NISSAN
MOTOR COMPANY

New-Generation VQ Engine Briefing

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Nissan Motor Co., Ltd.

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Agenda

1. The Powertrain concept
2. History of the VQ Engine
3. Concept behind the Newly-Developed V6 Engine
4. New-Generation VQ35/25HR Engine
5. Summary

1. The Powertrain concept

1-1. Nissan's Core Technology Values

Trusted Driving Pleasure

Trust :

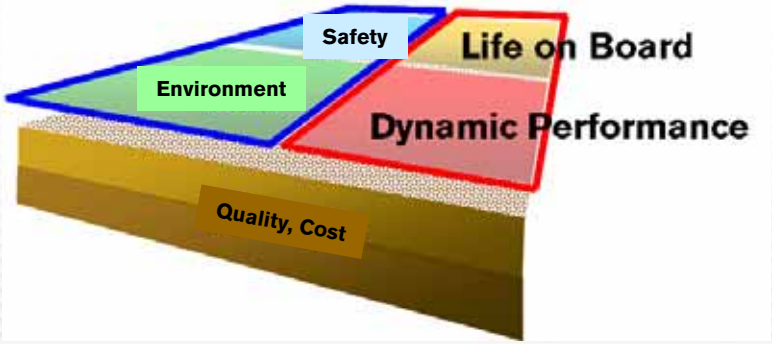
- ***Environment***
- ***Safety***

Driving Pleasure :

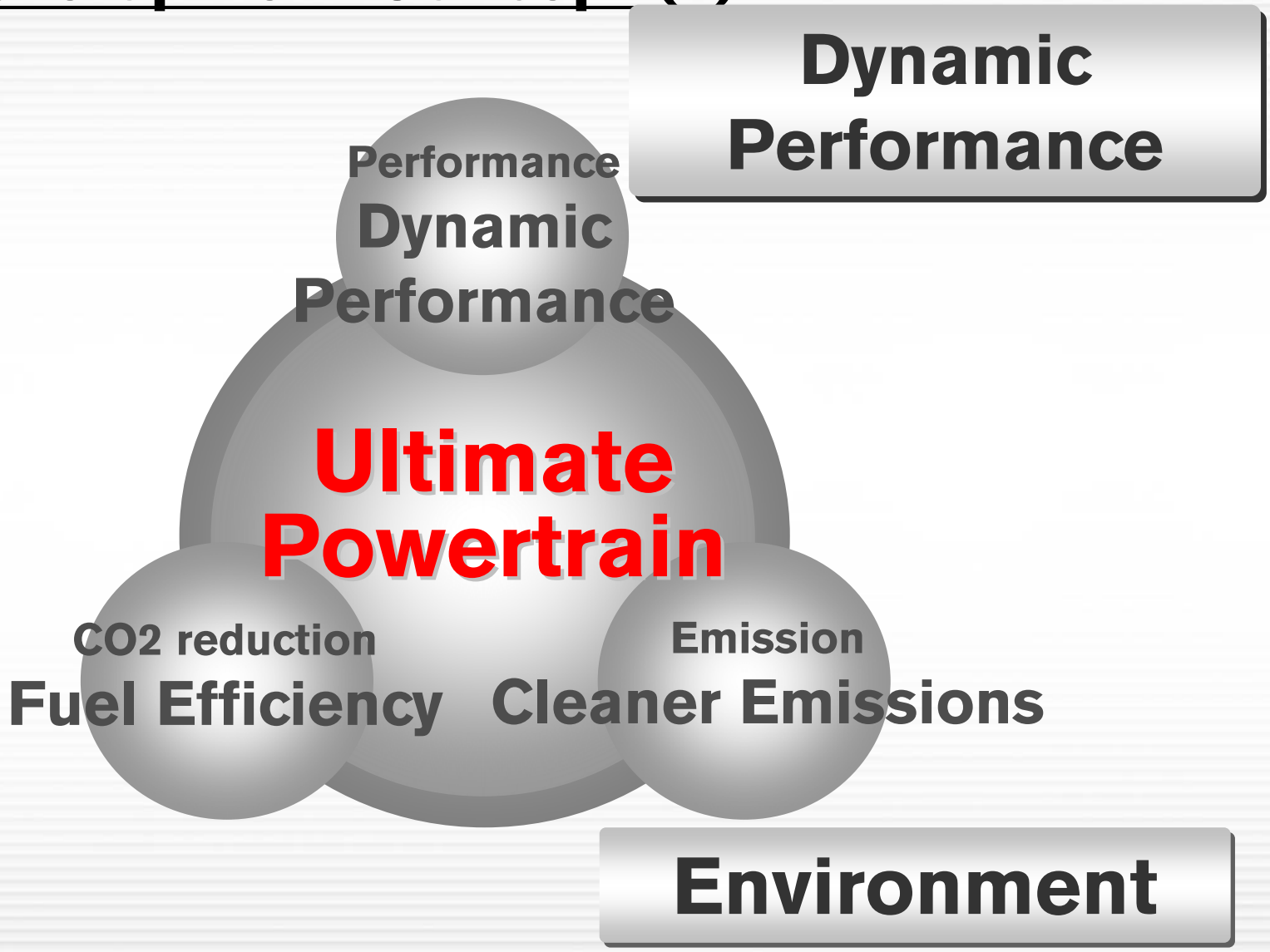
- ***Dynamic Performance***
- ***Life on Board***

Environment

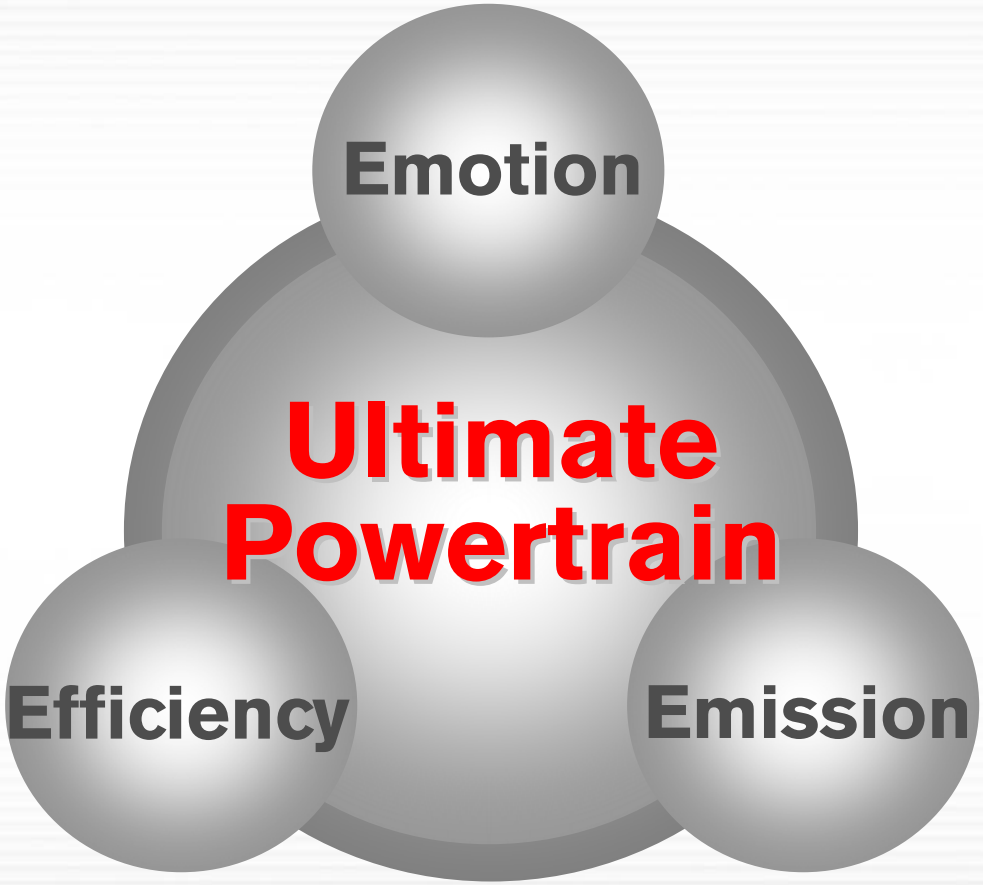
Dynamic Performance



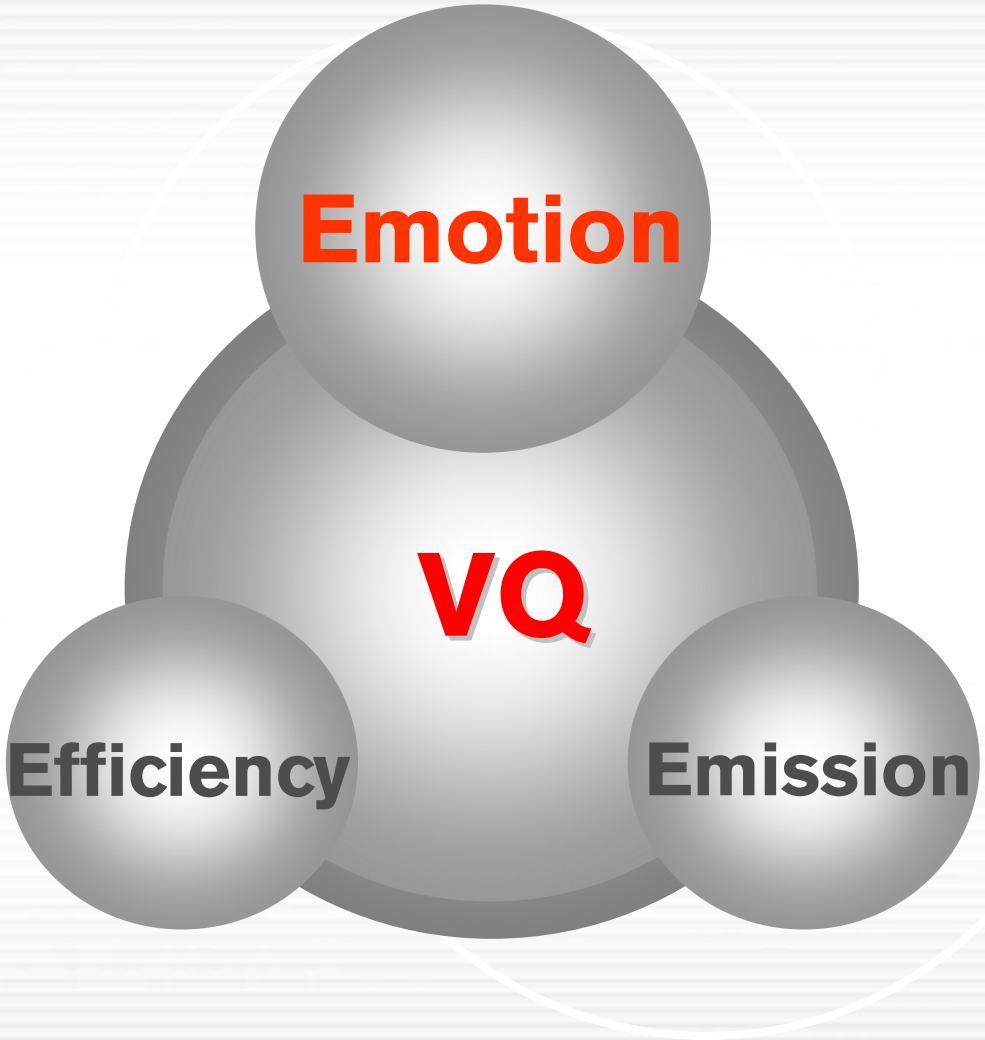
1-2. Development Concept (1)



1-2. Development Concept (2)



