member for mounting the engine to the airframe. As a result, it was estimated that the cause of the openings was that some of the fragments of the low pressure turbine blades and blades of the engine collided with the turbine rear frame.



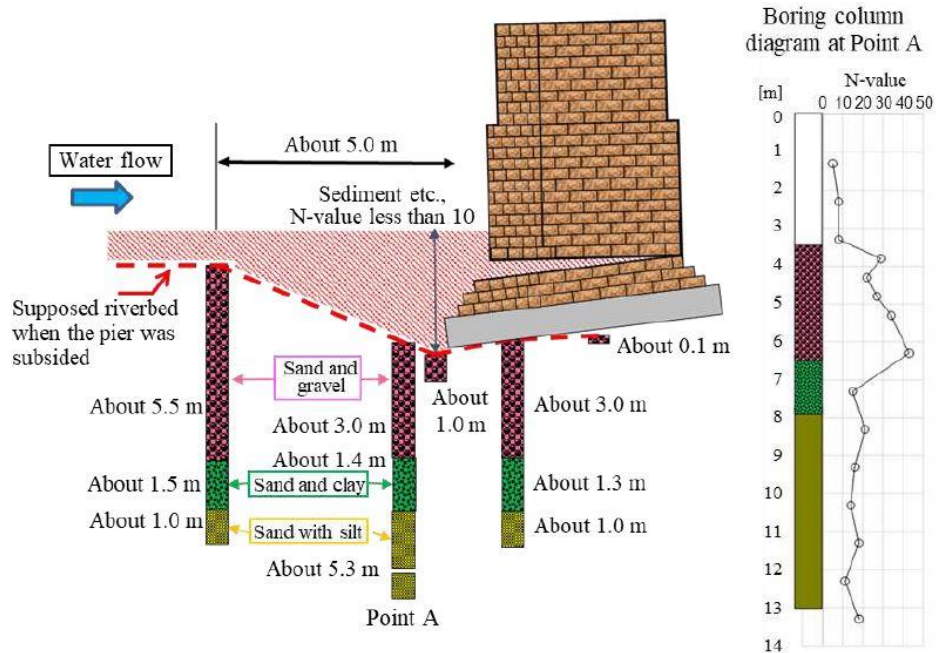
2LPT Missing vane in the fifth stage vane segment

(5) Cooperation with Domestic Research Institutes in the Railway Field

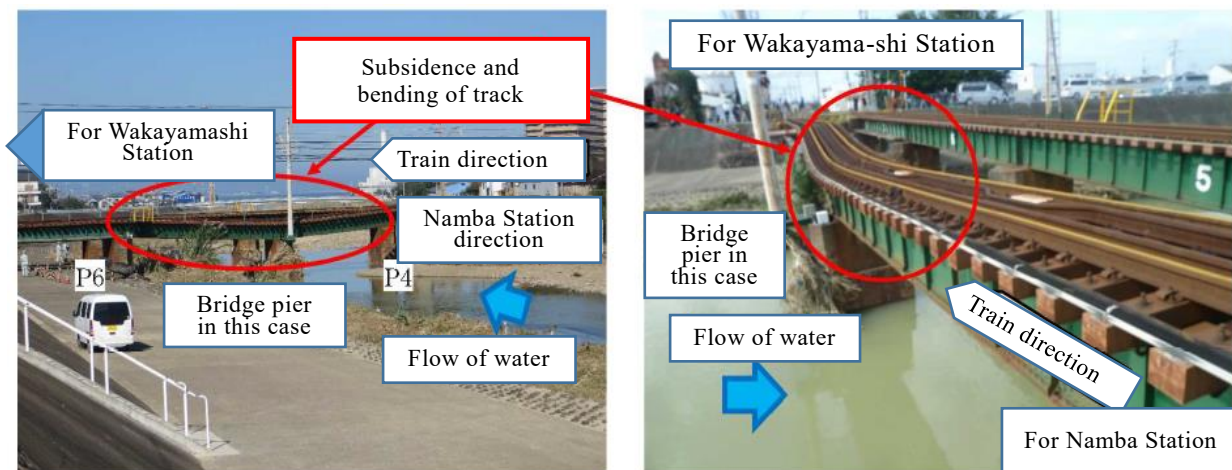
In the investigation of the train derailment accident (see page 84), which is presumed to be caused by the subsidence and inclination of the bridge pier, which was published in the report on January 31, 2019, the Railway Technical Research Institute (RTRI) was commissioned to analyze the effect of the running water on the bridge pier and the mechanism by which the bridge pier sank, and Naoyuki Ota, Director of the Disaster Prevention Technology Research Department of the Institute, participated in the investigation as an expert committee member and worked on the analysis including weather disaster prevention, ground disaster prevention and geology.

