Master Plan

—Creating Sustainable Railway Systems—

RESEARCH 2030

(FY2025–FY2029)

December 2024

Railway Technical Research Institute

Master Plan

Contents

Material: Vision of the Railway Technical Research Institute

1. Introduction

As social issues such as those related to the global environment become increasingly apparent, there is a growing demand for the steady implementation of the Sustainable Development Goals (SDGs), which aim to realize a more sustainable and better society. The Japanese government has proposed “Society 5.0,” an initiative that seeks to balance economic development with the resolution of social issues by achieving an advanced integration of cyberspace and physical space, while fostering a human-centered society. Efforts to realize a sustainable society are underway across a wide range of fields.

Changes in the social, economic, and railway environment in Japan have been occurring at an accelerating pace since the spread of COVID-19. Existing social issues, including frequent climate change and large-scale natural disasters, the realization of carbon neutrality by 2050, increasing geopolitical risks, and a decreasing working-age population due to a declining birthrate and an aging population, are also becoming more serious, evident, and complex. Particularly for railways, labor shortages, aging infrastructure, and the business continuity of regional railway companies are urgent issues.

Meanwhile, the science and technology fields have exhibited rapid progress in technical innovation on a global scale in relation to digital technologies such as artificial intelligence (AI), automatic train operation, and drones, as well as decarbonization technologies such as energy storage batteries, biofuels, energy-conserving train operation, and renewable energy.

While such advanced technologies have also been utilized for railways in efforts toward resolving these issues, collaboration with railway companies and related institutions is essential to address the rapidly changing and complex issues.

Given the rapidly changing social and economic environment and the evolving challenges facing the railway industry, the Railway Technical Research Institute (RTRI) has formulated the Master Plan RESEARCH 2030 (“Master Plan”) for FY2025 onward as an action plan to achieve the following vision: "We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society." In light of the rapid pace of change in society and the need to provide research and development (R&D) outcomes as soon as possible, we have set the period of the plan at five years, from FY2025 to FY2029.

We will promote R&D that creates innovative technologies with the aim of "Creating Sustainable Railway Systems" in order to realize safe, secure, smart, environmentally friendly, and sustainable railways in the future.

2. Basic policies of activities

Given the changes in society and technology, as well as progress in R&D, we will demonstrate our collective strength to prioritize further development to improve the safety of railway systems, with the highest priority given to enhancement of resilience against increasingly severe, widespread, and frequent natural disasters, while also focusing on various issues such as labor savings and decarbonization through the use of advanced technologies. We will accurately manage the full scope of research, ranging from basic to applied topics, as well as supporting its social implementation. We will also promote collaboration with railway companies and external research institutions, and efficiently advance R&D. Furthermore, we will promote the enhancement of the global presence of Japanese railway technologies and create a vibrant workplace where each employee can experience self-realization.

The basic policy of our activities will include the following goals in order to achieve these objectives.

(1) Improving safety with an emphasis on enhancing resilience against intensifying natural disasters

We will promote R&D that contributes to safer and more stable railway transportation as a top priority, with a particular focus given to R&D that contributes to the strengthening of railways against natural disasters such as earthquakes, heavy rains, and strong winds, which are becoming increasingly severe, widespread, and frequent. We will also actively conduct R&D with the goal of preventing failures and deterioration of wayside and vehicular equipment. Furthermore, we will actively engage in impartial activities such as diagnostic guidance related to investigating the damage produced by disasters and accidents, along with their causes, and propose recovery methods and measures to prevent their recurrence.

(2) Improving productivity and decarbonization of railway systems

We will strongly promote R&D that contributes to railway systems innovations, such as the improvement of productivity through sophisticating the automatic train operation and labor-saving maintenance using cutting-edge ICT, and the decarbonization of railways. We will also work on R&D to further reduce costs.

Our implementation of R&D will aim to create new value by promoting technical collaboration, as well as data collaboration and sharing, between different technical fields or railway companies.

The social implementation of the R&D outcomes will be conducted by supporting the development of the necessary laws and technical standards. We will also promote the use of environmentally advantageous railways, and improving the sustainability of regional railway companies.

(3) Providing solutions to various issues in railway technologies by demonstrating the collective strength of RTRI

While focusing on R&D for the future of railways, development of practical technologies with an immediate effect on railway operations and maintenance, and basic research, we will seamlessly promote the full scope of R&D activities from basic research

to applied development and also address various issues in railway technologies through cross-disciplinary structures that demonstrate our collective strength. We will allocate resources intensely to the core R&D technologies that will serve as the driving force for pursuing the essence of railway issues and their solutions, as well as sophisticate the core technologies.

We will disseminate our obtained R&D outcomes through a variety of media.

(4) Enhancing the global presence of Japanese railway technologies

We will strengthen technical exchanges with overseas railway companies and research institutions, invigorate R&D activities, and enhance the global presence of Japanese railway technologies. Furthermore, as a base for international standardization activities that supports the overseas expansion of Japanese railway technologies, we will demonstrate leadership and conduct strategic activities in close collaboration with related institutions in Japan and overseas.

(5) Creating a vibrant workplace where each employee can experience self-realization

We aim to create a workplace that promotes well-being, respects diverse values, and allows each individual to experience their own self-realization. We will foster a transparent and open environment in the workplace, where all employees can discuss issues openly and freely, as well as promote the creation of a vibrant workplace where all employees can work with a high level of awareness.

3. Activities

As public interest activities, we will promote the following eight activities: research and development, surveys, drafting technical standards, information services, publications, and seminars, diagnostic advisory, international standards, and qualification. In addition, we will strategically and systematically promote the activities of the Railway Technology Promotion Center and Railway International Standards Center, both of which are conducted in collaboration with railway engineering professionals, as well as international activities such as joint research with overseas universities and research institutions. Furthermore, we will actively promote revenue-generating projects to commercialize and widely disseminate our R&D outcomes.