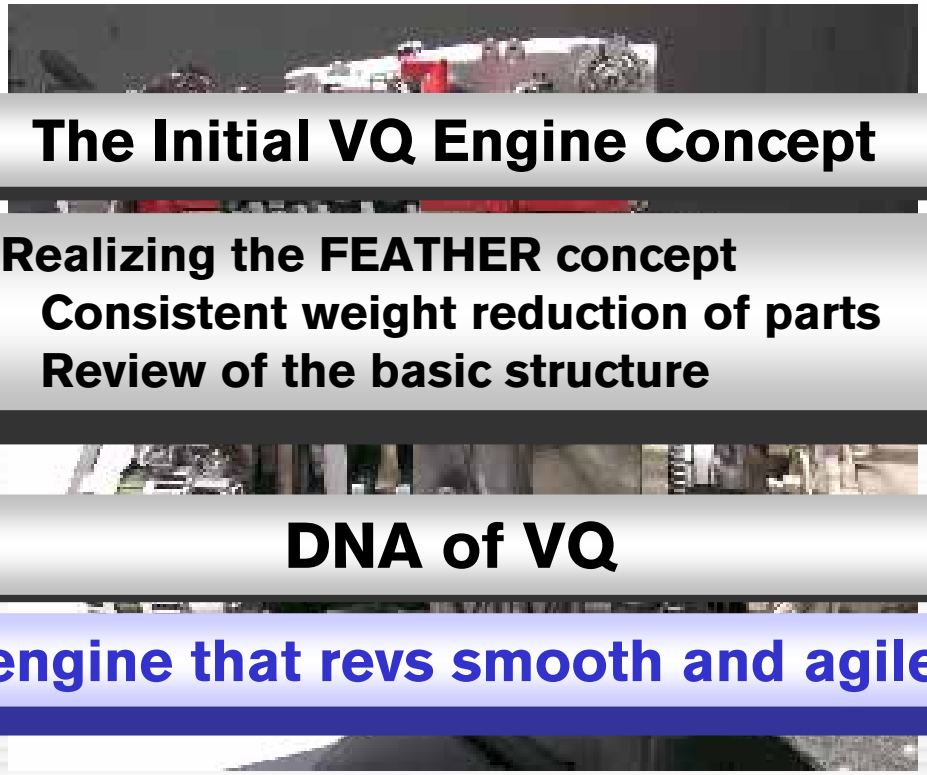
1-3. Logic behind the VQ Engine (1)



1-4. DNA of VQ

- **1988: The FEATHER concept engine was developed with focus on smooth and agile revving.**

"As agile as a feather"



The Initial VQ Engine Concept

- **Realizing the FEATHER concept**
  - **Consistent weight reduction of parts**
  - **Review of the basic structure**

DNA of VQ

"The engine that revs smooth and agile"

1-5. Emotional (1)

“Pleasant Acceleration Sound”

・Clear sound

“Maintaining the Exhilaration”

・Overwhelming power

・Long-lasting power

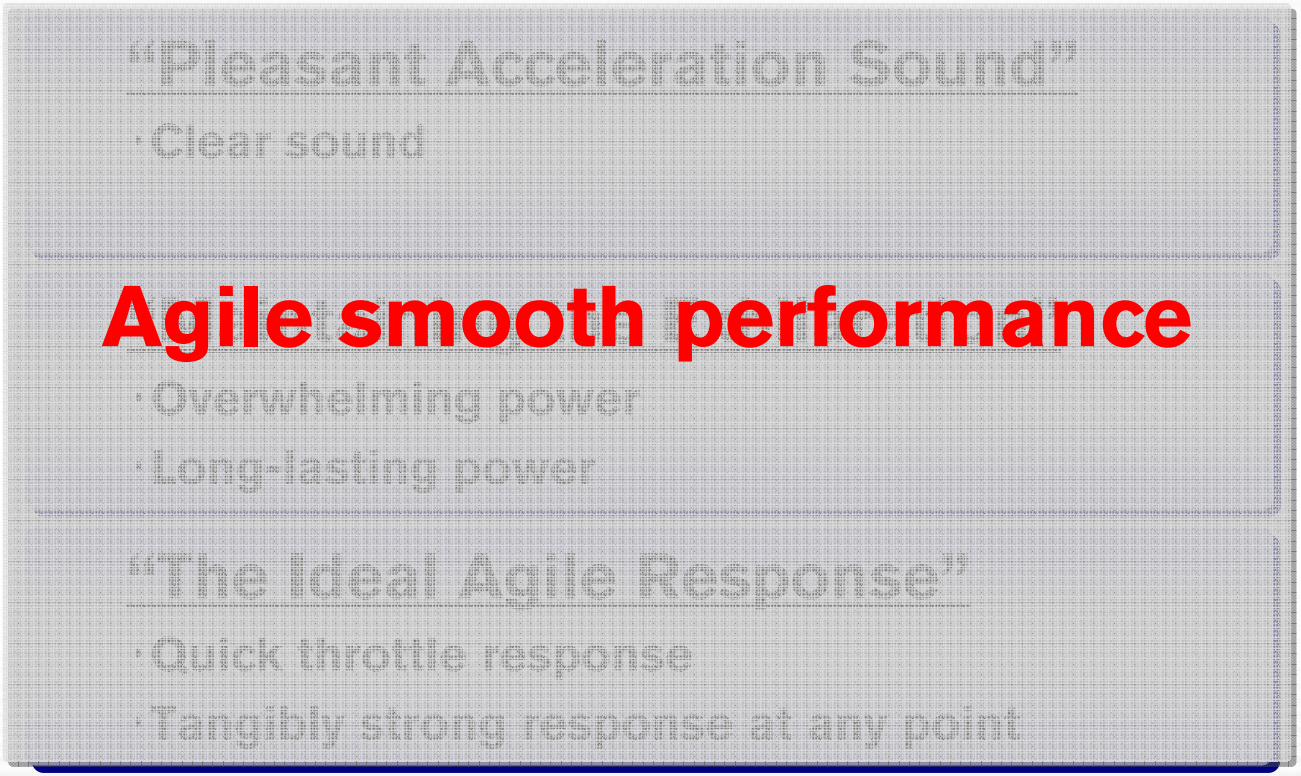
“The Ideal Agile Response”

・Quick throttle response

・Tangibly strong response at any point

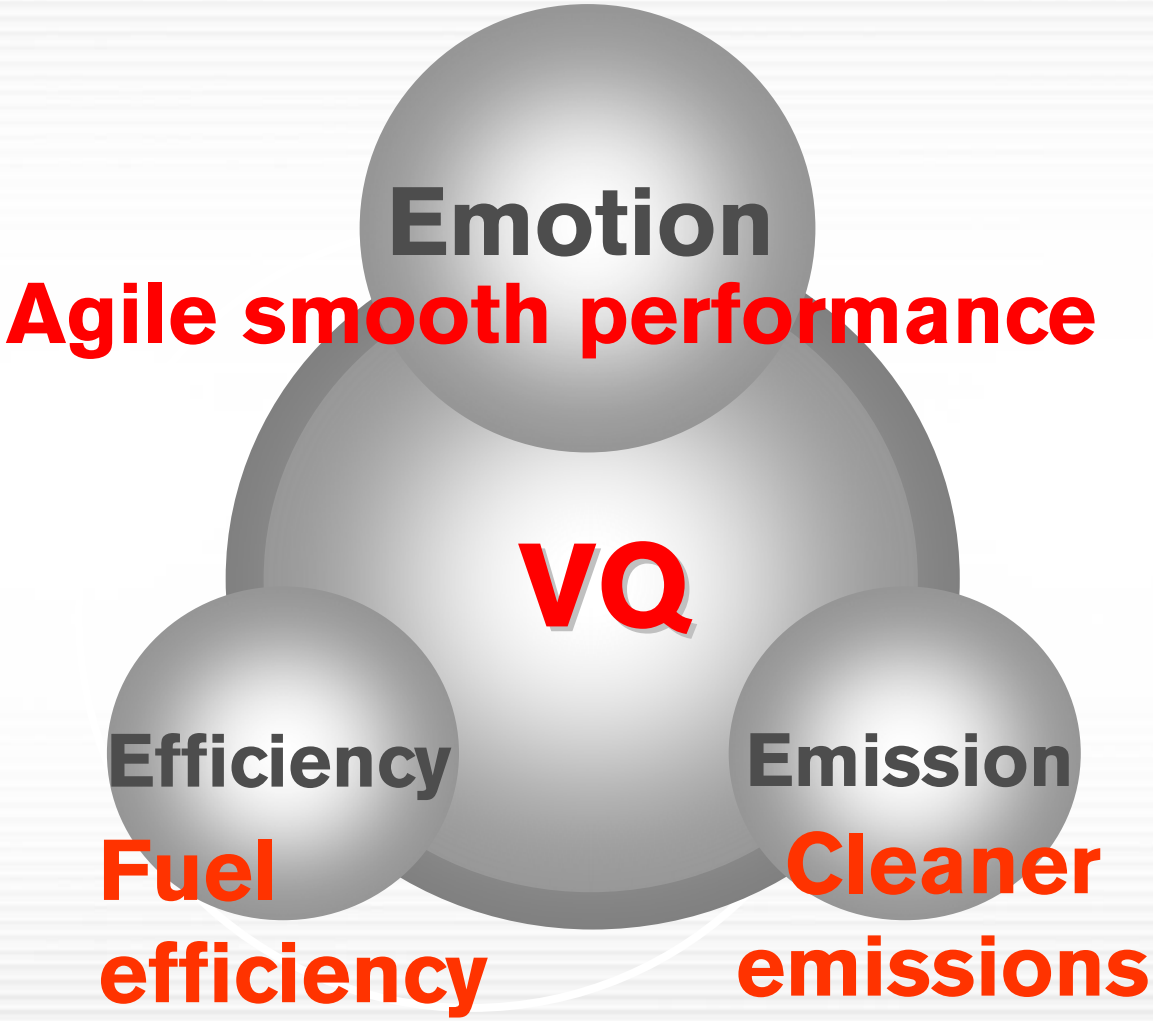
“The engine that revs smooth and agile”

1-5. Emotional (2)



"The engine that revs smooth and agile"

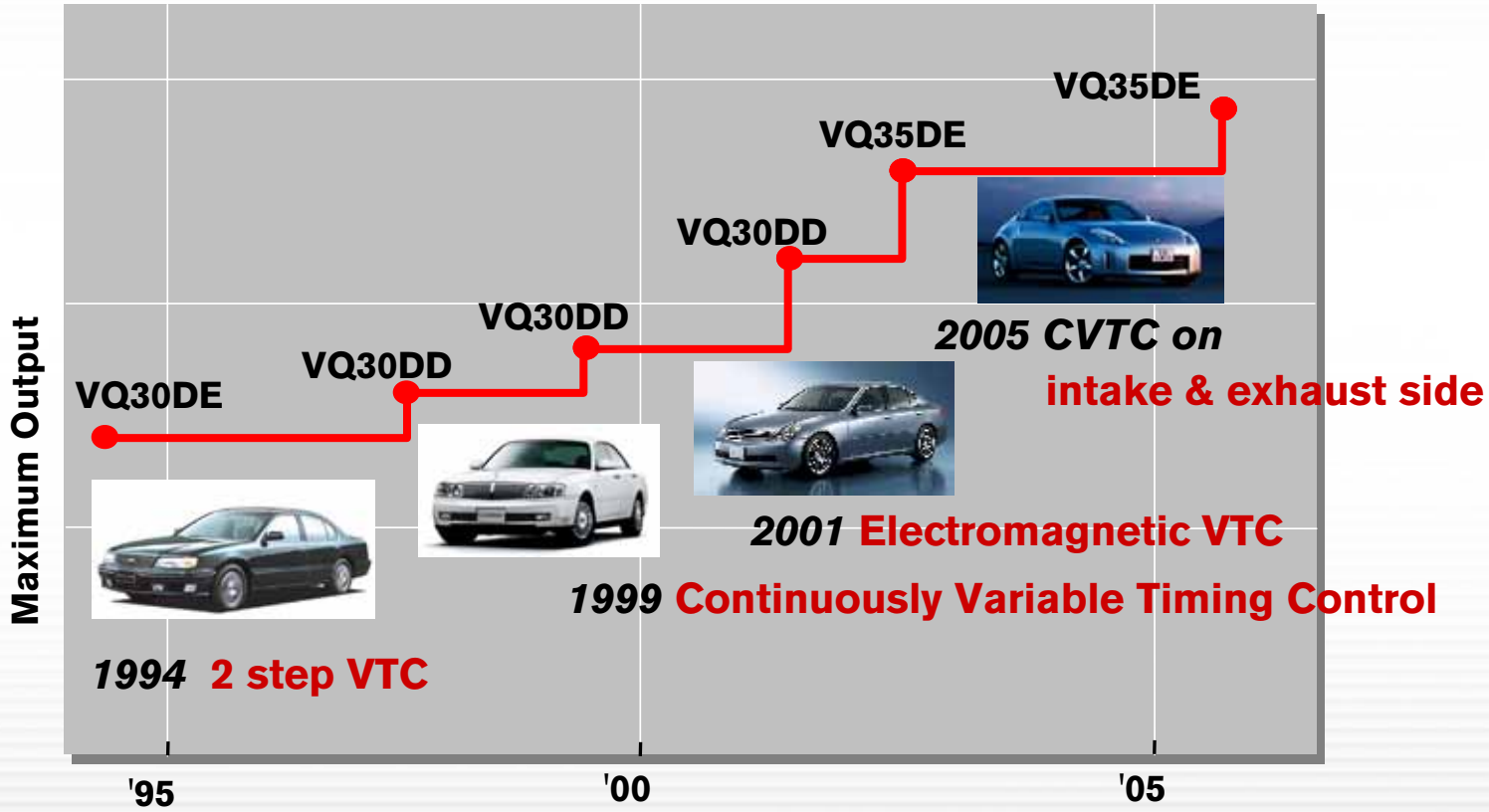
1-6. Considering the VQ Engine (2)



