



JASO M355

# *Diesel Engine Oil Seminar 2009* *- JASO Standards -*

**JAMA**

JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

*February, 2009*

*Japan Automobile Manufacturers Association, Inc.*

**JASO : Japanese Automobile Standard Organization**



JASO M355

Supported by



**PAJ**  
Petroleum Association of Japan



for

the JASO Diesel Engine Oil Seminar 2009



# Contents :

## JASO Diesel Oil Seminar 2009

### Introduction

### Engine & Oil Technologies

- Engine Technology
- Functions of Engine Oil & Examples

### JASO Standards

- JASO DH-1 / DH-2 / DL-1
- JASO On-file System

Break 20'

### Other Topics

- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
- Japanese OEM Requirements for ATF
- Hydraulic Fluid Standards for Construction Machinery (JCMAS)

### Summary

### Discussion



# *Objectives of the JASO Diesel Engine Oil Seminar*

## **To Improve Quality of Diesel Engine Oil for:**

- >Environmental protection and global warming reduction**
- >less fuel expenses, maintenance cost, disposal oil**

## **To Share Information of Japanese Activities Timely on:**

- >Diesel Engine Oil Specifications,**
- >Engine Technologies,**
- >Bio-diesel Impact, etc.**

# Organizations

## JAMA & PAJ Engine Oil Sub Committee

**JAMA**  
Oil Sub Committee

**PAJ**

### - Diesel Oil Group

Hino

Isuzu

Mazda

Mitsubishi

Mitsubishi Fuso

Nissan

Nissan Diesel

Toyota

### Oil Suppliers

Cosmo Oil

ExxonMobil

Idemitsu Kosan

Japan Energy

Nippon Oil

Showa Shell

### Observers

Afton Chemical

Chevron Japan

Infineum Japan

JALOS

Lubrizol Japan

### Diesel Oil Working Group

Standardization, *Promotion*, .....

- PCMO Group - ATF Group  
- MCMO Group



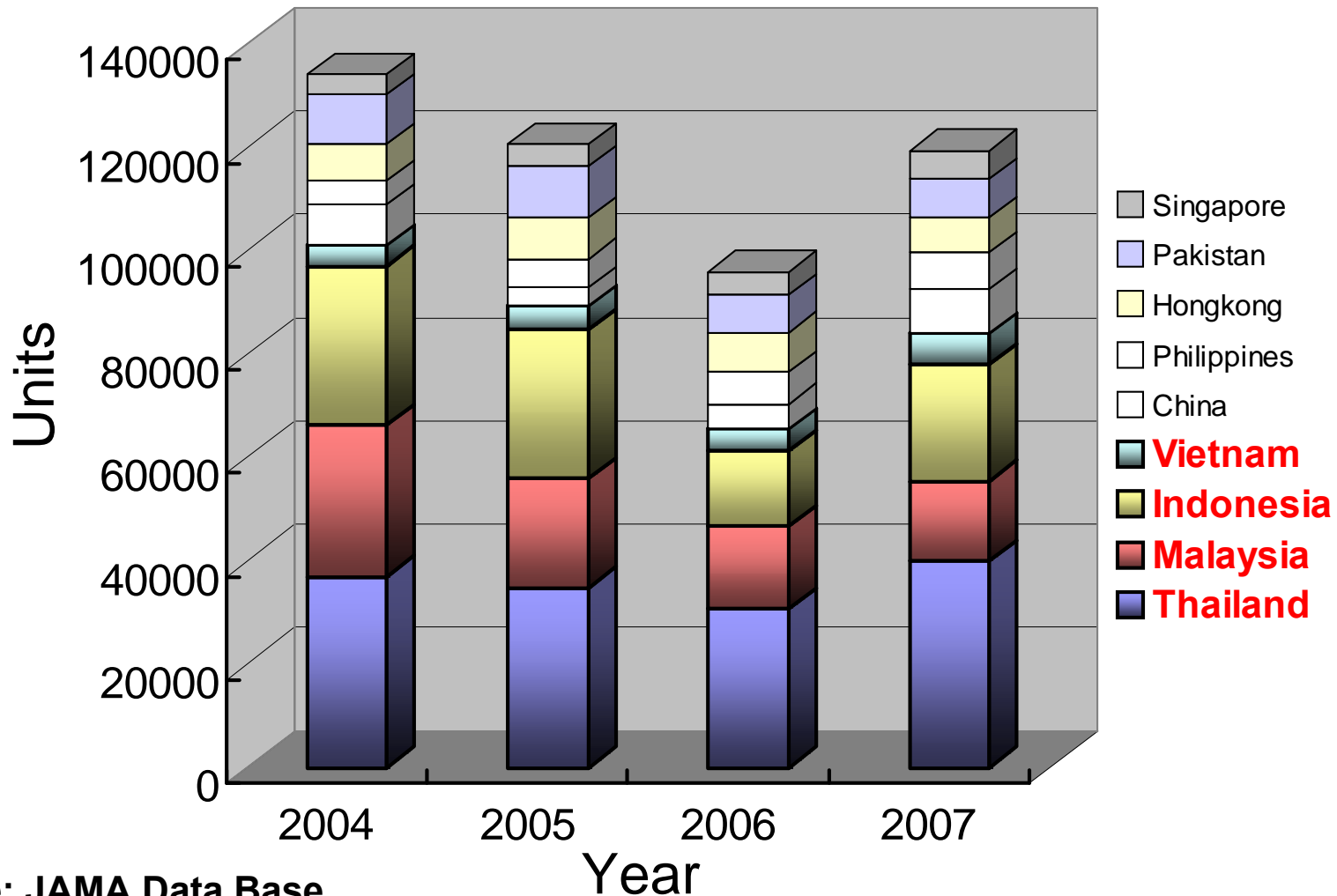
## Memberships of DH-1 Promotion

Today's Speakers are **in blue**.

Industry	Name	Company
OEMs	<b>Kenji Tomizawa</b>	Hino Motors
	Makoto Okamoto	Mitsubishi Fuso Truck & Bus
	<b>Tetsuji Ukai</b>	Nissan Diesel
Oil Suppliers	Masaki Yamanaka	Showa Shell Sekiyu
	Noriyuki Naganuma	Japan Energy
Additive Suppliers	<b>Jiro Magarifuchi</b>	Chevron Japan
	Kazuo Nishimura	Lubrizol Japan
	<b>Hitoshi Hamaguchi</b>	Evonik Degussa Japan
Other	Koichi Yasuda	Japan Lubricating Oil Society (JALOS)

# Japanese Truck & Bus Exports to Asia 2004-2007

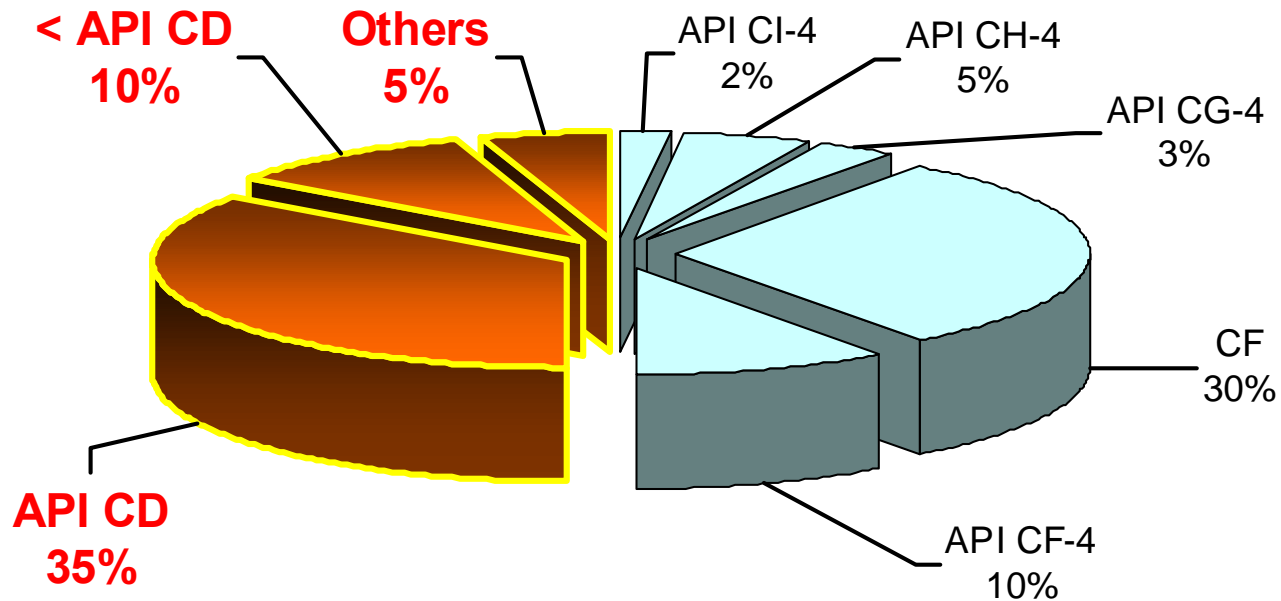
Many trucks and buses are exported to **Thailand, Malaysia, Indonesia and Vietnam.**



Source: JAMA Data Base

# Quality Grade of Heavy Duty Diesel Engine Oils in *Indonesia*

API CD and lower grade oils still make up  
a large part of the market today.

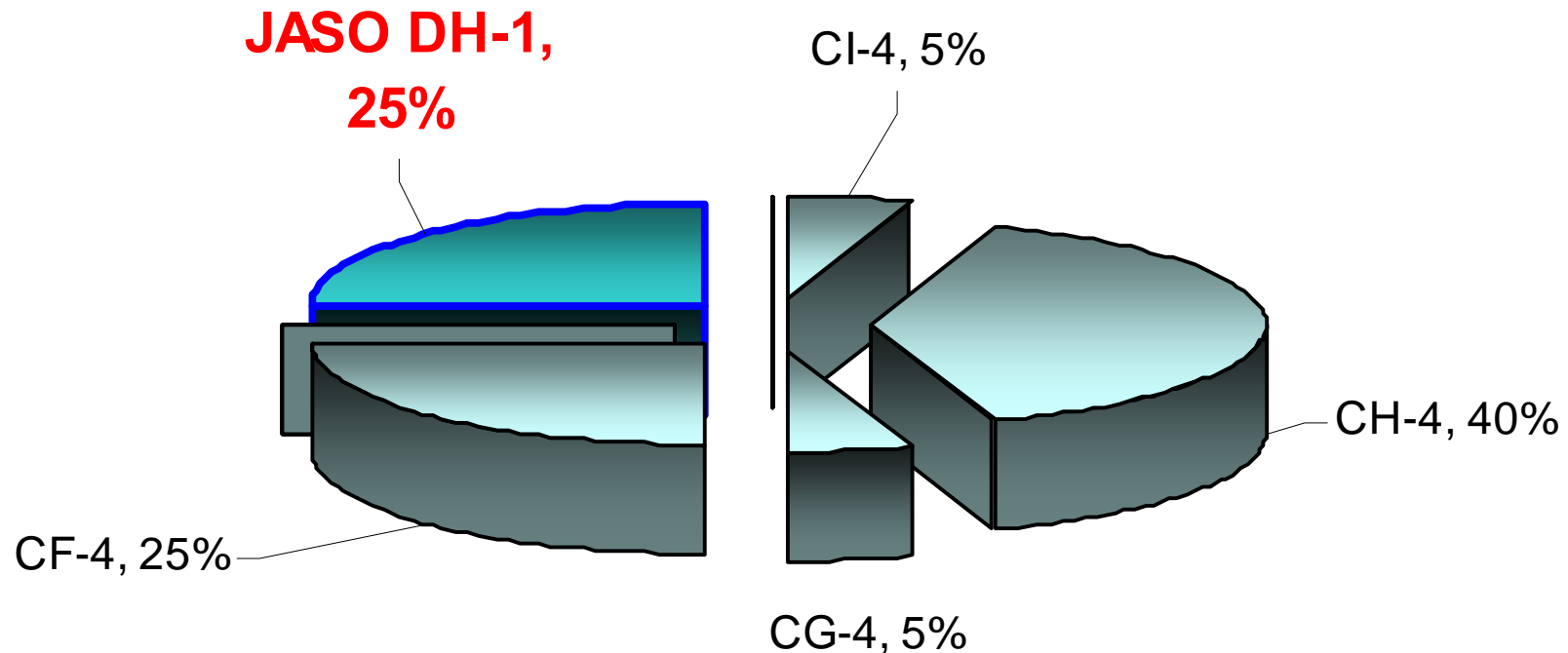






# Quality Grade of Heavy Duty Diesel Engine Oils in *Thailand*

API CF-4, JASO DH-1 grade and higher grade oils make up  
**100%** of the market.

