Development Phase/Products
—Automotive Business Unit—

In December 2004, FHI launched the new Subaru R1 minicar, in which powerful yet smooth running and excellent fuel economy performance were simultaneously actualized to higher levels. In the Subaru Forester, to which major refinements were made in January 2005, environmentally friendly specifications have been employed for fuel economy and exhaust emission performances, while the new 2.0l horizontally-opposed four-cylinder SOHC engine has been adopted for dramatic enhancement of the acceleration performance in the practical area.

Fuel Economy

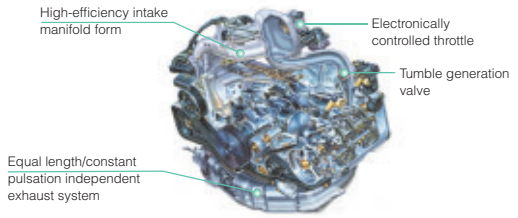
When motor vehicles consume fuel, they emit carbon dioxide (CO_2) in proportion to the amount of fuel. Improving fuel economy can contribute to preventing global warming, which is caused by heat-trapping substances, including CO_2, as well as saving limited energy resources.

Subaru promotes the development of technologies to improve fuel economy, including enhancement of efficiency with improved engines, reduction of transmission loss in the driveline, reduction of vehicle weight, and reduction of running resistance, while taking advantage of such features as all-wheel drive AWD)and high powered engines. Subaru is gradually introducing cars that meet the fiscal 2010 fuel economy standard, which is a fuel consumption target for gasoline-powered vehicles, into the market.

Improvement of the Engine

Forester

- The intake efficiency was improved by adopting electronically controlled throttles and intake manifolds with ports arranged vertically for the NA vehicle.



Forester 2.0l SOHC Engine

New R1 Mini-Sized Passenger Car

- Intake efficiency was improved by adopting the intake AVCS (active valve control system: variable valve timing) and electronically controlled throttles for the DOHC, 16-valve engine.

Enhanced Efficiency of the Driveline

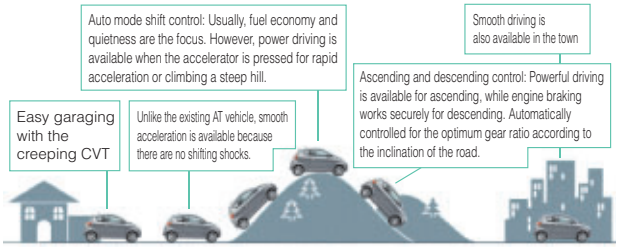
Forester

- Fuel consumption at idle was reduced by adopting the N control mechanism (the mechanism automatically shifts the mode to neutral when the car has been stopped by pressing the brake pedal for a certain time) also for the SOHC engine vehicle.
- The Info-ECO Mode*1 used for the turbo AT vehicle was also introduced to the SOHC engine vehicle.

New R1 Mini-Sized Passenger Car

- The i-CVT used for the R2 was also introduced to the R1. In addition, the Info-ECO Mode was adopted for the R1 and R2 to support driving with saved fuel consumption.

■ i-CVT Running Image



Column

Super Small Car

Due to their compactness, minicars, which support the bottom range of the small car market in Japan, naturally have the potential for actualizing excellent environmental performance, such as reduction of resources used in their life cycle from manufacture to disposal, as well as reduction of CO_2 emissions.

In particular, the Subaru R1 is even 100 mm smaller in overall length than the minicar criterion for length by focusing on personal use in urban areas. In such a small-sized car, the latest weight reduction technology developed for the New Legacy (80 kg lighter than the previous model) was adopted to realize the best fuel economy in the class (10-15 mode: 24 km/l, achieved +5% above the 2010 fuel economy standards) and excellent exhaust emission performance (50% reduced beyond the 2005 standard for exhaust emissions). For this small R1, a high quality upper class atmosphere and emotionally appealing interior and exterior design were adopted, while the economical and environmental performances were enhanced. You can actually feel "enjoyment in driving," "pleasure in possession," and "wisdom in modesty" with the "Super Small Car" that will be a good match for the environmental age to come.