2. History of the VQ Engine

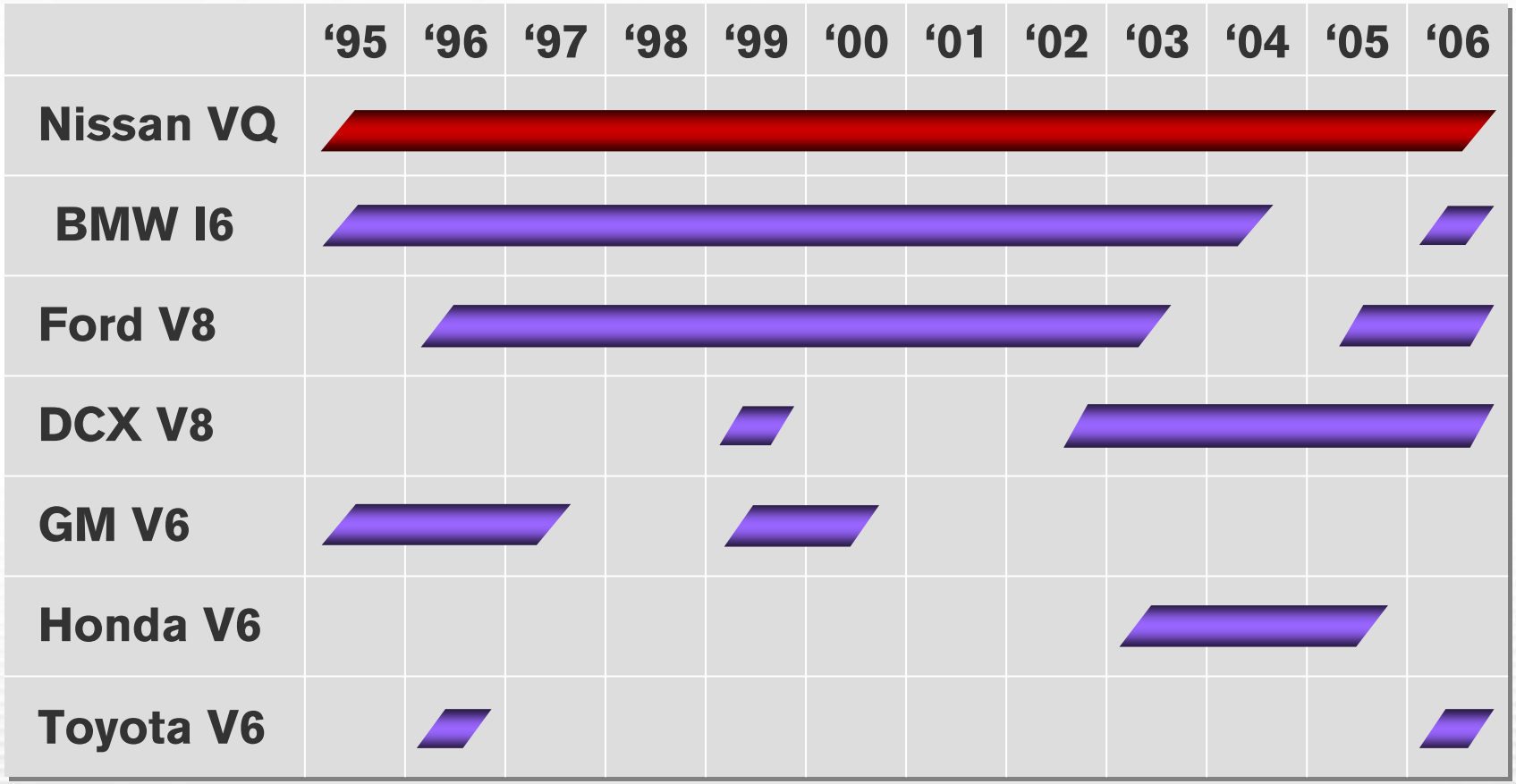
2-1. Evolution of the VQ Engine

- Constant improvements made to the VQ engine.
- Constant application of new technology.



2-2. Evaluation of the VQ Engine (1)

- On “Ward’s 10 Best Engines” list for 12 consecutive years.



2-2. Evaluation of the VQ Engine (2)

- **VQ's DNA evaluated as an engine that revs smooth and agile.**

"Ward's 10 Best engines" Comments

'95 "The smoothest, rev-happiest V-6 on the planet"

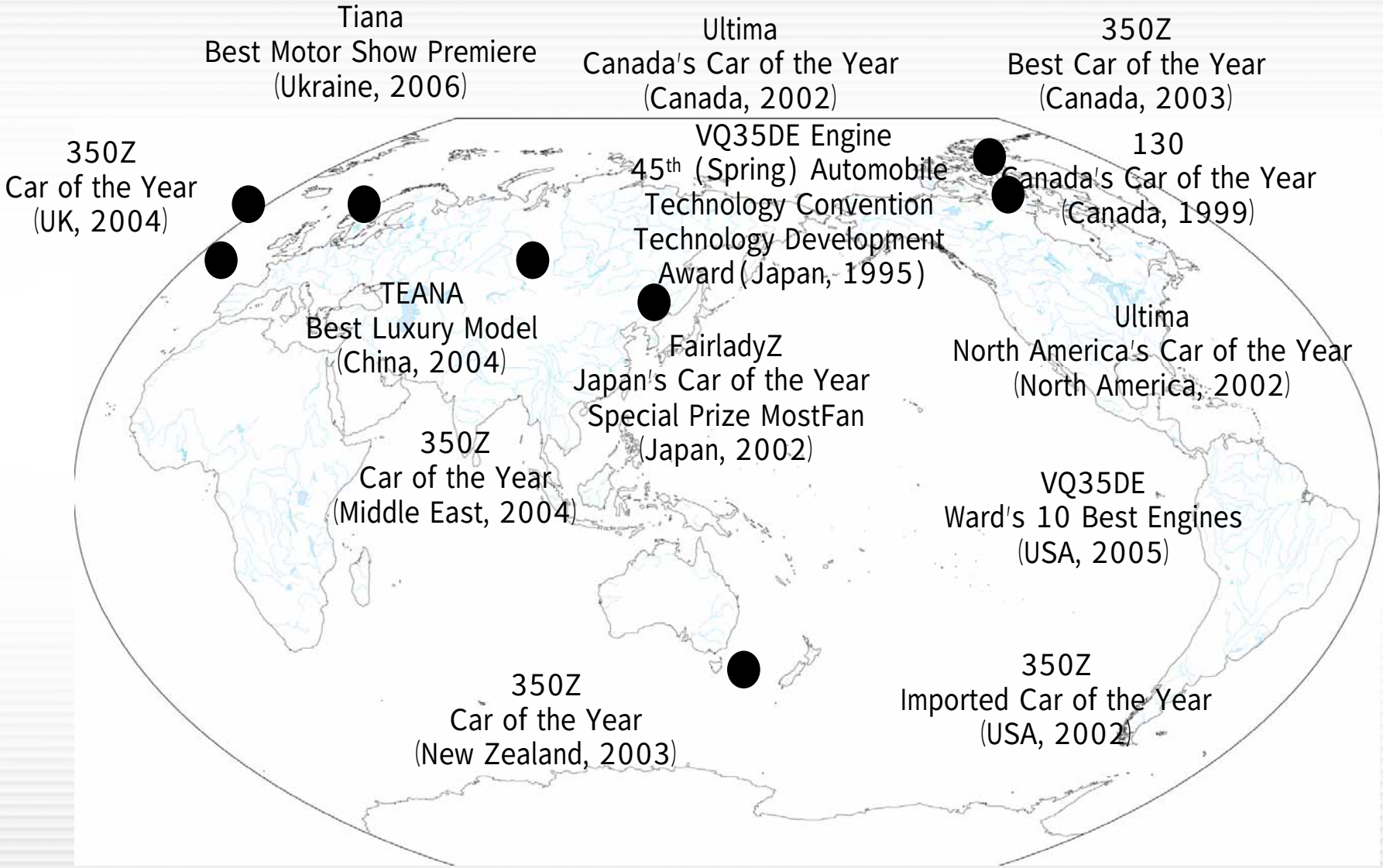
'98 "The light-on-the-feet feel in any speed range is the VQ's greatest delight"

'00 "It's cat-quick throttle response and unmatched smoothness also mean it's a genuine delight to drive"

'01 "Absolutely uncanny lack of vibration" "The throttle response is outstanding" "This is unquestionably the best-revving V-6 ever"

'06 "Spectacular in-gear accelaration" "This engine has brilliant throttle response in any speed range"

2-3. Evaluation of Cars Powered by VQ Engines



3. The Concept Behind the Newly-Developed V6 Engine

3-1. Considering Newly-Developed V6 engine (1)

- Start the development of a new V6 engine by reviewing principal dimensions aimed at even more agile and smooth revving.

High Response

High Revolution

- In continuation of VQ engine aspiration, the new engine name followed by “HR” which represents high rate of revolution and outstanding accelerator response.