These analyses revealed that, it was probable that the bridge pier sank and tilted because the protective function of the bridge pier against the scour had been weakened since before the occurrence of the accident, the river water increased at the time of the occurrence of the accident caused the scour in a wide area around the bridge pier, and the support base was greatly reduced.

In addition, based on these analyses, the JTSD discussed necessary measures to prevent recurrence and expressed the opinion to the Minister of Land, Infrastructure, Transport and Tourism (see page 25) on the necessity the Standards for Maintenance and Management of Railway Structures (Structure Section) known to the related railway track operators in order to prevent the same type of scour disaster.



Summary of the results of the boring survey



Situation around the accident site

In this way, the Japan Transport Safety Board is engaged in deliberations that make use of its expertise in a wide range of fields. In order to identify and prevent the causes of accidents that are becoming more diverse and complex, we will continue to carry out investigations in an appropriate manner that brings together Japan's wisdom, such as by actively incorporating outside expertise.

2. International cooperation

(1) Conclusion of memorandum on investigation cooperation between accident investigation authorities

Among the subjects of investigation by the Japan Transport Safety Board, there are many cases in which international cooperation is required for accident and other investigations in the fields of aviation and ships, and cooperation and coordination with the accident investigation authorities of the states concerned are indispensable.

In the aviation field, representatives of the accident investigation authorities of the state where the aircraft body or engine manufacturer belongs (the state of design and manufacture) and the accident investigation authorities of the state where the airline belongs (the state of operator) participate in the investigation. In the area of ships, coastal states and flag states (states where ships are registered) are obliged to report accidents, and relevant states may consult and conduct accident investigations.

Once an aircraft accident occurs, multiple states are involved in the investigation, depending on the states of occurrence, the state of registry, the state of operator, the state of design and manufacture, and the nationality of the person involved in the cause of the accident or the victim. The same is true for marine accidents. In order to investigate the causes of accidents and to prevent similar accidents, it is essential to cooperate and cooperate with other countries beyond the framework of domestic investigations.

The JTSB has concluded agreements with the accident investigation authorities of France, Australia, China, Taiwan, the Republic of Korea, Singapore, Mongolia and Finland on cooperation in accident investigation in order to facilitate such international accident investigation. This is to confirm that the accident investigation authorities of each country will cooperate with each other to contribute to the safety of transportation. It stipulates matters concerning the establishment of emergency contact points and the exchange of know-how on accident investigation so that investigations in the event of accidents, etc. related to both countries can be carried out more speedily and smoothly.

(2) Strengthening Cooperation with Foreign Accident Investigation Organizations in Anticipation of Domestic Passenger Jet in Service

The Civil Aeronautics Act and the Act for the Establishment of the Japan Transport Safety Board have been revised to (1) expand the scope of serious incidents (in the same way as other States of Design and Manufacture, the amendment would allow the Japan Transport Safety Board to investigate serious incidents that occur when aircraft are not in flight too) and (2) carry out specified investigations (when a part of an accident investigation carried out by a foreign accident investigation organization is delegated to the Japan Transport Safety Board (specified investigation)) in order to ensure that Japan's first domestic passenger jet (Mitsubishi Space Jet) put into service. These revisions came into effect on June 18, 2020. (See "Major activities of the past year" on page 3 for details.)

In order to ensure that these revisions can be implemented promptly and smoothly in the event of an unexpected situation, the JTSB has established a system for cooperation and investigation by deepening exchanges with accident investigation authorities in the United States and Canada, in particular.