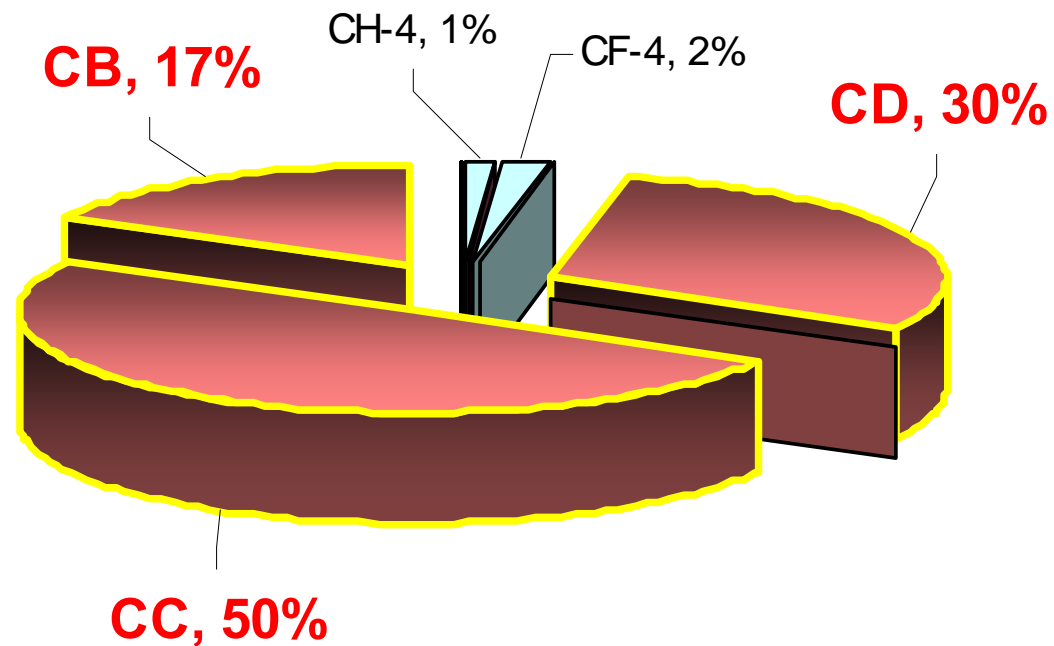


Source : SAE F&L Steering Committee for Asia 2006



# Quality Grade of Heavy Duty Diesel Engine Oils in *Vietnam*

API CD grade and lower grade oils still make up a large part of the market today.



Source : SAE F&L Steering Committee for Asia 2006

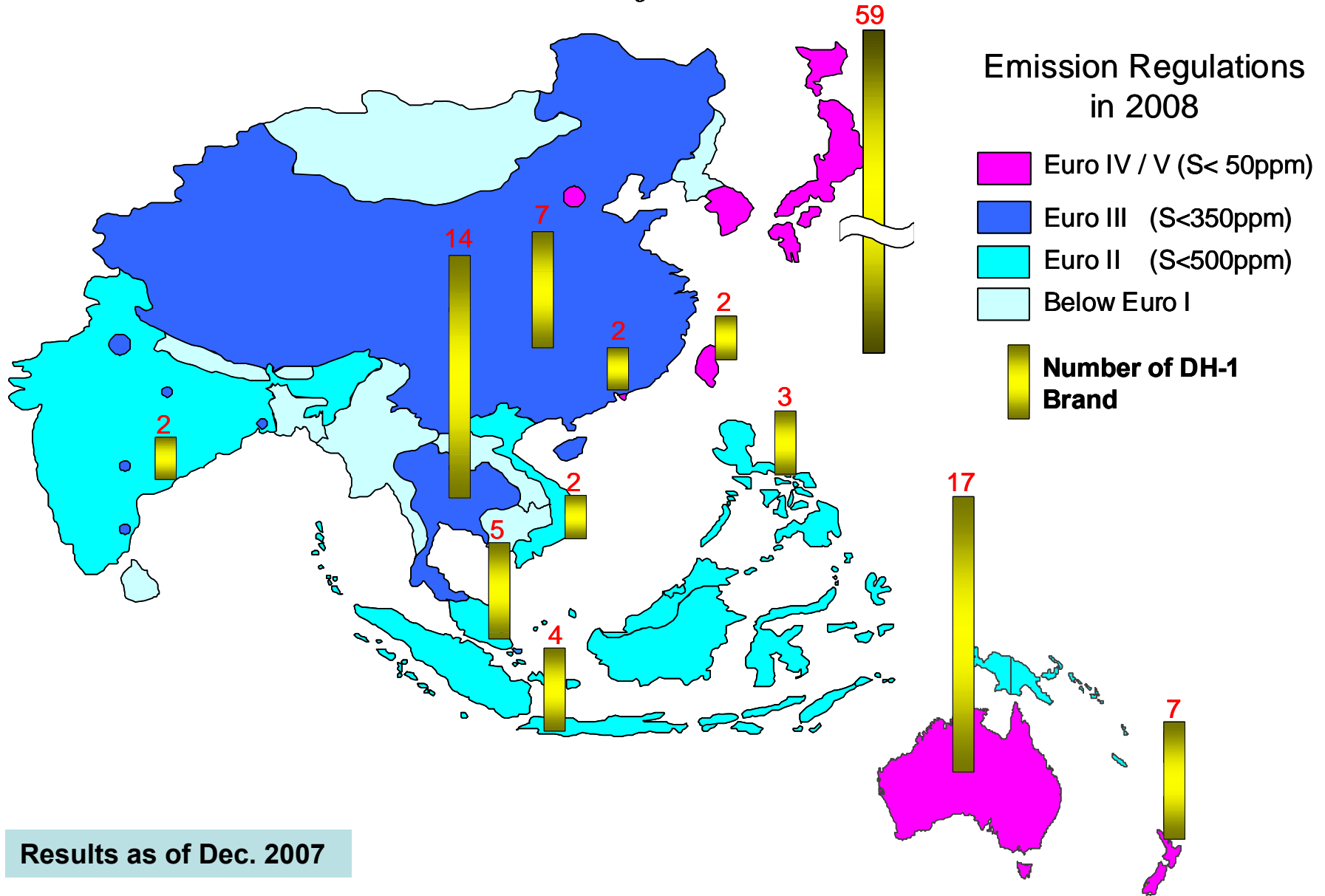


## *Past Activities for Promoting JASO Diesel Engine Oil Standards in Asia, Pacific*

- Seminars (2005 – 2007)
  - JASO DH-1 promotion seminars were held at 6 countries in Asia, having more than 1,000 attendees.
- Survey (2007)
  - Surveyed JASO DH-1 products from Asian market
  - Investigated measures for the DH-1 popularization by questionnaire
- Results
  - 36 DH-1 brands in 11 countries, including 9 brands on-filed.
  - JASO DH-1 has a potential market. **(only 25%)**
  - Products and its benefit are not recognized well.
  - JASO On-file system is not well known

# JASO DH-1 Market Survey

## *- Number of DH-1 Brand -*



Results as of Dec. 2007



# JASO DH-1 Products

Results as of Dec. 2007

Global Oil Company

Local Oil Company (ex Japan)

Marketer	Brand	SAE	API	On-file	Australia	New Zealand	China	Thailand	Taiwan	Indonesia	India	Vietnam	Hong Kong	Malaysia	Philippines
BP-Castrol	Tection HD	15W40	CI-4+		X	X									
BP-Castrol	Tection J-MAX	15W40	CH-4		X	X									
BP-Castrol	Tection Global	15W40	CI-4		X			X							
BP-Castrol	RX	10W40	CF		X									X	
BP-Castrol	RX Diesel	20W50	CF-4		X									X	
Caltex	Delo 400 Multigrade	15W40	CI-4+	X	X	X	X	X					X		X
Caltex	DELO CXJ	15W40	CF	X	X	X		X							
Caltex	Delo Gold	15W40	CH-4		X			X							
Hitachi	Hitachi Construction Machinery - Genuine Oil	15W40	CF-4	X			X					X		X	
Idemitsu	APOLLOIL MULTI RUNNER DH-1	10W30,15W40	CF-4	X					X	X				X	
Idemitsu	Idemitsu Extreme Diesel DH-1	15W40	?							X				X	
Mobil	Delvac 1	5W40	CI-4+		X						X	X			X
Mobil	Delvac MX Extra	15W40	CI-4+		X	X									
Shell	Rimula Super	15W40	CH-4		X	X		X					X		
Shell	Rimula X	15W40	CH-4		X	X		X			X			X	X
BP-Castrol	Vanellus C7	15W40	CI-4		X										
BP-Castrol	Tection Global ES	15W40	CI-4+		X										
Fuchs	Titan Ultra MC 1040	10W40	CI-4+		X										
Valvoline	Diesel extra long drain LD	15W40	CI-4		X										
Valvoline	Premium Blue	15W40	CI-4		X										
BP-Castrol	万里霸王	15W40	CI-4				X								
Komatsu	Komatsu - Genuine Oil	15W40	CF-4	X			X								
Shang Xi Japan Energy	JOMO DIESEL ENGINE OIL CF-4 15W-40	15W40	CF-4	X			X								
Shang Xi Japan Energy	JOMO DIESEL ENGINE OIL CF-4 15W-40H	15W40	CF-4	X			X								
Shell	金霸王	15W40	CH-4				X								
Caltex	Delo Sports Synthetic Blend	15W40	CI-4					X							
Conoco Phillips	Hydroclear Power D	15W-40	CI-4+					X							
Hino	Expert 21	20W50	CH-4					X							
Isuzu	Besco Duramax	10W30	CH-4	X				X							
Mobil	Delvac 1640		?					X							
PTT	Dynamic XJ	SAE 40	CF					X							
PTT	Dynamic Synthetic	5W40	CI-4					X							
Shell	Rimula R3X	15W40	CH-4					X							
Idemitsu	ID.RACING DIESEL DH-1	15W40	CF						X						
Hino	Hino Genuine Motor Oil	15W40	CH-4	X						X					
Pertamina	Meditran SX	15W40	CI-4							X					



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Break 20'