3-2. Technology of New-Generation VQ Engine

- Increased height of cylinder blocks
- Change of cylinder head
- Straight inlet port
- Reinforce chain cover durability
- Hydraulic CVTC on intake side
- Electromagnetic CVTC on exhaust side
- Change oil pump rotor
- Reinforce upper oil pan durability
- Reinforce lower oil pan durability
- Enlarge diameter of crankpin
- Improve cooling water flow
- Twin knock sensor
- Symmetric Twin intake System
- Sound insulating engine cover
- Reinforce rocker cover durability

- Asymmetric piston skirt
- Equal length exhaust manifold
- High ignitability iridium plug
- Lengthening of Conrod
- Hydrogen-free DLC valve lifters
- Increase spring power of valve spring
- Enlarge crank journal diameter
- Change diameter of valve
- Processing PVD Piston Ring
- Settings for ladder frame
- Spark plug modified into M12
- Increase compression ratio

3-3. Newly Built 2nd Engine Facility at Iwaki Plant

- Factory established for the sole purpose of VQ35HR, VQ25HR engine production

2nd Engine Facility

Introduction of state-of the-art processing equipment

4. New-Generation VQ35/25HR Engine

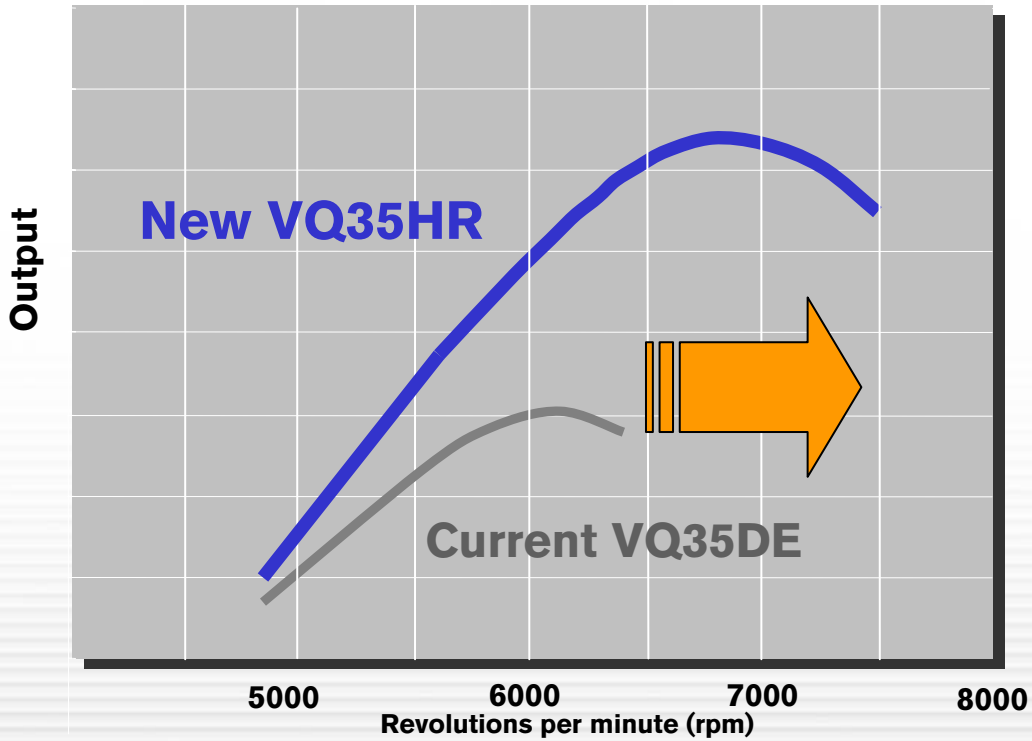
4-1. Aim of the New-Generation VQ35/25HR

Smooth, pleasant drive	Response	1) High rate of revolution Max 7500rpm
	Exhilaration	2) Pleasant acceleration sound Clear sound
	Acceleration sound	3) Top level power performance in class Improved intake･Exhaust･Combustion Efficiency
Fuel efficiency		4) Increased practical fuel efficiency Reduced friction
Cleaner emissions		5) Best-in-class emissions standard ☆☆☆☆(SU-LEV in Japan)

4-2. High Revolution Rate

4-2. High Revolution Rate

- **Reduced friction and vibration at high speeds.**
  - **Smoother piston action (reduced friction)**
  - **Installation of ladder frame (reinforced stiffness and reduced vibrations)**



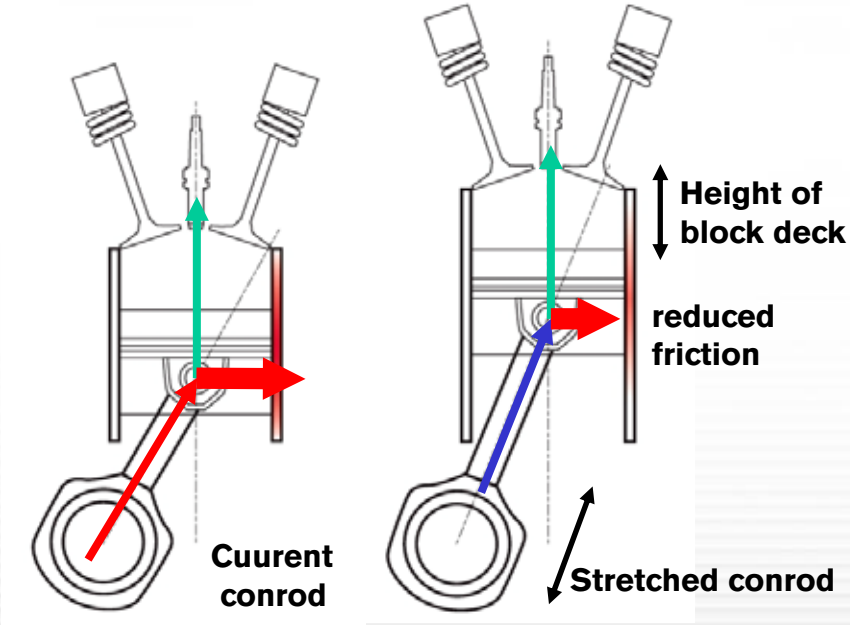
4-2-1. Smoother piston action (reduced friction)

Extension of conrod length

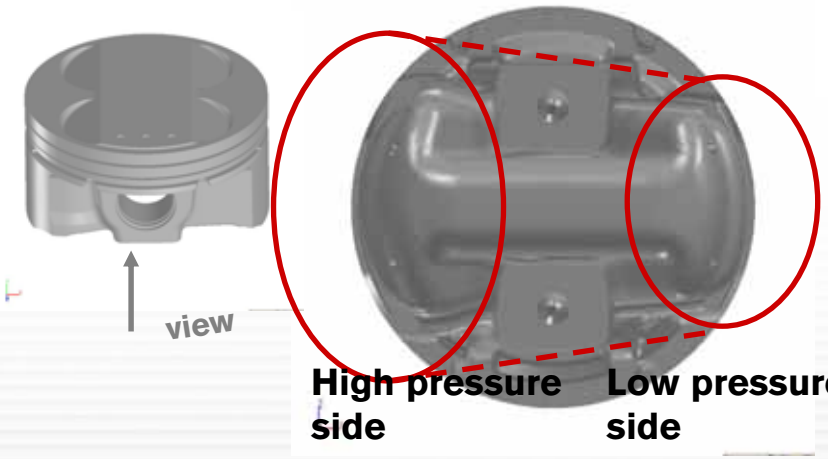
By minimizing piston inclination, reduced friction.

Asymmetric Piston Skirt

Skirt width reduced on side with least amount of pressure resulting in reduced friction.



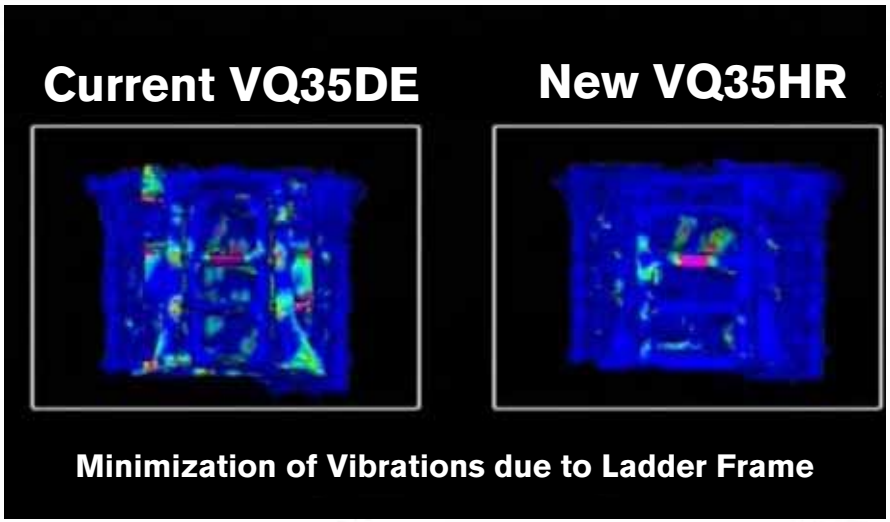
Extend the height of block deck and the length of conrod

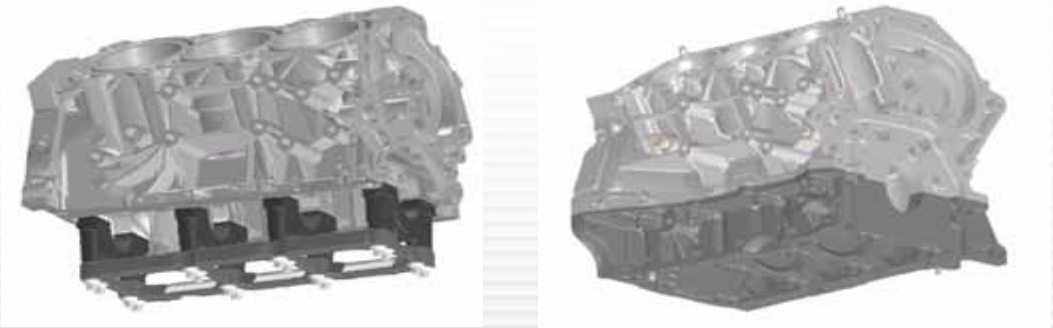


Asymmetric Piston Skirt

4-2-2. Addition of ladder frame (reduced friction due to reinforced stiffness)

- The ladder that supports the crank is placed at the bottom of the cylinder block to improve overall engine stiffness thereby minimizing vibrations at high revolution rates.



