Development Phase/Products —Automotive Business Unit—

The new model Subaru Legacy was put on the market in May 2003, and the new Subaru R2 minicar was launched in December 2003. Subaru actualized both thorough weight reduction and excellent body rigidity by evolving the body structure and adopting new technologies. Their environmental performance was also improved with upgraded driving and safety performances.

New Legacy

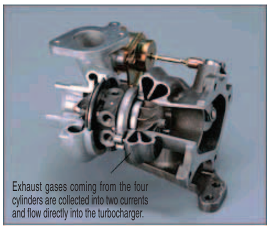
Fuel Economy

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 an improved engine, 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 produces cars that meet the fiscal 2010 fuel economy standards, which is a fuel economy target for gasoline-powered vehicles, and launches them into the market one after another.

Improvement of the Engine

New Legacy

- The supercharging efficiency was enhanced by adopting the twin scroll single turbocharger, which uses exhaust energy more effectively.
- The intake and exhaust efficiency was improved by adopting plastic intake manifolds (for the turbo vehicle) and intake manifolds with ports arranged vertically (for the SOHC and DOHC vehicles) and equal length/constant pulsation independent exhaust manifolds, of which exhaust interference is small.
- The weight of the engine was reduced.



Twin scroll single turbocharger

R2: New Mini-Sized Passenger Car

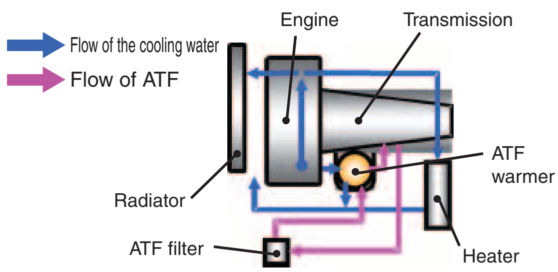
- Intake and exhaust efficiency, as well as combustion efficiency, were enhanced by using the newly designed tumble straight port cylinder head and plastic long-port intake manifolds with equal length for the DOHC 16-valve engine.
- Intake efficiency was improved by adopting the intake AVCS (active valve control system: variable valve timing) for the DOHC 16-valve engine.

Enhanced Efficiency of the Drive Line

New Legacy

- With the turbo-charged vehicle, fuel economy was improved by the application of the 5AT (increased steps) transmission, which utilizes low engine speed, as well as by securing the optimum driving force.
- Application of the new ATF (automatic transmission fluid) warmer, which warms ATF quicker, allowed reduction of cold oil agitation resistance and early execution of torque converter lock-up control, resulting in improved practical fuel economy.
- Friction was reduced by optimizing the bearing and applying surface treatment to the gear.
- The Info-ECO*1 mode was adopted for all AT vehicles and turbo engine MT vehicles.

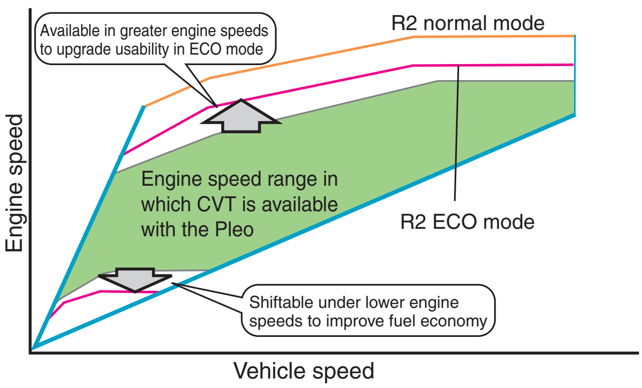
ATF Warmer System Diagram



R2: New Mini-Sized Passenger Car

- Shift characteristics were optimized according to the vehicle. For the DOHC-NA engine, the ECO mode was adopted to select fewer revolutions.
- The optimum tuning was actualized in accordance with the engine torque features by altering the torque converter fluid characteristics.

