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

Growing awareness of global environmental and social challenges has intensified the 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 introduced “Society 5.0,” an initiative designed to balance economic development with the resolution of social issues by integrating cyberspace and physical space, while maintaining a human-centered perspective. Efforts toward realizing a sustainable society are progressing across multiple sectors.

Since the spread of coronavirus disease 2019, the pace of socioeconomic and environmental changes in Japan, including those affecting the railways sector, has accelerated. Worsening social challenges, such as frequent climate change fluctuations, large-scale natural disasters, the goal of carbon neutrality by 2050, rising geopolitical risks, and the shrinking working-age population caused by a declining birthrate and aging demographics, have grown increasingly complex. Within the railway industry, labor shortages, aging infrastructure, and the business continuity of regional railway companies pose particularly urgent challenges.

Simultaneously, rapid technological progress has transformed science and engineering on a global scale. Innovations in digital technologies, including artificial intelligence (AI), automation technologies such as automatic train operation and drones, and decarbonization technologies encompassing energy storage systems, biofuels, and renewable energy, together with energy-efficient train operations, have advanced significantly. Although these cutting-edge technologies are increasingly applied to railway systems, collaboration among railway companies and related organizations essential to effectively tackle the evolving and complex challenges.

In light of these changes, the Railway Technical Research Institute (RTRI) has formulated the Master Plan RESEARCH 2030 (“Master Plan”) for FY2025 onward as a strategic framework to achieve the vision: “We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society.” Considering the rapid pace of social transformation and the need for timely research and development (R&D) outcomes, the Master Plan spans five years, from FY2025 to FY2029. Through this plan, RTRI aims to promote R&D that fosters innovative technologies under the “Creating Sustainable Railway Systems” theme to realize safe, secure, smart, environmentally friendly, and sustainable railways for the future.

2. Basic activity policies

Given the changes in society and technology, as well as progress in R&D, RTRI will leverage its collective capabilities to strengthen railway safety, prioritizing resilience against increasingly severe, widespread, and frequent natural disasters. Concurrently, R&D will target key goals such as labor saving and decarbonization through the application of advanced technologies. The Institute will manage research, ranging from basic to applied studies, and support its social implementation. The Institute will also promote collaboration with railway companies and external research institutions, and efficiently advance R&D. Furthermore, RTRI will work to elevate the international standing of Japanese railway technologies and create a vibrant workplace where each employee can experience self-realization.

To achieve these objectives, the basic policies of RTRI's activities include the following:

(1) Enhancing safety and resilience against natural disasters

R&D programs will focus on ensuring safe and stable railway transportation, emphasizing resilience against natural disasters such as earthquakes, heavy rains, and strong winds, whose frequency and severity continue to rise. Additional efforts will address the prevention of failures and deterioration in both wayside and vehicular equipment. Furthermore, RTRI will actively engage in neutral activities such as damage assessment and diagnostic guidance following disasters and accidents, and will propose effective recovery methods and preventive measures to avoid recurrence.

(2) Improving productivity and decarbonization of railway systems

R&D initiatives will drive railway system innovations, such as the improvement of productivity through sophisticating the automatic train operation and labor saving in maintenance that utilize cutting-edge ICT, and the decarbonization of railways. Cost-reduction technologies will also be pursued.

These efforts aim to generate new value through technical collaboration, data sharing, and integration across disciplines and railway companies.

Social implementation of R&D outcomes will be supported by contributing to the development of relevant laws and technical standards. RTRI will further encourage the use of environmentally favorable railway systems and enhance the sustainability of regional operators.

(3) Delivering comprehensive technological solutions through RTRI's collective strength

While focusing on R&D for the future of railways, development of practical technologies with an immediate benefit 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 fundamental issues in railway technologies through cross-disciplinary structures that demonstrate its collective strength. RTRI 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.

RTRI will disseminate its obtained R&D outcomes through a variety of media.

