

Research and
DevelopmentManagement
Approach**Material Issues and Our Approach**

To ensure sustainable improvement in the enterprise value of the Kawasaki Group, the internal companies, business divisions and Corporate Technology Division work as a cohesive unit, concentrating technologies available within the Group and utilizing technological synergies to develop new products and new businesses with a competitive edge.

We also strive for balanced R&D through new product and new business development as well as activities geared toward such development in the future in each internal company in addition to nurturing and reinforcing the basic technologies needed to realize these new products and new businesses.

Engineers from the internal companies and business divisions and specialists in the Corporate Technology Division, who have expertise in various fields, form project teams to share issues and work together to develop new products and new businesses, seeking always to achieve the overall optimization of management resources. The Corporate Technology Division acts as an intermediary, facilitating access to the technological core competencies of each internal company so that they can be applied to products in other internal companies. This promotes the multifaceted expansion of technology and realizes major synergistic effects.

By thus combining the core technologies of the internal companies and business divisions and the basic technologies of the Corporate Technology Division, we will utilize matrix-based operations to create technological synergies throughout the Kawasaki Group and further raise enterprise value.

Focus Activities and Medium-term Targets● **Goals for Fiscal 2019–2021**

- Reinforce the competitiveness of existing products and businesses.
- Build a platform that will support groundbreaking innovation to create new value in response to rapid changes in society.
- Achieve process reforms by such means as strengthening system design and *monozukuri* manufacturing capabilities.
- Establish intellectual property action plans as part of business strategy and build a framework to allocate IP rights where needed or keep such property confidential in the form of internal expertise.
- Build a framework for carrying out IP rights infringement prevention checks through design reviews and other precautions taken at specific development stages.

Progress, Results, and Challenges● **Goals for Fiscal 2020****Research and Development**

- ¥53.5 billion in R&D expenses.
- Work to create new products and businesses with an eye to business style transformation by, for example, creating de-facto standards via market development and reinforcing service businesses.
- Conduct pilot demonstrations of a Japan-Australia supply chain aimed at quickly realizing a hydrogen-powered society.
- Work to increase process sophistication through digital transformation while coordinating with total quality management (TQM) promotion activities.

Intellectual Property

- Advance IP landscape analyses, mainly for the hydrogen project, as part of efforts to form a patent portfolio.
- Before commencing R&D, carry out comprehensive examinations of preceding patents to avoid infringement.
- Focus efforts on the hydrogen, industrial robot, and precision machinery fields.

● **Fiscal 2020 Results****Research and Development**

- ¥44.9 billion in R&D expenses.
- Worked to create de-facto standards via market development in hydrogen and other fields and to reinforce service businesses in such fields as energy, rolling stock, robots, and motorcycles.
- Carried out test docking of a liquefied hydrogen carrier at a receiving terminal and the technological demonstration of a dry low-NOx gas turbine powered only by hydrogen combustion.
- Worked to enhance process sophistication using such tools as digital design and digital twins.

- **Goals for Fiscal 2021**

- **Research and Development**

- ¥49.5 billion in R&D expenses.
 - Reinforce product innovation to accelerate efforts to solve social issues under Group Vision 2030.
 - Reinforce DX and other aspects of process innovation as well as future platform technologies with the aim of realizing a stable growth scenario.
 - Apply TQM to research and development activities.
 - Complete pilot demonstrations of a Japan-Australia supply chain and advance research and development aimed at commercialization in order to quickly realize a hydrogen-powered society as part of efforts toward decarbonization.

- **KPI**

- **Progress**

	(FY)	2016	2017	2018	2019	2020
R&D expenditures	Billion yen	43.6	45.4	48.7	52.6	44.9

- **Structure**

The internal companies carry out R&D in areas specific to their businesses, while the Corporate Technology Division handles forward-looking R&D on a Company-wide basis. The internal companies and Corporate Technology Division work together closely on each project.

In addition, the entire Company works as one toward the realization of Group Vision 2030.