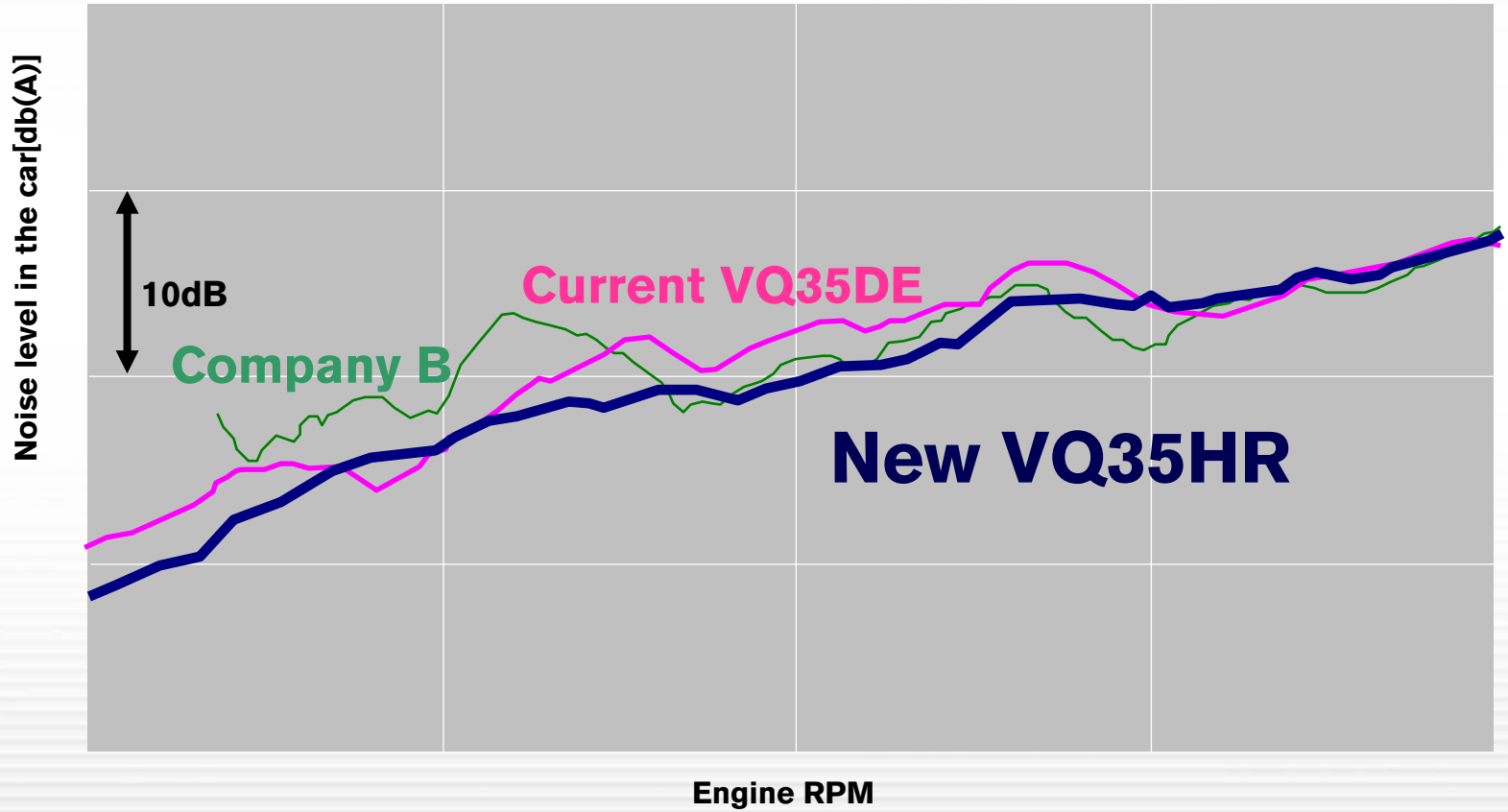


Current VQ35DE New VQ35HR

4-3. Pleasant Acceleration Sound

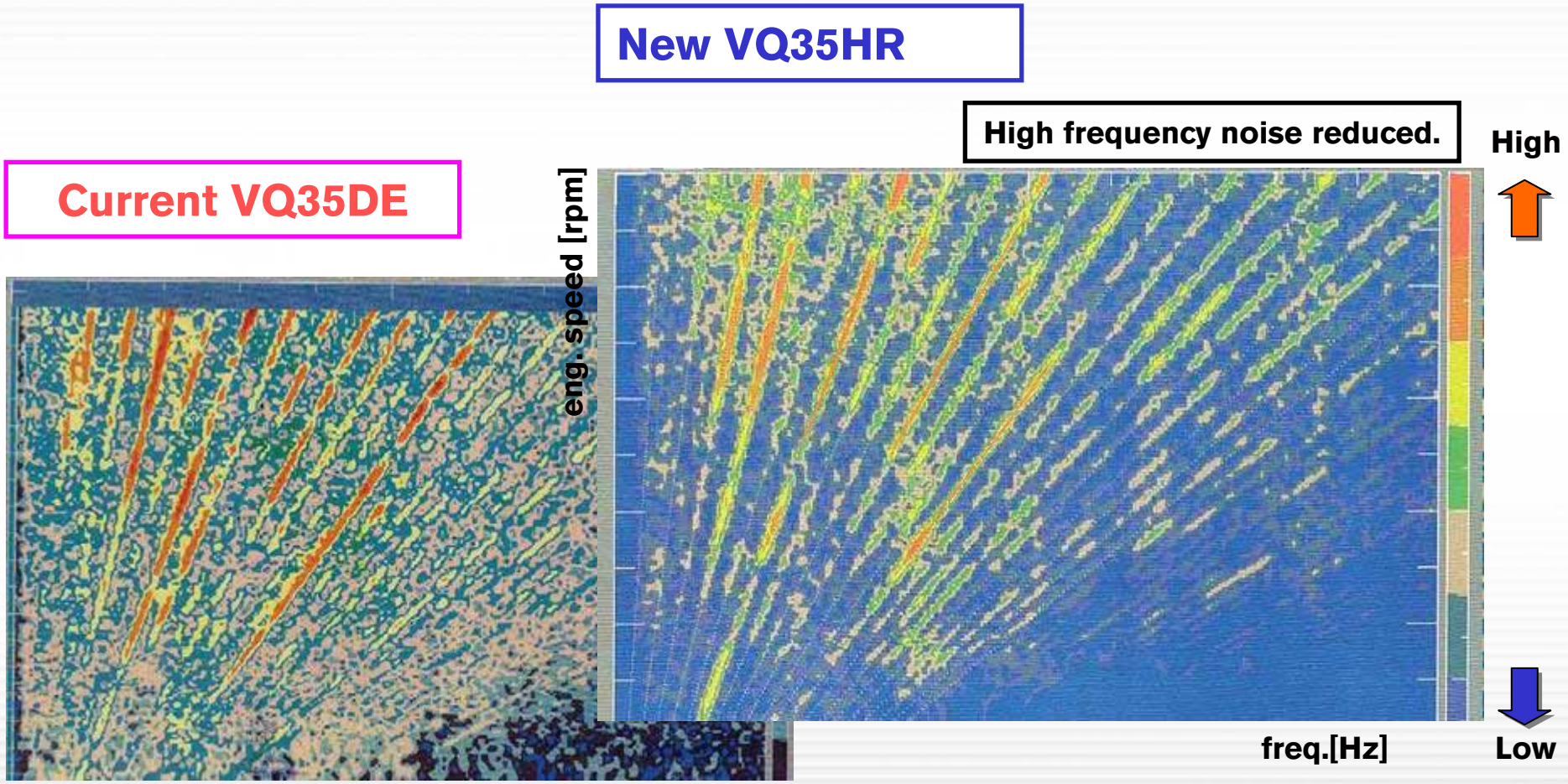
4-3. Pleasant Acceleration Sound (1)

- **Linear and clear acceleration sound in response to Engine RPM.**



4-3. Pleasant Acceleration Sound (2)

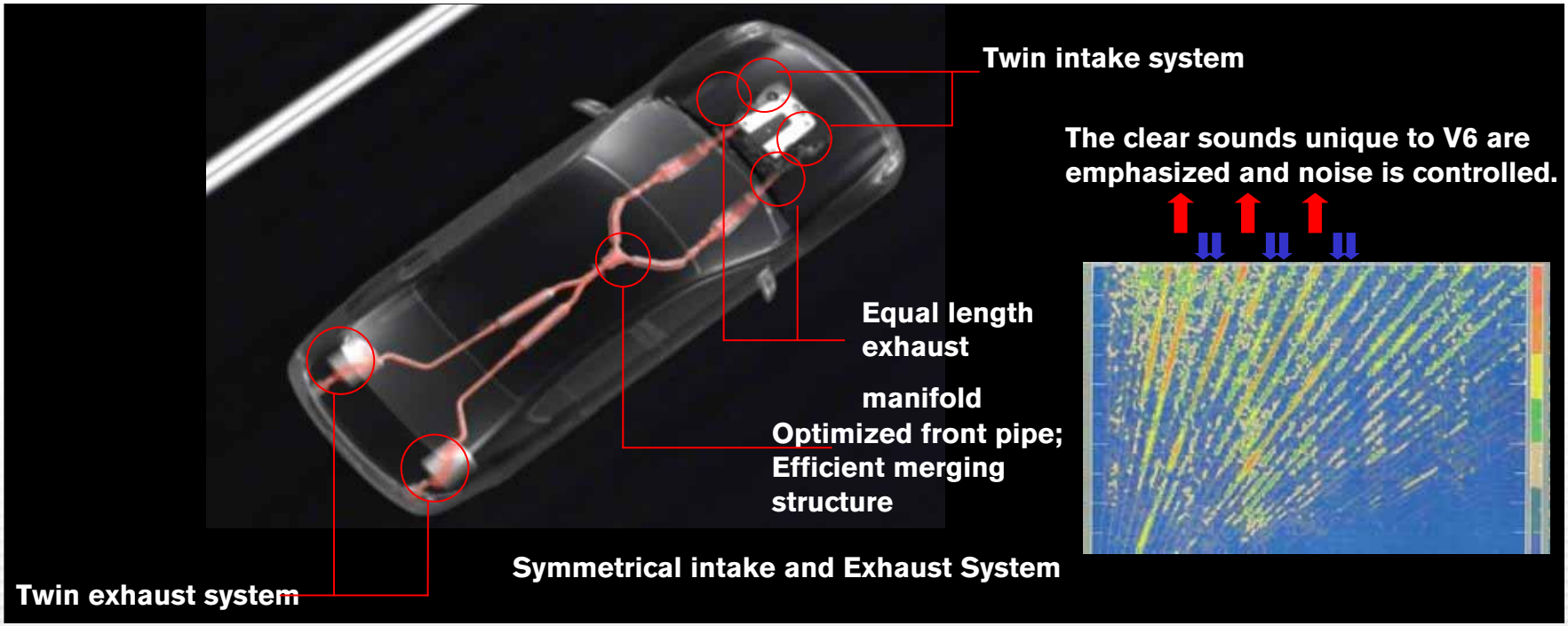
- **Reinforced sound clarity with reduced noise.**



4-3. Pleasant Acceleration Sound (3)

Symmetrical Intake and Exhaust System.

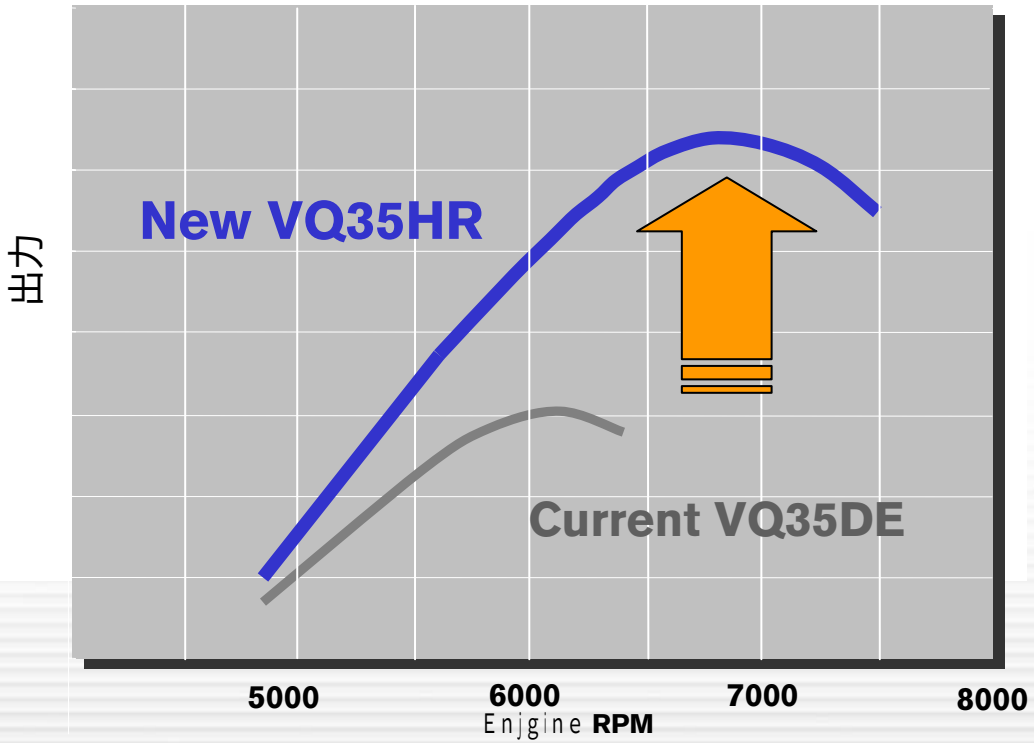
The symmetrical intake and exhaust system aids the production of clear and powerful sounds at high rates of revolution.