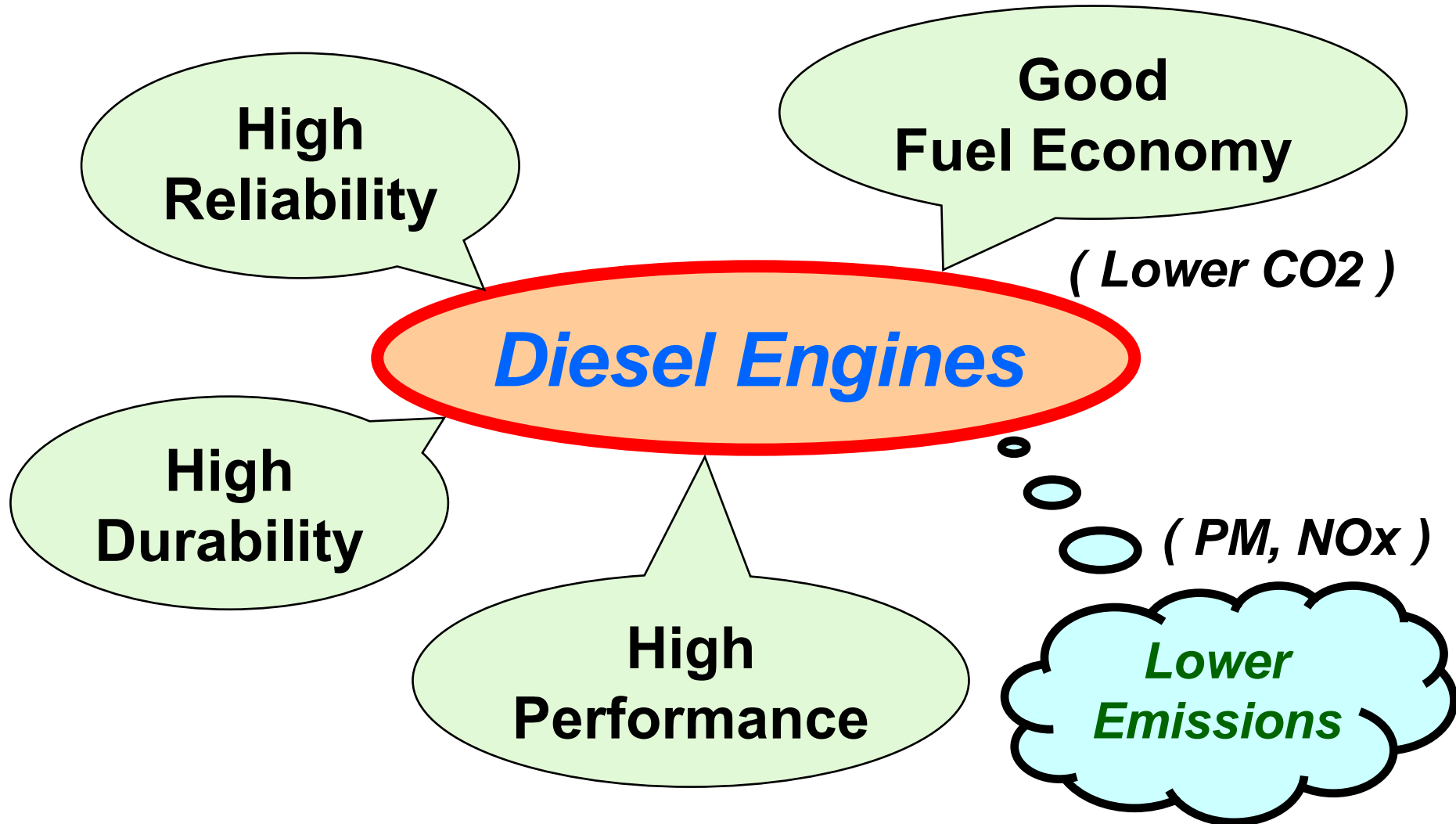
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- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
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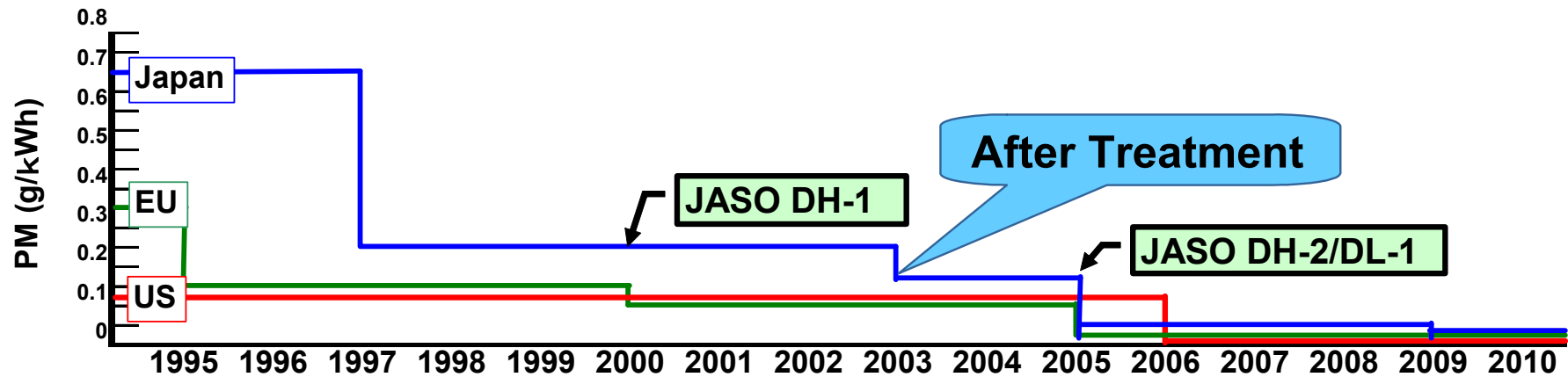
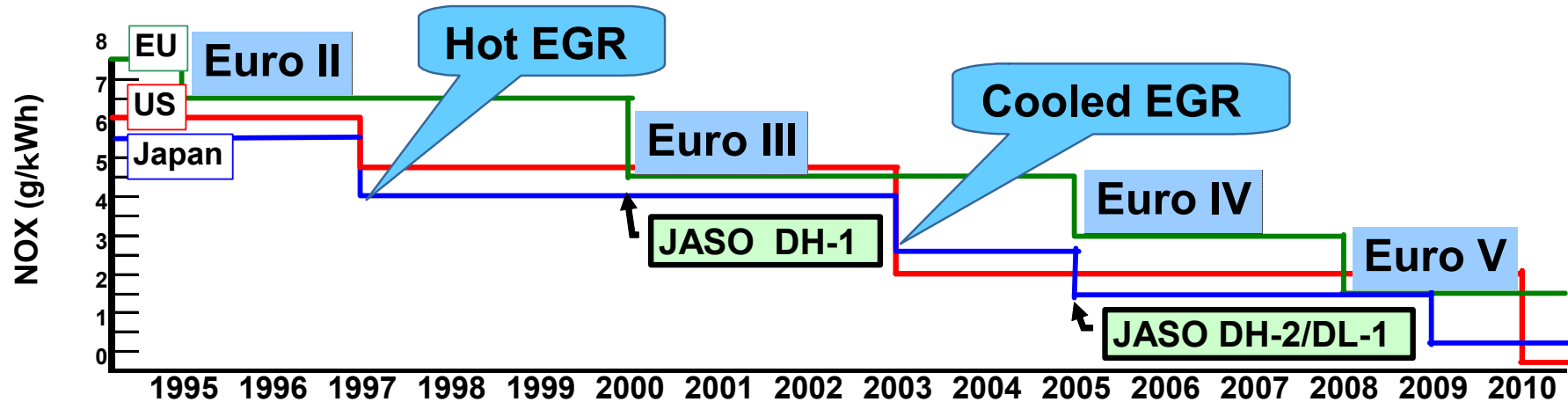
### Summary

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# Performance Requirements for Heavy-Duty Diesel Engines



# History of Exhaust Emissions Regulations in Japan, EU, USA



## Fuel Sulfur content

<b>Japan</b>	2000ppm	500ppm	50ppm	10ppm	
<b>EU</b>	2000ppm	500ppm	350ppm	50ppm	10ppm
<b>US</b>	500ppm	500ppm	15ppm		



# Exhaust Gas Emissions Regulations in Asia (Heavy-Duty Diesels)

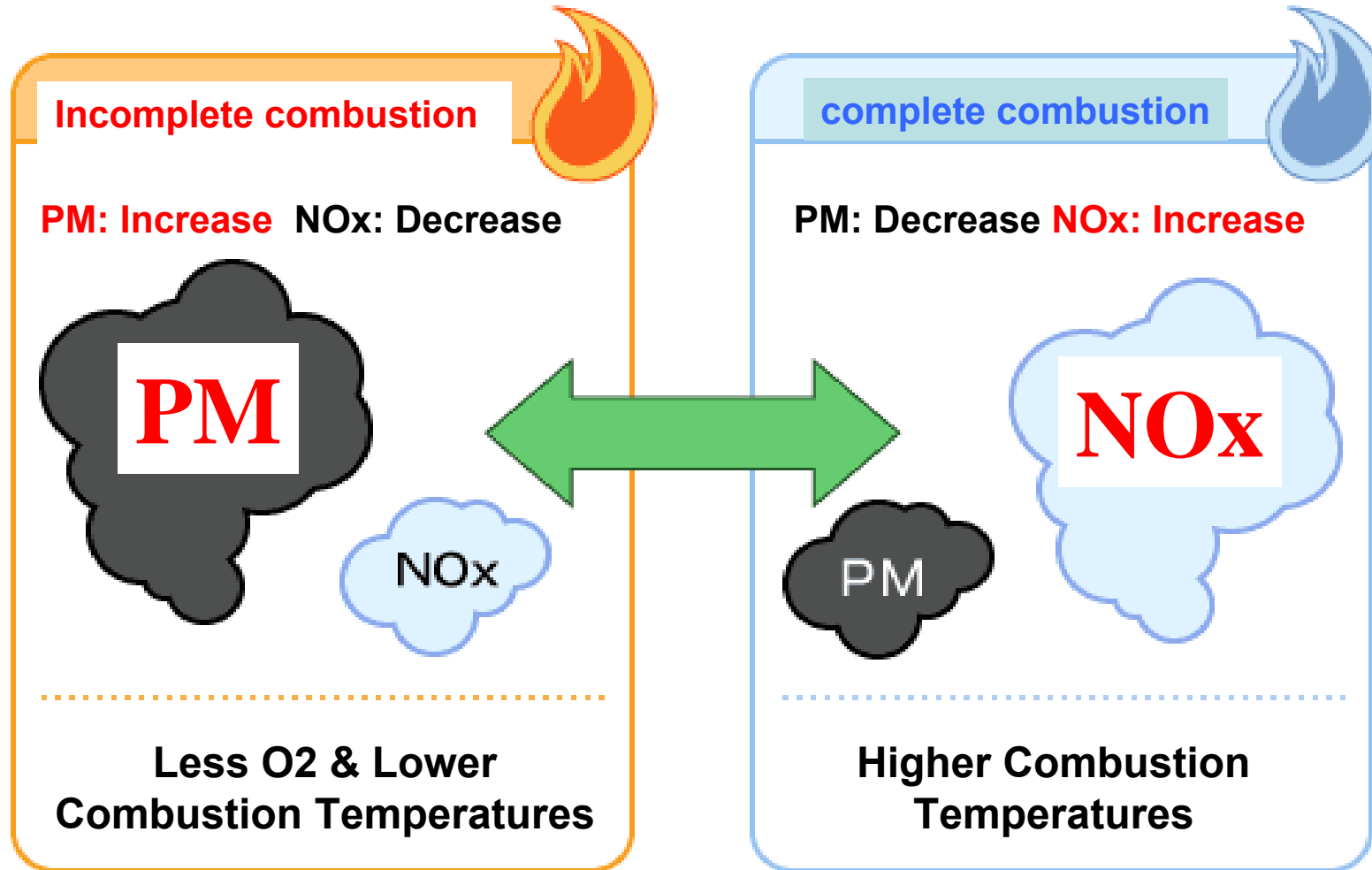
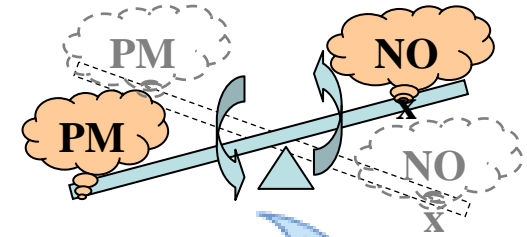
Revised Dec. 2008

Year		2006	2007	2008	2009	2010	2011	2012	2013
Europe		Euro IV			Euro V			Euro VI	
USA		EPA04	EPA07			EPA10			
Asia	Japan	JP05 (New Long Term)				JP09 (post NLT)		(GW>12t) (3.5<GW<=12t)	
	Indonesia	Euro II						(Euro IV)	
	Thailand	Euro II			Euro III			(Euro IV)	
	Vietnam		Euro II				(Euro III)		

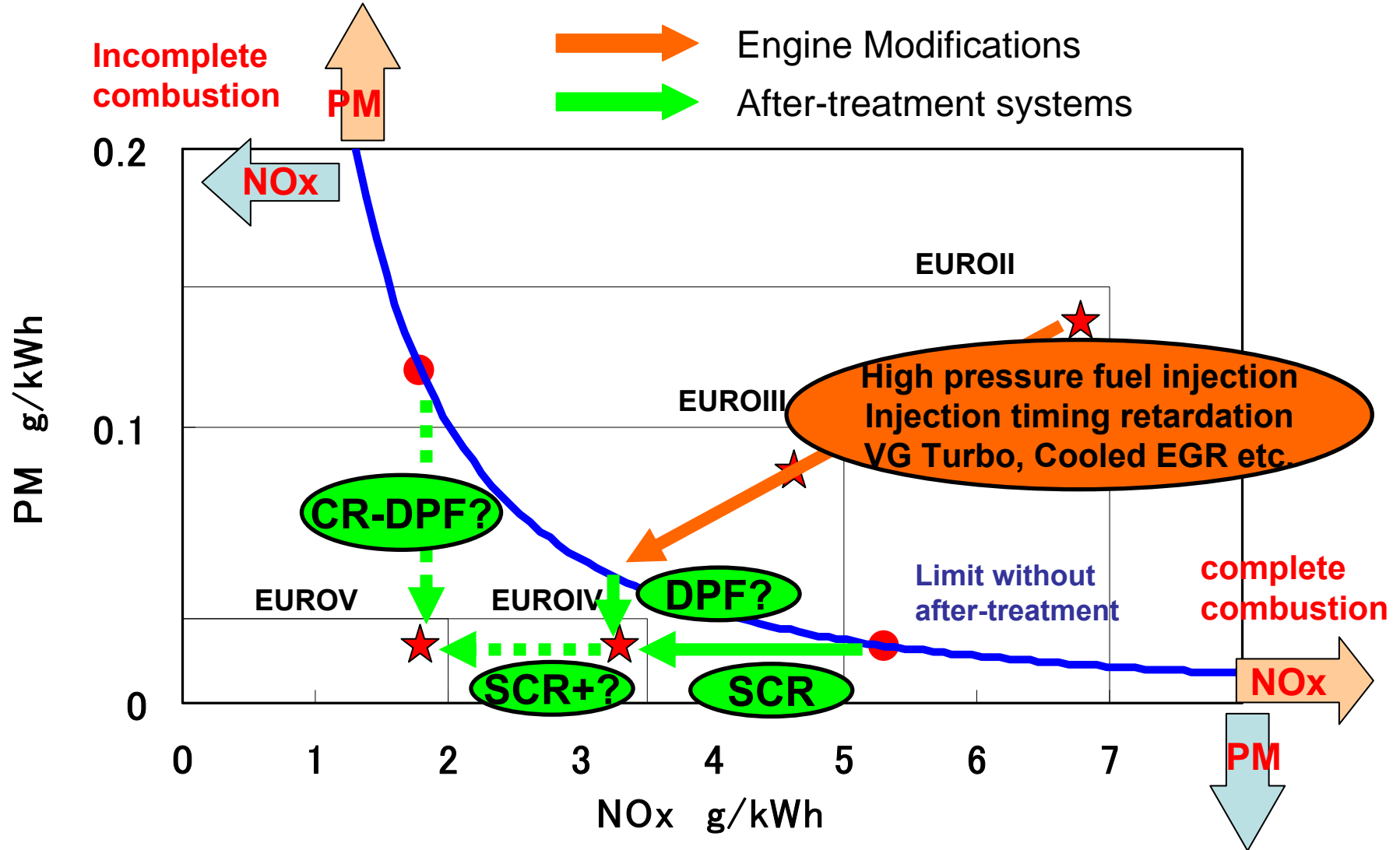
Color	Fuel S Level	Cooled EGR	After Treatment	Compatibility with JASO engine oil	
				DH-1	DH-2
Yellow	> 500 ppm	No	No	○ (Shorter Drain Interval)	×
Cyan	< 500 ppm	No	No	○	×
Blue	< 500 ppm	Yes/No	No	○	×
Green	< 500 ppm	Yes*	No	○	×
Magenta	< 50 ppm	Yes*	Yes*	×	○
Brown	< 15 ppm	Yes*	Yes*	×	○

