

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 competences 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 the MTBP 2019**

- Reinforce the competitiveness of existing products and businesses.
- Build a platform that will support groundbreaking innovation that creates 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 2019**

- ¥60.0 billion in R&D expenses
- Work to create new products and business that leverage digital innovation. In particular, focus efforts on service businesses that utilize ICT/IoT.
- Work to build a supply chain for hydrogen, a form of clean energy.
- Work toward process innovation using digital technologies.
- Acquire strategic intellectual property, mainly in robotics.
- Before commencing R&D, carry out comprehensive examinations of preceding patents to avoid infringement.

● **Fiscal 2019 Results****Research and Development**

- ¥52.6 billion in R&D expenses
- Formed operational tie-up aimed at quickly developing AI and IoT services in the Precision Machinery & Robot segment
- Carried out development aimed at demonstrations of the hydrogen supply chain, including that of the world's first liquefied hydrogen carrier
- Completed design aimed at introducing operational applications to increase the efficiency of airplane design and manufacturing processes

**Intellectual Property**

- Conducted the following strategic initiatives in coordination with management and business strategy
  - (1) Carried out comprehensive IP landscape analyses, covering IP and markets, for the hydrogen project, hybrid motorcycles, *Rexpeller*<sup>1</sup> condition monitoring system and U-KACC<sup>2</sup> on-site power generation
    1. *Rexpeller*: Kawasaki's azimuth thruster
    2. U-KACC: Kawasaki's U-KACC Boiler (short for Upgraded Kawasaki Advanced Clean Combustion)

(2) Grasped key points related to differentiation and development by participating in Robot Business Division development meetings

- Focused efforts on the hydrogen and industrial robot fields

● **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 defacto 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.

**KPI**

● **Progress**

	(FY)	2015	2016	2017	2018	2019
R&D expenditures	Billion yen	43.6	43.6	45.4	48.7	52.6

**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. In addition, the internal companies and Corporate Technology Division work together closely on projects.

The Corporate Technology Division comprises the Corporate Technology Planning Center, Technical Institute, System Technology Development Center, Hydrogen Project Development Center, Manufacturing Improvement Center, IT Strategy Planning Center, Administration Department and TQM Department. All of these collaborate to advance R&D.

● **Responsible Officer**

Hiroshi Nakatani, 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)	2015	2016	2017	2018	2019
<b>Total</b>	Billion yen	43.6	43.6	45.4	48.7	52.6
<b>Breakdown by segment</b>						
Ship & Offshore Structure		0.8	0.8	0.8	1.1	0.9
Rolling Stock		1.2	0.8	0.8	0.8	0.6
Aerospace Systems		4.3	3.8	4.0	6.1	6.9
Gas Turbine & Machinery		4.1	3.9	3.8	–	–
Energy System & Plant Engineering		1.1	1.3	1.4	3.9	4.1
Motorcycle & Engine		13.3	14.3	15.8	15.6	16.0
Precision Machinery & Robot		6.1	5.3	5.4	6.2	5.9
Head Office, other		12.4	13.0	13.0	14.6	17.8
<b>Percentage of sales</b>	%	2.8	2.9	2.9	3.1	3.2
<b>Number of employees engaged in R&amp;D</b>	Persons	1,791	1,868	1,888	1,941	1,916

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 to 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****Partnership with U.S.-Based Artificial Intelligence (AI) Startup**

Kawasaki formed a partnership with OSARO Inc., a U.S.-based startup boasting excellent AI software development technologies. By actively promoting open innovation to gain access to superior knowledge, we are accelerating product and service development in the rapidly developing field of AI technology.

San Francisco-based OSARO was founded in 2015 with a focus on the development and sale of autonomous control software for industrial robots. The company has particularly robust expertise in the area of AI applications for image recognition and motion control.

Kawasaki previously engaged in joint proof-of-concept testing with OSARO to explore the possibilities of applying OSARO-developed AI to Kawasaki robots. Under the new partnership, we will ramp up joint development. At the same time, Kawasaki hopes to build expertise in AI applications for environmental recognition, operation and movement path planning, and operation determination technologies in order to advance the automation and autonomization of a wide range of Kawasaki products, such as those in the transport system and energy fields.

As Japan faces increasing labor shortages due to demographic graying and declining birth rates and communications technology continues to develop, demand for products and services utilizing AI, ICT and IoT is growing. To address these needs, Kawasaki has been proactively developing many new products and services, such as operational support systems for waste-to-energy plants utilizing AI.

Moving forward, Kawasaki will reinforce its development framework by further promoting open innovation in order to continue providing new value to society.



**Kawasaki Becomes a Preferred Partner of US AI Startup (October 7, 2019 Kawasaki press release)**  
[https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20191007\\_3958](https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20191007_3958)

**New Product and Business Development**

Key new products and businesses that were in development or for which development was completed in fiscal 2019 are as follows.