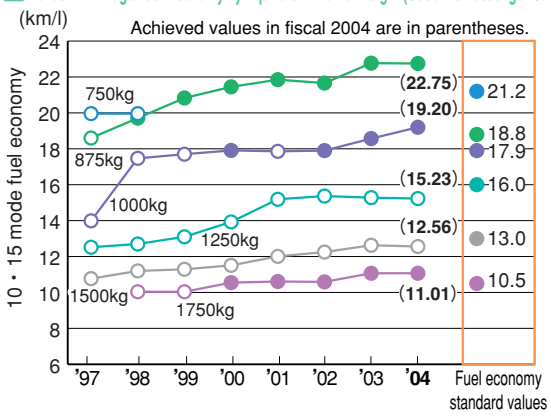
- Environmental Performance of Subaru R1
  - Fuel consumption: 24.0 km/l (2WD)
  - Exhaust emissions : 50% reduction beyond the 2005 standard " ☆☆☆ "
  - Noise: Conformity to the 1998 regulations
  - Air conditioner: CFC's substitute HFC134a, 400 g
  - Substance with environmental impact: Achieved the 2005 goal for lead set by the Japan Automobile Manufacturers Association (1/3 or less of the 1996 level)
  - Recycling: Use of materials easy to recycle and recycled materials, material indication, and implementation of design for easy dismantling

*1.Info-ECO mode: Fuel economy was improved by optimizing the engine control, shift change control, and lock-up control of the AT. When the car is running with good fuel economy, the information lamp is lit to notify the driver of the condition.

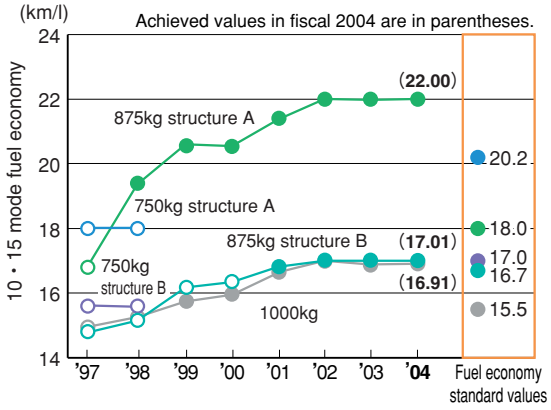
Trends in Improvement of the Average Fuel Economy by Equivalent Inertial Weight

In an effort to meet the fiscal 2010 fuel economy standards, we achieved the target in three out of the five ranks of equivalent inertial weight for gasoline passenger cars. In gasoline mini-sized trucks, we succeeded in attaining the target in all applicable ranks of the equivalent inertial weight.

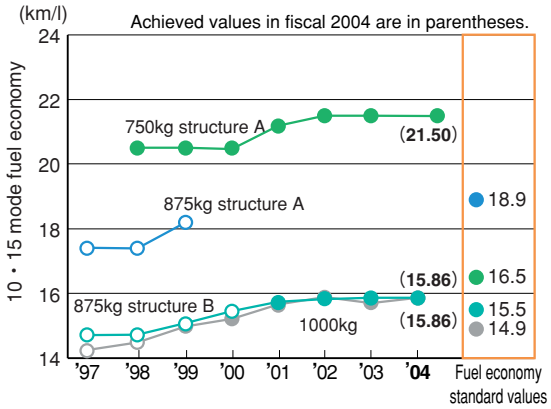
Trends in Average Fuel Economy by Equivalent Inertial Weight (Gasoline Passenger Cars)*1