\*:Estimated

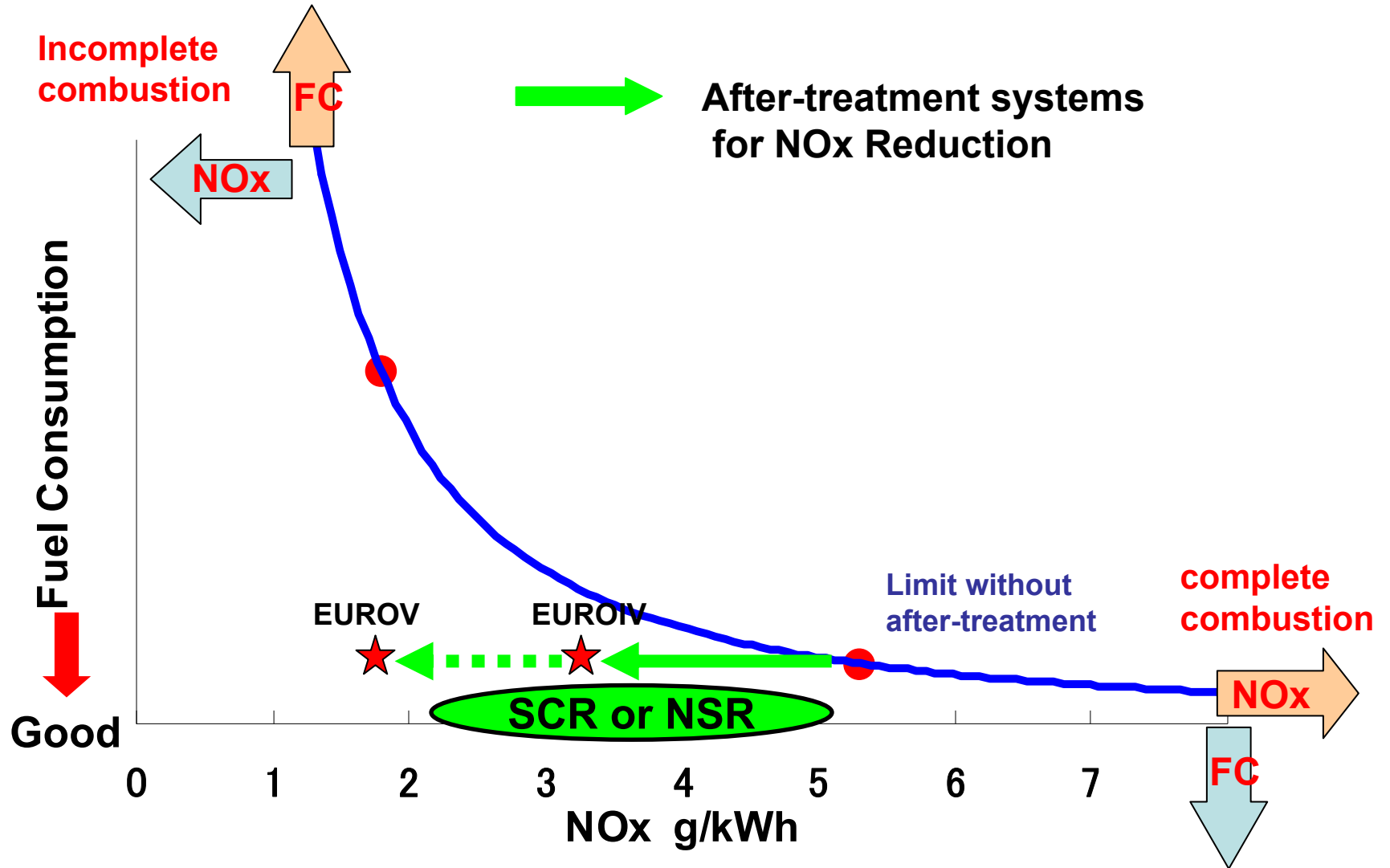
# Trade-Off Relationship between **PM** and **NOx**



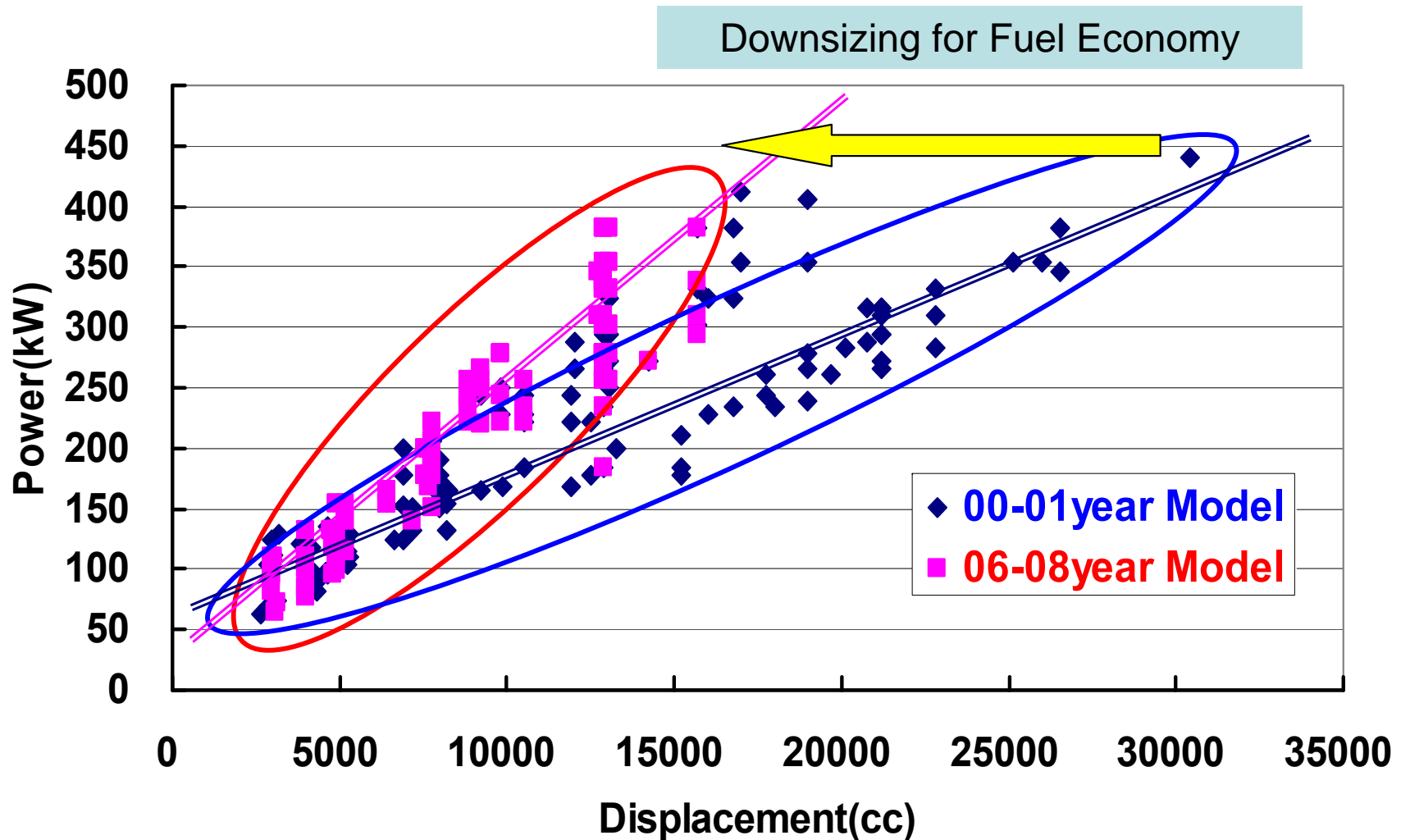
# Strategy of Exhaust Emission Reduction in the EU