(4) Strengthening the global presence of Japanese railway technologies

RTRI will reinforce technical exchanges with overseas railway companies and research institutions, invigorate R&D activities, and advance global recognition of Japanese railway technologies. Furthermore, as a base for international standardization activities that supports the overseas expansion of Japanese railway technologies, RTRI 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

RTRI seeks to create a workplace that fosters well-being, respects diverse values, and supports individual growth and self-realization. The Institute 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 part of its public-interest mandate, RTRI will promote eight activities: R&D, surveys, drafting of technical standards, information services, publications and seminars, diagnostic advisory services, international standards, and qualifications. Additionally, RTRI will strategically and systematically promote the activities of the Railway Technology Promotion Center and Railway International Standards Center, both conducted in collaboration with railway engineering professionals. International activities, such as joint research with overseas universities and research institutions, will also be strengthened. Furthermore, RTRI will actively promote revenue-generating projects to commercialize and widely disseminate its R&D outcomes.

3.1 Public-interest activities

3.1.1 R&D 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 in 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).

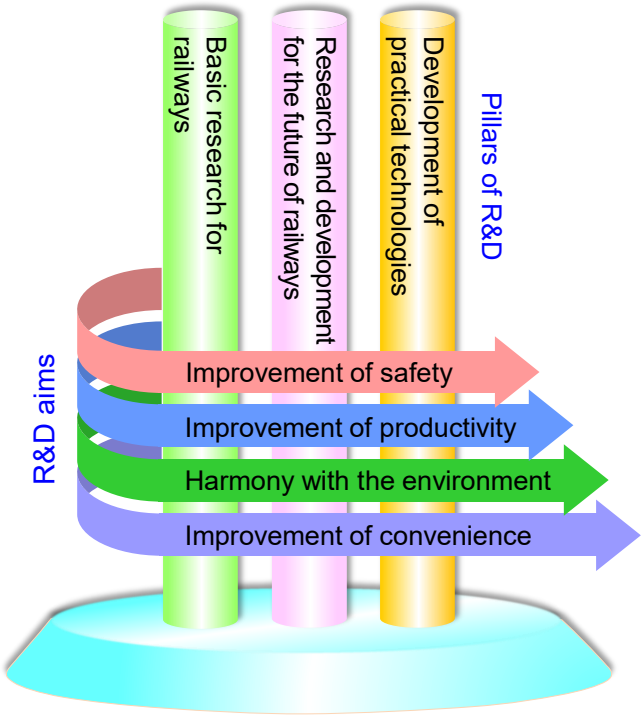


Figure 3-1. R&D aims and pillars

(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 technologies, 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.

During the practical development phase, researchers with advanced expertise at RTRI independently and proactively engage in the formulation of laws, regulations, and technical standards necessary for the social implementation of innovative technologies. Additionally, to promote international standardization, R&D projects are designed considering their potential contribution to global standards development.

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. These include physical technologies for experiments and measurements using innovative test facilities, as well as simulation technologies that incorporate railway-specific theories and knowledge. The Institute will cultivate researchers with the ability, knowledge, and experience to utilize core technologies effectively and to identify the essence of issues.

RTRI will explore the potential of applying cutting-edge digital technologies, such as image analysis, AI, and platform development, across fields that can transform society. Integration of these technologies with RTRI's strength—its core technologies—will enable the development of innovative solutions.

3) Efforts to advance R&D efficiently

In implementing R&D, RTRI will aim to create new value, enhance the quality of R&D outcomes, and shorten development timelines through technical and data collaboration across different disciplines and railway companies.

RTRI is committed to accurately identifying technical development needs through activities such as joint research with railway companies. The Institute will also modularize its R&D outcomes and progressively promote their social implementation.

Efforts such as joint research with domestic and overseas universities, research institutions, and related companies will be strengthened. External resources, such as advanced information processing technologies, high-speed communication networks, high-resolution observation systems, and large-scale datasets on weather and seismic activity, will be effectively utilized. Mastery of testing and analytical techniques will also be pursued to enhance research sophistication.

(3) R&D for the future of railways

RTRI will establish project-based R&D themes that address the needs of railway companies and societal trends while leveraging advanced capabilities and distinctive research strengths. These projects will demonstrate the Institute's collective strength.