Trends in Average Fuel Economy (Gasoline Mini-sized MT Trucks)*1

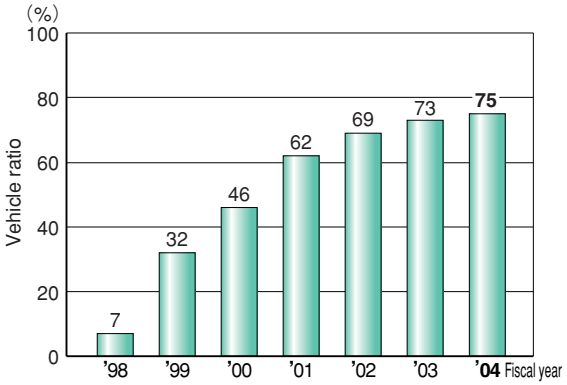


Trends in Average Fuel Economy (Gasoline Mini-sized AT Trucks)*1

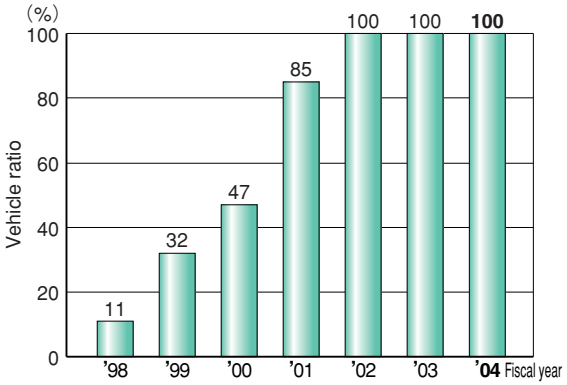


Trends in Improvement of Attainment Rates for Fiscal 2010 Fuel Economy Standards

Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Passenger Cars)



Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Mini-sized Tucks)



Note: Regarding the 2002 data, there were errors in the graphs of the Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards in the 2004 Environmental & Social Report. They have been corrected as shown in the above graphs.

Exhaust Emissions

Substances such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx), which are emitted from automobiles, are one of the causes of air pollution in metropolitan areas where there is intensive motor traffic. In order to improve the state of the air, Subaru is gradually launching low emission vehicles (certified by the Ministry of Land, Infrastructure and Transport) that meet standards stricter than the regulations.

Application Status of Low Emission Vehicles

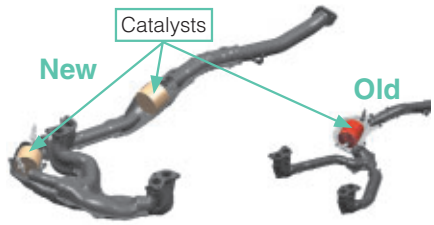
The 2.0l SOHC engine vehicle has reached the " ☆☆☆ " level, with exhaust emissions reduced 50% beyond 2005 standards by reviewing the catalyst layout in the Forester, to which major refinements were made in fiscal 2004.

Also, the new R1 minicar conformed to the " ☆☆☆ " level, with exhaust emissions reduced 50% beyond the 2005 standards.

*1.The values in the graph with colored circles mean that the goals have been achieved, while those with blank circles mean that the goals have not yet been attained.

Exhaust Emissions Measures in Forester

The equal length/constant pulsation independent exhaust system*1 was adopted in the NA vehicle for enhancement of the purification performance of catalysts by changing their layout and size.



Change in the Exhaust System Layout

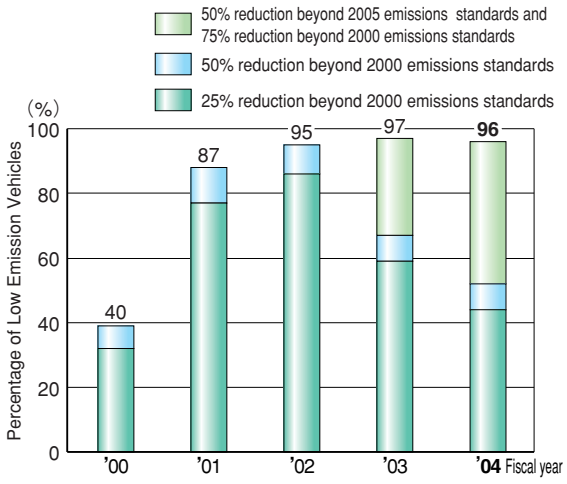
Exhaust Emissions Measures in the New R1 Mini Car

The Active Valve Control System (AVCS) was adopted for optimization of combustion, while the air-fuel ratio control performance was enhanced by introducing electronically controlled throttle valves. The post-treatment performance was also improved by adopting the maniverter, in which the exhaust manifolds and the catalytic converter were integrated.

