Scope

Kawasaki Heavy Industries Quarterly Newsletter

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About the Cover
The front section of the new Series E6 that debuted on the Akita Shinkansen line. Check out *Frontline* for a more in-depth look.

KAWASAKI HEAVY INDUSTRIES, LTD.

Scope

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Series E6 Debuts on the Akita Shinkansen Line

The Series E6 logo by the design section of Kawasaki's Rolling Stock Company. The red streaks express the wind at 320 km/h, and the silver loop the trajectory that leads from the present to the future.

The first Shinkansen to don a crimson-red top, the Series E6 debuted this spring on the Akita Shinkansen Line.

Kawasaki's Rolling Stock Company design section, working under the supervision of renowned industrial designer Ken Okuyama, proposed ideas for the exterior and interior designs of the Series E6 in a competition hosted by East Japan Railway Co. (JR East). Kawasaki has played a central role in the design and manufacture of numerous Shinkansens in the past, but this is the first time ever that the original design proposed by a single manufacturer for both the interior and exterior of a Shinkansen has been fully adopted.

Designing for a Memorable Trip

The design competition, the first to be held in Japan for a Shinkansen, had a very simple theme: "Your concept of comfort and relaxation." After refining its initial designs to incorporate Okuyama's suggestions, Kawasaki won the competition.

The Series E6 itself was designed to showcase "the finest workmanship and optimal design for a memorable trip." This reflects a shift in the Japanese preference from mass production and mass consumption to careful workmanship, a spirit of thrift and economy, and symbiosis with the environment, as well as from material abundance (luxury, splendor) to spiritual enrichment (comfort, reliability, safety).

Commitment to the Finest Details

Specific methods were discussed to give concrete shape to this design concept.

Attention was paid to the finest details to create an interior environment that provides superior comfort to passengers through outstanding workmanship, optimal design, and carefully thought-out arrangements of materials and facilities. High-quality materials were used where needed, and places where passengers would directly touch the materials were carefully designed and fabricated to be pleasant to the touch. To ensure a pleasurable ride, individual seats were fully equipped with such amenities as a headrest, table, drink holder and a handle near the aisle to hold onto when walking through the train.

As for the exterior, the goal was to create a distinctive design that embodied an image that would stay in people's minds. The design team considered designs that would heighten the excitement of travel when the train arrives at the platform, and also embody the sense of speed, safety and superior quality associated with Shinkansens. Care was also taken so that the exterior color would not clash with that of the Series E5, with which the Series E6 would link for the leg between Tokyo and Morioka on the Tohoku Shinkansen Line.

Inspired by the Culture and Tradition of Akita

For the exterior color, which is the first part of the train a passenger will see, crimson-red was used on the top of the cars to express the elegance of the history and culture of Akita. It is a bold color never before used on a Shinkansen. The *hiun* white

(Left) The refined and stylish colors of the first-class Green Car seats. (Above) The regular-class cabin, meant to remind passengers of the harvest season. The seats were designed and manufactured by Kawasaki Rolling Stock Component Co., Ltd., headquartered within the Hyogo Works.

body and silver striping make a powerful combination that creates the very image of high speed.

Popular associations with Akita also provided inspiration for the interior design. Yellow represents the harvest season, reddish brown the Kanto Festival, the most widely known festival in Akita, beige the Akita cedar, and blue Lake Tazawa, a popular tourist destination.

The vestibule leading to the first-class Green Car cabin is brown, beige and blue, effectively arranged so as to create a sophisticated atmosphere. The amount of attention paid to passenger comfort is evidenced by the smallest details. These include the use of curved walls to facilitate movement between cars, decorative floor lighting, and optimally placed handrails leading passengers to the cabin. The seat coverings are brown and blue, creating calm and sophistication, and each seat has an electric leg-rest and a power outlet.

The regular-class cabin was inspired by the traditional rice culture of Akita. The gold-colored seats represent the ears of rice at harvest, while the aisle, in brown, is likened to a footpath between rice fields. The space is meant to be uplifting and to remind the passengers of nature's bounty.

● No Compromise, Even in the Smallest of Details

This type of design work is rooted in a firmly established concept and a deep commitment even to the most inconspicuous of details. Take the air conditioning vents, for instance. Most passengers would not even notice them, but that is exactly what the designers aimed for. They redesigned them over and over again to arrive at the optimal form that would make them the least obtrusive and unnoticeable. These efforts were rewarded with the full support of JR East.