CVT Shift Characteristics of the R2



*1. Info-ECO mode: Fuel economy was improved by optimizing the engine control, shift change control and lock-up control for the AT, and controlling the turbo-charging pressure. When the car is running with good fuel economy, the information lamp comes on to indicate it.

Weight Reduction

For the new Legacy and the new R2 minicar, drastic weight reduction was implemented in order to upgrade fuel economy, driving, and safety performance, while improving body rigidity and driving quality simultaneously. The improved New Ring-Shaped Reinforcement Frames with reinforced subframes around pillars allowed higher body rigidity and improved collision safety performance. At the same time, weight was drastically reduced by adopting lightweight materials.

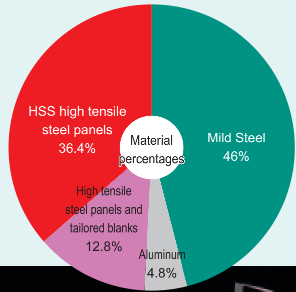
New Legacy

A 130 kg increase for the new Legacy was forecasted considering future driving environments that require further collision safety measures, reinforced braking, enhancement of suspension rigidity, upgrading of power, renewal of the exhaust system, enhancement of aerodynamic performance, and comfort equipment. In order to reduce vehicle weight under such conditions, optimum weight reduction technologies were applied to use proper materials for the proper places, based on the concept of mass development.*1

◆Body/Chassis

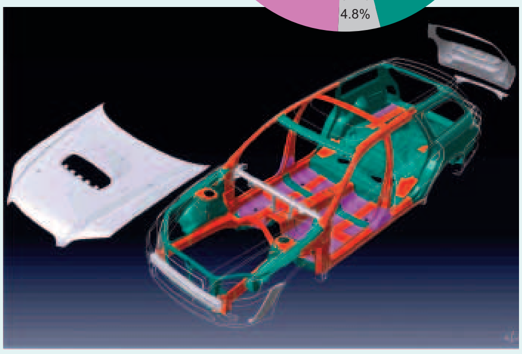
Reviewing the body structure thoroughly, we adopted new technologies and manufacturing methods, utilized such new materials as ultra high tensile steel panels, applied more laser welding, and rationalized the structure, which made up a 230 kg weight reduction for the GT wagon. In total, Subaru realized a 100 kg weight reduction for the GT wagon (see the chart below, the Major Components for the New Legacy Weight Increase and Decrease). This was not a mere weight reduction but rationalization of the structure with increased rigidity in the suspension and body and upgraded braking.

Weight Reduction in the New Legacy (Comparison on material usage and elements)



◆Engine

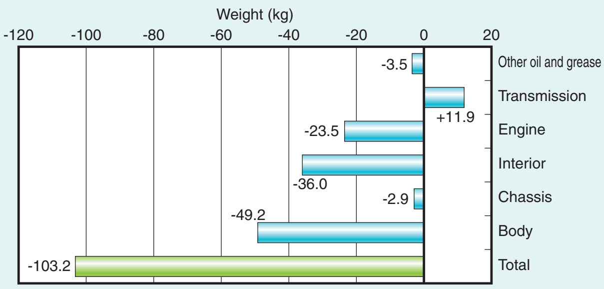
The turbo system was reviewed. The turbocharger was improved by adopting the twin scroll style and the titanium alloy turbine. For the turbo system, 15 kg were reduced through a shift to the single turbocharger from the sequential turbocharger, which had been adopted for the previous Legacy. Also for the turbo engine, 24 kg was eliminated by paring down the aluminum parts and using plastic materials.



◆Transmission

The drastic weight increase was expected to be caused by changing from the existing four-speed automatic transmission to the five-speed automatic transmission. Since the automatic transmission had the restriction that the stress applied on the part must be within the fatigue limit of the material, it was difficult to remarkably reduce weight from one part. Therefore, we reviewed the design of each part to replace materials step by step, and then to pare and hollow parts in about 400 spots. Consequently, the weight of transmission was increased by only 11.9 kg, which was less than half of the increase we had expected.