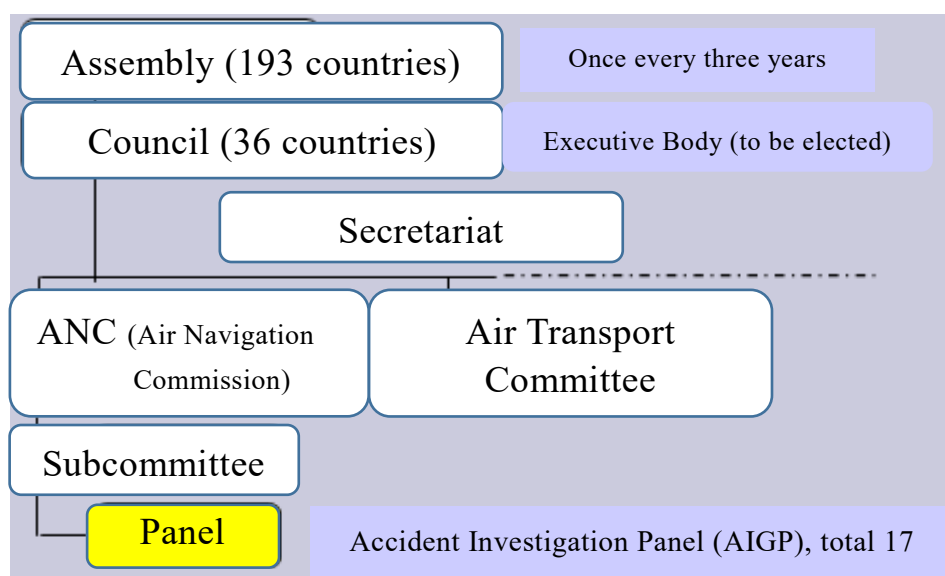
Specifically, in December 2019, 3 investigators were dispatched to the National Transportation Safety Board (NTSB) of the United States and the Transportation Safety Board (TSB) of Canada, where they explained the investigation system for domestic jetliners in Japan and the organization and operation system of the Japan Transport Safety Board. At the same time, they exchanged opinions on the contents of cooperation and contact persons with other countries. Besides, the NTSB and TSB explained their organizations, operational systems, and analysis facilities. Moreover, the JTSB has deepened its knowledge of the roles of the accident investigation authorities of the states of design and manufacture of Boeing and Bombardier aircraft, as well as recent efforts, and working to promote mutual

understanding.

(3) Creation and coordination of rules in international organizations

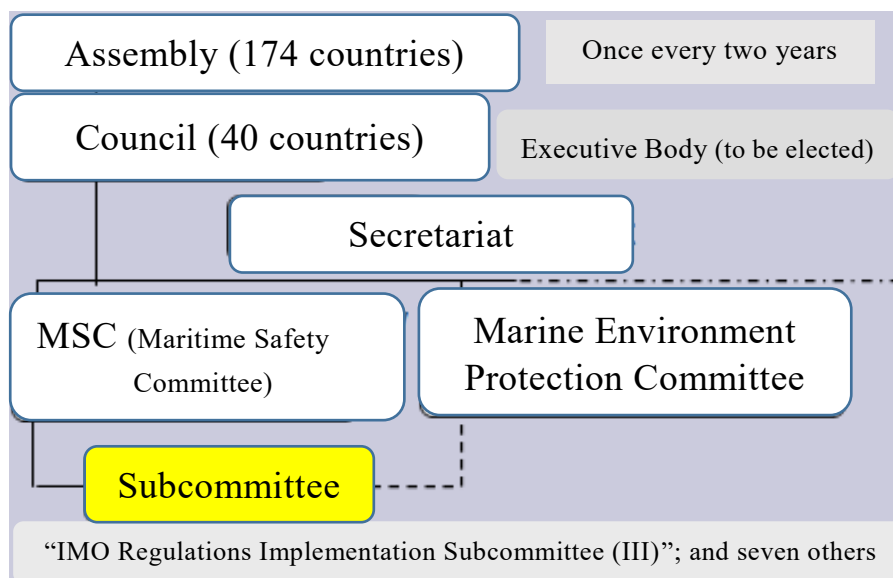
The International Civil Aviation Organization (ICAO), headquartered in Montreal, is a specialized agency of the United Nations under the Convention on International Civil Aviation (commonly known as the Chicago Convention), which has been established for the development of international civil aviation. ICAO has established international standards development of international standards, recommended practices and guidelines for the safety and security of international air transport. International standards for accident and incident investigations are stipulated in Annex 13.