3.1 Public interest activities

3.1.1 Research and development activities

(1) R&D aims and pillars

We have set four R&D aims, namely: (1) Improvement of safety, including enhancement of resilience against intensifying natural disasters; (2) Improvement of productivity," including sophistication of automatic train operation and labor-saving maintenance; (3) Harmony with the environment, including decarbonization of railway systems; and (4) Improvement of convenience, including improving the comfort of railway cars and stations, as well as passenger flow forecasting.

We have also set a series of "Pillars of R&D" in order to effectively utilize resources and advance R&D: (1) R&D for the future of railways; (2) Development of practical technologies; and (3) Basic research for railways (Figure 3-1).

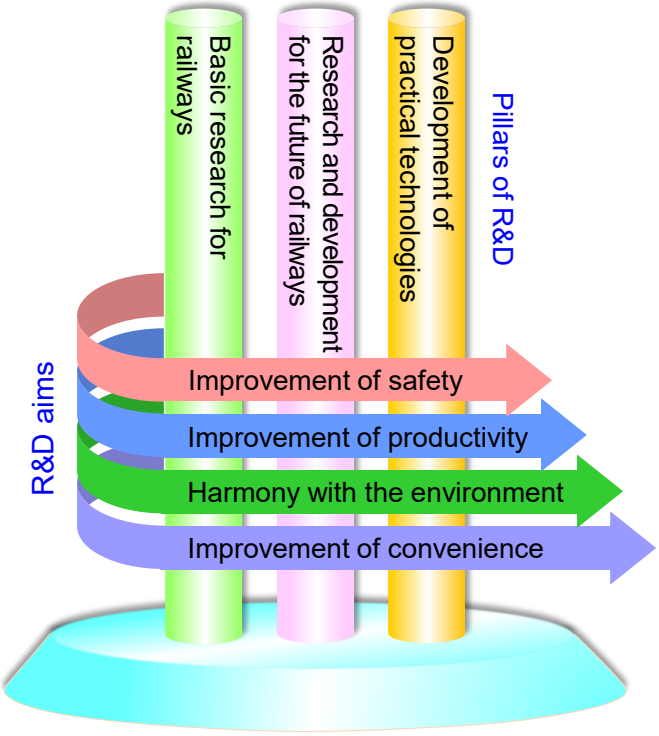


Figure 3-1. R&D aims and pillars

(2) Advancing R&D

1) Principles of R&D projects

R&D projects are advanced by setting goals and roadmaps for each project to realize the ideal state of sustainable railways in the future, while considering changes in social conditions, various issues that are more serious, evident, and complex, as well as the rapid progress of technical innovation.

Each roadmap comprehensively covers the full scope of R&D, from basic research, which is the source of innovative technology, to applied development. Each roadmap will also accurately set an achievement point and milestones based on the phases of the R&D project, such as fundamental research, fundamental technology research, applied technology development, and practical development, where it will seamlessly promote the project while managing its progress.

In the phase of practical development, researchers with advanced specialized knowledge will independently and proactively engage in the formulation of laws, regulations, and technical standards necessary for the social implementation of innovative technologies. In addition, in order to promote international standardization activities, R&D projects will be set in consideration of their adoption in international standards.

2) Sophistication of core R&D technologies

We will allocate resources intensely to the core R&D technologies that will serve as the driving force for pursuing the essence of railway issues and their solutions, and we will sophisticate these core technologies. We will strengthen techniques and technologies that are continuously applicable to R&D projects, highly versatile, and generate common benefits for the entire railway industry. This includes physical technologies for experiments and measurements using innovative test facilities, as well as simulation technologies that incorporate railway-specific theories and railway knowledge. In addition, we will develop researchers with the ability, knowledge, and experience to effectively utilize core technologies and to identify the essence of issues.

We will explore the potential of applying cutting-edge digital technologies, such as image analysis, AI, and platforms, across fields that can transform society. By integrating these technologies with the core technologies, which are the strengths of RTRI, we strive to develop innovative solutions.

3) Efforts to efficiently advance R&D

When we implement R&D, we will aim to create new values, enhance the quality of R&D outcomes, and shorten development timelines by promoting technical collaboration, as well as data collaboration and sharing, across different technical fields and railway companies.

We are committed to accurately identifying the needs for technical development through activities such as joint research with railway companies. We will also modularize our R&D outcomes and progressively promote their implementation in society.

We will strengthen efforts such as joint research with domestic and overseas universities, research institutions, and related companies, as well as actively utilize resources from external institutions. These external resources include acquiring advanced technologies and knowledge, such as sophisticated information processing and high-

speed communication networks. They also involve the use of high-density observation networks and data such as weather and earthquake information, as well as the mastery of testing and analysis techniques.

(3) R&D for the future of railways

We will set and address project-based R&D themes that respond to the needs of railway companies and social trends, which can utilize the high capabilities and distinctive research areas of RTRI and demonstrate the collective strength of RTRI.

As a general rule, the implementation period for R&D themes will be five years. However, the plan will be flexibly revised as needed in order to accurately determine the technical situation and needs of railway companies, modularize the R&D outcomes as needed, and enable social implementation.