Major Components for the New Legacy Weight Increase and Decrease



Comparison between old GT-B E-tune Ⅱ and new 2.0GT

New R2 Mini-Sized Passenger Car

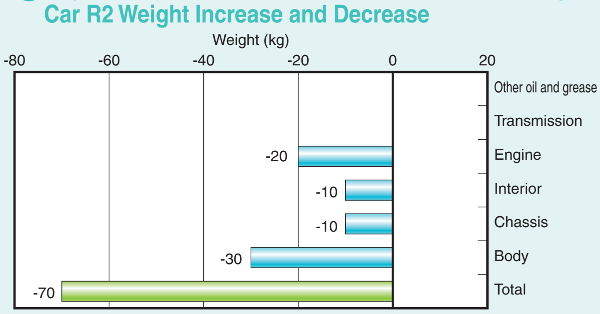
Under the concept that "Aim for secure safety because of a small car," Subaru tackled weight reduction, achieving both swift running and good fuel economy. Consequently, the vehicle weight was reduced by 70 kg, which is 9% of the total vehicle weight (see the chart below, Major Components for the New Mini-Sized Passenger Car R2 Weight Increase and Decrease) while upgrading collision safety performance.

◆Body

High tensile steel panels were used for 33% of the body. The plate thickness was reduced by adopting the curved surface body panel form, while applying more efficient collision safety structure such as the one-motion form, to eliminate inflection points.

Subaru R2

Major Components for the New Mini-Sized Passenger Car R2 Weight Increase and Decrease



Comparison between R2 R (2WD, i-CVT) and PLEO LS (2WD, i-CVT)

◆Chassis

Metal sheets were used for the exhaust system, and weight was reduced in the tires and the wheels.

◆Interior

The seat structure was redesigned, and the heater and evaporator were integrated.

◆Engine

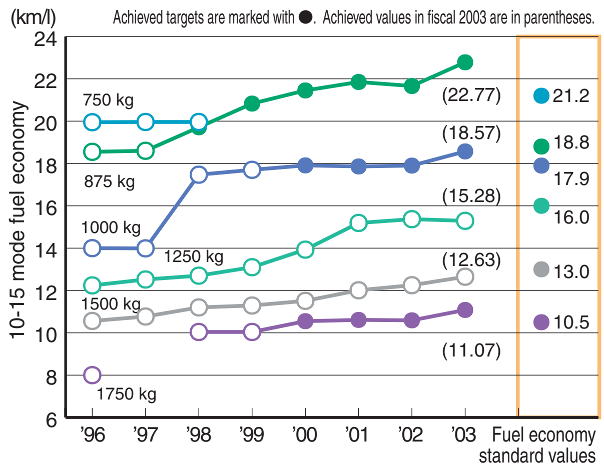
The cast iron cylinder block was pared down, intake system parts were integrated, and auxiliary equipment was installed directly.

*1. Mass development: Cross-sectional activity by the cross-functional team to reduce vehicle weight.

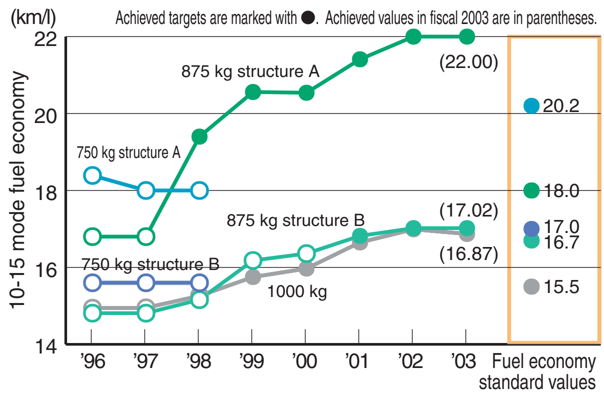
Trends in Average Fuel Economy by Equivalent Inertia Weight