The process of developing a car that was faithful to the design entailed overcoming numerous difficulties in reconciling it to the functions it was intended to serve. The experience of making refinements provided a valuable opportunity to engage in a deeper level of discussion. It also allowed the engineers to work in tandem with the designers, so that the resulting product satisfied both the design and functional requirements.

Manufacturing the lead car. The elegant, streamlined shape of the nose is handcrafted by skilled workers, an exquisite blend of cutting-edge technology and superb craftsmanship.

The Series E6 will be linked with the E5 for the leg between Tokyo and Morioka. Care was taken with regard to the color so the images of the two trains would not clash.

● Two New Refinements for Passenger Comfort

Kawasaki also designed and manufactured the lead car of the Series E6, which employs a distinctive 13 m long nose.

The elongated nose is shaped to reduce the noise, or tunnel boom, that high-speed trains create upon entering and exiting tunnels.

Like the Series E5, all Series E6 cars have full active suspension and body tilt control. The full active suspension detects and reduces car body vibration, while the body tilt control system increases passenger comfort by reducing the centrifugal force felt when the train takes a curve, as well as enabling the navigation of curves at higher speeds. Along with these features for increasing passenger comfort during operation, a full wraparound inter-car fairing was installed to reduce aerodynamic noise.

● Leveraging Kawasaki's Experience and Expertise

Kawasaki has extensive experience in manufacturing rolling stock, and it made full use of this experience and its wealth of expertise in developing the Series E6.

In the winter, the Akita Shinkansen inevitably must travel through snow, which sticks to the undercarriage and can hinder the train's operation. Kawasaki's solution was to develop a heater that attaches to the undercarriage and melts the snow.

The train is also designed for accessibility. This includes large-size Western toilets that can accommodate electric wheelchairs, and toilets accessible for passengers with special needs.

For security, there are emergency intercom systems in passenger cabins and restrooms, as well as security cameras in the cabins and vestibule areas.

To light the doorways and aisles, the train uses energy-efficient LEDs for an environmentally friendly operation.

The Series E6 was introduced on the Akita Shinkansen Line in March 2013. It will initially operate on the leg between Tokyo and Morioka at a maximum speed of 300 km/h, and at the end of fiscal 2013, it is scheduled to begin operating at 320 km/h, which will be the highest speed in Japan. By delivering world-class facilities and meeting global standards that make it fit for immediate service on European tracks, the Series E6 is taking passengers for an exhilarating ride.

Design that is Modern, Simple and Timeless: An Interview with Ken Okuyama, Design Supervisor for the Series E6

I have always had an interest in train design, and I have actually designed cars for a number of European companies. Compared to the European trains I've worked on, the technological standard of the Japanese Shinkansen is amazingly high. The elongated nose for reducing tunnel boom, the craftsmanship that went into creating the elegant, streamlined shape and the engineering skills required to flexibly process millimeter-thick aluminum sheets to fabricate the car body — these are only a few examples of the countless improvements the Shinkansen incorporates. When I visited Kawasaki's Hyogo Works, I had a chance to meet the people who were actually making these trains. And I was just impressed by how passionate they all were. The people in the design section were also very passionate, and we had many productive discussions.

When we chose the color for the exterior of the Series E6, we were careful not to make the red too gaudy. We arrived at the crimson-red after countless trial and error, and I believe it is very close to the ideal color. But it was still a bold proposition given what we are used to seeing with Shinkansens. So I am very grateful to the people at JR East for choosing our design. As for the interior, we tried to express the culture of Akita by making it feel as if your trip to Akita begins the moment you step inside the train.

I always say that a designer is like a chef. Your skills are measured by how well you express through design the state-of-the-art technology that went into the making of the Shinkansen. The goal is a modern, simple yet timeless design that is not too flamboyant, not simplistic or myopic, and that will never go stale.

Ken Okuyama

CEO, Ken Okuyama Design (founded 2006)

Served as Chief Designer for General Motors, Senior Designer for Porsche and Design Director for Pininfarina. Produced numerous industrial designs, including automobiles and motorcycles for Enzo Ferrari and Maserati Quattroporte, trains, aircraft, ships, furniture, robots and theme parks.