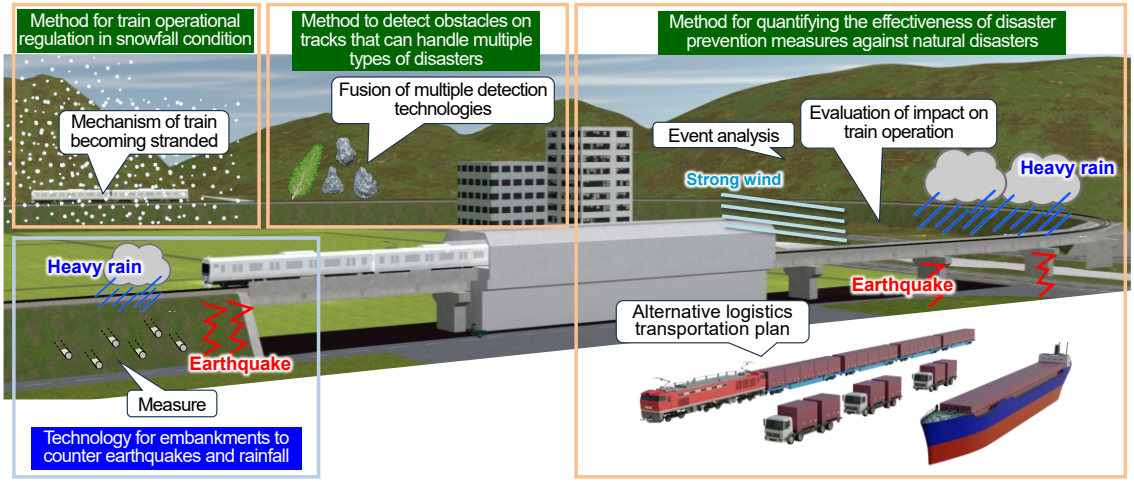
Specifically, we will address the following five project-based R&D themes.

- Enhancement of resilience against intensifying natural disasters
- Sophistication of automatic train operation
- Labor-saving maintenance
- Decarbonization of railway systems
- Elucidation of railway-specific phenomena through simulation

1) Enhancement of resilience against intensifying natural disasters

Objective: We will aim toward the development of quantification methods for evaluating the effects of disaster prevention measures against natural disasters, and sophistication of tangible and intangible measures in order to contribute to enhancing the resilience of railways through effective measures against increasingly severe, widespread, and frequent natural disasters.

Overview: We will develop a method based on the analysis of disaster events, which can rationally evaluate the effectiveness of disaster prevention measures against natural disasters of different types and scales using quantitative and unified indices. At the same time, we will propose a method for planning alternative transportation during disasters, a method to detect obstacles on railway tracks for multiple types of disasters, a method for train operation control against trains becoming stranded due to snowpack, and low-cost technology for embankments to counter earthquakes and rainfall (Figure 3-2).



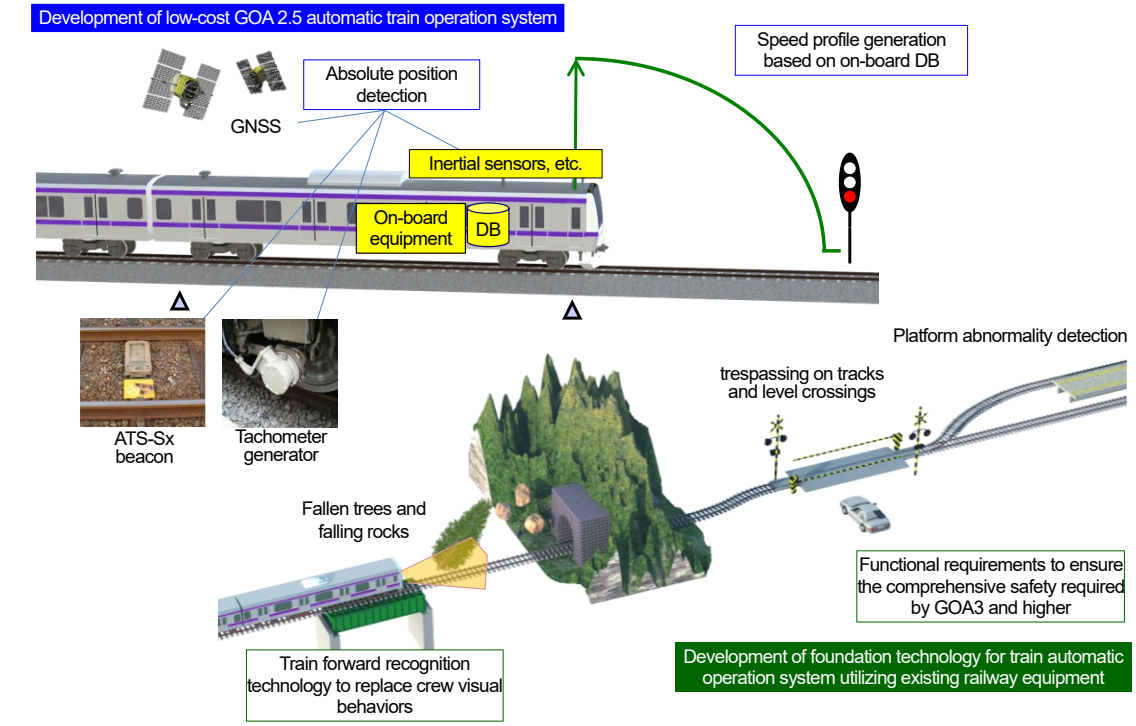
Topic	2025	2026	2027	2028	2029	Expected result
Quantification method for evaluating effects of disaster prevention measures against natural disasters	Analysis of events occurring in natural disasters Evaluation method for the impact of earthquakes on train operations Evaluation method for the impact of rainfall on train operations Mathematical model for alternative transportation plan for railway logistics in case of disasters etc.			Quantification method for evaluating effectiveness of disaster prevention measures against natural disasters Guidelines for planning alternative transportation during disasters		• Manual for assessing pre- and post-disaster measures • Guidelines for planning alternative transportation
Method for detecting obstacles on railway tracks for multiple types of disasters	Method for detecting obstacles on railway tracks for multiple types of disasters			Sophistication of obstacle detection systems by combining multiple detection methods		• Obstacle detection devices, technologies, and installation manuals (linked to automatic driving)
Method for train operation control in snowfall condition	Elucidation of mechanism of trains becoming stranded due to snowpack Methods for estimating snow depth and snow characteristics on tracks			Method for train operation control against trains becoming stranded due to snowpack		• Manual for handling trains becoming stranded due to snowpack
Technology for embankments to counter earthquakes and rainfall	Effect of rainfall countermeasure work on embankments for improving seismic resistance			Low-cost technology for improving embankment resistance to earthquakes and rainfall		• Design and reinforcement manual