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

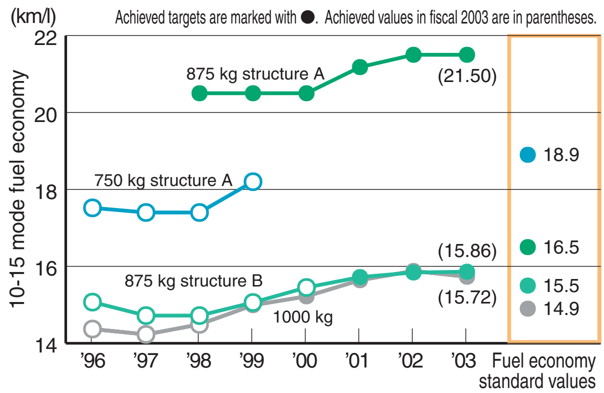
Trends in Average Fuel Economy by Equivalent Inertia Weight (Gasoline Passenger Cars)



Trends in Average Fuel Economy by Equivalent Inertia Weight (Gasoline Mini-Sized MT Trucks)

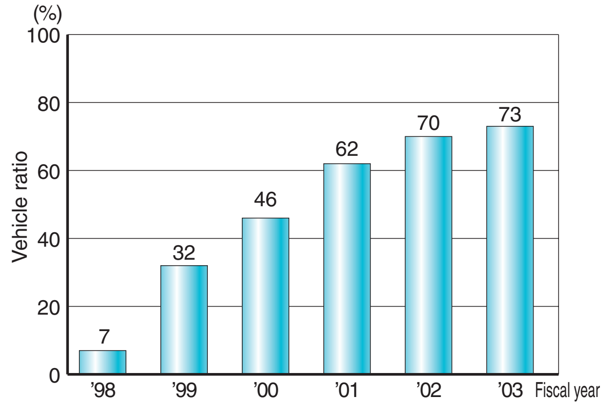


Trends in Average Fuel Economy by Equivalent Inertia Weight (Gasoline Mini-Sized AT Trucks)

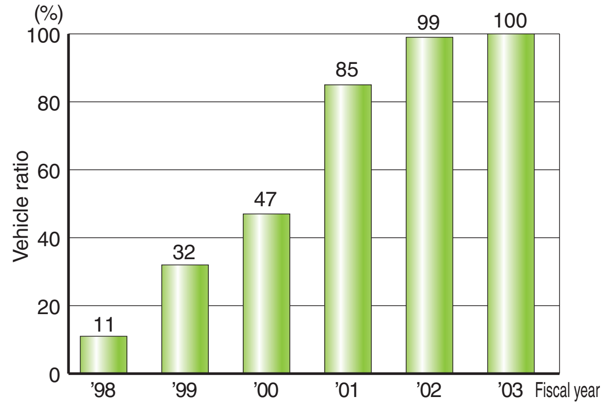


Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards

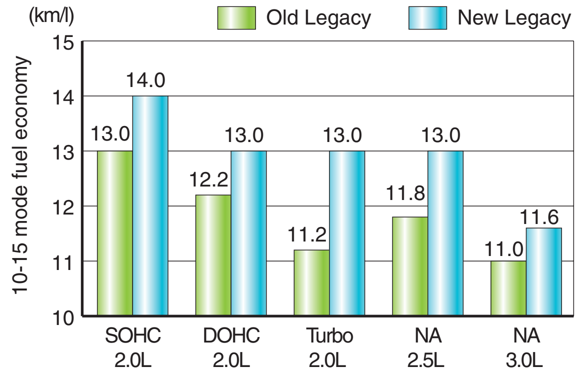
Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Passenger Cars)