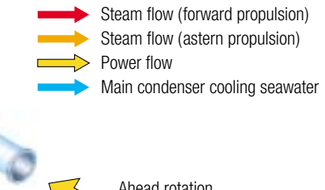
Features of the Kawasaki URA Reheat Steam Turbine: Powering LNG Carriers on Less Fuel

First LNG Carrier Powered by New URA Reheat Steam Turbine

The *Energy Horizon*, built at the Sakaide Shipyard, is the first carrier in a line of 177,000 m³ LNG carriers that Kawasaki has developed as the largest class of its next-generation general-purpose vessels.

It is also the first LNG carrier to be powered by the Kawasaki URA Reheat Steam Turbine Plant, a new type of propulsion plant incorporating Kawasaki's URA reheat steam turbine.

This next-generation LNG carrier achieves a 15% increase in fuel efficiency over existing vessels, as a result of the use of the Kawasaki URA Plant as well as improved propulsion performance due to an optimized hull form.



Steam flow (forward propulsion)
Steam flow (astern propulsion)
Power flow
Main condenser cooling seawater

LNG Carriers and Steam Turbines
The cargo tanks of LNG carriers are covered with an overlay of high-performance insulation panels (Kawasaki Panel System). Still, a small amount of boil-off loss is unavoidable due to the extremely low temperature (-162°C) at which LNG is stored. To make effective use of the boil-off gas, the steam turbine boiler plant has been adopted in the carrier.This plant burns gas to generate steam, which is then used to drive the steam turbine and produce propulsion energy. If needed, the plant can also run on heavy oil or other types of fuel oil.

Reduction Gears
Reduction gears connected to the high/intermediate-pressure turbine and the low-pressure turbine reduce the turbine speed to 70-80 rpm. The rotational force generated by the turbines rotates the propeller attached to the aft side of the shaft connected to the reduction gears, thus producing the thrust that moves the ship forward.

Each of the gears is made of super-hard special alloy steel that is finished to high precision with ultrafine gear grinders. The eccentric shaft bearings ensure each of the gears is firmly engaged.

Boil-off gas

Reheat Boiler
The main boiler consists of two reheat boilers, each of which contains a superheater section and reheater section. The steam used in the high-pressure turbine is sent back to the boiler to be superheated again.

High/intermediate-pressure Turbine
The rotor of the intermediate-pressure and high-pressure turbine system features an integrated, compact structure as shown in the photograph, and is installed in the same turbine casing, which is divided horizontally.

How Reheating Works

1. The main steam produced in the two boilers is first sent on to power the high-pressure turbine.
2. The steam used to drive the high-pressure turbine is sent back to the boiler to be reheated, after which it is sent on to power the intermediate-pressure turbine.
3. The steam used to drive the intermediate-pressure turbine is then sent on to power the low-pressure turbine.

★ The turbines are divided into the high/intermediate-pressure turbine system and the low-pressure turbine system to avoid losing power in case either one breaks down.
★ The steam used to drive the low-pressure turbine is sent on to the main condenser, where it is cooled by the seawater flowing through the cooling tubes and turned back into water. This water is then sent back to the boiler.
★ In addition to reheating steam, the Kawasaki URA Reheat Steam Turbine drives various design features that improve fuel efficiency, such as increased steam temperature and pressure as well as turbine blade enhancements.

Kawasaki Gas Turbine Sales Pass 10,000 Mark

Kawasaki sold its first gas turbine standby generator set back in 1977. Manufactured entirely in Japan, the generator set was powered by an industrial gas turbine that was a product of Kawasaki's expertise and its outstanding experience cultivated through global collaborative efforts to develop and manufacture large aircraft engines. In 1983, Kawasaki sold its first gas turbine cogeneration system. And in 2011, the number of Kawasaki gas turbines sold surpassed the 10,000 mark.

Kawasaki has always stayed at the forefront of the industry by developing new technologies and related products, and it now enjoys a dominant share in the Japanese market in small and medium-sized industrial gas turbines.

Kawasaki's marketing efforts have spanned the entire globe, with markets established in Russia, Germany and Indonesia, among other regions. Kawasaki will continue to actively promote its energy and environmental businesses, leveraging the world-class technology demonstrated by its proven track record both in Japan and abroad.