Figure 3-2. Enhancement of resilience against intensifying natural disasters

2) Sophistication of automatic train operation

Objective: We will aim for widespread adoption of automatic operating systems through reducing their costs by developing elemental technologies for train control and forward recognition, and support the establishment of the technical standards needed for social implementation.

Overview: We will develop low-cost GOA 2.5 automatic train operation systems that do not require large capital investments and can be applied to regional railways by establishing absolute position detection technology for low-cost GOA 2.5 automatic train operation systems that utilize ATS-Sx, the global navigation satellite system (GNSS), inertial sensors, and other techniques. We will also systematize the functional requirements for ensuring the comprehensive safety requirement of GOA3 and higher, and develop evaluation methods. We will also develop forward recognition technology that will serve as the foundation technology for automatic operation systems utilizing existing railway equipment (Figure 3-3).



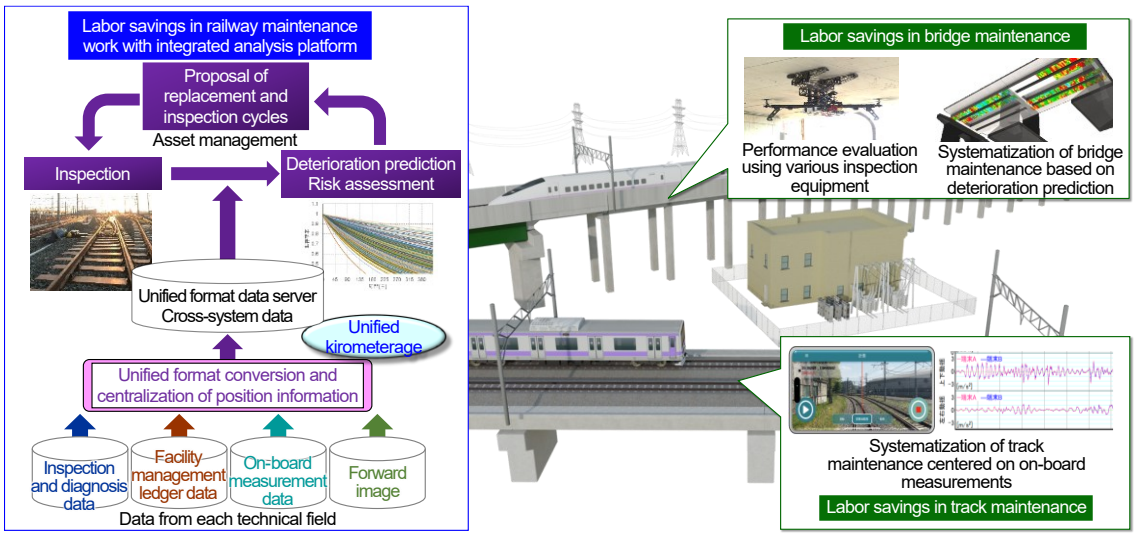
Topic	2025	2026	2027	2028	2029	Expected result
Development of low-cost GOA 2.5 automatic train operation systems	Absolute position detection technology for low-cost GOA 2.5 automatic train operation systems → Development of low-cost GOA 2.5 automatic train operation systems					• Low-cost GOA 2.5 automatic train operation systems
Development of foundation technology for train automatic operation systems utilizing existing railway equipment	Systematization of sensing functional requirements corresponding to GOA levels					• Functional requirements for automatic operation systems that utilize existing railway equipment
	Train forward recognition technology to replace crew visual behaviors → Development of crew visual behaviors assist system					• Crew visual behaviors assist system under GOA 2.5

Figure 3-3. Sophistication of automatic train operation

3) Labor-saving maintenance

Objective: We will aim to establish a maintenance system that can achieve both safe and stable operation, as well as labor savings. This will be achieved by developing maintenance methods and elemental technologies, and by supporting the establishment of the technical standards necessary for social implementation.

Overview: We will propose new maintenance methods that can also be applied to regional railways, and build support tools for maintenance by conducting fact-finding surveys on the actual conditions of various maintenance operations on railway facilities, applying the integrated analysis platform to commercial lines, and suggesting methods for setting reasonable component replacement and inspection cycles. We will also systematize track maintenance primarily based on on-board measurements, and bridge maintenance based on the latest inspection equipment and deterioration predictions (Figure 3-4).