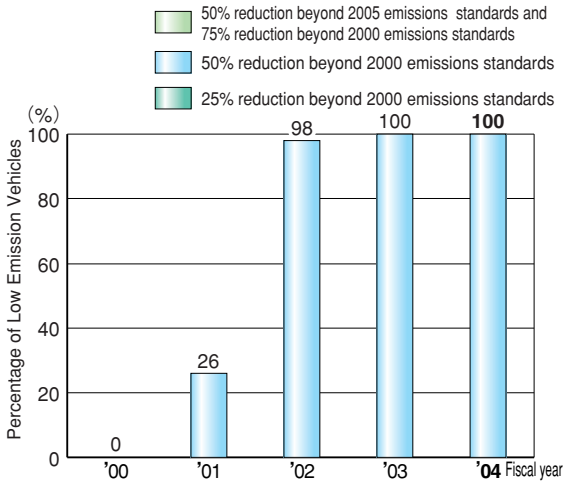
Trends in Improvement of the Percentages of Low Emission Vehicles

The system to certify low emission vehicles started in April 2000. The percentages of the low emission vehicles shipped as Subaru are as follows.

■Trends in Percentages of Low Emission Vehicles on Gasoline Passenger Cars



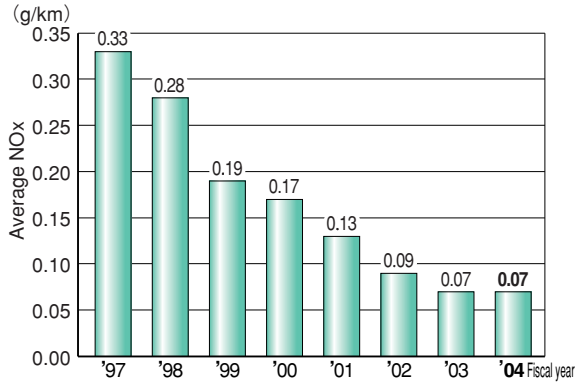
■Trends in Percentages of Low Emission Vehicles on Mini-sized Gasoline Trucks



Trends in NOx Averages

By launching low emission vehicles which meet the standards represented by the low emission vehicle certification standard into the market, Subaru has been able to reduce the average amount of NOx emitted by Subaru vehicles every year as shown in the chart below.

■Trends in NOx Averages of Subaru Vehicles



Notes:
- The figures were calculated from the regulation values (10・15 mode and 11 mode) at the time of shipment.
- Going back to fiscal 2000, calculations were made with regulation or conversion values for the new test mode. The new test mode is a combined mode, where the regulation values set individually for the 10・15 mode and 11 mode are integrated.
- Until fiscal 1999, the figures were calculated from the regulation values for the 10・15 mode.

*1. Equal length/constant pulsation independent exhaust system: This exhaust system aims at a reduction in exhaust noise and enhancement of engine performance.

Reference Fiscal 2010 Fuel Economy Standards (10・15 Mode)

◆ Gasoline Passenger Cars

Equivalent inertial weight (kg)		～750	875	1000	1250	1500	1750	2000	2250	2500～
Vehicle weight (kg)	Lower limit		703	828	1016	1266	1516	1766	2016	2266
	Upper limit	702	827	1015	1265	1515	1765	2015	2265	
Fiscal 2010 fuel economy standards (km/l)		21.2	18.8	17.9	16.0	13.0	10.5	8.9	7.8	6.4

◆ Gasoline Mini-sized Trucks

Equivalent inertial weight (kg)		～750		875		1000～
Vehicle curb weight (kg)	Lower limit			703		828
	Upper limit	702		827		
Vehicle structure (Note)		StructureA	StructureB	StructureA	StructureB	—
Fiscal 2010 fuel economy standards (km/l)	AT	18.9	16.2	16.5	15.5	14.9
	MT	20.2	17.0	18.0	16.7	15.5