The Japan Transport Safety Board is actively participating in the Expert Meeting (Accident Investigation Panel (AIGP)) to discuss amendments to the Annex, and is contributing to efforts to establish international rules for accident investigations.



Organization chart of the ICAO

The International Maritime Organization (IMO) (Headquarters: London) is a specialized agency of the United Nations to promote international cooperation on maritime issues such as the safety of ships and the prevention of marine pollution from ships. The IMO has a General Assembly, a Board of Directors, and a Committee, among which the IMO Rules Implementation Subcommittee serves as a forum for discussion on how to ensure the responsibility of the flag state, etc., including investigation of marine accidents, etc. The Japan Transport Safety Board participates in this subcommittee meeting and analyzes the marine accident and other investigation reports submitted by various countries to draw out lessons on safety improvement. The Board is continuously engaged in activities to disseminate them internationally through the IMO website. Japanese translations of these survey reports are also posted on the JTSTB website to help improve the safety of Japanese vessels.



Organization chart of the IMO

Moreover, the JTSB is deepening cooperation with accident investigation organizations in foreign countries by exchanging opinions at annual meetings of the International Transport Safety Association (ITSA), an international organization with the aim of improving the safety of global Transport Safety, which is headed by the chairman of accident investigation organizations in 17 countries and regions including the United States and France.

In addition, there is a framework for cooperation and collaboration among multilateral accident investigation authorities. For more information, see Chapter 7: International efforts for accident prevention.

(4) Examples of cooperation with foreign accident investigation authorities

The following is an introduction to recent examples of cooperation in investigations of accidents, etc., carried out in cooperation with other countries.

1. Examples of cooperation in the aviation field

In the investigation of the collision of a helicopter (Bell 412 EP) on a mountain slope in Gunma Prefecture on August 10, 2018, a test on the existence of an error code at the factory of the manufacturer of the digital flight control computer was conducted in the presence of an aircraft accident investigator of the United States of America, the State of Design and Manufacture of the helicopter. As a result of the test, an error code was detected during the test run. However, according to the information from the video camera, there was no video showing the error code during the flight during the flight, and there was no information that a problem had occurred on the aircraft. Therefore, it is considered that there was no abnormality with the aircraft. In this way, steady efforts are made to confirm each piece of information that may be related to the cause of the accident through international cooperation.