In principle, the implementation period for R&D themes will be five years. However, the plan will be flexibly revised to accurately determine the technical situation and needs of railway companies, modularize R&D outcomes, and enable social implementation.

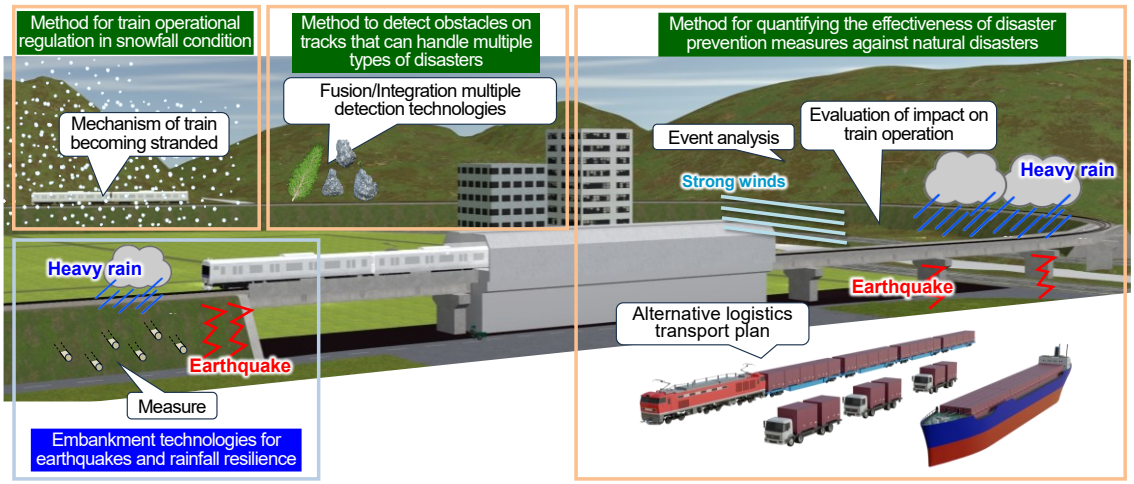
Specifically, RTRI will address the following five project-based R&D themes:

- Enhancing resilience against intensifying natural disasters
- Advancing automatic train operation
- Labor saving in maintenance
- Decarbonizing railway systems
- Elucidating railway-specific phenomena through simulation

1) Enhancing resilience against intensifying natural disasters

Objective: RTRI will develop quantitative methods for evaluating 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: RTRI will design analysis-based methodologies that quantitatively and uniformly assess the effectiveness of disaster prevention measures for different disaster types and scales. 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 operational control against trains becoming stranded due to snowpack, and cost-effective embankment technologies for earthquakes and rainfall resilience (Figure 3-2).