# Trade-Off Relationship between *Fuel Consumption* and *NOx*



# Relationship between Displacement and Power of Diesel Engine in Japan





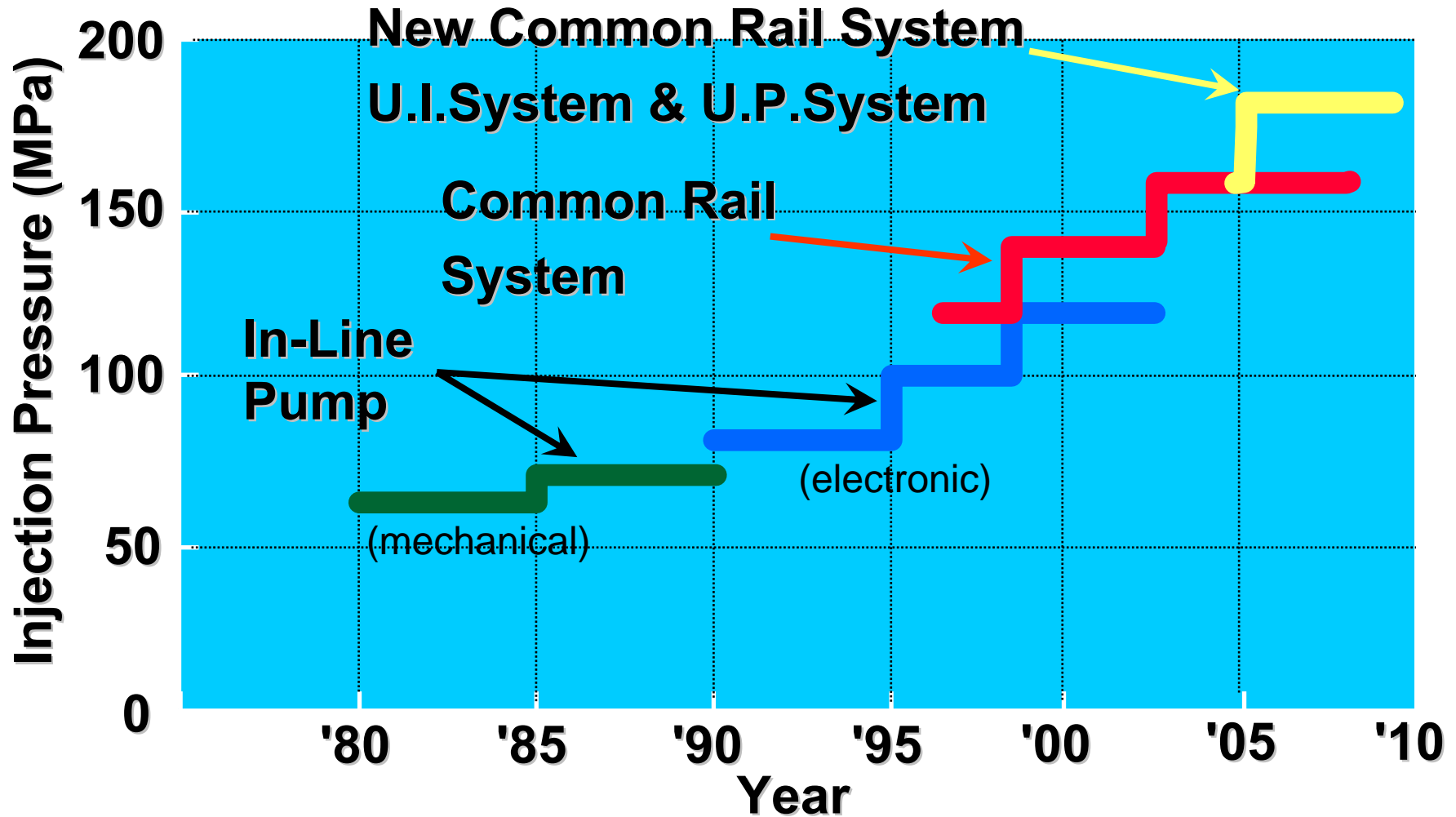
# Technology Adopted for JP05 \* Truck

*\*New Long Term Exhaust Emission Regulation in Japan  
(equiv. to Euro IV)*

	Engine Displacement (Liter)	Combustion Technology			Aftertreatment Technology			Hybrid	
		Injection System		VG Turbocharger	Cooled EGR	DPF	Urea SCR		NSR
		CR	Other						
LD-Truck	2.95	√	-	-	√	√	-	-	-
	2.98	√	-	-	√	√	-	-	-
	2.98	√	-	-	√	√	-	-	√
	3.00	√	-	√	√	√	-	-	-
	3.00	√	-	√	√	√	-	-	√
	4.01	√	-	√	√	√	-	-	-
	4.01	√	-	√	√	√	-	-	√
	4.01	√	-	√	√	√	-	√	-
4.73	√	-	√	√	√	-	-	-	
MD-Truck	4.90	√	-	-	√	√	-	-	-
	5.19	√	-	√	√	√	-	-	-
	6.40	√	-	√	√	√	-	-	-
	7.55	√	-	-	√	√	-	-	-
	7.68	√	-	√	√	√	-	-	-
	7.79	√	-	√	√	√	-	-	-
HD-Truck	8.87	√	-	√	√	√	-	-	-
	9.20	√	-	√	√	-	√	-	-
	9.84	√	-	√	√	√	-	-	-
	12.74	-	√	√	√	√	-	-	-
	12.88	√	-	√	√	-	√	-	-
	12.91	√	-	√	√	√	-	-	-
	13.07	-	√	√	√	-	√	-	-
15.68	√	-	√	√	√	-	-	-	

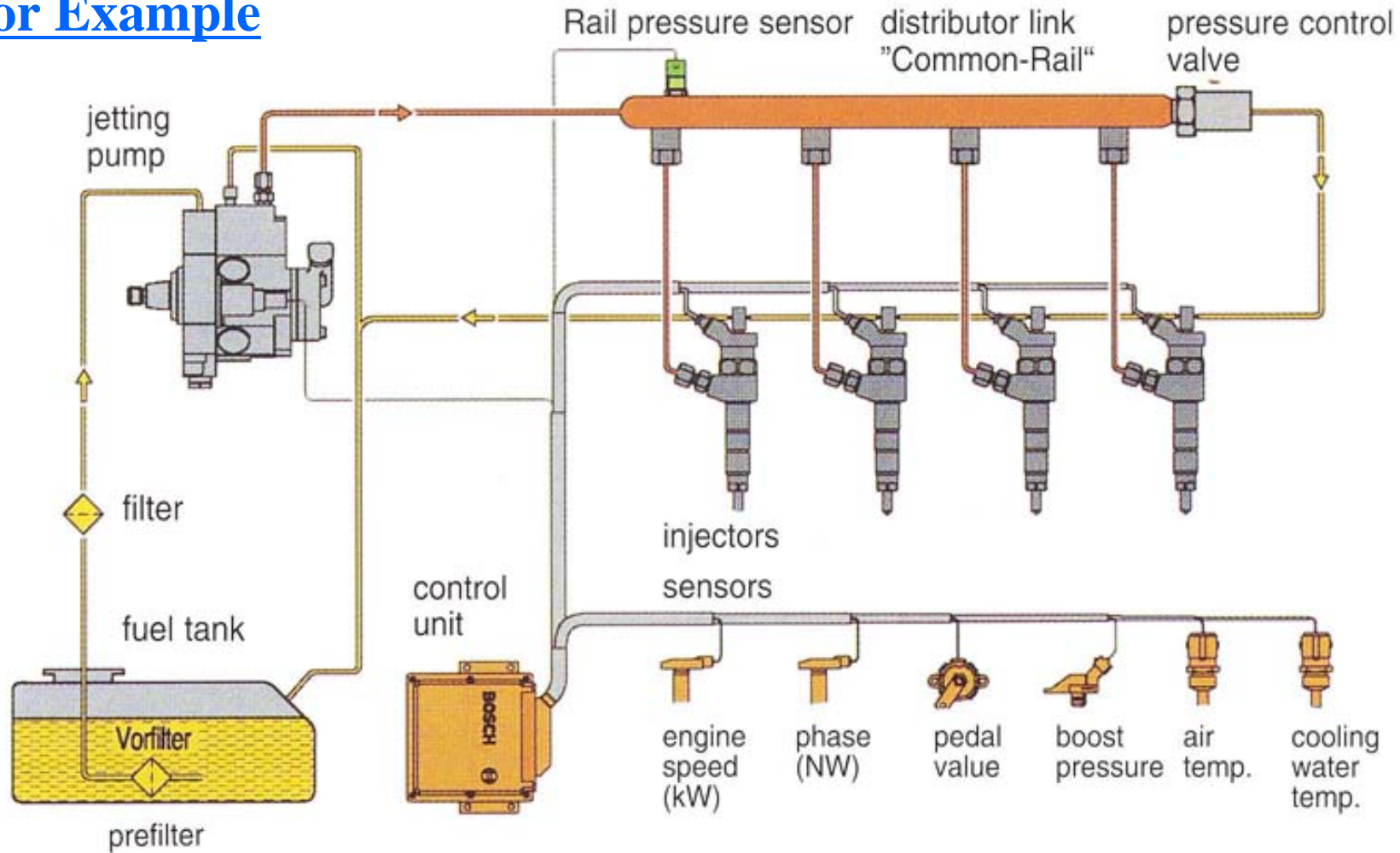
Source : JAMA Material

# Fuel Injection Pressure Trends *for PM Reduction in the Japanese Market*



# Common Rail System

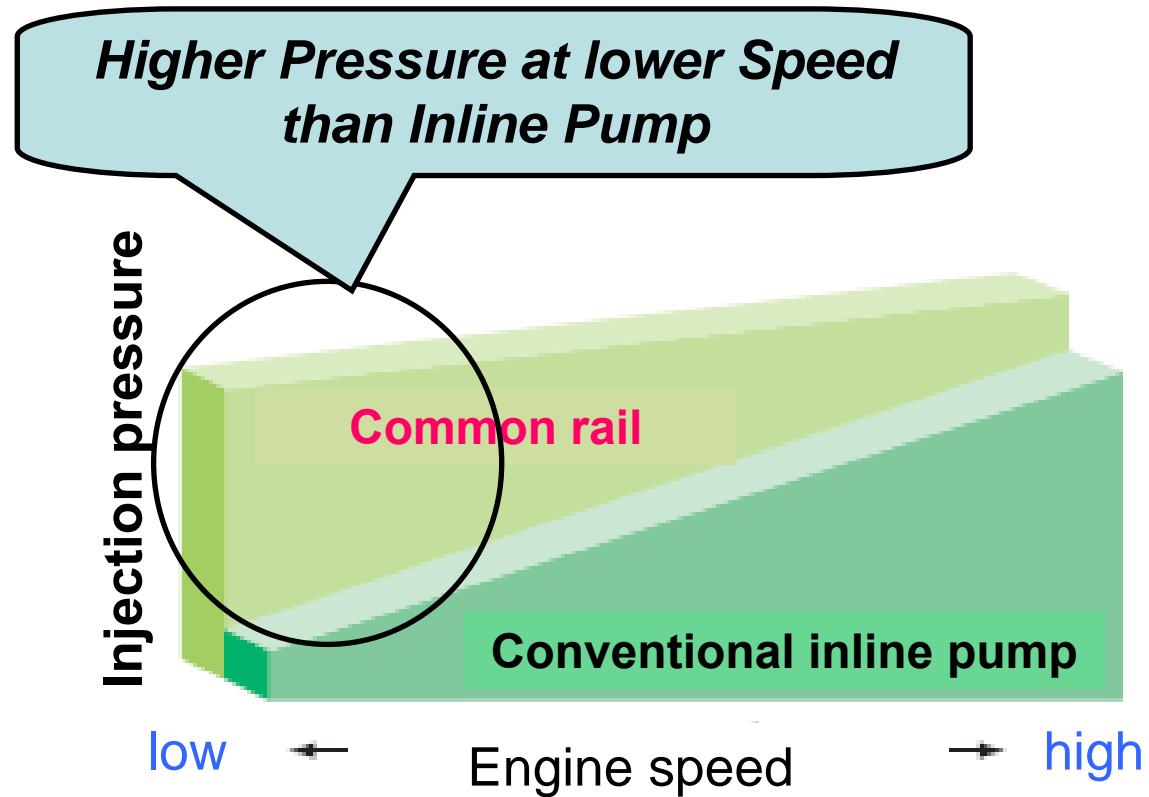
## For Example



Source: Bosch Home page

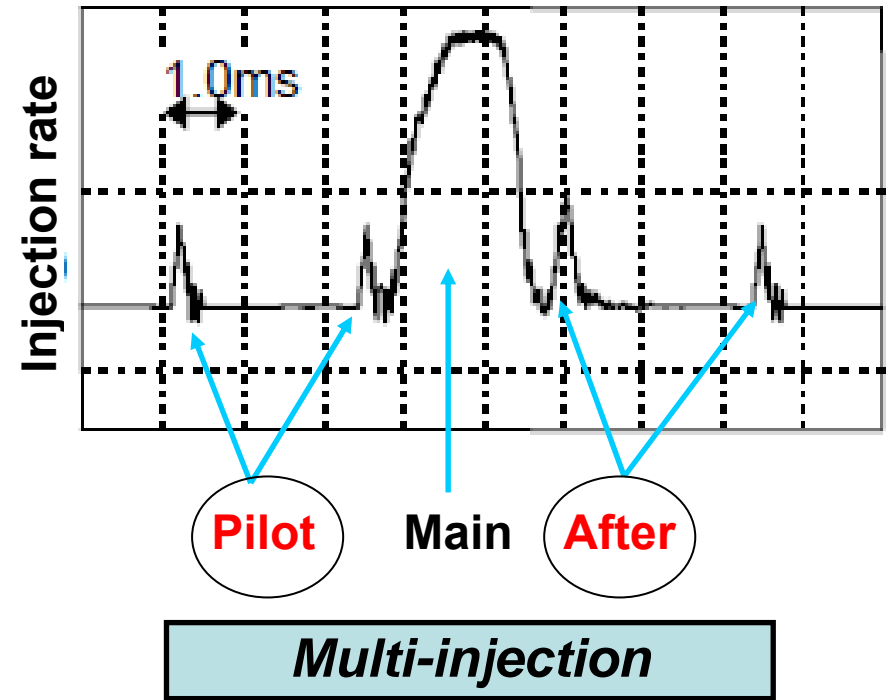
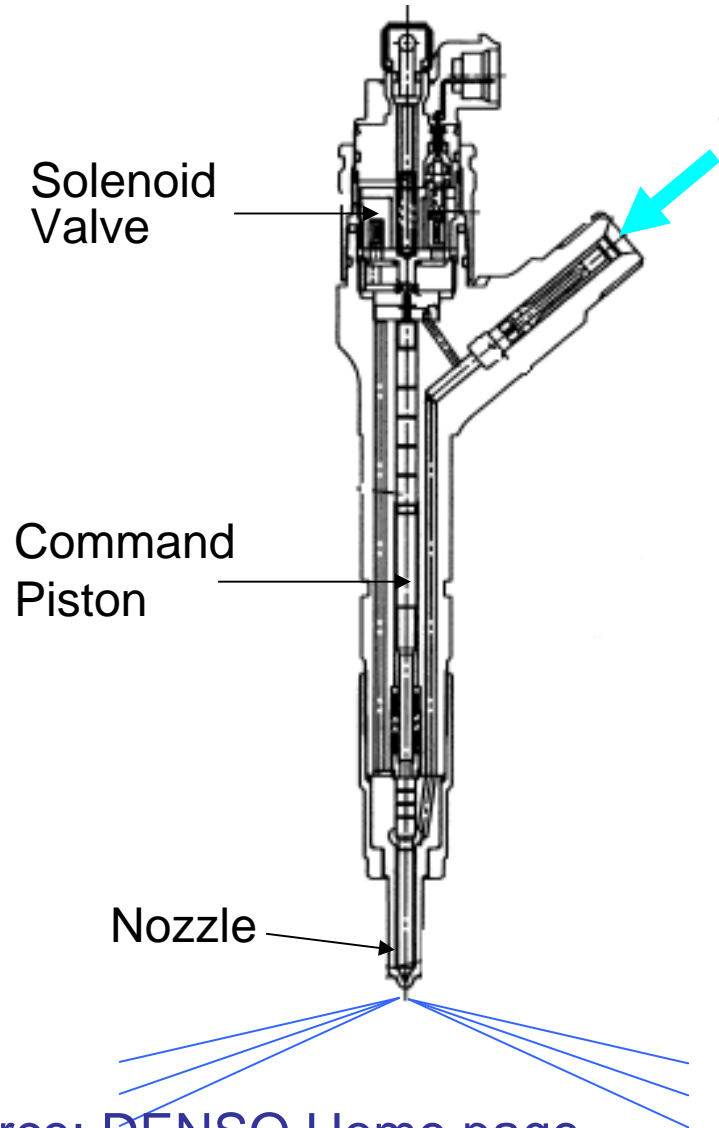