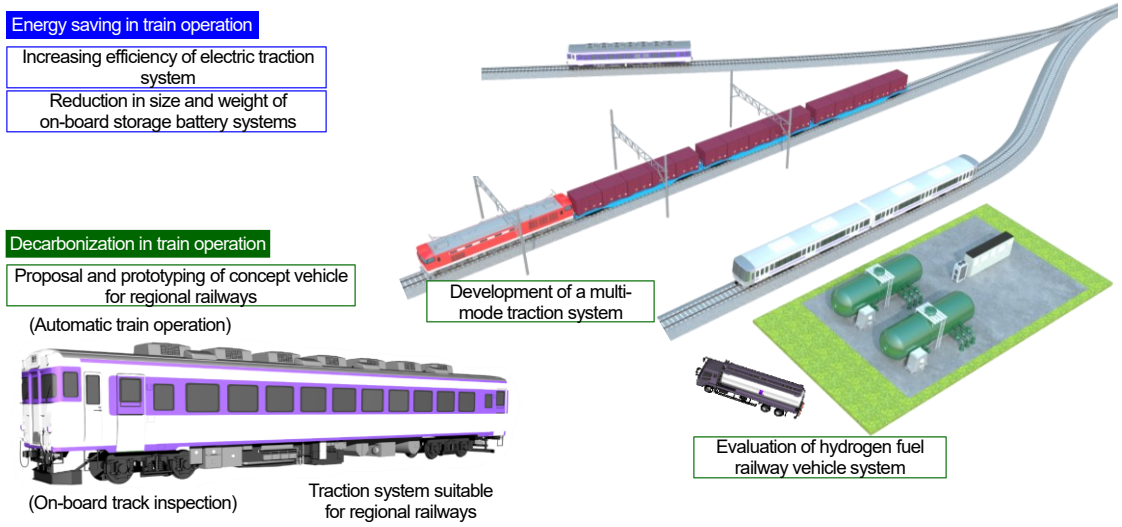
Topic	2025	2026	2027	2028	2029	Expected result
Labor savings in railway maintenance work with integrated analysis platform	Fact-finding surveys on the actual conditions of various maintenance operations on railway facilities and consideration of labor-saving measures					• Support for examination of technical standards for railway maintenance • Maintenance planning support tool for railway facilities using the integrated railway maintenance platform
	Application of integrated analysis platform to commercial lines					
			Method of setting rational parts replacement and inspection cycles			
Labor savings in track maintenance	Method of estimating track conditions using mobile information terminals					• Track CBM based primarily on on-board measurements, database for track maintenance, and optimization of inspection method and cycle
	Method for building track databases using mobile information terminals		Systematization of track maintenance centered on on-board measurements			
Labor savings in bridge maintenance	Evaluation of deformation around bridge boundaries based on on-board measurements					• Database for bridge maintenance, deterioration prediction and optimization of inspection cycle based on inspection and evaluation methods
	Evaluation of bridge performance with use of various inspection equipment and degradation modeling method for bridges					
				Systematization of bridge maintenance based on deterioration prediction		

Figure 3-4. Labor-saving maintenance

4) Decarbonization of railway systems

Objective: We will develop and support the social implementation of fundamental technologies that contribute to reducing CO_2 emissions, particularly from running trains, for the realization of carbon neutrality by 2050 and a decarbonized society.

Overview: We will develop fundamental technologies to achieve further energy savings and decarbonization in train operation, by increasing efficiency of electric traction system including diesel-electric multiple units, by reducing the size and weight of on-board storage battery systems, as well as developing a multi-mode traction system suited to various revenue lines and evaluating the performance of hydrogen-fueled railway vehicle system (Figure 3-5).

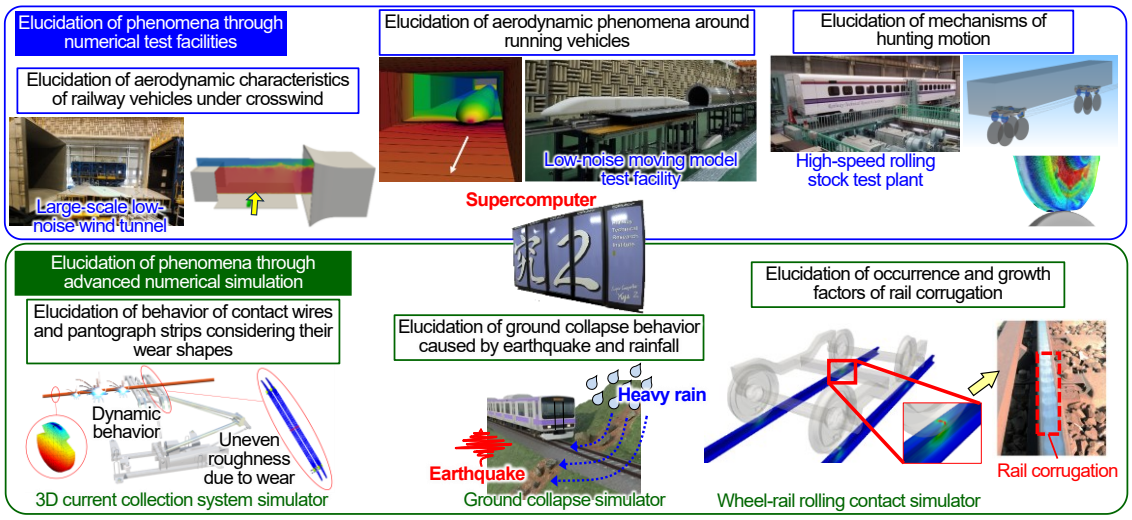


Topic	2025	2026	2027	2028	2029	Expected result
Energy saving in train operation	Development of lightweight, highly efficient power generation system for diesel-electric multiple units					• Highly efficient traction system • Reduction in size and weight of on-board storage battery systems
	Combined control method for reducing size and weight of on-board batteries			Increasing efficiency of electric traction system		
Defossilization in train operation	Examination of configuration of multi-mode traction system			Development of highly efficient multi-mode traction system		• Consideration of specifications for multi-mode vehicles suited to revenue lines, and operational test of new multi-mode traction system • Evaluation of hydrogen-fueled vehicle system • Concept vehicle for regional railways
	Evaluation of powertrain for hydrogen-fueled vehicle			Evaluation of hydrogen-fueled vehicle system		
	Proposal of concept vehicle for regional railways			Prototyping of concept vehicle for regional railways		