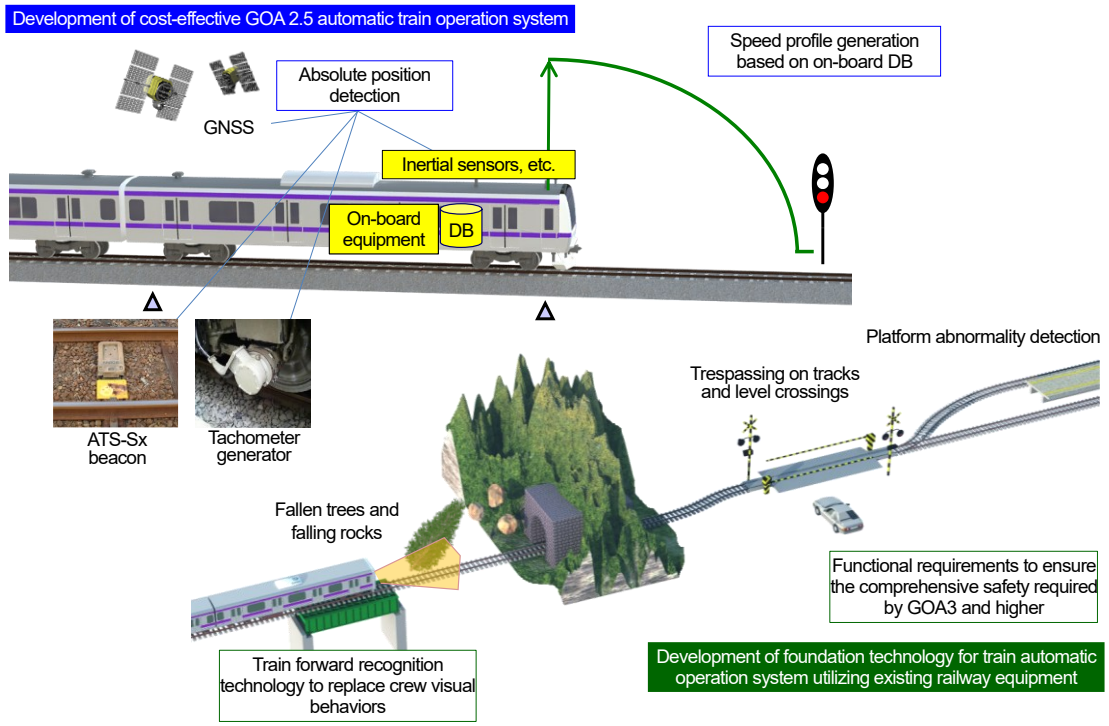
Topic	2025	2026	2027	2028	2029	Expected result
Quantification method for evaluating effects of disaster prevention measures against natural disasters	Analysis of events occurring in natural disasters Evaluation method for the impact of earthquakes on train operations Evaluation method for the impact 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 operational 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
Embankment technologies for earthquakes and rainfall resilience	Effect of rainfall countermeasure work on embankments for improving seismic resistance			Cost-effective technology for improving embankment resistance to earthquakes and rainfall resilience		• Design and reinforcement manual

Figure 3-2. Enhancing resilience against intensifying natural disasters

2) Advancing automatic train operation

Objective: RTRI will enable widespread adoption of automated systems by lowering costs through the development of elemental technologies for train control and forward recognition, while supporting the establishment of technical standards needed for social implementation.

Overview: The Institute will develop cost-effective GOA 2.5 automatic train operation systems that do not require large capital investments and are suitable for regional railways, utilizing technologies such as ATS-Sx, global navigation satellite system (GNSS), and inertial sensors for absolute position detection. RTRI will also systematize the functional requirements for ensuring the comprehensive safety requirement of GOA3 and higher, and develop evaluation methods. The Institute will also develop forward recognition technology that will serve as the foundation technology for automatic operation systems utilizing existing railway equipment (Figure 3-3).



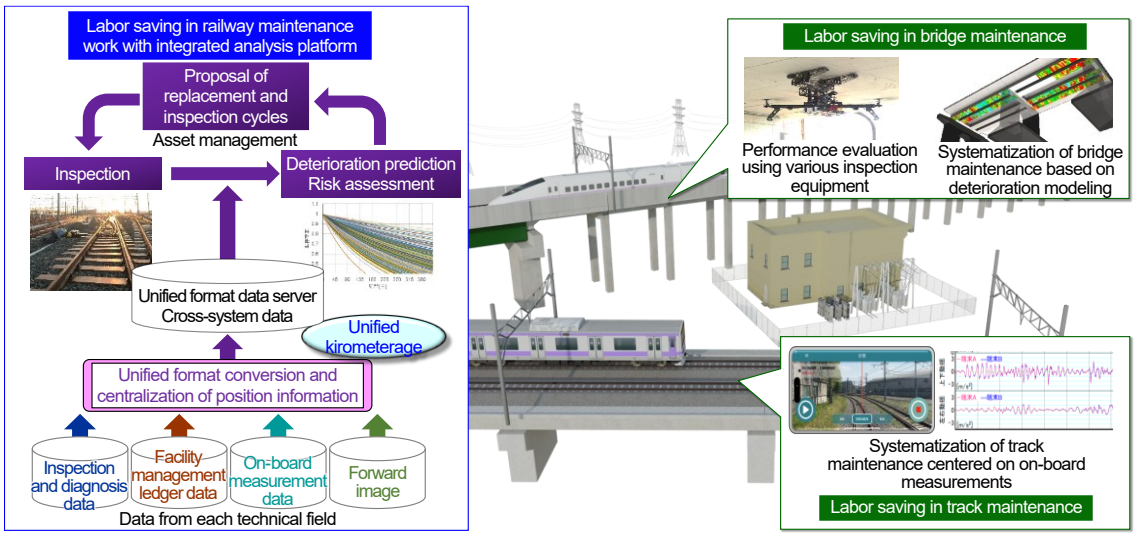
Topic	2025	2026	2027	2028	2029	Expected result
Development of low-cost GOA 2.5 automatic train operation systems	Absolute position detection technology for low-cost GOA 2.5 automatic train operation systems →		Development of low-cost GOA 2.5 automatic train operation systems			• Low-cost GOA 2.5 automatic 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. Advancing automatic train operation