Note: Structure A:① $\frac{\text{Maximum load capacity}}{\text{Gross vehicle weight}} \leqq 0.3$

② FF (front engine/front drive) vehicles or FF-based 4WD vehicles (excluding trucks); Pleo vans

Structure B:Vehicles other than Structure A; Sambar vans and trucks

Reference Exhaust Emission Regulation Values, Low Emission Vehicle Certification Standard by the Ministry of Land, Infrastructure and Transport

◆ New Short-term Regulations for Gasoline and LPG Passenger Cars

	10・15 mode (g/km)			11 mode (g/test)			Remarks
	CO	HC	NOx	CO	HC	NOx	
2000 exhaust emission regulations	0.67	0.08	0.08	19.0	2.20	1.40	
2000 emissions standards, 25% reduction level	0.67	0.06	0.06	19.0	1.65	1.05	☆ Good low emission vehicle
2000 emissions standards, 50% reduction level	0.67	0.04	0.04	19.0	1.10	0.70	☆☆ Excellent low emission vehicle
2000 emissions standards, 75% reduction level	0.67	0.02	0.02	19.0	0.55	0.35	☆☆☆Ultra low emission vehicle

◆ New Long-term Regulations for Gasoline and LPG Passenger Cars

	Combined mode (g/km)				Remarks
	CO	NMHC	NOx	Combination	
2005 exhaust emission regulations	1.15	0.05	0.05	10・15 mode & 11 mode	
2005 emissions standards, 50% reduction level	1.15	0.025	0.025	10・15 mode & 11 mode	☆☆☆ low emission vehicle
2005 emissions standards, 75% reduction level	1.15	0.013	0.013	10・15 mode & 11 mode	☆☆☆☆ low emission vehicle

◆ New Short-term Regulations for Gasoline and LPG Passenger Cars

	10・15 mode (g/km)			11 mode (g/test)			Remarks
	CO	HC	NOx	CO	HC	NOx	
2002 exhaust emission regulations	3.30	0.13	0.13	38.0	3.50	2.20	
2000 emissions standards, 25% reduction level	3.30	0.10	0.10	38.0	2.63	1.65	☆ Good low emission vehicle
2000 emissions standards, 50% reduction level	3.30	0.07	0.07	38.0	1.75	1.10	☆☆ Excellent low emission vehicle
2000 emissions standards, 75% reduction level	3.30	0.03	0.03	38.0	0.88	0.55	☆☆☆Ultra low emission vehicle

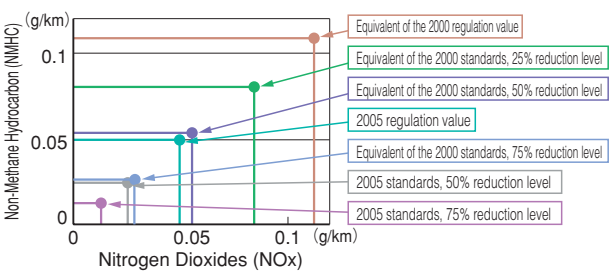
◆ New Long-term Regulations for Gasoline and LPG Passenger Cars

	Combined mode (g/km)				Remarks
	CO	NMHC	NOx	Combination	
2007 exhaust emission regulations	4.02	0.05	0.05	10・15 mode & 11 mode	
2005 emissions standards, 50% reduction level	4.02	0.025	0.025	10・15 mode & 11 mode	☆☆☆ low emission vehicle
2005 emissions standards, 75% reduction level	4.02	0.013	0.013	10・15 mode & 11 mode	☆☆☆☆ low emission vehicle

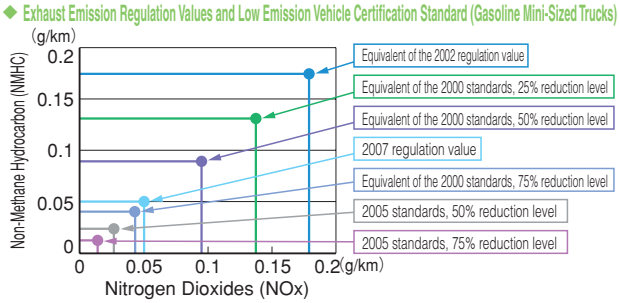
Reference Comparison of the Exhaust Emission Regulation Values