4-4. Top Level Power Performance in Class

4-4. Top Level Power Performance in Class

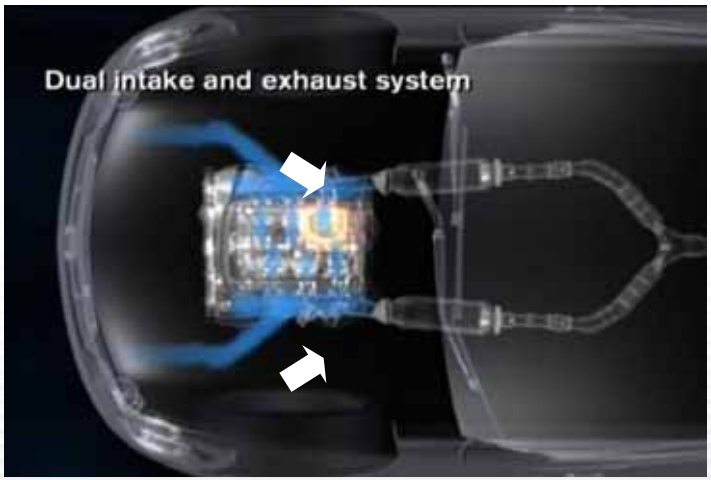
- **Improvements in Intake・Exhaust・Combustion Efficiency.**
  - **Reduces resistance to intake by 18%**
  - **Utilizes VTC intake and exhaust controls on both sides**
  - **Suppresses exhaust loss**



4-4-1. Reduces resistance to intake by 18%

- **Dual intake and exhaust system.**
- **Straight intake port.**

Ensures the efficient intake of air.

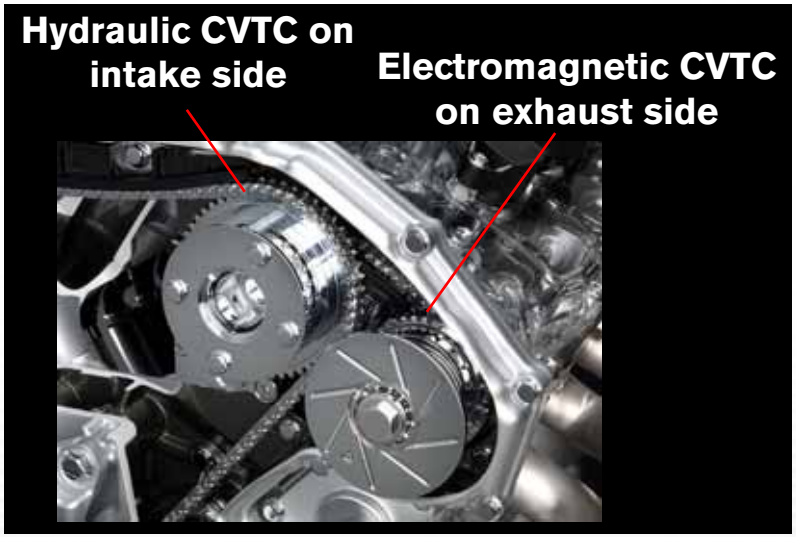


Dual intake and exhaust system

Straight Intake Port

4-4-2. Utilizes CVTC intake and exhaust controls on both sides

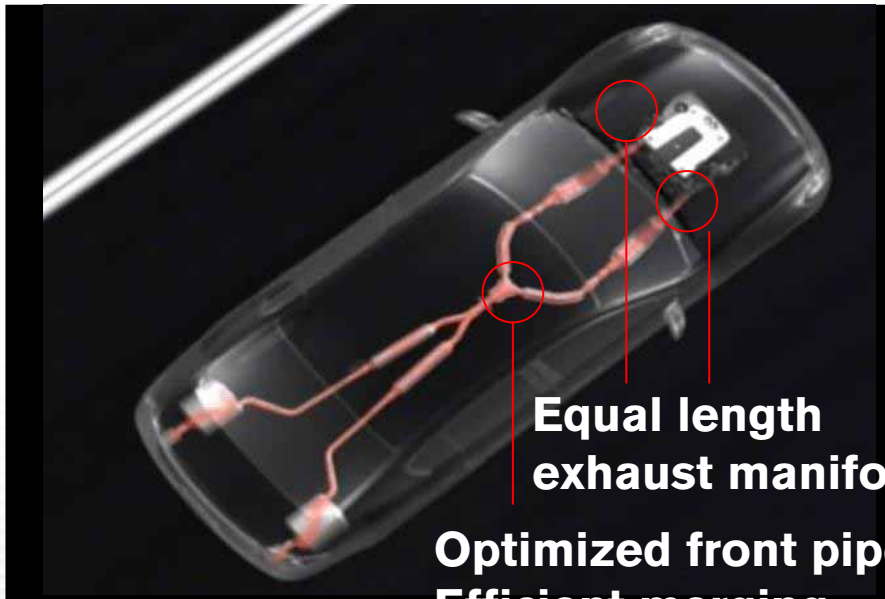
- **High degree of flexibility in setting valve timings improve the combustion efficiency for a wide range of engine rpms.**

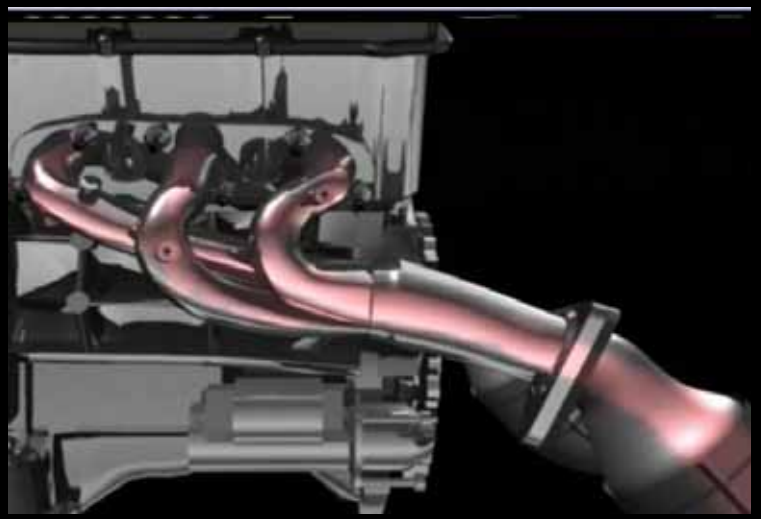


CVTC intake and exhaust controls on both sides

4-4-3. Surpresses Exhaust Loss

- Equal length exhaust manifold.
- Symmetrical exhaust system.





Equal length exhaust manifold

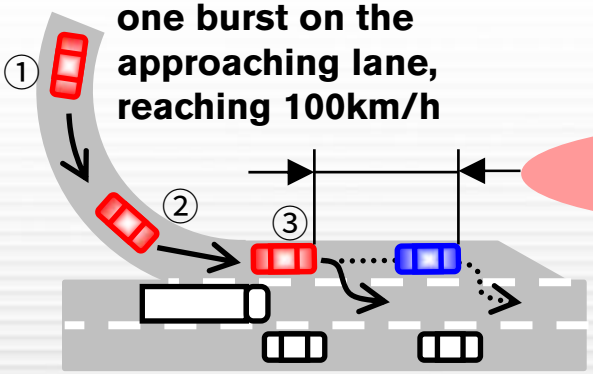
4-4-4. Performance of VQ35HR powered vehicles (1)

■ Powerful starting + stress-free long-lasting acceleration expandable to 7,500rpm.

Eg: Expressway entrance ⇒ **The VQ35HR's formidable power is most strongly felt under driving conditions that demand smooth acceleration from low to high speed.**

① After passing through the tollbooth, the vehicle gradually accelerates on the ramp

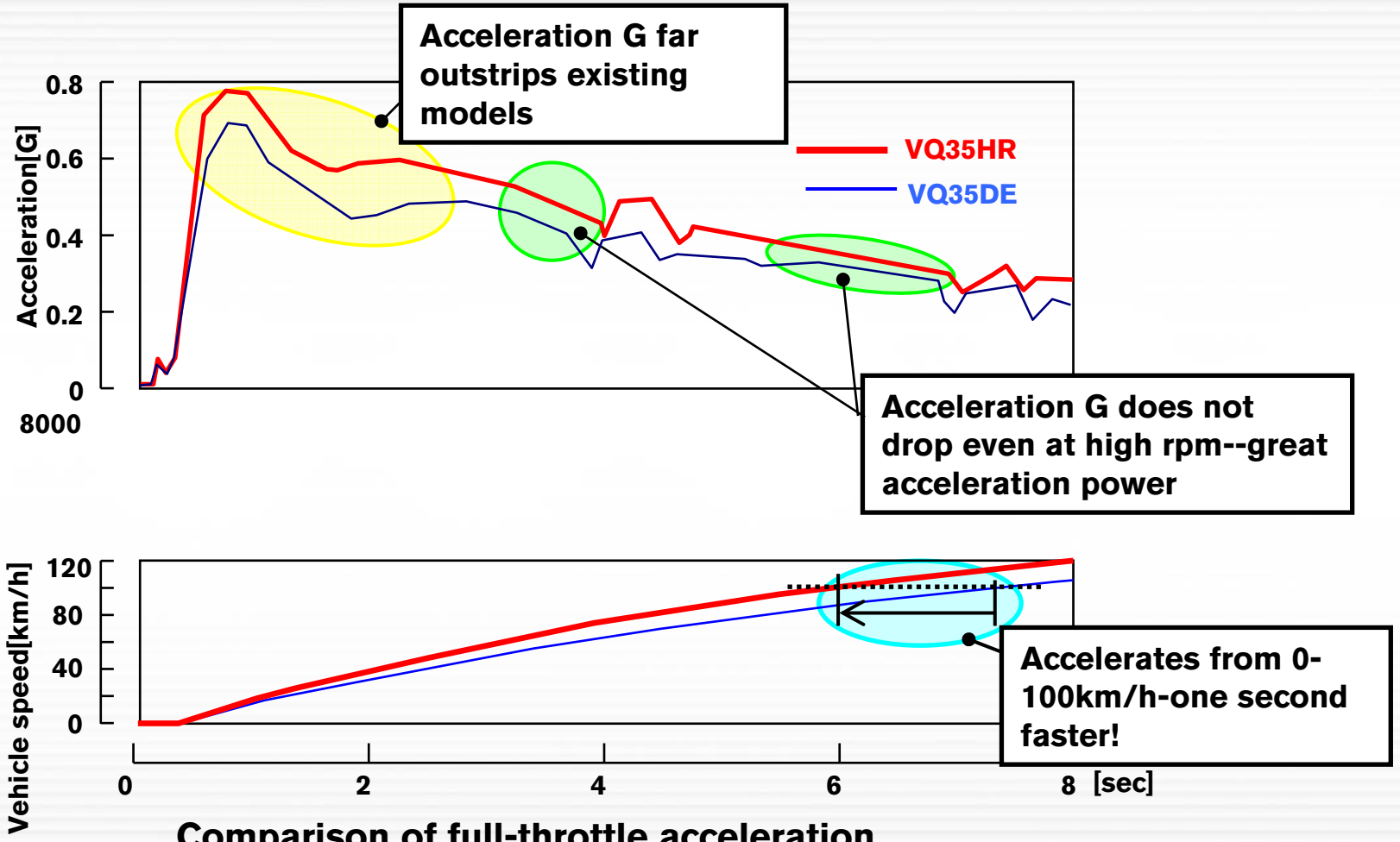
② It then accelerates in one burst on the approaching lane, reaching 100km/h



③ The vehicle attains the expressway traffic flow and merges into the main lane.

Attains speed even on short approach!