● **Aerospace Systems**

- Fan Drive Gear System for the PW1500G\*
  - \* PW1500G: A jet engine for the French company Airbus's A220 regional aircraft



Fan Drive Gear System

● **Energy System & Plant Engineering**

- World's largest gas-to-gasoline (GTG) plant
- New type of hydrogen liquefier



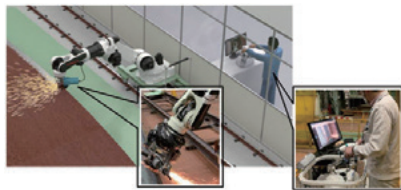
Gas-to-gasoline (GTG) plant



Liquefaction system using the new type of hydrogen liquefier

● **Precision Machinery & Robot**

- Successor®-G remotely-operated robotic system for grinding, deburring and surface finishing



Grinding operations using the Successor®-G

● **Transportation**

- Liquefied hydrogen carrier
- Z900 Supernaked
- TERYX KRX 1000 Trail Adventure Side x Side



Installation of liquefied hydrogen tank for marine transport



Z900 Supernaked



TERYX KRX 1000 Trail Adventure Side x Side

**Process Innovation**

Kawasaki uses a proprietary production system, the Kawasaki Production System (KPS) for its mass-produced products. The KPS was developed by Kawasaki based on the production system of Toyota Motor Corporation, known as the Toyota Production System (TPS). The system is aimed at thoroughly eliminating waste in production processes.

**Effects of Process Innovation**

Using IT to provide detailed instructions for the work of each individual and analyze accumulated performance data, Kawasaki is expanding the scope of the KPS to include custom order products, as well. We are leveraging digital innovation to innovate development and design processes in an effort to enhance design and production efficiency.

## 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 2019, eight 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 54.

### Effects of Environmental Innovation (non-consolidated)

	(FY)	2015	2016	2017	2018	2019
CO <sub>2</sub> emission reduction through product-based contributions	kt-CO <sub>2</sub>	750	900	22,920	29,130	23,140

\* 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 CO<sub>2</sub> 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](https://global.kawasaki.com/en/corp/sustainability/green_products/index.html)

## Intellectual Property Management

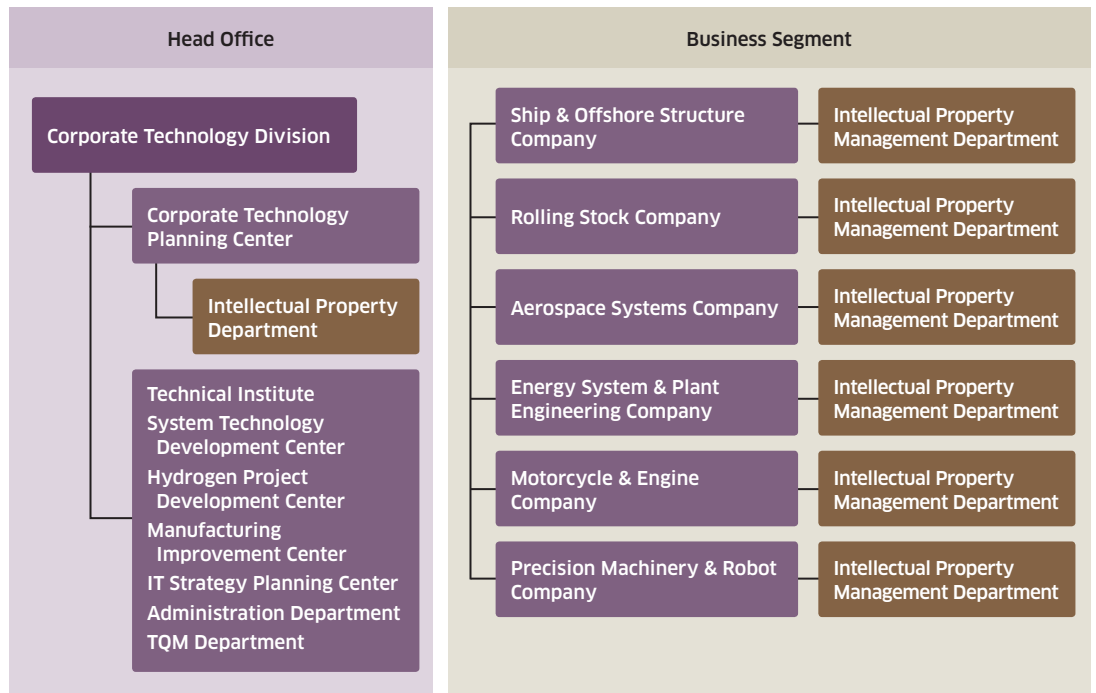
### Principles of Intellectual Property Management

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 provide support in line with each segment's business activities.

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.