The Corporate Technology Division comprises the Corporate Technology Planning Center, Technical Institute, System Technology Development Center, Manufacturing Improvement Center, IT Strategy Planning Center, Administration Department, and TQM Department. Working together with the Head Office Presidential Project Management Division and Hydrogen Strategy Division, these bodies collaborate to advance R&D.

- **Responsible Officer**

Hiroshi Nakatani, Director, Managing Executive Officer, General Manager of Corporate Technology Division

- **Responsible Executive Organ and/or Committee**

The internal companies and the Corporate Technology Division meet regularly to share information about the market environment and business strategy and form consensus regarding development themes.

They also regularly take steps to concentrate technologies from across the Company to plan and follow up on important Company-wide R&D, facilitate the horizontal exchange and sharing of technologies, and promote synergy.

Research and
Development

Performance Data

R&D Expenditures (consolidated global)

	(FY)	2016	2017	2018	2019	2020
Total	Billion yen	43.6	45.4	48.7	52.6	44.9
Breakdown by segment						
Ship & Offshore Structure		0.8	0.8	1.1	0.9	0.8
Rolling Stock		0.8	0.8	0.8	0.6	0.8
Aerospace Systems		3.8	4.0	6.1	6.9	5.6
Gas Turbine & Machinery		3.9	3.8	–	–	–
Energy System & Plant Engineering		1.3	1.4	3.9	4.1	4.0
Motorcycle & Engine		14.3	15.8	15.6	16.0	15.1
Precision Machinery & Robot		5.3	5.4	6.2	5.9	6.2
Head Office, other		13.0	13.0	14.6	17.8	12.2
Percentage of sales	%	2.9	2.9	3.1	3.2	3.0
Number of employees engaged in R&D	Persons	1,868	1,888	1,941	1,916	1,956

Note: In April 2018, the former Aerospace Company and the jet engine business of the former Gas Turbine & Machinery Company were integrated into the newly established Aerospace Systems Company. The former Plant & Infrastructure Company and the energy and marine-related businesses of the former Gas Turbine & Machinery Company were integrated into the newly established Energy System & Plant Engineering Company. In addition, the former Precision Machinery Company was renamed the Precision Machinery & Robot Company.

Open Innovation**Open Innovation Policy**

In addition to leveraging the technological synergies that come from bringing our technologies together, we also work with outsourcers to introduce state-of-the-art technologies in an efficient manner. By making use of outside resources, not simply sticking to in-house innovation, we are able to provide solutions to social issues as well as create value that we would not be able to offer singlehandedly or at least not without overly large expenditures of cost and time.

Initiative in Open Innovation**Maritime and Port Authority of Singapore Chooses Consortium That Includes Kawasaki for Ship Parts 3D Printing Project**

A consortium that includes Kawasaki has been selected by the Maritime and Port Authority of Singapore to participate in a ship parts 3D printing project.

Through the Business Idea Challenge in-house idea submission framework, Kawasaki is pursuing a new approach that involves digitalizing spare ship parts and using 3D printers at ports to print said parts. This will enhance spare parts availability in times of emergency and maximize safe ship operating times.

The consortium is led by Wilhelmsen, a leading global maritime company, and includes marine equipment manufacturers Kawasaki, Wärtsila, and Hamworthy Pumps; maritime classification society DNV (formerly DNV GL); technology partners thyssenkrupp, Ivaldi Group, and Tytus3D; and forward-looking end users OSM, Gearbulk, Thome Group, Berge Bulk, Wilhelmsen Ship Management, BW Group, Executive Group, Carnival Maritime, and Yinson.

The Maritime and Port Authority of Singapore is advancing this 3D printing project to promote the digitalization and additive manufacturing of ships and ship parts. The consortium that includes Kawasaki is one of the 11 consortiums under the project that are equipping Singapore-registered vessels with 3D printed parts to verify their applicability. These tests are planned to be carried out by the first quarter of 2022. The consortium to which Kawasaki belongs will handle 10 of a total 26 part types to be tested.