4-4-4. Performance of VQ35HR powered vehicles (2)

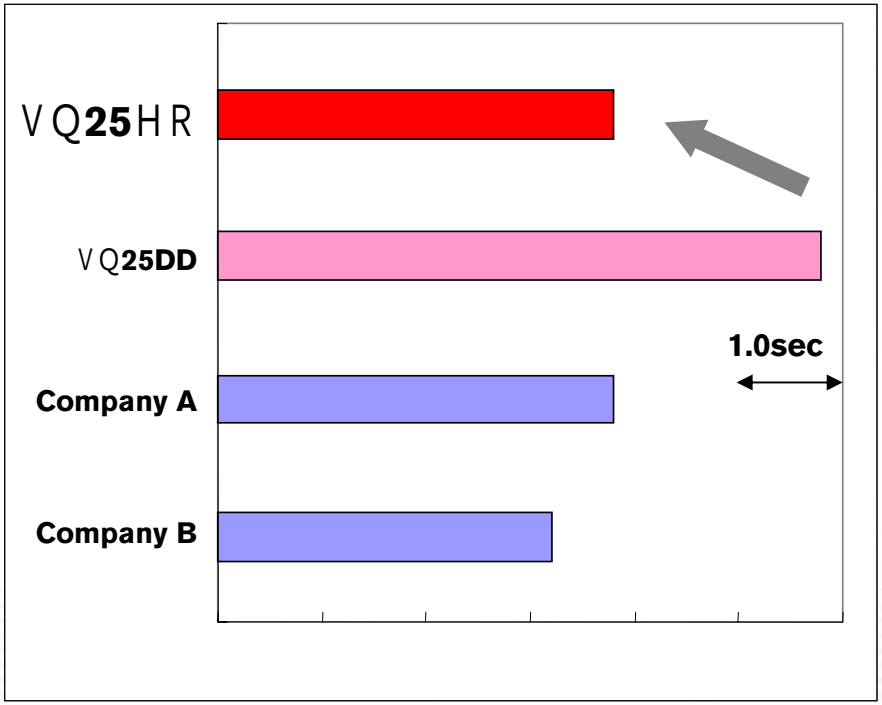


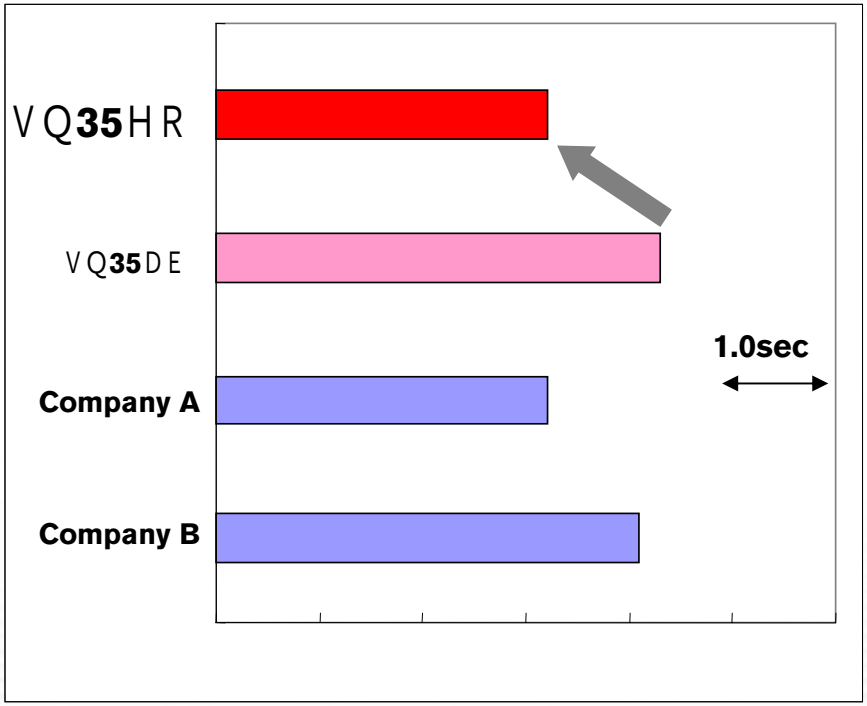
Comparison of full-throttle acceleration

New VQ35HR vs Current VQ35DE

4-4-4. Performance of VQ35HR powered vehicles (3)

0-100km/h acceleration time

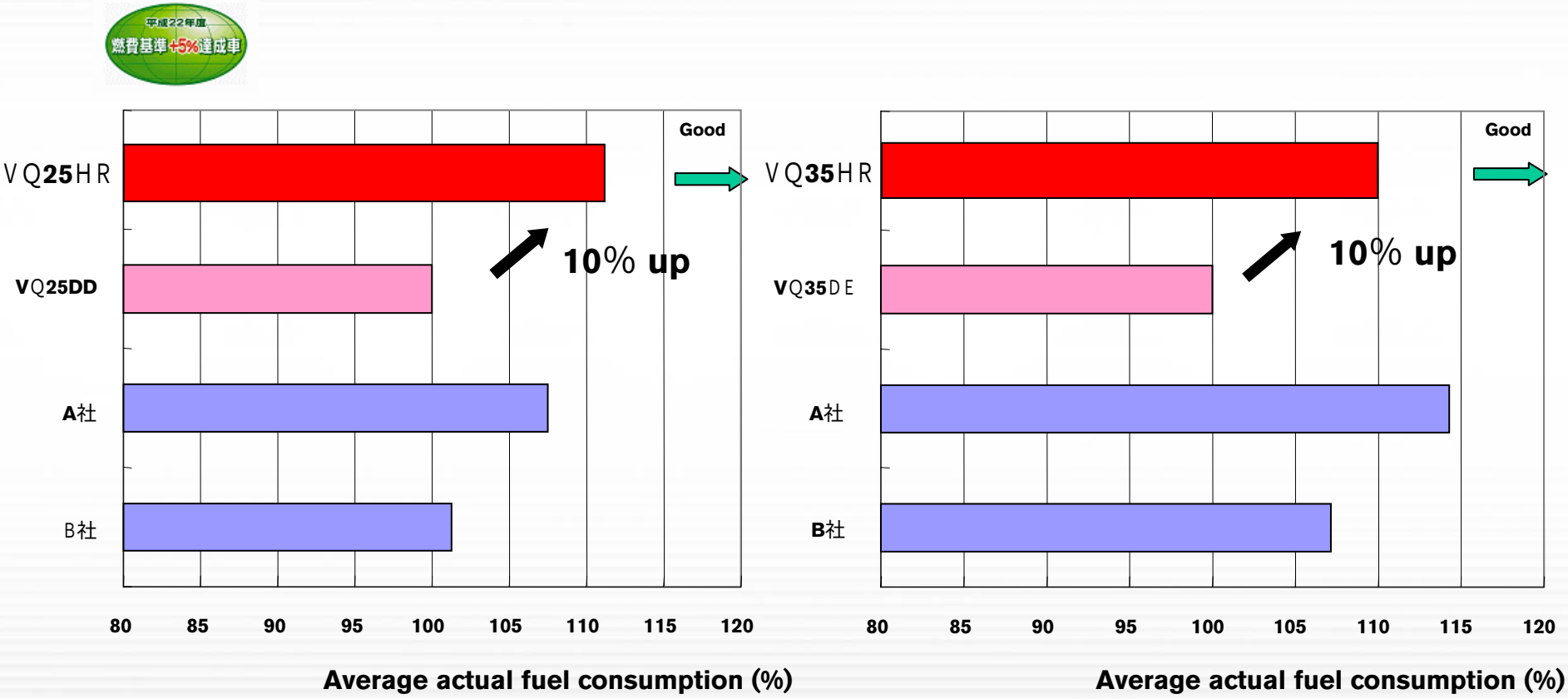




4-5. Improved Fuel Efficiency

4-5. Improved Fuel Efficiency (1)

Improved fuel efficiency in daily use situations.



(Figures are from in-house measurements)

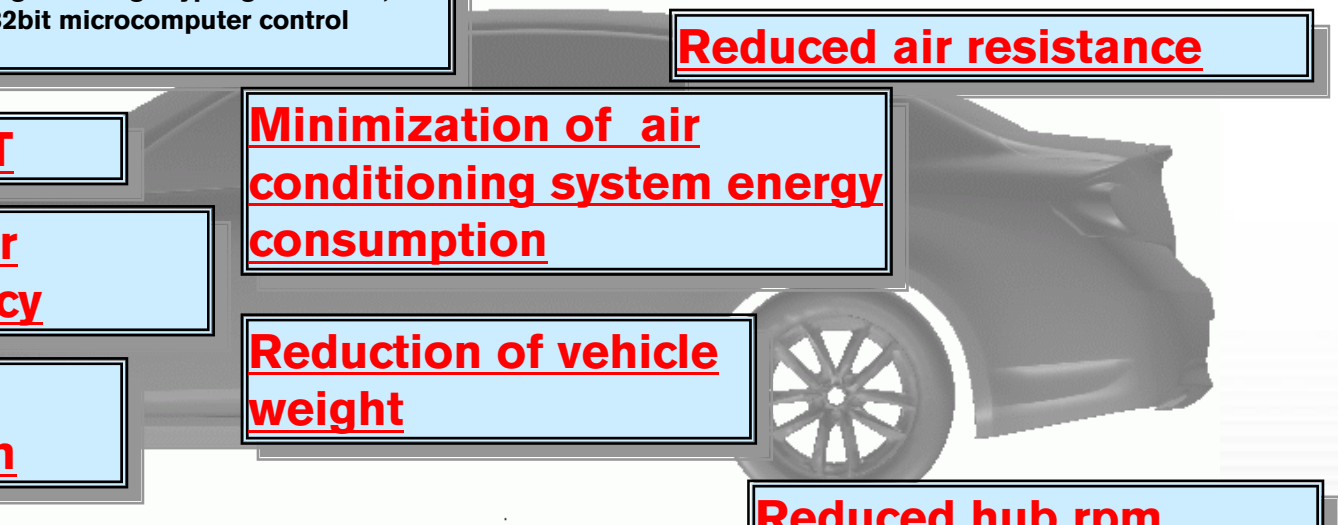
※Average actual fuel consumption: Weighted average of fuel consumed running on city streets, suburban streets and expressways, including air-conditioner use, night driving and traffic jams.

4-5. Improved Fuel Efficiency (2)

VQ35HR/VQ25HR

- Cylinder heads: Improved water flow (alleviated knocking), iridium plugs (high ignitability)
- Main moving parts: Asymmetric pistons, low tension and low friction piston rings
- Mirror finish of roller bearings
- Valve operating system: Diamond Like Coating valve lifter (reduces friction by 40%)
- Hydraulic CVTC on intake side、Electromagnetic CVTC on exhaust side (Partial area operation)
- EGI parts：Atomizing fuel injector, long-discharge-type ignition coil,
- Engine control: Twin knock sensor, 32bit microcomputer control

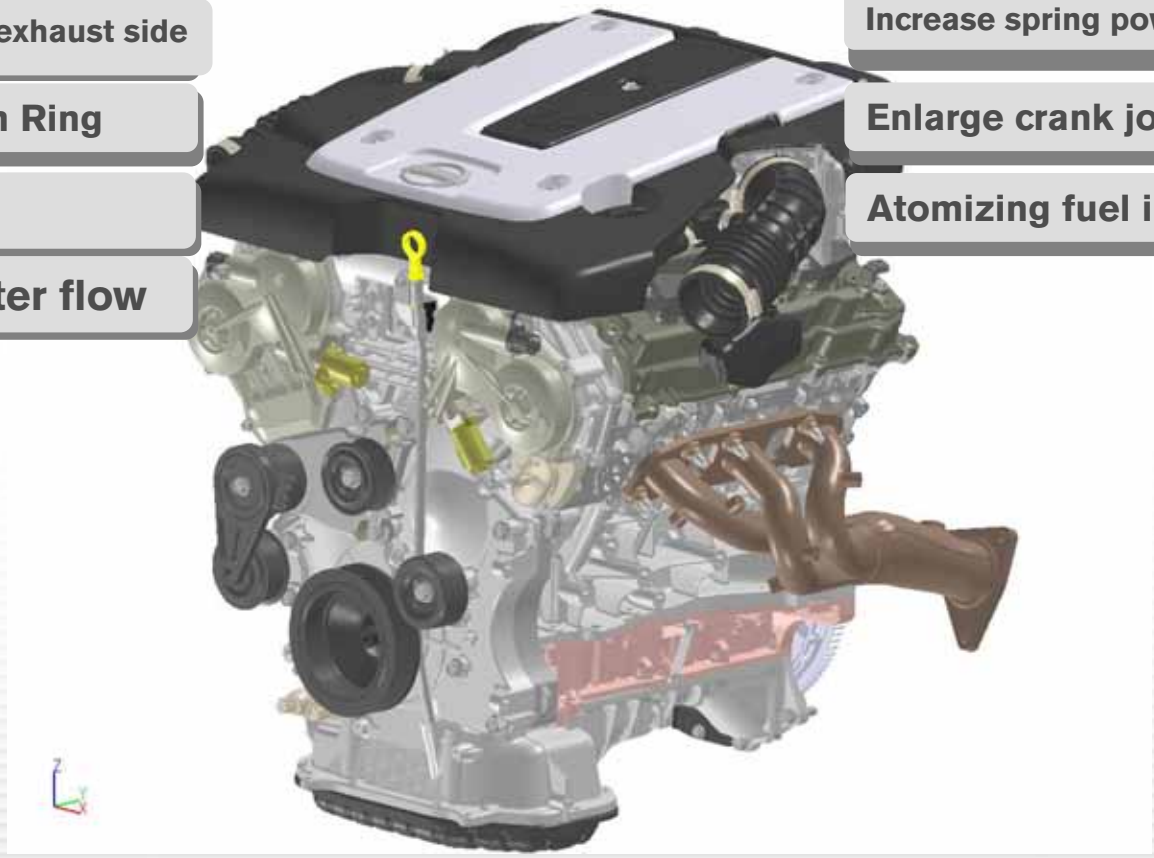
Over 40 improvements to fuel efficiency have been incorporated, raising actual fuel efficiency by 10%.