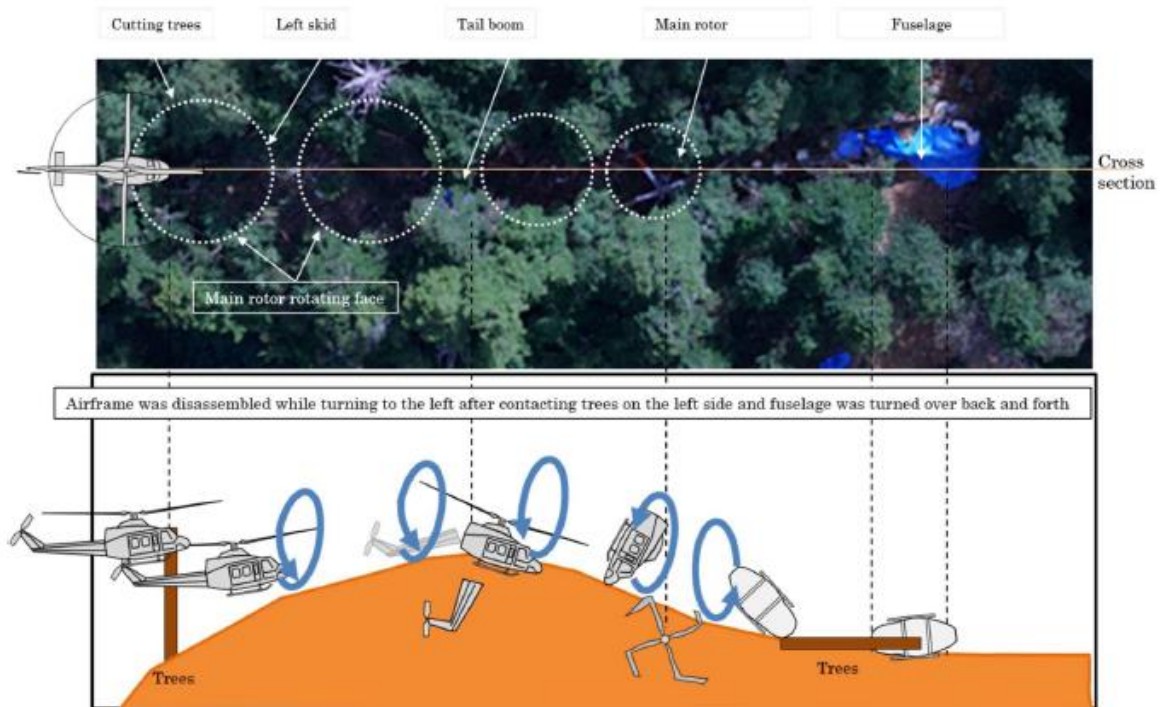
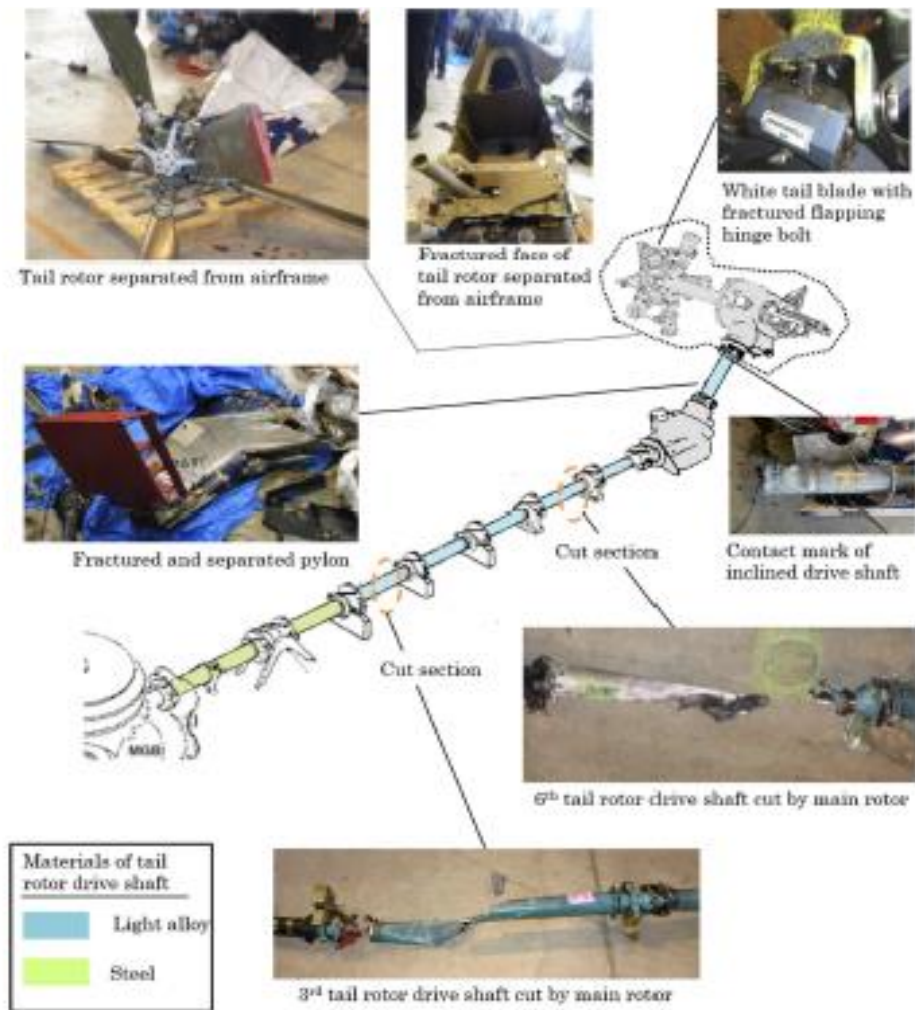