Over 1,000 users and other representatives participated in an event held at the end of October 2012 to commemorate the sale of 10,000 Kawasaki gas turbines.

Total number of units

10,000
8,000
6,000
4,000
2,000

1971
Launched R&D efforts in small gas turbines.

1972
Developed the KG72 prototype engine (300 hp class).

1974
Completed the S1A prototype gas turbine (300 hp class) for producing electricity.

1975
Completed the M1A prototype gas turbine (1,000 kW class) based on the S1A. Subsequently developed a series of new models including the S2A.

1977
Completed the S1A-powered Kawasaki PU200 (150 kW), the first gas turbine generator made entirely in Japan. Marketed for applications as a standby generator.

1977
Completed the M1A-powered Kawasaki PU1250 (1,000 kW class) gas turbine generator. Applications included standby use, regular use and maritime applications.

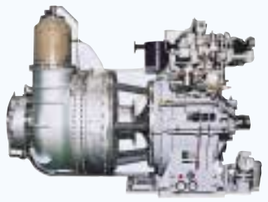
1978
An M7.4 earthquake struck off the coast of Miyagi Prefecture. Gas turbine generator sets' advantage in disasters was demonstrated.

1979
Completed the MPU200 mobile generator set.

1984
Delivered the first cogeneration system (CGS), combining two PU1250 Kawasaki gas turbines and an exhaust heat boiler.

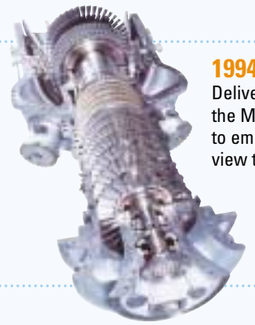
1988
Launched the MD series of pump-drive gas turbines.

Launched the PUC15 CGS equipped with an M1A-13 gas turbine for regular use.



1989
Developed the M1A-13CC Cheng-cycle gas turbine, which powered the PUCC15 Cheng-cycle CGS launched this year. The M1A-13CC increased shaft output and dramatically improved thermal efficiency by capturing the steam produced by exhaust heat and redirecting it to the gas turbine.

1994
Delivered the first PUC60 CGS featuring the M7A-01, the first Kawasaki gas turbine to employ a multilayered structure with a view to increasing capacity.



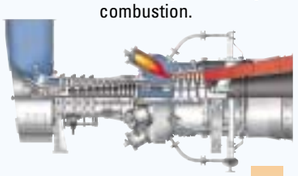
1995
Sold the first GP1500D CGS equipped with Kawasaki's Dry Low Emission (DLE) combustion system.

The Kobe Earthquake (M6.8) occurred. Approx. 96% of Kawasaki's gas turbine standby generator sets were operational in affected areas.

1996
Kawasaki gas turbine deliveries passed the 5,000 mark.

5,000 mark passed

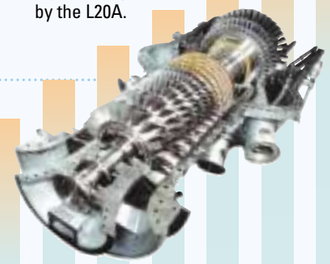
1997
Delivered the first PUC60PLUS CGS using steam augmented combustion.



1999
Delivered the first PUC70 CGS fitted with the M7A-02 gas turbine.

2001
The PUC180 CGS demonstration plant, featuring the large L20A gas turbine, began operation at Kawasaki's Akashi Works. The L20A attained the world's highest level of electrical efficiency (35%) in this class.

2004
Sold a PUCS500 combined power plant (total capacity: 50,000 kW) powered by the L20A.



2009
Delivered the first PUC80 CGS fitted with the M7A-03 gas turbine.

2011
Total sales of Kawasaki gas turbines passed the 10,000 mark.

The Tohoku Earthquake (M9.0) occurred. Approx. 99.9% of Kawasaki's gas turbine standby generator sets were operational in affected areas needing emergency power supplies.

10,000 mark passed

2012
Developed and launched the L30A, boasting the world's highest level of electrical efficiency (above 40%) in the 30 MW class.