- Reduced air resistance
- New low-friction AT
- Minimization of air conditioning system energy consumption
- Improved alternator generating efficiency
- Reduction of vehicle weight
- Reduced electrical power consumption
- Reduced hub rpm resistance
- Reduced brake drag resistance

4-5. Improved Fuel Efficiency (3)

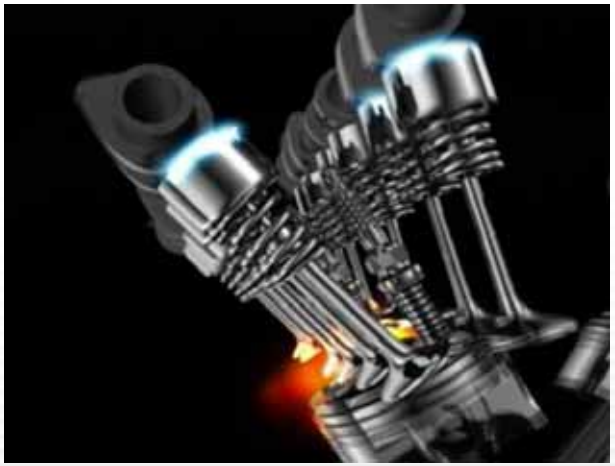
- Asymmetric piston skirt
- Mirror finish of roller bearings
- Hydraulic CVTC on intake side
- Electromagnetic CVTC on exhaust side
- Processing PVD Piston Ring
- Twin knock sensor
- Improve cooling water flow
- 32bit microcomputer control
- Increase compression ratio
- Spark plug modified into M12
- High ignitability iridium plug
- Long-discharge-type ignition coil
- Hydrogen-free DLC valve lifters
- Increase spring power of valve spring
- Enlarge crank journal diameter
- Atomizing fuel injector

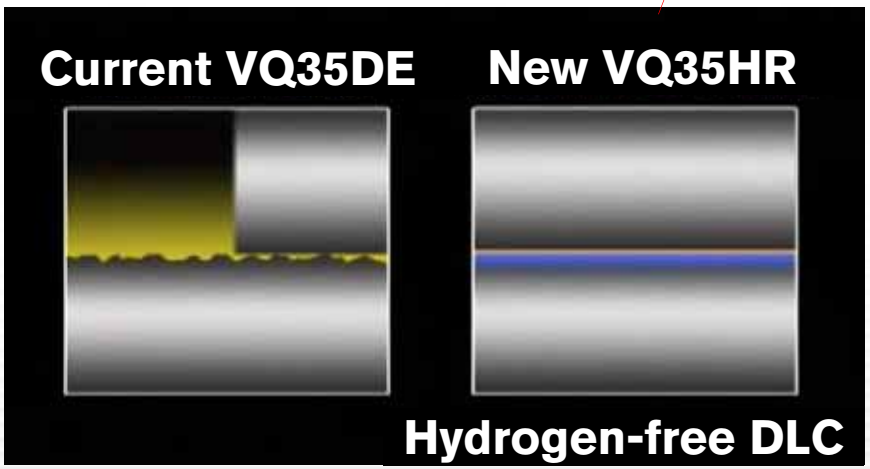


4-5. Improved Fuel Efficiency (4)

- **Use of the world's first hydrogen-free DLC.**

Cam-valve lifter friction reduced by 40%

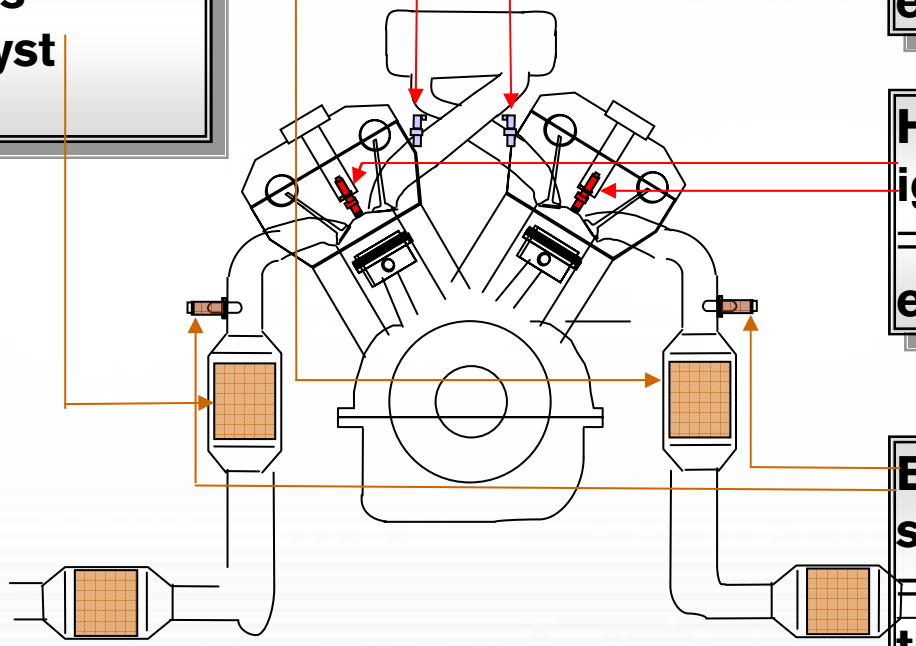




4-6. Best-in-class emissions standard

4-6. Realizing Best-in-class emissions standard (1)

Ultra low heat mass catalyst supports
⇒Shorten catalyst activating time



Atomizing fuel injector
⇒Reduce engine-out emissions

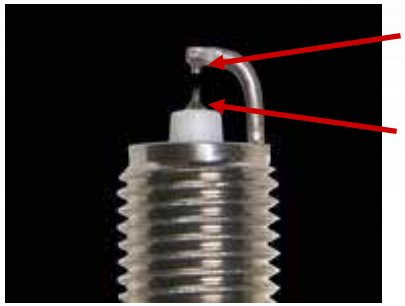
Highly ignitable irridium ignition plugs
⇒Reduce engine-out emissions

Early activating A/F sensors Control system
⇒Makes control of theoretical air fuel ratio possible immediately aftrer starting

4-6. Realizing best-in-class emissions standard (2)

- **Highly ignitable iridium plugs**

Stabilize combustion when starting.



SU-LEV

- **Early activating A/F sensors**
- **Ultra-low heat mass catalysts**
- **Atomizing fuel injector**

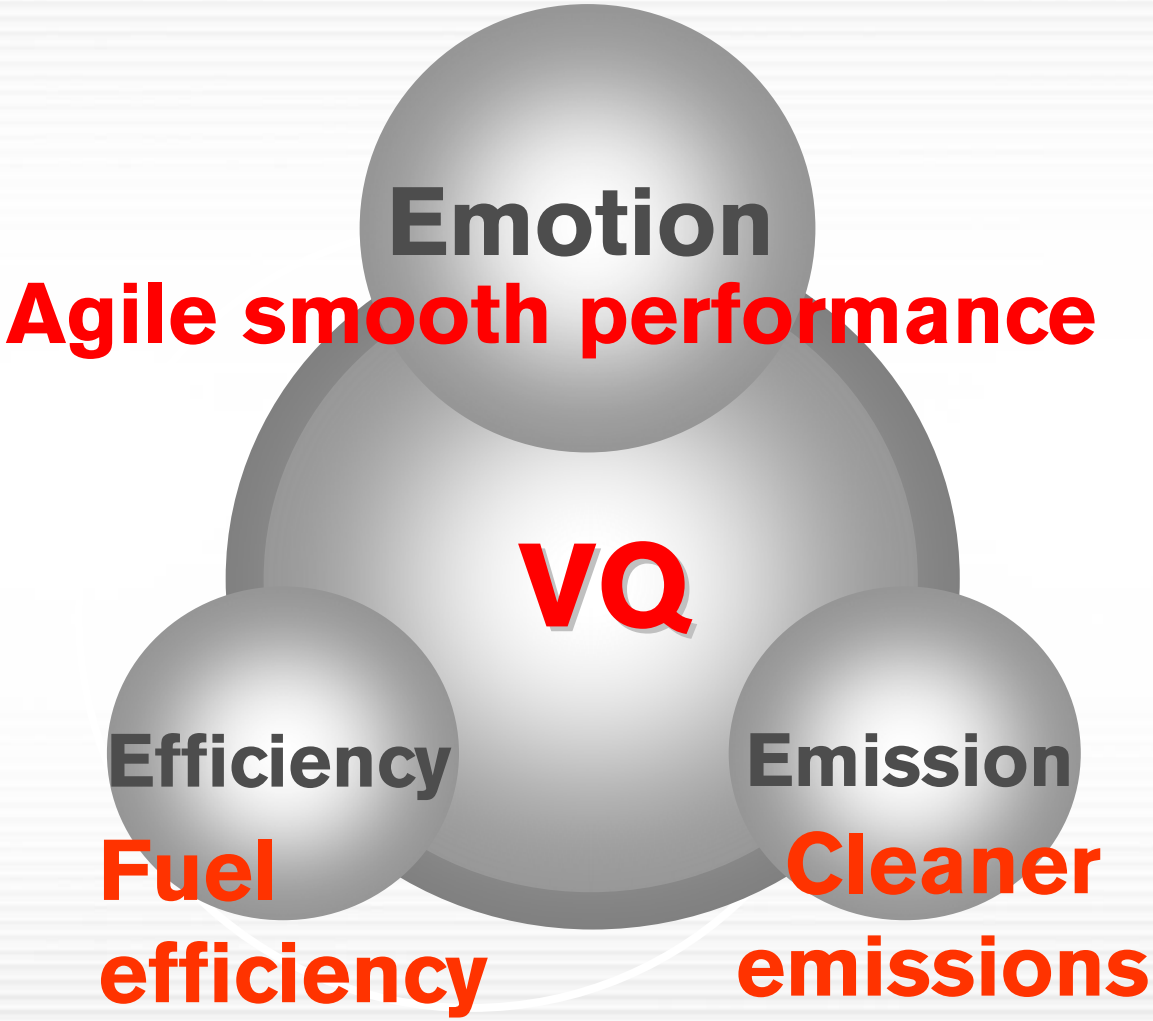
-> Fuel burns at theoretical air fuel ratio immediately after starting.

5. Summary

5-1. Aim of the New-Generation VQ35/25HR

Smooth, pleasant drive	Response	1) High rate of revolution Max 7500rpm
	Exhilaration	2) Pleasant acceleration sound Clear sound
	Acceleration sound	3) Top level power performance in class Improved intake·Exhaust·Combustion Efficiency
Fuel efficiency		4) Increased practical fuel efficiency Reduced friction
Cleaner emissions		5) Best-in-class emissions standard ☆☆☆☆ (SU-LEV in Japan)

1-6. Considering the VQ Engine(2)



Thank you for your kind attention.