Figure 3-5. Decarbonization of railway systems

5）Elucidation of railway-specific phenomena through simulation

Objective: We will elucidate the mechanisms of railway-specific phenomena by sophisticating the core technologies, such as numerical test facilities and numerical simulations, that will drive the pursuit of the essence of railway issues and their solutions.
Overview: We will elucidate the aerodynamic characteristics of railway vehicles under crosswind, the aerodynamic phenomena around running vehicles, and the mechanisms of hunting motion by using the numerical test facilities that simulate the functions of RTRI's distinctive physical test facilities. We will also employ advanced numerical simulations using coupled analysis and AI to elucidate railway-specific phenomena that are difficult to reproduce through measurements or experiments, such as dynamic behavior of contact wires and pantograph strips considering their wear shapes, collapse behaviors of ground due to earthquakes and rainfall, and rail corrugation (Figure 3-6).



Topic	2025	2026	2027	2028	2029	Expected result
Elucidation of phenomena through numerical test facilities	Development of computational method for numerical wind tunnel to simulate running vehicles under crosswind → Elucidation of aerodynamic characteristics of running vehicles under crosswind using numerical wind tunnel					• Elucidation of aerodynamic characteristics of running vehicles, including crosswind conditions unreproducible in real wind tunnel tests • Improvement of prediction accuracy for pressure vibration in tunnels, including two trains passing each other, considering differences in train nose shapes, and for aerodynamic forces under crosswind • Improvement of efficiency for testing for vehicles, and replication of hunting motion in main lines
	Development of numerical computation methods and experimental methods to study aerodynamic phenomena in moving model rig → Elucidation of aerodynamic phenomena moving model rig and improvement of prediction accuracy					
	Development of elemental technologies for numerical rolling stock test plant in advanced car dynamics simulator → Practical application of numerical rolling stock test plant and functional expansion of virtual running tests in main lines					
Elucidation of phenomena through advanced numerical simulation	Development of contact algorithm for contact wires and pantograph strips → Elucidation of dynamic behavior of contact wires and pantograph strips considering their wear shape					• Elucidation of dynamic behavior of current collection systems, considering surface roughness caused by wear of contact wires and pantograph strips • Elucidation of ground collapse behavior during rainfall for earth structures deformed by earthquakes • Elucidation of occurrence and growth factors of rail corrugation
	Development of elemental technologies for simulating ground collapse caused by earthquake and rainfall → Elucidation of ground collapse behavior caused by earthquake and rainfall using ground collapse simulator					
	Development of wheel-rail rolling contact simulation method and estimation of occurrence and growth factors of rail corrugation → Verification of wheel-rail rolling contact simulation method and elucidation of occurrence and growth factors of rail corrugation					

Figure 3-6. Elucidation of railway-specific phenomena through simulation

(4) Development of practical technologies

We will address technical challenges in railways to provide practical solutions in a prompt, timely and accurate manner (Table 3-1).

1) Technical development requested by Japan Railway (JR) companies

Upon receiving specific requests, we will promptly provide the technical solutions that contribute to solving various issues in the actual fields, considering the circumstances of each commercial line and maintenance operations. We will particularly promote practical applications by allocating resources intensely to the R&D projects for which solutions are in high demand among railway companies and are expected to propagate a large impact effect when applied practically.

2) Self-directed development of practical technologies implemented by RTRI

By fully understanding the demand of railway companies and using the facilities distinctive to RTRI, analytic technology, and know-how, which are the advantage of RTRI, we will address R&D projects that can be rapidly adapted to solving on-site issues.

Table 3-1. Examples of planned projects for “Development of practical technologies”

Improvement of safety	○Disaster-resistant systems against rain, wind, snow, and earthquakes ・Seismic design methods for railway structures against earthquake-induced events (fault displacement, tsunamis, aftershocks, etc.) ○Systems resistant to accidents and failures ・Inspection method based on simulations of crack growth in bogie frames ・Pantograph monitoring technologies for Shinkansen ○Enhancing the safety of train operations ・Training to maintain or improve cognitive functions in train drivers
Improvement of productivity	○Labor savings and cost savings in maintenance ・Labor savings in the work of adjusting wheel slip control for electric locomotives ・Automation of tunnel deterioration diagnosis work ・Automation of gas pressure welding for rail ○Labor savings and cost savings in construction ・Quality control method for railway embankments using ICT-based construction information
Harmony with the environment	○Decarbonization ・Energy savings in train operation using driving advisory systems ・ Superconducting feeding system targeted for long-distance transmission ○Improvement of the environment inside trains and stations, and along railway lines ・Development of partially inclined sound-absorbing noise barriers for large-scale renovations
Improvement of convenience	○High speed ・Estimation of the spatial distribution of micro-pressure waves around tunnel portals ○Improvement of railway services ・Application of next-generation tilt control systems to existing tilting trains ・ Evaluation method for station facilities based on estimation of passenger distribution ・Evaluation method for facility improvement effects based on analysis of train delay factors

3) Research and development commissioned by the government

We will efficiently promote the implementation and dissemination of R&D outcomes in society by utilizing government commissions and national subsidy systems.