3) Labor saving in maintenance

Objective: RTRI will establish maintenance practices that enable safe, stable operation and labor efficiency by developing innovative methodologies, elemental technologies, and supporting the establishment of technical standards necessary for social implementation.

Overview: The Institute 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 optimized methods for scheduling component replacement and inspection cycles. RTRI will also systematize track maintenance based primarily on on-board measurements and bridge maintenance guided by the latest inspection equipment and deterioration modeling (Figure 3-4).



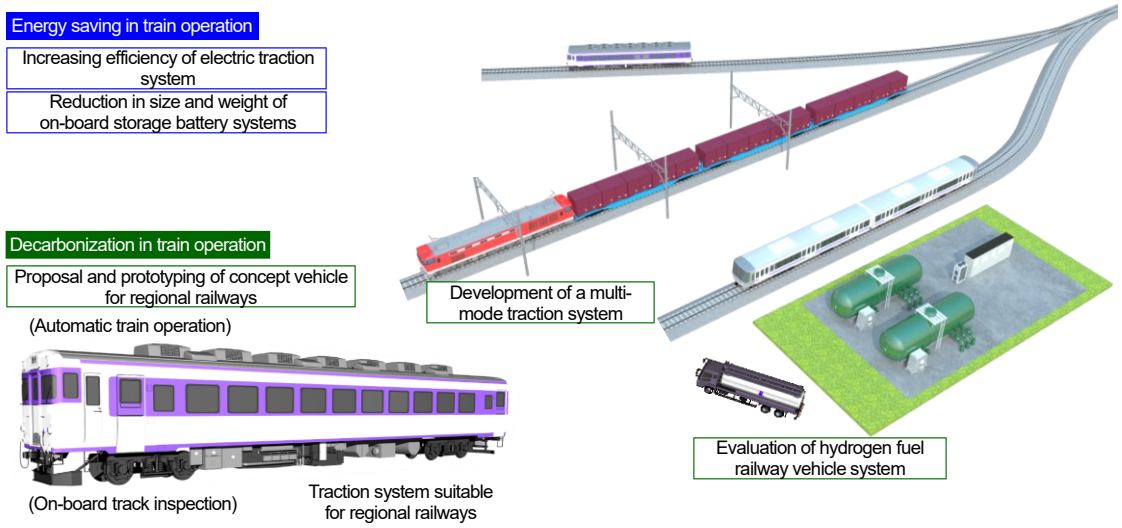
Topic	2025	2026	2027	2028	2029	Expected result
Labor saving in railway maintenance work with integrated analysis platform	Fact-finding surveys on the actual conditions of various maintenance operations on railway facilities and consideration of labor-saving measures					• Support for examination of technical 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 saving 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 saving in bridge maintenance	Evaluation of deformation around bridge boundaries based on on-board measurements					• Database for bridge maintenance, deterioration modeling 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 modeling			

Figure 3-4. Labor saving in maintenance

4) Decarbonizing railway systems

Objective: RTRI will develop and support the social implementation of fundamental technologies that reduce CO_2 emissions, particularly from running trains, for achieving carbon neutrality by 2050 and a decarbonized society.