Maritime and Port Authority of Singapore Chooses Consortium That Includes Kawasaki for Ship Parts 3D Printing Project
(December 16, 2020 Kawasaki News Release) (Japanese language only)
https://www.khi.co.jp/pressrelease/detail/20201216_1.html

New Product and Business Development

Key new products and businesses that were in development or for which development was completed in fiscal 2020 are as follows.

● **Aerospace Systems**

- New helicopter model H145/BK117 D-3



H145/BK117 D-3

● **Energy System & Plant Engineering**

- KG-18-T 100 MW-class combined cycle power plant
- New gas engine model with 51.0% electric efficiency
- Hydrogen liquefier



KG-18-T 100 MW-class combined cycle power plant



Kawasaki Green Gas Engine KG-18-T



Hydrogen liquefier used for demonstration operation

● **Precision Machinery & Robot**

- Automated PCR testing system
- Robotic assisted surgery system



Exterior of the automated PCR testing system



Inside the automated PCR testing system



hinotori™ robotic assisted surgery system

● **Transportation**

- Kawasaki-MAN B&W 7S60ME-C10.5-LGIP LPG dual-fuel system marine engine
- TERYX KRX 1000 eS off-road four-wheeler
- Rolling stock for the Dhaka Metro MRT Line-6 in Bangladesh



Kawasaki-MAN B&W 7S60ME-C10.5-LGIP



TERYX KRX 1000eS



Rolling stock for the Dhaka Metro MRT Line-6 in Bangladesh

Process Innovation

- Improved plant-level production processes using value stream mapping (VSM).
- Promoted the use of the Kawasaki Production System (KPS), most notably with systems for providing work instructions and collecting performance data using ICT, including tablet computers and cloud technologies.
- Utilized next-generation work instruction systems that leverage projection mapping and other XR technologies.

Effects of Process Innovation

By adopting a system for providing work instructions and collecting performance data using tablet computers in assembly processes, we achieved a 30% lead time reduction.

Environmental Innovation

At Kawasaki, we have defined a set of in-house criteria to improve the environmental performance of our products through energy and resource conservation and to reduce our environmental footprint by reducing the amount of industrial waste produced and chemical substances used in our production processes. Products that meet these criteria are registered as Kawasaki-brand Green Products.

Kawasaki-brand Green Products are marked with an environmental label that shows the product's environmental advantages as one way to communicate our efforts in this area to our customers and other stakeholders. In 2020, 10 products were newly registered, and the registrations of products for which the three-year registration limit expired were renewed, bringing the total number of registered Kawasaki-brand Green Products to 61.

Effects of Environmental Innovation (non-consolidated)

	(FY)	2016	2017	2018	2019	2020
CO ₂ emission reduction through product-based contributions*	kt-CO ₂	900	22,920	29,130	23,140	24,150

* The calculation method was revised in fiscal 2017 to one which uses a flow-based method where the expected life of a product launched during this fiscal year is used as the evaluation period for calculating the difference in CO₂ emissions between our products and standard grade products in the industry over this period of usage.