# Merits of the Common Rail System (1) *for PM Reduction*





# Merits of the Common Rail System (2) *for NOx Reduction / Regeneration of DPF*

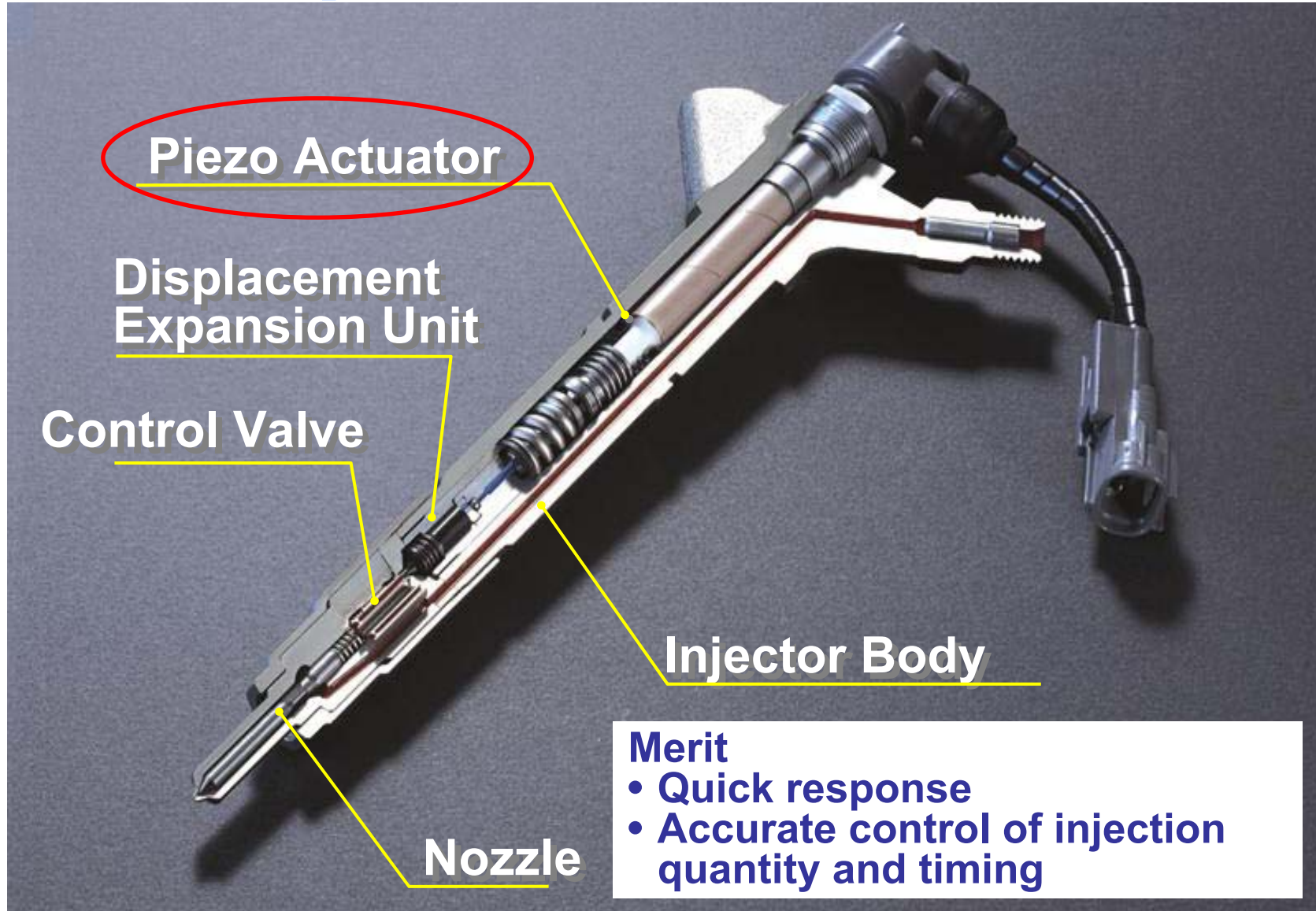


Source: DENSO Home page

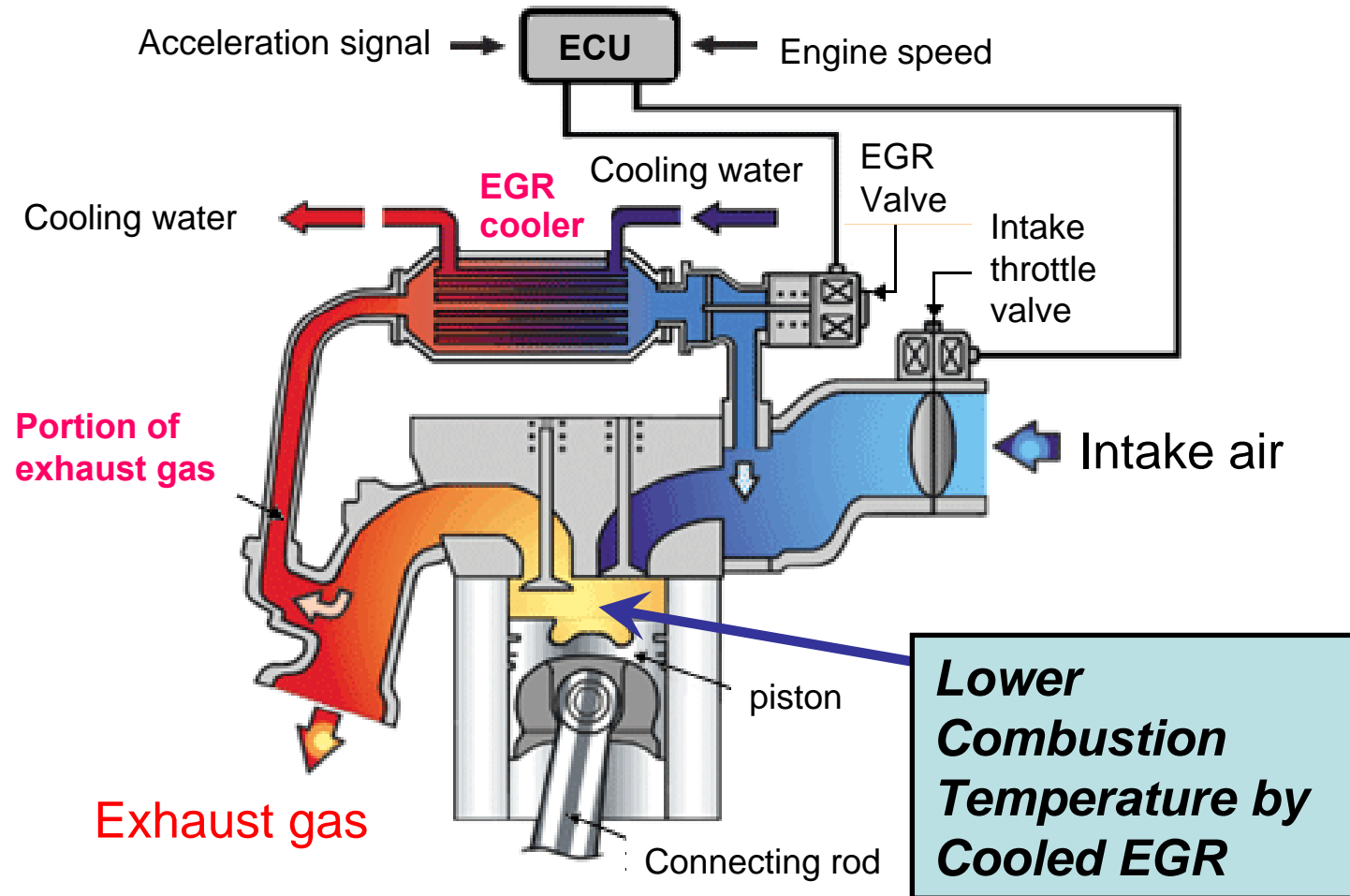
# *The Newest Piezo Injector*

For Example

Source: Engine Technology magazine No.42



# Cooled EGR for NO<sub>x</sub> Reduction

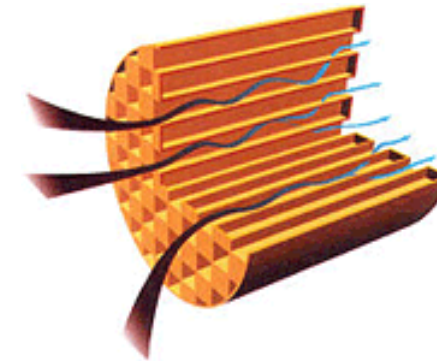
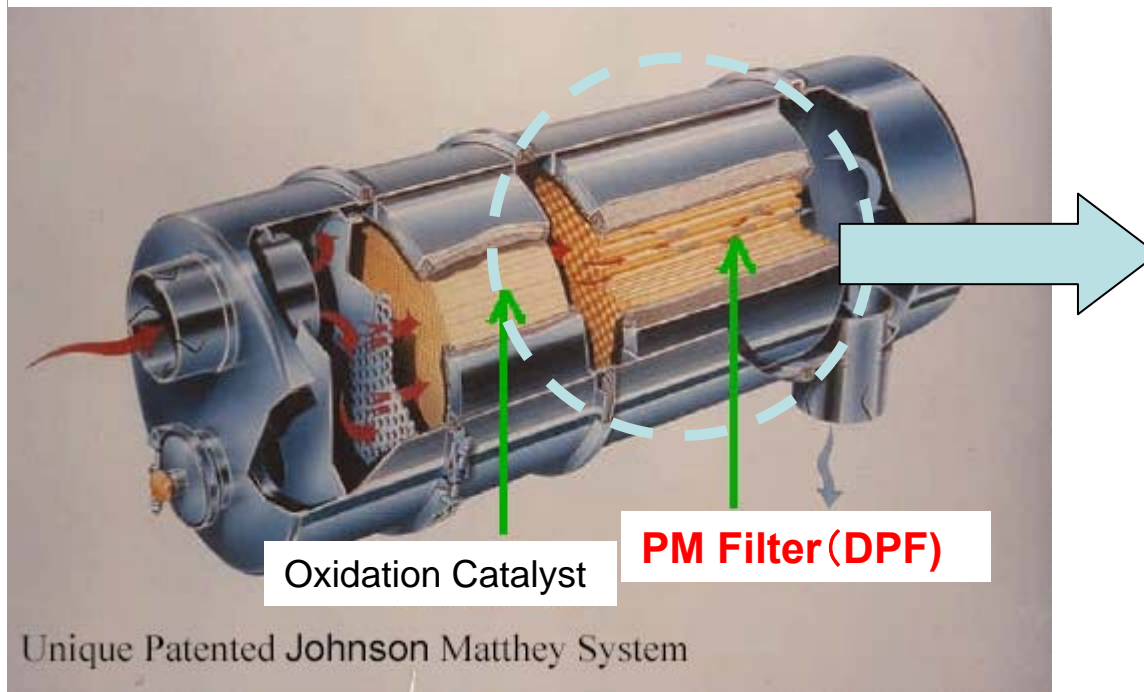