'70 '75 '80 '85 '90 '95 '00 '05 '10

Natural Gas Compressors for Oil Project off Vietnam

Kawasaki recently delivered two natural gas compressors for a floating production, storage and offloading (FPSO) system, which will be operated in oil fields off the coast of Vietnam near Vung Tau. The oil field development project is being led by Lamson Joint Operating Company.

An FPSO is a floating vessel designed to process and store crude oil extracted from offshore oil fields until it can be offloaded onto a tanker. These vessels can be operated at any water depth and are also easy to transfer and reuse. The FPSO will be used for the development project at the Thang Long and Dong Do fields, located 160 km off the coast of Vung Tau. PetroVietnam Technical Services Corporation is the EPCI (Engineering, Procurement, Construction, Installation) and Time Charter main contractor for the FPSO package.

Kawasaki's compressors will be used to pressurize gas separated during the oil production process and transfer it to the mainland via a submarine pipeline. The order comes from Global Process Systems Pte. Ltd., a Singapore-based company constructing the FPSO topside. Commercial operation of the FPSO is expected to begin in the fourth quarter of 2013.

The order is a testament to Kawasaki's proven track record and reliability as a supplier of natural gas compressors. Kawasaki will continue to expand sales of its natural gas-related products and actively pursue its energy and environmental business.

1,000th BK117 Helicopter Delivered

In December, Kawasaki delivered the 1,000th BK117 twin-engine multi-purpose helicopter, which it jointly manufactures with Eurocopter Deutschland GmbH (previously Messerschmitt-Bölkow-Blohm).

Since its market debut in May 1982, the BK117 has been purchased by customers around the world. The 1,000th sale, a BK117C-2, was delivered to the Shimane Prefectural Government to be deployed by the Shimane Air Rescue Team as a fire-fighting and disaster-relief helicopter. It was the 158th C-2 model delivered by Kawasaki.

Developed and manufactured jointly by Kawasaki and Eurocopter Deutschland, the BK117 is a best-selling helicopter that has earned high marks for its roomy cabin space, compact body and excellent mobility, as well as the large clamshell doors at the rear, which facilitate the loading and unloading of materials and equipment. The BK117 covers a broad spectrum of applications, including broadcasting, transporting cargo and passengers, fire-fighting and disaster-relief operations, police work and emergency medical services.

As a leading helicopter manufacturer in Japan, Kawasaki will continue its research, development and manufacturing efforts to contribute to Japanese aircraft technology.

Tokyo Gas Orders World's Largest-class Aboveground LNG Storage Tank

Kawasaki and Shimizu Corporation recently announced a joint contract awarded for the construction of two aboveground storage tanks, one for LNG and one for LPG, from Tokyo Gas Engineering Co., Ltd., a wholly owned subsidiary of Tokyo Gas Co., Ltd. The LNG and LPG storage tanks will be constructed at Tokyo Gas's Hitachi LNG terminal, which is scheduled to go into service in fiscal year 2015.

The LNG tank ordered for this project is a 9% nickel steel and prestressed concrete (PC) storage tank, and with a capacity of 230,000 kl, it is among the largest aboveground full-containment LNG storage tanks in the world. The LPG tank ordered for this project has a capacity of 50,000 kl.

Located in the Hitachi district of the Port of Ibaraki, the Hitachi LNG terminal will help underpin Japan's increasing demand for natural gas. It is expected to help boost the overall stability of the nation's supply infrastructure by adding to the combined capacity of the three existing terminals in the Tokyo Bay.

Since the delivery of its first underground LNG tank in 1982 and aboveground tank in 1983, Kawasaki has outfitted Japan with every type of LNG tank on the market, including single/double/full-containment tanks, in-pit tanks, PC tanks, and in-ground and underground membrane tanks. Kawasaki has also been active in international LNG tank construction projects in Korea, Spain and elsewhere. To date, there are 28 Kawasaki-built LNG tanks in successful operation around the world.

Kawasaki will continue to build on its track record by further expanding its energy storage business around the world, with a focus on cryogenic storage tanks.

Battery Power System for Tokyo Monorail Delivered

Kawasaki delivered an order to Tokyo Monorail Co., Ltd. in March for a Battery Power System (BPS) intended mainly for the purpose of emergency train runs.