Kawasaki-brand Green Products

https://global.kawasaki.com/en/corp/sustainability/green_products/index.html

Intellectual Property Management

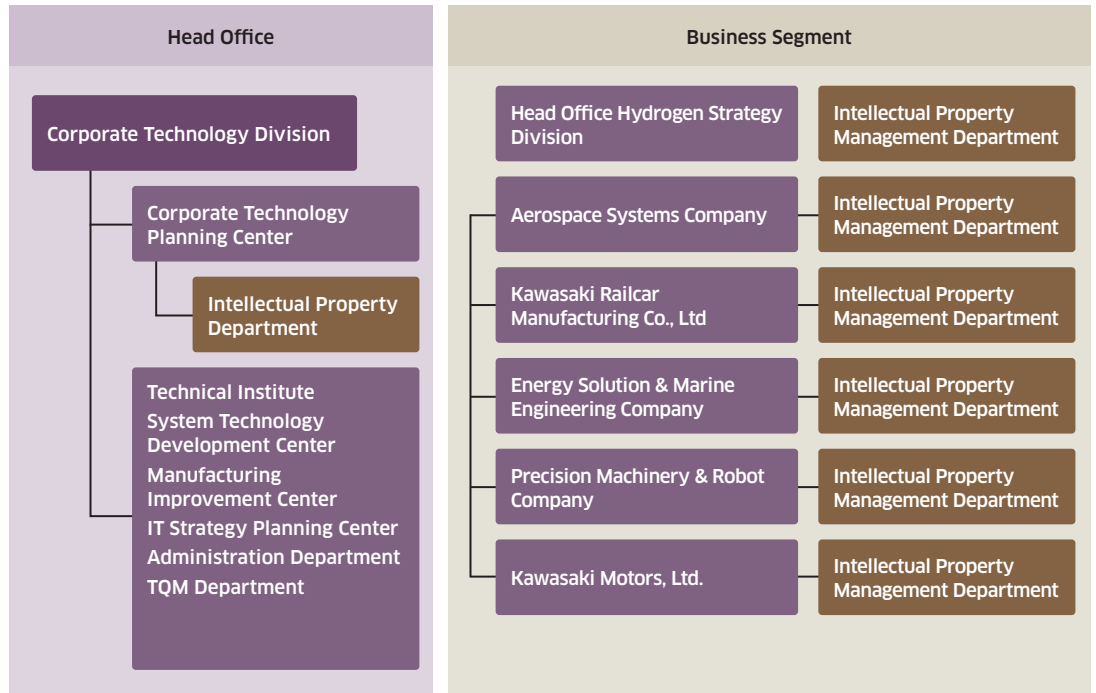
Principles of Intellectual Property Management

To survive amid intense global competition, we must raise enterprise value by developing business pursuits that leverage our core competence. Toward this end, we rely on intellectual property, which is a vital management resource, and the key to securing and successfully applying this corporate asset is to undertake activities from a three-point perspective that adds intellectual property to business and R&D as a third component of our core competence.

Structure

To promote strategic intellectual property activities, we maintain a structure whereby the Intellectual Property Department in the Corporate Technology Planning Center of the Corporate Technology Division drafts and implements corporate measures and works with the intellectual property management departments of the internal companies to carry out intellectual property activities in line with each segment's business.

Intellectual Property Activities Structure



● **Responsible Officer**

Sukeyuki Namiki, Representative Director, Vice President and Senior Executive Officer

● **Responsible Executive Organ and/or Committee**

The Intellectual Property Committee formulates operating and basic policies regarding Company-wide intellectual property activities.

Strategic Intellectual Property Activities

By taking part in business planning from the earliest stages, providing information useful for developing a business strategy that leverages IP information, making suggestions regarding strategy, and developing an IP strategy that will strengthen the business strategy, we strive to implement IP activities in coordination with management and the business strategy.

Countermeasures to the Improper Use of Kawasaki Group Brands

We have in place appropriate countermeasures based on trademark and other rights for dealing with commercial activities that make unauthorized use of Kawasaki Group brands, the manufacture and sale of counterfeit products, the use and application for registration of trademarks similar to those of the Kawasaki Group, and related issues. By further developing such activities, we will protect and further enhance market confidence in our brands.

Invention Reward System

Based on the Patent Law regulation pertaining to inventions by employees, Kawasaki has established a provision in its internal rules regarding inventions by employees to reward employees at specific milestones, such as the filing of a patent application (application reward), patent registration (registration reward), and practical application (performance-based reward).

The Company faithfully adheres to this provision. In addition, the same reward system is applied even when the invention is not made public for strategic reasons. Of note, the performance-based reward is fairly awarded after duly taking into consideration how the Company has benefited from the invention, using an evaluation standard based on comparisons with other companies in the same industry as well as trends in society.

Employee Training

Intellectual property is an important management resource for increasing our business competitiveness. As such, Kawasaki's basic policy is to secure and effectively utilize its own intellectual property while respecting the valid intellectual property rights of third parties. In line with this policy, we carry out grade-specific activities to foster correct awareness of intellectual property.