Source: ISUZU Homepage

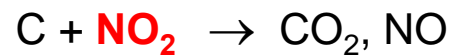
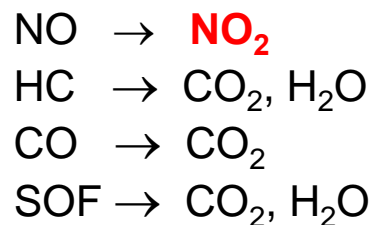
# CR-DPF (CRT<sup>TM</sup>) for PM Reduction

(Continuously Regenerating Diesel Particulate Filter)

## For Example



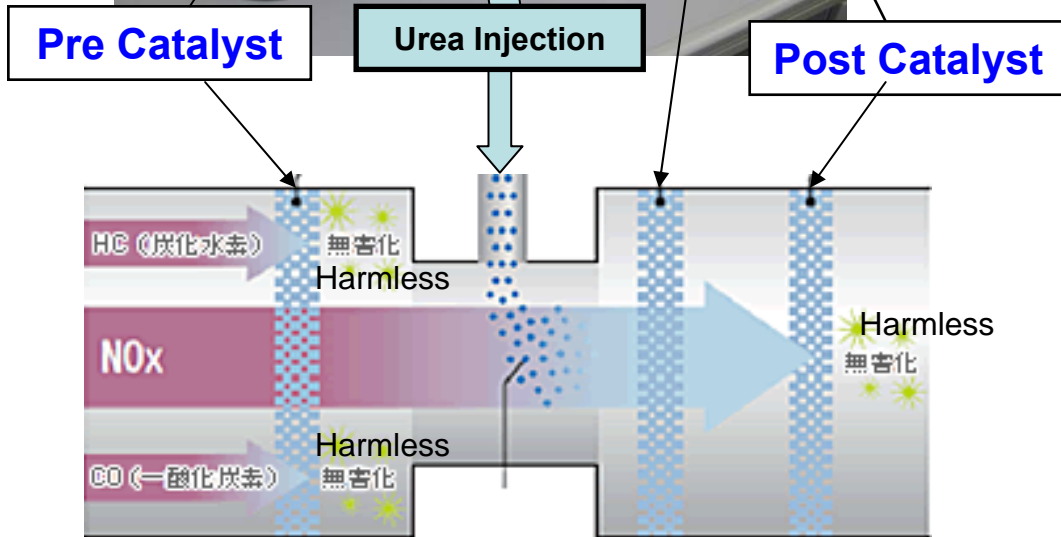
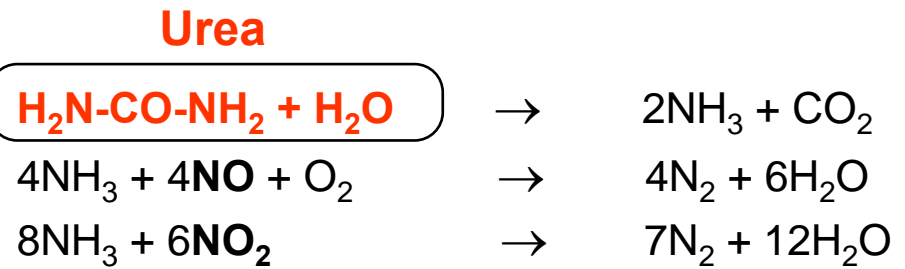
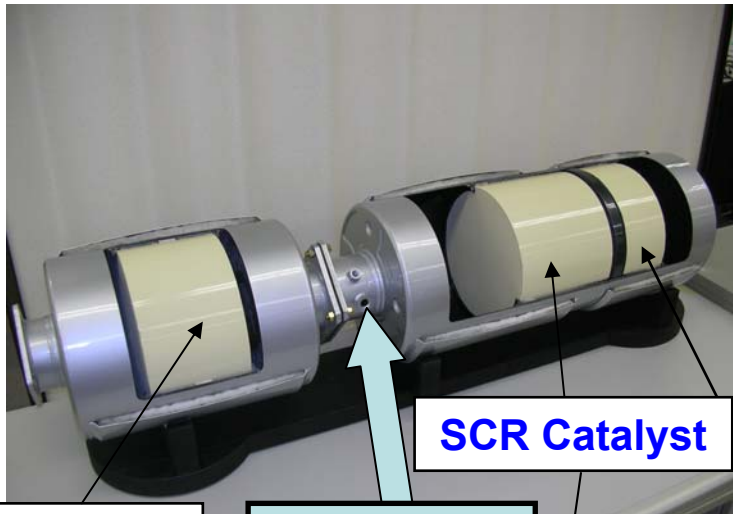
Source : NGK





# SCR System for NOx Reduction ( *Selective Catalytic Reduction* )

For Example



## Infrastructure for Urea SCR

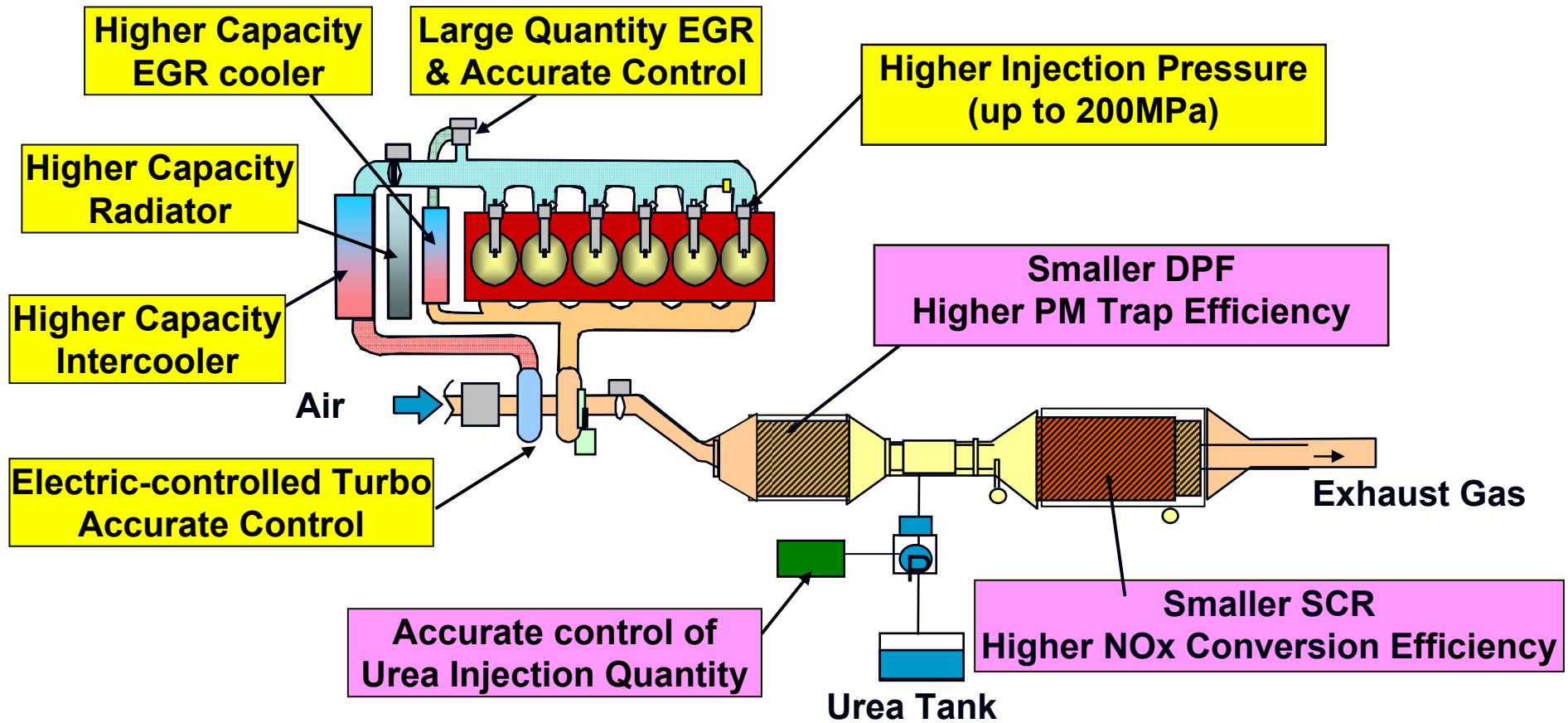


Source : Mitsubishi FUSO HP

# Technology for JP09 \*

*\* :Post New Long Term Exhaust Emission Regulation in Japan  
(equiv. to Euro V)*

## For Example



Source : JAMA Material



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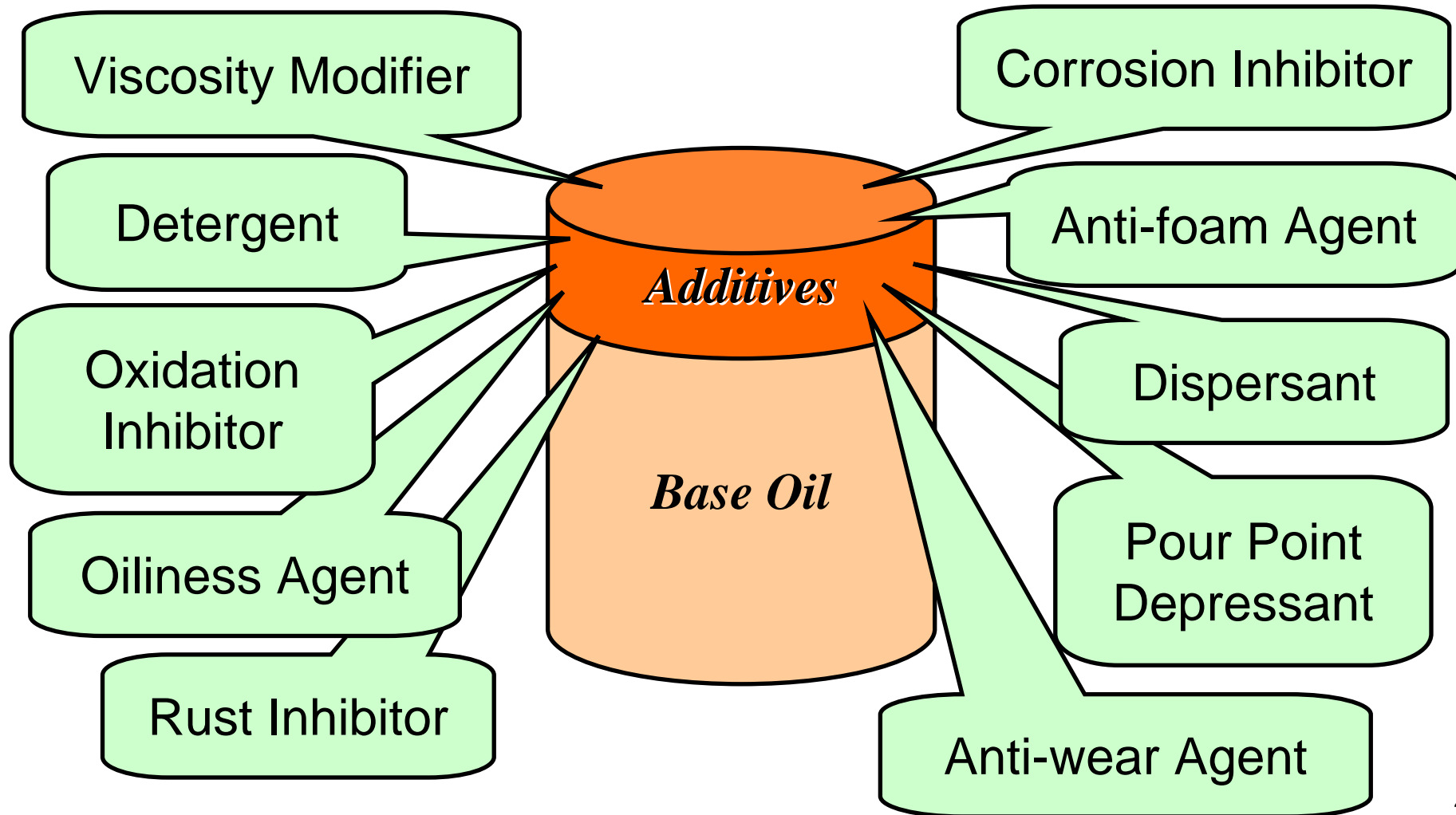
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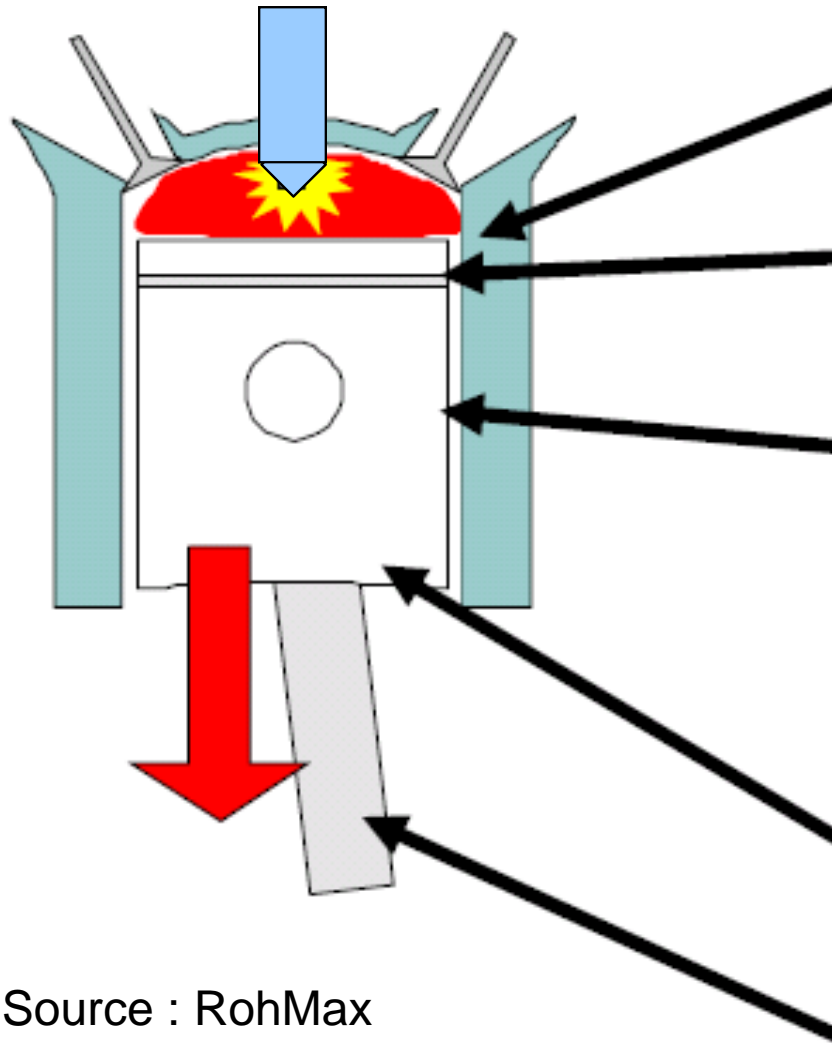
# Composition of Engine Oils