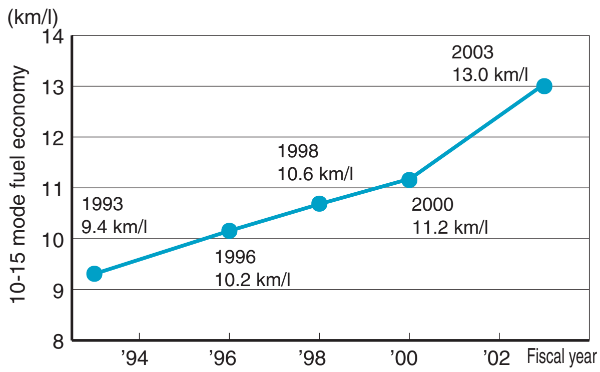
Trends in Attainment Rates for Fiscal 2010 Fuel Economy Standards (Gasoline Mini-Sized Trucks)



Fuel Economy of the New Legacy (AWD-AT IW = 1500 kg)



Trends in Fuel Economy of the Legacy Turbo AT



Exhaust Emissions

Substances emitted from automobiles, such as carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxides (NOx), are one of the causes of air pollution in metropolitan areas where there is heavy motor traffic. In order to improve air quality, Subaru is launching low emission vehicles (certified by the Ministry of Land, Infrastructure and Transport) that meet higher standards than the regulation standards in the market one after another.

Application Status of Low Emission Vehicles

The 2.0L SOHC engine vehicle has reached the "ultra low emission" level for the first time at Subaru by reviewing the catalyst layout in the new Legacy that has received a full model change in fiscal 2003. The "ultra low emission" level is 75% more stringent than the 2000 emissions standard. Additional models, the 2.5L SOHC vehicle and the 3.0L DOHC vehicle, also meet the "ultra low emission" level. The vehicles with other engines also meet the "good low emission" level, which is 25% more stringent than the 2000 standard.

The new R2 minicars that are powered by naturally aspirated engines, also satisfy the "ultra low emission" level, which is 75% more stringent than the 2000 emissions standard, while the vehicle with a supercharger meets the "excellent low emission " level, which is 50% more stringent than the 2000 emissions standard.

The new Legacy, powered by the 2.0L SOHC engine (B4, Touring Wagon) and the 3.0L DOHC engine(Touring Wagon, Outback), and the R2, powered by the naturally aspirated engine, also meet the "U-LEV" level, that is 50% more stringent than the 2005 emissions standard.

Exhaust Gas Measures for the New Legacy

- Optimized combustion chamber form with the fully improved cylinder head
- Upgraded air-fuel ratio control performance by adopting the electronically controlled throttle valve
- Adoption of the HC adsorbent catalyst (turbo and SOHC vehicles)

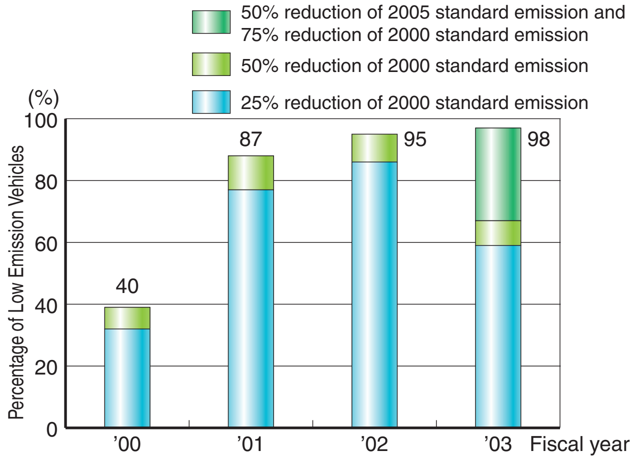
Exhaust Gas Measures for the New R2 Minicar

- Optimized combustion chamber form with the fully improved cylinder head and control of uneven combustion among the cylinders
- Optimized combustion by adopting the Active Valve Control System (AVCS)
- Upgraded air-fuel ratio control performance by adopting the electronically controlled throttle valve
- Upgraded after treatment capability due to pared down walls and increased cells in the catalytic honeycomb
- Improved air-fuel ratio control performance by adding the O_2 sensor to the downstream of the catalyst (adoption of the double O_2 sensor system)