Overview: The Institute will develop fundamental technologies to achieve further energy savings and decarbonization in train operations by improving electric traction systems, including diesel-electric multiple units, by reduce in 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 vehicles system (Figure 3-5).

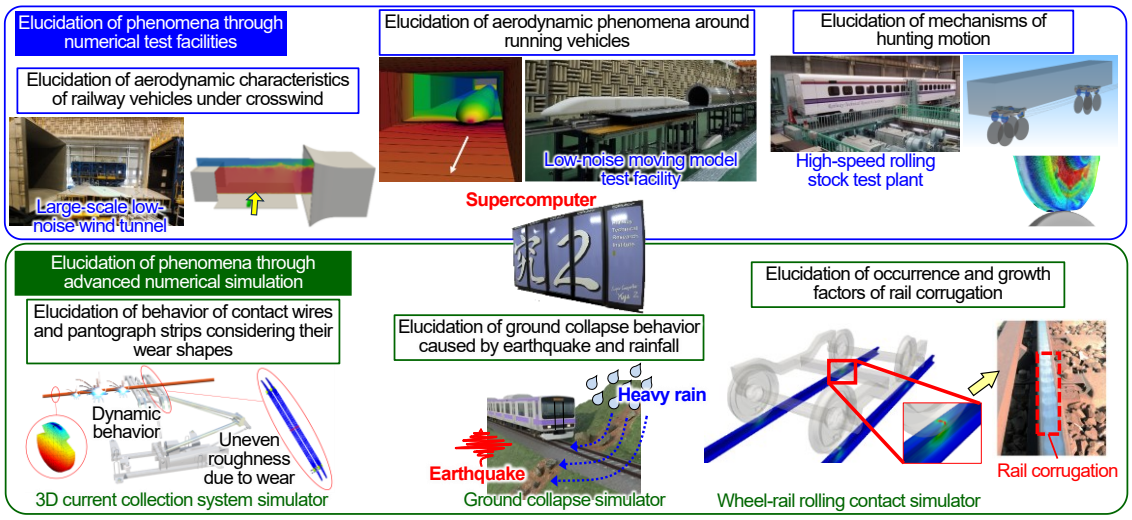


Topic	2025	2026	2027	2028	2029	Expected result
Energy saving in train operation	Development of lightweight, highly efficient power generation system for diesel-electric multiple units					• Highly efficient traction system • Reduction in size and weight of on-board storage battery systems
	Combined control 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. Decarbonizing railway systems

5) Elucidating railway-specific phenomena through simulation

Objective: RTRI will clarify the mechanisms underlying railway-specific phenomena by advancing core technologies, such as numerical testing facilities and numerical simulations, that will drive the pursuit of the essence of railway issues and their solutions.
Overview: RTRI will investigate the aerodynamic characteristics of railway vehicles under crosswind, the aerodynamic phenomena around running vehicles, and mechanisms of hunting motion using numerical test facilities simulating RTRI's distinctive physical testing facilities. Additionally, RTRI will employ advanced numerical simulations using coupled analysis and AI to elucidate railway-specific phenomena difficult to reproduce through measurements or experiments, such as the 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. Elucidating railway-specific phenomena through simulation

(4) Development of practical technologies

RTRI will address technical challenges in railways to provide prompt and accurate practical solutions (Table 3-1).

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

Upon receiving specific requests, RTRI will promptly deliver technical solutions that resolve various field issues while considering the circumstances of each commercial line and maintenance operation. RTRI will particularly promote practical applications by allocating resources intensively 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 thoroughly understanding the demand of railway companies and using the facilities distinctive to RTRI, analytic technologies, 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.

3) Government-commissioned R&D

RTRI will efficiently promote R&D outcome implementation and dissemination by leveraging government commissions and national subsidy programs.