Figure showing inverted airframe when crashed

Besides, in the investigation of the uncontrollable crash of a helicopter (Aerospatiale AS332L) that occurred in Gunma Prefecture on November 8, 2017, the French Bureau of Accident Investigation (BEA) participated in the investigation of the tail rotor system at the manufacturer of the helicopter. As a result of detailed examination of many parts supporting the tail rotor, we were able to estimate that the cause of the crash was the tail rotor separated from the airframe during the flight and became uncontrollable.

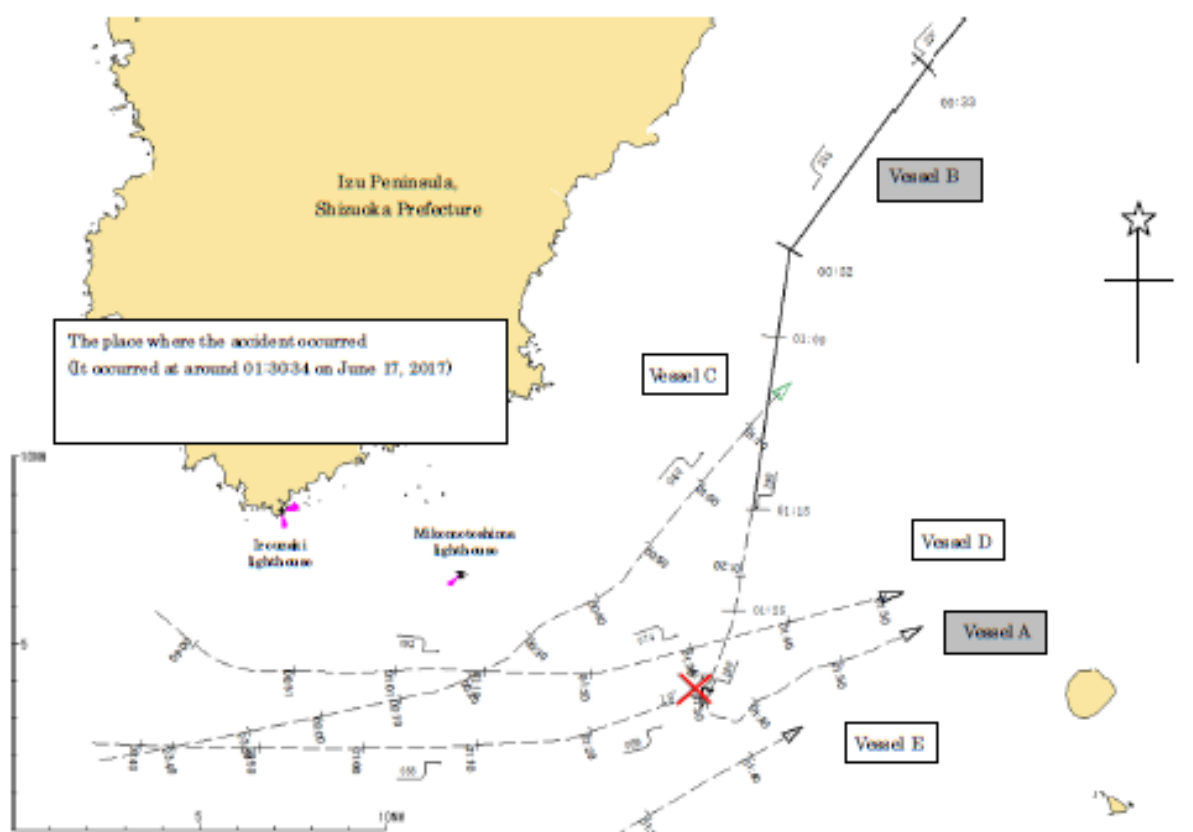


Tail Rotor drive shafts had contact marks

2. Examples of cooperation in marine field

The United States Coast Guard, which was commissioned by the Maritime Safety Investigation Authority (NTSB) of the United States of America, provided investigation data for the collision accident investigation of the container ship ACX CRYSTAL (Vessel A) and the missile destroyer USS FITZGERALD (Vessel B), for which the report was published on August 29, 2019. Along with various information collected by the marine accident investigators of the Japan Transport Safety Board and technical advice from research institutes in Japan, the JTSB has been able to organize and analyze factual information and put together the causes and preventive measures. It was the first time the Japan Transport Safety Board had obtained and reflected detailed information on accidents involving U.S. Navy vessels in its report.