(5) Basic research for railways

In R&D activities classified as basic research for railways, which is the source of innovative technologies such as the elucidation of railway-specific phenomena, we will proactively promote challenging R&D projects with a significant impact on railway operations when their results lead to practical applications, and utilize advanced numerical simulation technologies and RTRI's innovative test facilities.

In the R&D projects of "Elucidation and prediction of phenomena," we will conduct basic research on prediction of natural disasters and enhancing the resilience of railway systems, improving the running safety of train sets, support for safety management based on human factors, and increasing the speed of Shinkansen trains suitable for the wayside environment. Regarding the R&D projects "Detection and assessment", we will aim to improve detection technologies and make assessment more efficient and automated. In the R&D projects of "New technologies and materials," we will establish foundation technologies such as for digitalization and decarbonization, and material utilization technologies suited for circular society (Table 3-2).

For research projects that have a significant impact not only on the railway industry but also on society as a whole, we will promote them efficiently by utilizing external research grant programs.

Table 3-2. Example of planned projects for “Basic research for railways”

Elucidation and prediction of phenomena	○Prediction of natural disasters and enhancing the resilience of railway systems ・Health assessment of the soundness of scoured bridge foundations ・Modeling method of the group of railway structures for the earthquake disaster simulations ○Improving the running safety of train sets ・Elucidation of deceleration, deformation, of train sets during collisions and proposal damage mitigation guidelines ・Elucidation of train set behavior during earthquake focusing on on-rail safety limit ○Support for safety management based on human factors ・Risk perception and psychological assessment of pedestrians passing level crossings ・Prediction of passenger behavior patterns during train evacuations ○Increasing the speed of Shinkansen trains suitable for their wayside environment ・Methods for estimation of sound source contribution of aerodynamic noise from the bogie at wayside measurement points ・Methods for separating noise from lower parts based on estimation of the frequency spectrum of aerodynamic noise
Detection and assessment	○Improvement of detection ・Detection methods for anomalous lift force in pantographs ・Verification of the measurement method of rail axial force based on rail magnetic properties ○Efficiency improvement and automation of assessments ・Automation of flaw evaluation in nondestructive testing for bogie parts using AI ・Methods for detecting metal fittings of overhead contact lines at risk of fatigue fracture using imaging technologies
New technologies and materials	○Foundation technologies such as for digitalization and decarbonization ・Evaluation methods for AI decision errors compromising safety ・Development of high-accuracy 3D track space data using simple on-board devices ・Performance evaluation of traction motors with magnetic wedges ○Materials for circular society ・Recycling, reusing and reducing railway materials ・Application of environmentally friendly raw materials to composite frictional materials

(6) Test facilities

1) Updating and introducing test facilities

We will update the existing test facilities and improve their functionalities based on the prioritization of necessity and urgency. We will also introduce new test facilities, which are highly necessary for high-quality R&D activities.

2) Updating of supercomputers

We will continue to maintain an advanced numerical computational environment, such as by introducing a new supercomputer with the theoretical performance required for numerical testing and advanced numerical simulations to elucidate railway-specific phenomena.

3.1.2 Surveys

We will collect and analyze information concerning mid- to long-term trends domestically and overseas, in the fields of safety, the environment, and the transportation economy, as well as labor savings and cutting-edge technical trends that contribute to decarbonization, and use the results in R&D, along with actively disseminating them. We will also conduct surveys to predict the future of railways and extract technical issues for R&D.

3.1.3 Technical standards

In collaboration with the government and relevant organizations, we will promote the support for developing design standards as well as maintenance and management standards, which are oriented toward labor savings and efficiency in construction and maintenance, for addressing urgent issues such as labor shortages and the aging infrastructure. Regarding design standards, we will promote a transition to a new system of performance-based design, with the goal of unifying and structuring basic concepts to allow their use across the entire railway system.

3.1.4 Information services

We will collect and accumulate railway technology information from Japan and overseas, and actively disseminate it. Additionally, we will use various media, such as mass media and the Internet, to disseminate R&D outcomes and information about our activities.

We will use the Damage Information System for Earthquake on Railway (DISER) to distribute information that will contribute to rapid recovery and other response efforts in the event of an earthquake.

3.1.5 Publications and seminars

We will utilize the advantages of e-books to improve the quality and immediacy of periodical publications such as the RTRI Report, Railway Research Review (RRR), Quarterly Report of RTRI (QR), and Ascent, and expand lectures and technical forums using online distribution and other means, in order to disseminate R&D outcomes to society. In addition, we will provide systematic training courses on topics in railway technologies, covering a wide range of technical fields from introductory to practical levels.

3.1.6 Diagnostic advisory

We will respond in a timely, accurate, and meticulous manner to a wide range of technical requests from railway companies and continue to actively support them. We will provide technical support related to disasters, accidents, and failures in a cross-disciplinary manner. We will also conduct rapid surveys to determine the extent of damage and its causes, and propose recovery methods and measures to prevent recurrence.

3.1.7 International standards

With the aim of maintaining and invigorating Japanese railway technologies, as well as expanding them overseas, we will promote strategic international standardization activities for the International Organization for Standardization (ISO) and International

Electrotechnical Commission (IEC). We will promote the proposal of new standards in technical fields in which Japan has strengths, and incorporate Japanese design ideas and technologies into standards that are proposed by other countries. We will promote collaboration and cooperation with related standardization organizations and strengthen support for activities such as those of convenors selected from Japan.

3.1.8 Qualification

We will contribute to the development of human resources in the entire railway industry in Japan by maintaining and improving the technical level of railway engineers through the Railway Design Engineer Examination, as well as promoting an environment that facilitates taking the examination.