In 2003, the 2005 Exhaust Emission Standards were released as new criteria for gas emissions. Compared with the existing 2000 Exhaust Emissions Standards, the new standards require a further reduction of 50% or more in exhaust emissions. However, application of the regulation to mini-sized trucks starts in 2002 and 2007.

◆ Exhaust Emission Regulation Values and Low Emission Vehicle Certification Standards(Gasoline Passenger Cars)



◆ Exhaust Emission Regulation Values and Low Emission Vehicle Certification Standard (Gasoline Mini-Sized Trucks)



Clean Energy Vehicles

Clean energy vehicles have such features as emitting fewer global warming substances (carbon dioxide) and air pollutants (carbon monoxides, hydrocarbons, nitrogen oxides, etc.) and have less of an effect on the environment than gasoline vehicles. However, there are technical problems related to cost and driving distances. Subaru has been developing clean energy vehicles that have the gasoline vehicle-level performance and utility.

Development of Secondary Batteries (Chargeable Batteries) for Hybrid Vehicles, Electric Vehicles, and Fuel Cell Electric Vehicles

In May 2002, FHI established NEC Lamilion Energy, Ltd., jointly with NEC Corp. as a planning and development company for automotive manganese lithium-ion battery packs. By utilizing NEC's laminated manganese lithium-ion battery cell technology and Subaru's automotive battery pack technology, the new company will develop secondary batteries for hybrid vehicles, electric vehicles, and fuel cell electric vehicles, which are much thinner, lighter, and affordable, yet exhibit higher performance than existing ones. The company is aspiring to develop secondary batteries that will be accepted as an international de facto standard.

Natural Gas Vehicles

A natural gas vehicle, the Legacy B4 2.0CNG, which is based on the new Legacy, has been on general sale since May 2004. In addition, the car was exhibited at low-pollution vehicle fairs and other events in various areas (see page. 64 for reference) so that many visitors could actually drive the CNG.

In May 2005, the improved model, where the exhaust emission performance of the CNG was drastically upgraded by reducing exhaust emissions 75% beyond the 2005 standards, was put on the market as a low-pollution vehicle with exhaust emissions reduced 75% beyond 2005 standards certified under the Low-Pollution Vehicle Designation System by eight prefectural and municipal governments.

New Legacy B4 2.0 CNG

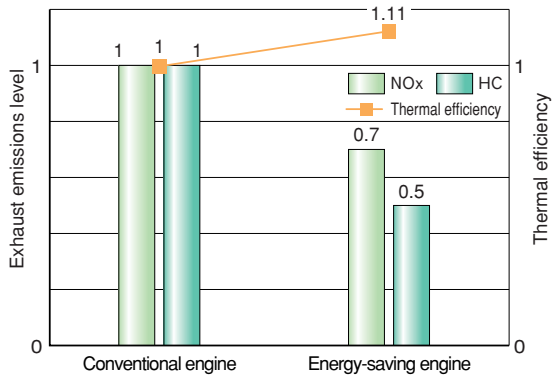
Sticker for Low-Pollution Vehicle Designated by Eight Prefectural and Municipal Governments

Joint Development of Energy-Saving Engines by Industry, Academia, and Government

For the technical development to realize cleaner, energy-saving power sources for the future, national-scale cross-sectoral approaches are required among industry, academia, and government. Subaru has been involved in the Energy Use Rationalizing Technology Strategic Development Project by the New Energy and Industrial Technology Development Organization of Japan (NEDO) since 2003.

As achievements in fiscal 2004, we obtained epochal data that the thermal efficiency was improved by 6%–11% by avoiding knock with a compression ratio of 14 while HC and NOx were simultaneously reduced from the exhaust emissions. In fiscal 2005 as the last year of the project, we aim to actualize a new gasoline engine that emits fewer pollutants yet the efficiency is as high as the diesel engine.