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

Improvement of safety	○Disaster-resistant systems for 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 ○Safety enhancement of train operations ・Training programs to maintain or improve cognitive functions in train drivers
Improvement of productivity	○Labor saving and cost saving in maintenance ・Labor saving in wheel slip control adjustments for electric locomotives ・Automating tunnel deterioration diagnosis ・Automating gas pressure welding for rails ○Labor and cost saving in construction ・ICT-based quality control methods for railway embankments during construction
Harmony with the environment	○Decarbonization ・Energy saving in train operations using driving advisory systems ・Superconducting power feeding systems for long-distance transmission ○Improving the environment inside trains, at stations, and along railway lines ・Developing partially inclined sound-absorbing noise barriers for large-scale renovations
Improvement of convenience	○High speed ・Estimating the spatial distribution of micro-pressure waves around tunnel portals ○Improving railway services ・Applying next-generation tilt control systems to existing tilting trains ・Method for evaluating station facilities based on passenger distribution estimation ・Evaluating facility improvement effects based on train delay factor analysis

(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, RTRI will proactively promote challenging R&D projects with significant impact potential on railway operations when their results lead to practical applications, and utilize advanced numerical simulation technologies and RTRI's innovative test facilities.

For R&D projects concerning “elucidation and prediction of phenomena,” RTRI will conduct basic research on forecasting natural disasters and enhancing the resilience of railway systems, improving the running safety of train sets, supporting safety management based on human factors, and increasing Shinkansen train speeds compatible with the wayside environment. Regarding “detection and assessment” projects, RTRI will aim to improve detection technologies and enhance efficiency and automation in assessment processes. For projects classified under “new technologies and materials,” RTRI will establish foundational technologies such as digitalization and decarbonization, and material utilization technologies suited for a circular society (Table 3-2).

For research projects with substantial societal impact beyond railways, the Institute will actively utilize external research grant programs.

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

Elucidation and prediction of phenomena	○Forecasting natural disasters and enhancing railway system resilience ・Health assessment of scoured bridge foundations ・Modeling of railway structure groups for earthquake disaster simulations ○Improving the running safety of train sets ・Elucidating train set deceleration and deformation during collisions and damage mitigation guidelines ・Analyzing train set behavior during earthquakes, focusing on on-rail safety limits ○Supporting safety management based on human factors ・Risk perception and psychological assessment of pedestrians at level crossings ・Predicting passenger behavior patterns during train evacuation ○Increasing Shinkansen train speeds compatible with the wayside environment ・Methods for estimation of sound source contribution of aerodynamic noise from the bogie at wayside measurement points ・Methods for isolating lower-part noise based on estimation of the aerodynamic frequency spectra
Detection and assessment	○Detection improvement ・Detection methods for anomalous lift force in pantographs ・Verifying rail axial force measurement based on rail magnetic properties ○Efficiency enhancement and assessment automation ・AI-based automation of flaw evaluation in nondestructive testing of bogie parts ・Imaging-based detection of fatigued overhead contact line metal fittings
New technologies and materials	○Foundational technologies such as for digitalization and decarbonization ・Evaluating AI decision errors impacting safety ・Developing high-accuracy 3D track space data using simple on-board devices ・Evaluating the performance of traction motors with magnetic wedges ○Materials for a circular society ・Recycling, reusing, and reducing railway materials ・Applying environmentally friendly raw materials to composite frictional materials

(6) Test facilities

1) Updating and introducing test facilities

RTRI will update the existing test facilities and improve their functionalities based on necessity and urgency. The Institute will also introduce new test facilities necessary for high-quality R&D activities.

2) Updating of supercomputers

RTRI will continue to maintain an advanced numerical computational environment by introducing a new supercomputer with the capability to perform advanced numerical testing and simulations to elucidate railway-specific phenomena.

3.1.2 Surveys

RTRI will collect and analyze information on mid- to long-term domestic and international trends in safety, environment, transportation economy, labor saving, and cutting-edge technologies related to decarbonization. The insights gained will inform R&D and be actively disseminated. The Institute will also conduct surveys to predict the future of railways and identify key technical issues for R&D.