The BPS is a 2-parallel system consisting of 40 GIGACELL* modules, and was installed at the Shinagawa Substation. Another BPS is scheduled for installation at the Tamagawa Substation during fiscal year 2013. These two installations will provide emergency power in the event of a power outage, enabling stalled trains to transport passengers to the nearest station for a smooth evacuation.

After the Tohoku Earthquake in March 2011, Tokyo Monorail considered further ways to secure passenger safety in the event of a power outage stalling trains midway between stations. Kawasaki proposed using the BPS, which efficiently accumulates and stores regenerative electric power. In April 2011, Kawasaki conducted a demonstration test with Tokyo Monorail at the Katsushima Substation to verify the BPS's ability to power trains in an emergency.

The BPS uses Kawasaki's proprietary high-capacity nickel-metal hydride GIGACELL batteries. Their rapid charging and discharging capabilities enable the BPS to operate without any kind of control device, such as a chopper, so it can be connected directly to the traction power line. The absence of the controller means no controller-related losses and delays, no electromagnetic interference (EMI) that can interfere with railway signal and communication systems, and a more compact, cost-effective system. The BPS contributes to safe, reliable rail transport and the efficient use of energy.

Unlike many conventional energy storage systems for railways, the high capacity of the BPS enabled by the GIGACELL allows it to power trains in an emergency. In addition, Tokyo Monorail can expect further energy savings by introducing more train cars fitted with a regenerative braking system, as with other railway operators that already use the BPS.

Kawasaki has delivered a number of BPS to railway operators both in Japan and abroad, including demonstration tests, to help stabilize line voltage and save energy through the effective use of regenerative electric power. Numerous railway operators, including monorail and subway operators, have expressed interest in BPS-powered emergency runs as an effective measure in the event of a major earthquake.

Kawasaki will continue to actively market its BPS to help railway operators meet safety and energy-saving needs.

* GIGACELL is a registered trademark of Kawasaki Heavy Industries, Ltd.

New 250cc Sport-Model Motorcycles Launched

With spring in the air, Kawasaki launched three new 250cc models in its ever-popular Ninja lineup: the Ninja 250, the Ninja 250 Special Edition with special livery, and the Ninja 250 ABS Special Edition, with ABS as a standard feature. The Ninja 250 is an all-around sport model for active riders who enjoy sport riding.

Kawasaki also launched the Z250, a new 250cc addition to the Z Series of naked sport motorcycles, in April. It features a beefy, aggressive design that gives it an imposing presence on top of top-notch sport performance.

Great for long-distance touring on freeways as well as for getting around town, the 250cc class is a perennial favorite. Kawasaki's superb attention to every detail of the bodywork gives these new models a sophisticated look that goes beyond anything one would expect in a 250cc class motorcycle.

The superior rigidity of the Ninja 250's and the Z250's diamond-shaped steel-tube frames ensures a high level of performance and easy handling. Their lightweight and compact liquid-cooled, four-stroke, parallel twin-cylinder DOHC four-valve engines (248 cm^3) deliver substantial torque at low and medium rpm and strong acceleration at high rpm. The fuel injection system and three-way catalyst provide superior environmental performance in conformity with the latest emissions regulations for motorcycles.

These latest additions to the Kawasaki lineup will appeal to a wide range of users, from novices to accomplished riders, with their unique styling and outstanding performance.

Ninja 250 Special Edition

Z250

I was always fond of trains and the Shinkansen (bullet train) when I was a kid,
and the same can be said for most of my coworkers at Kawasaki Heavy Industries.
There's no greater joy than being able to create something you love and adore.
Yet, Kawasaki makes more than just the Shinkansen.
We also build railway cars, subway cars, freight cars, locomotives and other rolling stock.
Our customers can be found in the United States, the United Kingdom, China, Southeast Asia, Latin America and Africa.
Therefore, I know that one day I may very well stumble across one of the exact same rolling stock that I helped build.
Working at a job that presents us with this dream is what makes our love for Monozukuri so strong.

This is why Kawasaki Heavy Industries is literally site of a loving dedication to manufacturing.

Kawasaki's Hyogo Factory—pictured here—first opened in 1906.
Over the past century, we have gone on to develop a number of leading technologies,
improved the safety of rolling stock and helped to increase speed and comfort in the process.
Today, Kawasaki also operates two full-scale rolling stock plants in the United States.

Kawasaki, working as one for the good of planet

Kawasaki

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