Exhaust Emissions Level and Thermal Efficiency of the Energy-Saving Gasoline Engine



List of Events where CNG*1 Was Exhibited

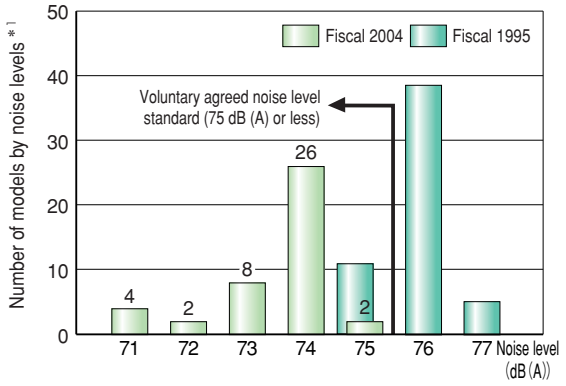
Events	Organizers	Venues
April 24 (Saturday) Fureai Festival in Ohta	Gunma Distribution Council	Gunma Sports Complex Sub-ground
May 22 (Saturday) Open Seminar on the Environment by Keio University	Keio University	Faculty of Science and Technology, Keio University Yagami Campus
June 5–6 (Saturday–Sunday) Eco Car World 2004	Ministry of the Environment, etc.	Yokohama Minato Mirai 21 Area Red-brick Warehouse Square
June 27 (Sunday) Environmental Fair 2004	Joetsu Municipal Government	Joetsu Shimin Plaza
July 14 (Wednesday) Lecture in Commemoration of Exceeding 20,000 NGVs	Japan Gas Association	Tokyo International Forum (Yurakucho)
July 16 (Friday) LEV Exhibition for the Land, Infrastructure and Transportation Day	Ministry of Land, Infrastructure and Transportation	Joint Government Building No. 3 Parking lot on the ground floor
July 22 (Thursday) Low Pollution Seminar by the Gunma Prefectural Government	Ministry of Land, Infrastructure and Transportation Gunma Land Transport Office	Maebashi Chamber of Commerce and Industry Hall
July 24–25 (Saturday–Sunday) Clean Energy Festa in Koriyama	Koriyama Municipal Government	Koriyama Culture Park
August 29 (Sunday) Official Car of the Hokkaido Marathon	Hokkaido Athletic Sports Association, etc.	Makomanai Open Stadium-Nakajima Park
September 4 (Sunday) Motor Show in Gunma	Gunma Land Transport Office	On the premises of Maebashi Land Transport Office
September 10 (Friday) Regional New Energy Seminar	Niigata Prefectural Government	Niigata Unison Plaza
September 17–19 (Friday–Sunday) LEV Fair in Osaka	Osaka Municipal Government	Asia and Pacific Trade Center
September 19 (Sunday) LEV Fair Nagoya 2004	LEV Fair Nagoya Executive Committee	Hisaya-odori Park Hikari-no-Hiroba
October 10 (Sunday) Environmental Festival by the Gunma Prefectural Government	Gunma Prefectural Government	Gunma Prefectural Government Building
October 23–24 (Saturday–Sunday) Cleanup Fair by the Tochigi Prefectural Government	Tochigi Prefectural Cleanup Fair Executive Committee	Tochigi Prefectural Children's Comprehensive Science Museum
November 7 (Sunday) Environmental Fair by the Ohta Municipal Government	Ohta Municipal Environmental Fair Executive Committee	City Hall Square

*1. CNG: A vehicle that uses compressed natural gas as fuel.