3.1.3 Technical standards

In collaboration with the government and relevant organizations, RTRI will support the development of design, maintenance, and management standards focused on labor savings and efficiency in construction and maintenance. These efforts will address urgent challenges such as labor shortages and aging infrastructure. Regarding design standards, RTRI 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

RTRI will gather and archive railway technology information from Japan and overseas, disseminating it actively. Additionally, RTRI 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

RTRI will leverage e-books to improve the quality and timeliness of periodicals 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 widely. Systematic training programs covering a broad spectrum of railway technologies—from introductory to advanced levels—will be provided.

3.1.6 Diagnostic advisory

RTRI 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. RTRI 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

To maintain and invigorate Japanese railway technologies domestically and globally, RTRI will lead strategic international standardization activities for the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC). RTRI will promote the proposal of new standards in technical fields in which Japan have strengths, and incorporate Japanese design ideas and technologies into standards that are proposed by other countries. RTRI 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

RTRI will contribute to the development of human resources across Japan's railway industry by maintaining and improving the technical expertise of railway engineers through the Railway Design Engineer Examination and promoting an environment conducive to examination participation.

3.1.9 Railway Technology Promotion Center

Focusing on maintaining and improving technical capabilities, systematizing technologies, solving technical issues, and providing technical information, RTRI 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, RTRI 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. RTRI will also facilitate information sharing through research on topics highly relevant to railway companies.

3.1.10 Railway International Standards Center

With the aim of maintaining and invigorating Japanese railway technologies, RTRI 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 firms.

RTRI 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. RTRI will also increase awareness of the international standards among Japanese stakeholders and continue to foster human resources.

3.1.11 International activities

RTRI 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 boost RTRI's international profile.

By supporting overseas expansion and human resource development for railway operators and related companies, and deploying RTRI-developed technologies internationally, RTRI will foster greater confidence in Japanese railway technology and contribute to its global dissemination.

3.2 Revenue-generating projects

RTRI will pursue revenue-generating projects to commercialize R&D outcomes and drive their wide adoption. To this end, 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 Compliance promotion

RTRI will continue to promote compliance-related education and awareness, supporting activities such as the operation of internal control systems and internal audits.

4.1.2 Information management

RTRI will strengthen security measures, including those related to information access within the organization. Information management education will be implemented to guard against cyberattacks and other risks. The Institute will also advance the updating and migration of various core systems to cloud-based platforms.

4.2 Vibrant business management

4.2.1 Creating a vibrant workplace

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

The Institute 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

RTRI 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

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

RTRI will enhance the employees' capabilities through training and other means. In the R&D division, the Institute will actively facilitate personnel exchanges with railway companies and overseas research institutions to develop experts skilled in analyzing and solving core railway issues.

4.3 General facilities

RTRI will upgrade facilities to allow them to contribute to sustainable activities, continuing to introduce solar power generation and improving the living environment for employees through initiatives such as the renovation of aging accommodations.

4.4 Reconstruction of research buildings

The first phase of construction will involve new research building to be completed by FY2029. Timelines for the second and third phases will be considered in detail around FY2029.

4.5 Funding

RTRI expects to receive ordinary revenue from JR companies (contribution revenue), totaling 70 billion yen (an annual average of 14 billion yen) over the Master Plan period (Table 4). Budgets for each fiscal year will be formulated based on the progress of the Master Plan and expected ordinary revenue at that time.

Table 4. Key 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

*Approximately 85% of personnel expenses will be allocated from contribution revenue, with the remainder from business revenue and other sources.

5. Conclusion

Facing increasingly significant and complex challenges, such as social changes due to the pandemic, natural disasters, the pursuit of carbon neutrality, and labor shortages, RTRI will promote diverse activities, including R&D, to achieve a safe, secure, smart, environmentally friendly, and sustainable railway system.

The Institute will advance R&D by setting clear objectives and roadmaps for social implementation and will serve as a leader and driver of technological innovation in concert with railway companies and other organizations. RTRI will aim to sophisticate core R&D technologies, which will be the driving force for pursuing the essence of railway issues and solving them - such as advanced physical and simulation technologies and digital innovations - as well as to foster the creation of innovative technologies that generate industry-wide benefits.

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 commits to fully supporting the objectives 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