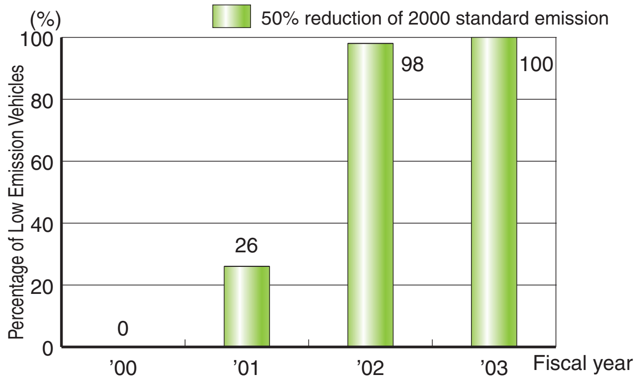
Trends in Percentages of Low Emission Vehicles

The low emission vehicles certification system started in April 2000. The percentages of the Subaru brand low emission vehicles are as follows.

Trends in Percentages of Low Emission Vehicles on Gasoline Passenger Cars



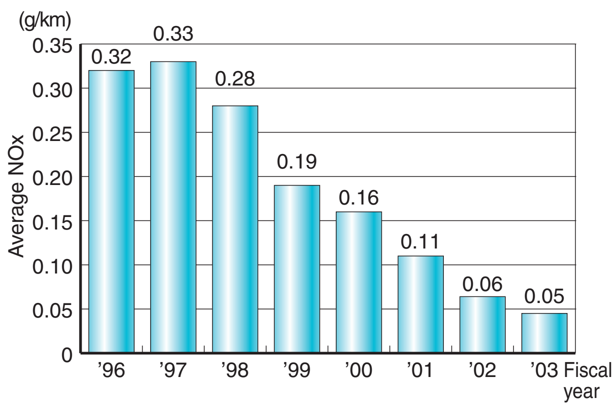
Trends in Percentages of Low Emission Vehicles on Mini-Sized Gasoline Trucks



Trends in NOx Averages

By putting more low emission vehicles 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 Average NOx Emissions of Subaru Vehicles

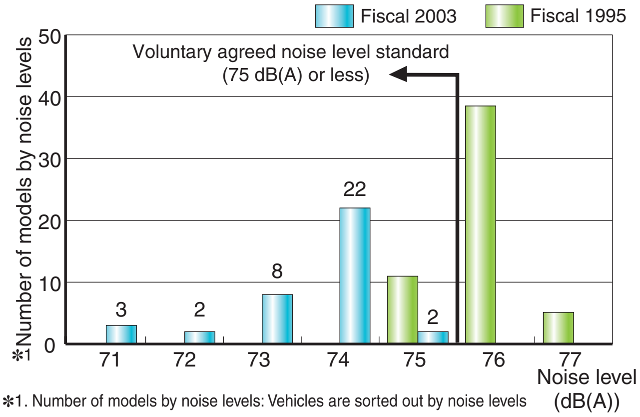


Notes: · The figures were calculated based on the regulation values and the standard values at the time of shipment.
· From fiscal 2003, some of the models were calculated with the regulation values to conform to the new test mode. The new test mode is a combined mode in which the 10-15 mode and 11 mode are combined.