Besides, seven of the Marine Accident Investigation Reports that were published in 2019 were sent to the State of the Flag of the Vessel in response to requests from the State of the Flag of the Vessel, and the JTSB is engaged in daily international cooperation by seeking opinions.



Estimated Route Chart of Vessel A and Vessel B

(5) International cooperation — Supports for accident investigation and development

In addition to the cooperation with the foreign accident investigation authorities in the accident investigation, the status of the support for strengthening the accident investigation in foreign countries based on the accident investigation in Japan is introduced.

1. In response to a request from the Government of India, the Japan International Cooperation Agency (JICA) has been carrying out the technical support named “Project for Strengthening Railway Safety” since November 2018. The JTSB has been participating in this project since the start of this project, and has been promoting the significance of accident investigations and necessary systems to many Indian railway safety engineers.

In particular, in July 2019, 10 people in charge of railway accident investigations, including senior officials of the Indian Railways Ministry, visited Japan and provided 10 days of training, including lectures on the basics of accident investigations (the overall flow of investigations, on-site investigation procedures, how to prepare reports, etc.) and on numerous accident investigation cases that have been conducted in Japan. This is the first time the Japan Transport Safety Board has conducted such training in the railway field.

The trainees enthusiastically learned Japan's railway accident investigation methods and railway safety systems, and on the final day, as a result of their training in Japan, they drew up an action plan

to establish their own railway accident investigation know-how in India. In January 2020, a general meeting was held in India to confirm the status of activities under this Action Plan, and the Director of Railway Committee of the Japan Transport Safety Board, Mr. Okumura, and the Railway Accident Investigators are also working on support to promote activities.



Left: Lecture by Mr. Okumura



Right: Visit by Indian railway accident investigation personnel (trainees) who came to Japan

2. Besides, In Myanmar, where JICA projects such as railway vehicle maintenance, management, and service improvement are in progress, JICA also held seminars to introduce the mechanism of railway accident investigations and recommendations for the prevention of recurrence in Japan as part of support for human resource development in the railway field.

The railway lines in Myanmar are not electrified, and a large number of more than 100 diesel railcars used in Japan have been sent there and help transport passengers. However, due to the lack of knowledge, skills, and replacement parts, such as the maintenance standards for Japanese diesel railcars, it is not possible to maintain and manage the railcars sufficiently, and a considerable number of railcars have failed. Therefore, Japanese experts provide technical guidance on the maintenance and management of railcars.



Mr. Okumura explaining at a railway safety seminar

Against this backdrop, more than 40 people from Myanmar attended the Railway Safety Seminar held on January 31, 2019 in the seminar room of the Railway Technology Center adjacent to the Myanmar Railway Head Office. At the meeting, Mr. Okumura, Director of the Railway Committee of the Japan Transport Safety Board, and Railway accident investigators, explained the outline of Japan's railways, the occurrence of railway accidents, the history of the establishment of the Japan Transport Safety Board, and the outline of the activities of the Board. Based on actual accident investigation cases, they explained the flow of accident investigation, including analysis methods, recommendations for preventing recurrence, and follow-up after the issuance of recommendations. In response to this, lively Q & A sessions were held regarding the accident investigation organization and system, as well

as the difference between the pursuit of responsibility and the investigation of the cause.

In Myanmar, there are about 300 derailment accidents every year, and they are struggling hard to prevent recurrence.



Work on track maintenance

In this way, the Japan Transport Safety Board is advancing various international activities to strengthen cooperation and cooperation systems with other countries. We will continue to strengthen exchanges and cooperation with foreign accident investigation organizations and international cooperation for the implementation of more accurate accident investigations.