3.1.9 Railway Technology Promotion Center

With a primary focus on maintaining and improving technical capabilities, systematizing technologies, solving technical issues, and providing technical information services, we will engage in activities that ensure the safety of railway systems and contribute to advancing the technical standards of those involved in railways, in collaboration with the government and relevant organizations. In particular, we will focus on providing support for solving the technical issues faced by regional railways through on-site visits as well as ICT-based diagnosis and advice. We will also promote the sharing of information useful for the railway industry through research on topics of high interest to railway companies.

3.1.10 Railway International Standards Center

With the aim of maintaining and invigorating Japanese railway technologies, we will act as a central organization responsible for international standardization activities while closely cooperating with the government, domestic standards development organizations, railway companies, and railway-related companies.

We will work on clarifying and documenting Japanese technologies and know-how, as well as promoting understanding and utilization of international standards that were proposed and led by Japan. We will also increase awareness of the international standards among Japanese stakeholders and continue to foster human resources.

3.1.11 International activities

We will promote and expand joint research with overseas universities and research institutions, as well as facilitate personnel exchanges with each of them. Through these efforts, we will acquire cutting-edge technologies and develop global human resources representing each technological field, while invigorating R&D, improving its quality and efficiency, and enhancing the presence of RTRI.

Through proactive support for overseas expansion and human resource development by railway operators and related companies, as well as the international deployment of technologies developed by RTRI and technical exchanges with overseas partners, we will foster greater confidence in Japanese railway technology and contribute to its global dissemination.

3.2 Revenue-generating projects

We will promote revenue-generating projects in order to commercialize R&D outcomes, and drive their wide adoption. To this end, we will identify the needs of railway companies and other customers by conducting marketing and promotional activities, and will actively implement initiatives to promote the practical application of R&D outcomes, thereby providing high-quality results from the client's perspective.

4. Management

4.1 Sound and appropriate business management

4.1.1 Promotion of compliance

We will continue to promote education and awareness related to compliance. We will also promote activities such as the operation of internal control systems and internal audits.

4.1.2 Information management

We will strengthen security measures, including those related to information access within the organization. We will implement information management education against cyberattacks and other threats. We will also promote the updating and migration of various core systems to cloud computing.

4.2 Vibrant business management

4.2.1 Creating a vibrant workplace where each employee can experience self-realization

We will aim to create a workplace that fosters well-being, where each employee can experience self-realization through various measures to achieve flexible work styles, improve the work environment, promote health management, and respect diverse values.

We will cultivate an open work environment where employees of all ages and positions can discuss issues openly and freely, and create a workplace where employees, ranging from experienced to young employees, can work with a high level of awareness.

4.2.2 Human resources

(1) Personnel

We will aim to set the number of personnel (salaried) at approximately 535. We will adjust the number of personnel in a flexible manner, in response to operational needs and the progress of our plans.

(2) Recruitment and training

We will secure the necessary personnel for our activities through planned recruitment. We will promote efforts to enhance understanding of RTRI through initiatives related to supporting the career development of students and strengthening collaboration with universities.

We will enhance the employees' capabilities through training and other means. Regarding the R&D department, we will continue to actively engage in personnel exchanges with railway companies and overseas research institutes, and strive to steadily develop employees who can pursue the essence of railway issues and solve them.

4.3 General facilities

We will improve facilities to allow them to contribute to sustainable activities. We will continue to introduce solar power generation facilities and will begin improving the living environment of our employees, such as by renovating aging accommodations.

4.4 Reconstruction of research buildings, etc.

The first phase of construction will involve constructing a new research building, with completion scheduled for FY2029. The start dates for the second and third phases of construction will be considered in detail around FY2029.

4.5 Funding

The contribution to be received from JR companies (contribution revenue), which is our main ordinary revenue, is expected to total 70 billion yen (annual average of 14 billion yen) during the Master Plan period (Table 4).

The budget for each fiscal year will be formulated based on the progress of the Master Plan and expected ordinary revenue at that time.

Table 4. Main expected uses of ordinary revenue during the Master Plan period

Main use	Annual average
Personnel expenses: 27.8 billion yen	5.5 billion yen*
R&D expenses: 16.7 billion yen	3.3 billion yen
Facility investment: 8.4 billion yen (including 5.9 billion yen for testing and research facilities)	1.6 billion yen

*The proportion of contribution revenue that is allocated to total personnel expenses is expected to be approximately 85%, with the remainder allocated from business revenue and other sources.

5. Conclusion

In response to various issues that are becoming increasingly serious, evident, and complex, such as social changes due to the pandemic, natural disasters, the realization of carbon neutrality, and labor shortages, we will promote various activities, including R&D, with the aim of realizing a safe, secure, smart, environmentally friendly, and sustainable railway systems in the future.

We will advance R&D by proposing R&D objectives and roadmaps for social implementation and will play a role as a leader and driver of technical innovation in close collaboration with railway companies and other organizations. We will aim to sophisticate the core technologies for R&D, which will be the driving force for pursuing the essence of railway issues and solving them - such as physical and simulation technologies that RTRI excels at, including cutting-edge digital technologies - as well as to foster the creation of innovative technologies that generate common benefits for the entire railway industry.

Based on the vision of "We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society," RTRI pledges to invest its utmost efforts to promote the activities of the Master Plan RESEARCH 2030.

Reference

RTRI's Vision

RISING

Research **I**nitiative and **S**trategy—**I**nnovative, **N**eutral, and **G**lobal

Vision

"We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society."

Mission

①To intensify research and development activities so as to improve railway safety, technology and operation, responding to customers' needs and social change

②To develop professional expertise in all aspects of railways and, as an independent and impartial research body, to fulfill our tasks using the best science available in an ethical way

③To pioneer cutting-edge technologies for Japanese railways and become a world leader

Strategy