Noise

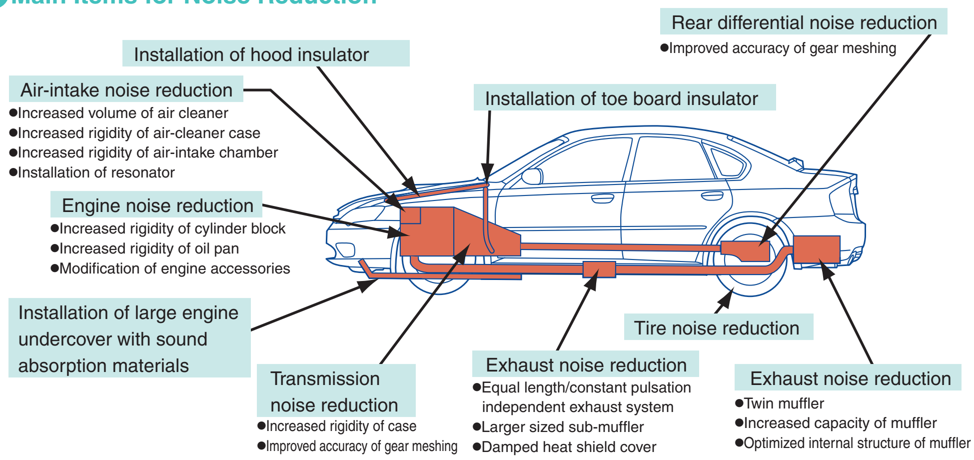
Subaru has been working to reduce the noise generated from the engine, transmission, air intake and exhaust, and tires in order to reduce the noise induced by a vehicle. In addition, Subaru reduces the noise induced by the rear differential of AWD vehicles. In fiscal year 2003, Subaru adopted the equal length/constant pulsation independent exhaust system and the twin muffler for the new Legacy to reduce noise further. Also in other models, Subaru is aspiring to reduce noise by increasing the capacity of the exhaust system and by promoting adoption of large undercovers.

Trends in Acceleration Noise (Domestic/Passenger cars)



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

Main Items for Noise Reduction



Equal length/constant pulsation independent exhaust manifolds

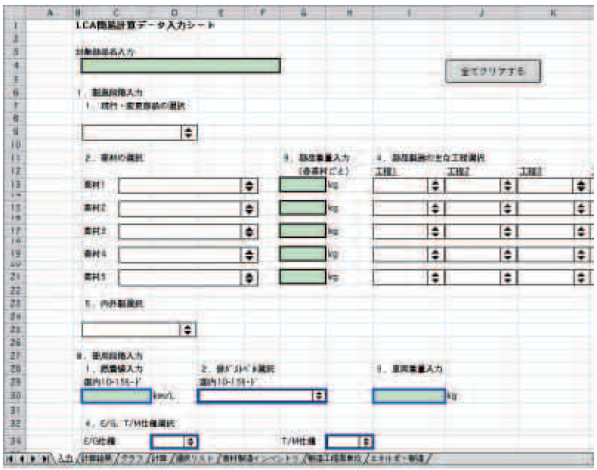
LCA Activities

In April 2002, Subaru established the LCA Utilization Investigative Commission to study LCA. In fiscal year 2003, we started using LCA on a trial basis, through the arrangement of data and application of LCA case study on parts in the development stage. Subaru has developed LCA simplified calculation software for easy LCA application to parts level development in order to utilize the LCA concept for the development process.

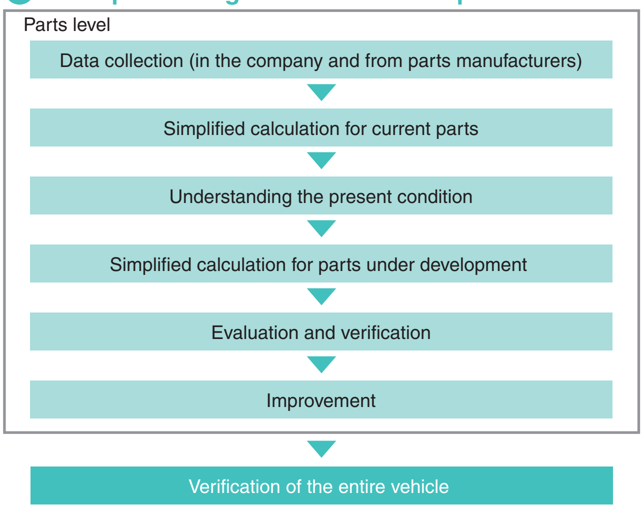
An example of the LCA concept is to evaluate and verify the effects of material changes for weight reduction and the effects on fuel economy in practical use for the total lifecycle by applying simple estimates in parts levels, such as body panels and interior products.

We will continue to scrutinize and accumulate in-house data in order to expand the LCA application.