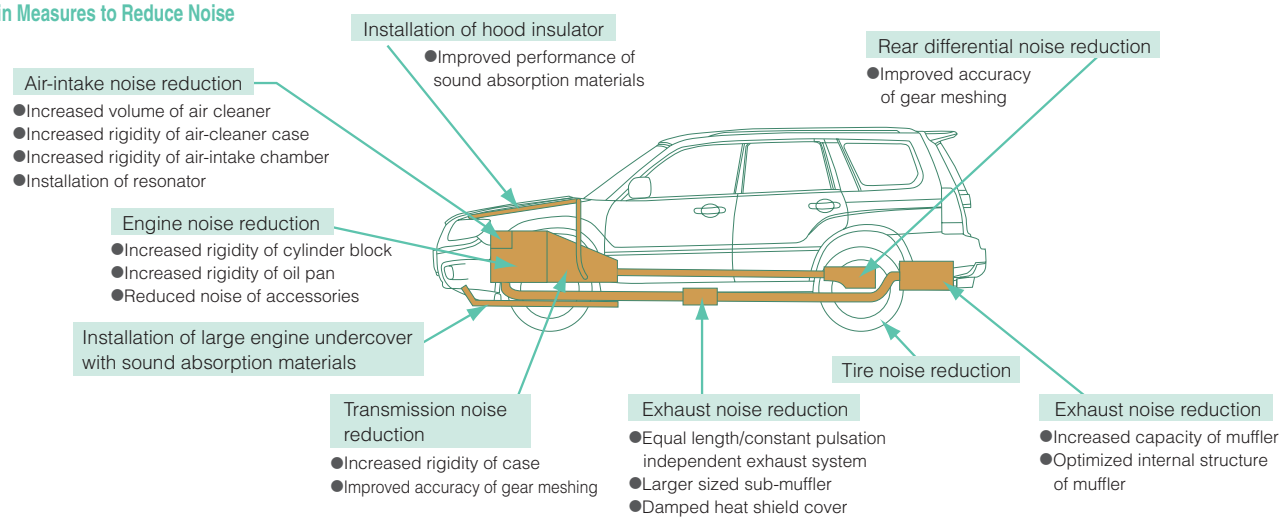
Noise

Subaru has been actively working to reduce the noise generated from the engine, transmission, air intake and exhaust, and tires in order to reduce automobile noise. In fiscal 2004, the noise was further reduced in the Forester by significantly reviewing its air intake and exhaust system in the annual improvement. Also for other models, Subaru is promoting the reduction of noise by increasing the capacity of the exhaust system, as well as by promoting adoption of the equal length/constant pulsation independent exhaust system and large undercovers.

Trends in Acceleration Noise (Domestic/Passenger cars)



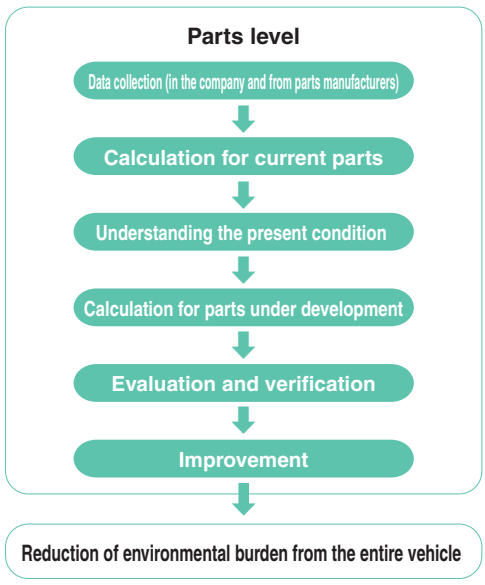
Main Measures to Reduce Noise



LCA Activities

Life Cycle Assessment (LCA) is a method to numerically evaluate the environmental burden over the product lifecycle starting from resource collection and manufacture to use until the disposal stage. In April 2002, Subaru established the LCA Utilization Investigative Commission. Since then, we have worked on the construction of an in-house database and the development of LCA calculation software for easy LCA application in order to reduce the environmental burden over the car lifecycle. Disseminating the LCA concept through these activities, we will continue to further improve the in-house data and study the effective application of LCA for further reduction of the environmental burden over the car lifecycle.

Concept of Using LCA in the Development Phase



*1. Number of models by noise levels: Vehicles are sorted by noise levels because the same model can be in different noise level categories depending on the engine power and transmission type.