Data Input Sheet



Concept of Using LCA in the Development Phase



Clean Energy Vehicles

Clean energy vehicles emit less global warming substances (carbon dioxide) and air pollutants (carbon monoxides, hydrocarbons, nitrogen oxides, etc.) and are less harmful to the environment than the 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 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 FHI'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 cheaper 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

The Legacy B4 CNG has been limitedly introduced to the market since fall 2002. Ten vehicles were delivered to local governments and gas companies in fiscal 2002, and two vehicles at the beginning of fiscal 2003 for the purposes of data collection and practical evaluation through actual use. In addition, the car was exhibited at 14 sites, including low-pollution vehicle fairs (see Social Contributions), so that people could actually view and drive the CNG. The NGV, which is based on the new Legacy launched in spring 2003, has been on sale since May 2004.

Legacy B4 2.0 CNG

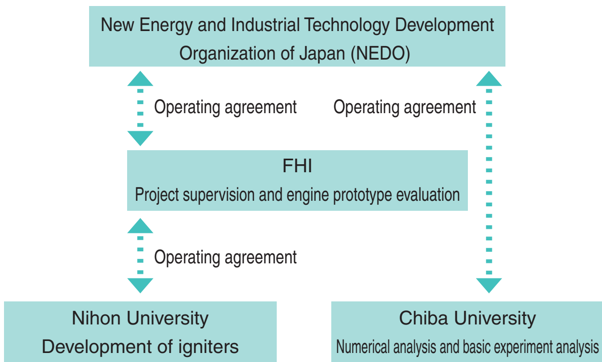
Legacy B4 CNG Ran Around Japan

In August 2003, we provided the Legacy B4 CNG for the Saitama Energy Association Network, an organization of filling stations in Saitama Prefecture, to cooperate for the "Project of Running Across Japan by NGV" organized by the association (a part of the program to investigate and actualize sophisticated management of oil dealers in 2003 supported by the Agency for Natural Resources and Energy).

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

For cleaner, energy-saving power sources for the future, national-scale cross-sectoral development is required among the industry, academia, and government, besides research and development at each company. 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. Jointly with Chiba University and Nihon University under consignment from NEDO, Subaru is conducting basic research on new gasoline engines that emit fewer pollutants with higher efficiency parity with diesel engines. We will contribute to conservation of future energy in Japan by developing gasoline engines of super high compression ratios, which has been thought to be difficult, by the industry, academia, and government through NEDO.

Research System and Responsibility



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

Gasoline Passenger Cars

Equivalent inertia 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 inertia weight (kg)		—750		875		1000—
Vehicle weight (kg)	Lower limit	|		703		828
	Upper limit	702		827		|
Vehicle structure (Note)		Structure A	Structure B	Structure A	Structure B	—
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 FWD (front-wheel drive) vehicles or FWD-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 Authorization 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 standard emission 25% reduction level	0.67	0.06	0.06	19.0	1.65	1.05	Good low emission vehicle
2000 standard emission 50% reduction level	0.67	0.04	0.04	19.0	1.10	0.70	Excellent low emission vehicle
2000 standard emission 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 standard emission 50% reduction level	1.15	0.025	0.025	10-15 mode & 11 mode	U-LEV
2005 standard emission 75% reduction level	1.15	0.013	0.013	10-15 mode & 11 mode	SU-LEV

New Short-Term Regulations for Gasoline and LPG Mini-Sized Trucks

	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 standard emission 25% reduction level	3.30	0.10	0.10	38.0	2.63	1.65	Good low emission vehicle
2000 standard emission 50% reduction level	3.30	0.07	0.07	38.0	1.75	1.10	Excellent low emission vehicle
2000 standard emission 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 Mini-Sized Trucks

	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 standard emission 50% reduction level	4.02	0.025	0.025	10-15 mode & 11 mode	U-LEV
2005 standard emission 75% reduction level	4.02	0.013	0.013	10-15 mode & 11 mode	SU-LEV