**Additives are formulated to ensure engine oil performance.  
Engine oil works for engine protection.**





# Functions of Engine Oil



**Cooling**

**Sealing**

**Lubrication**

- Reduce Friction

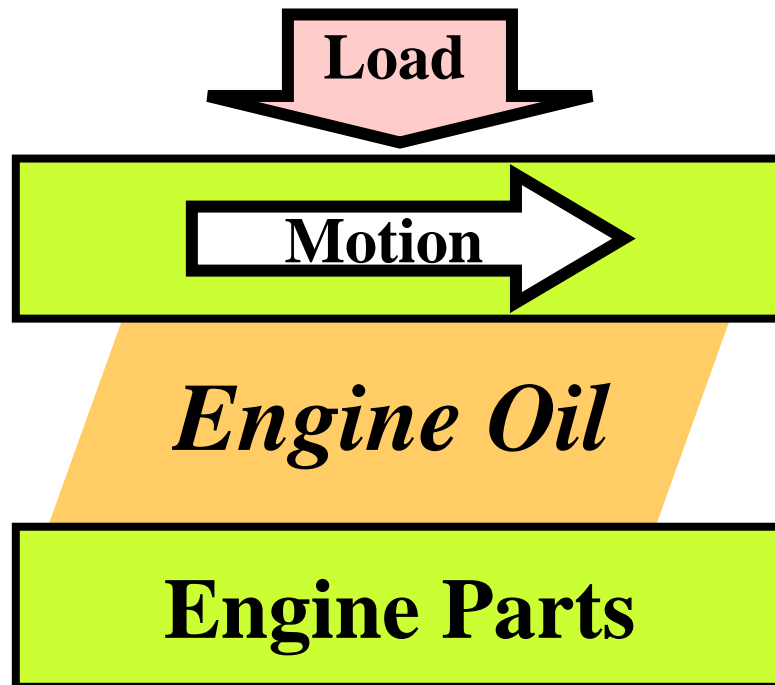
- Wear Protection

**Cleaning**

**Anti-corrosion**

Source : RohMax

# Lubrication : 1



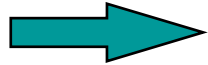
- **Friction**  
can be reduced  
when engine parts  
slide on the oil film
- **Wear**  
can be prevented  
when engine parts  
are separated by  
the oil film

*Lubrlicity is important for Engine Protection*

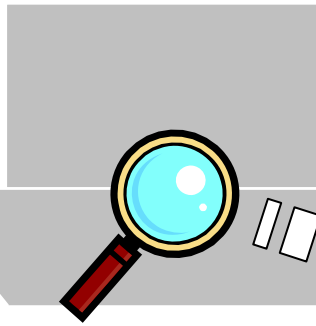
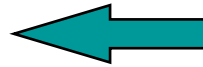


# Lubrication : 2

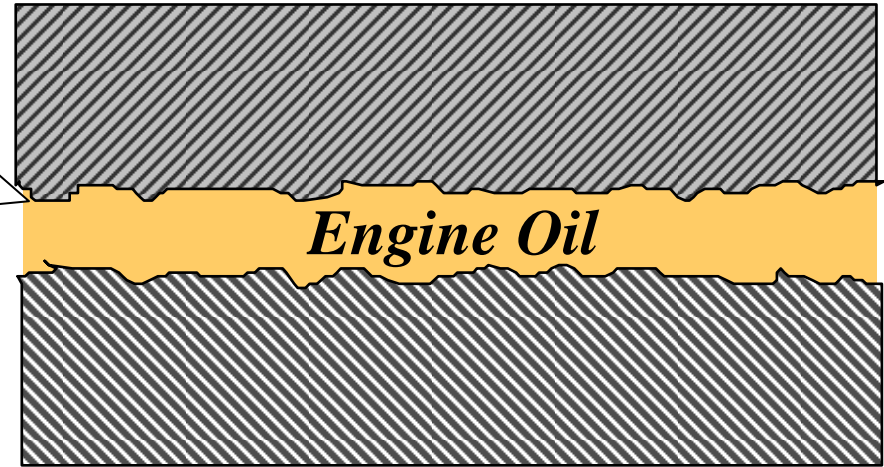
**Force**



**Friction**

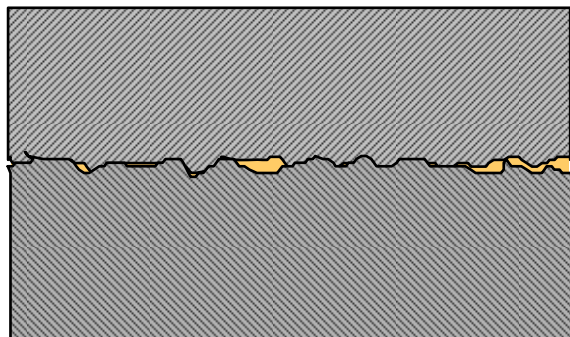


Source : Showa Shell



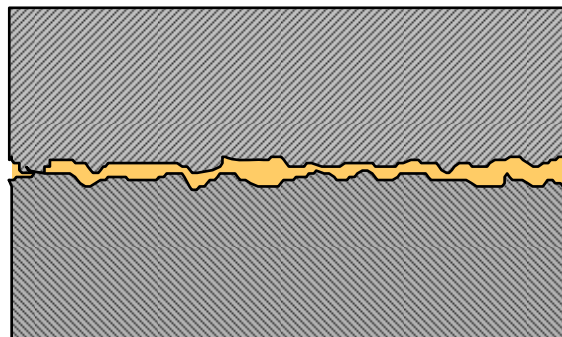
Friction is counteraction force against moving force between two surface.

**Boundary Lubrication**



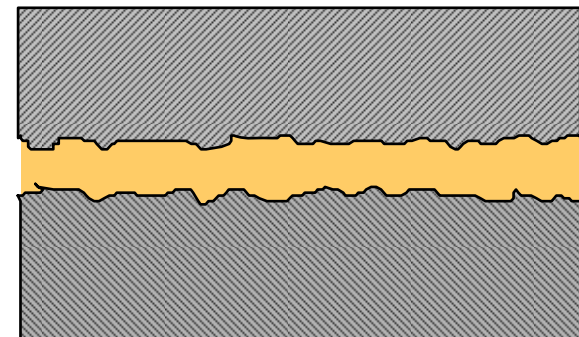
**Clutch, Gear**

**Mixed Lubrication**



**Piston & Cylinder**

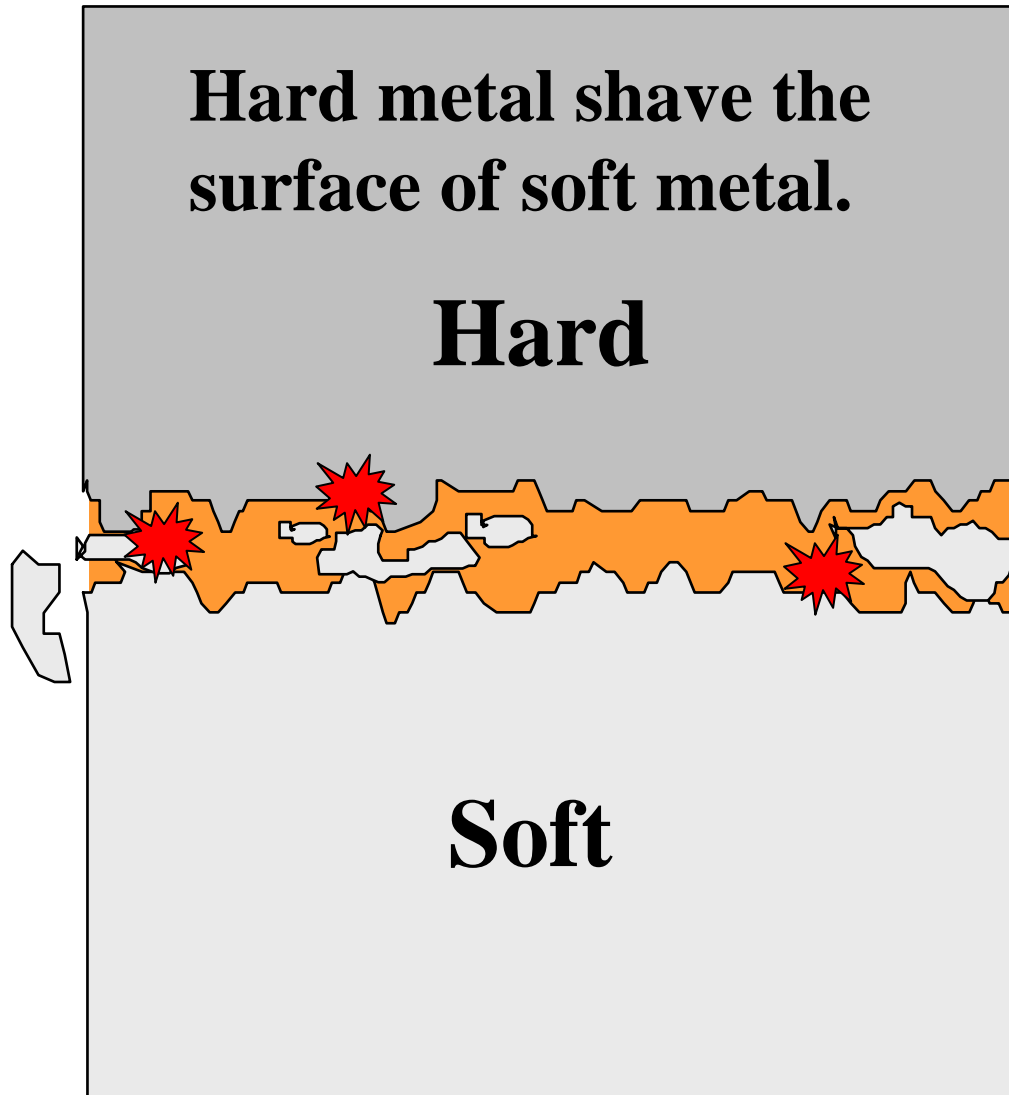
**Hydrodynamic Lubrication**



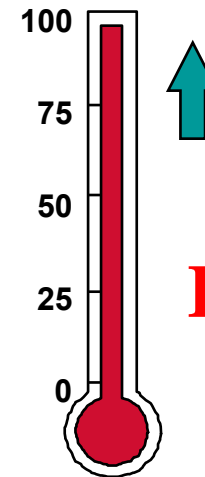
**Connecting rod**

## Lubrication : 3

### Friction is a cause of wear



Friction causes the following phenomena



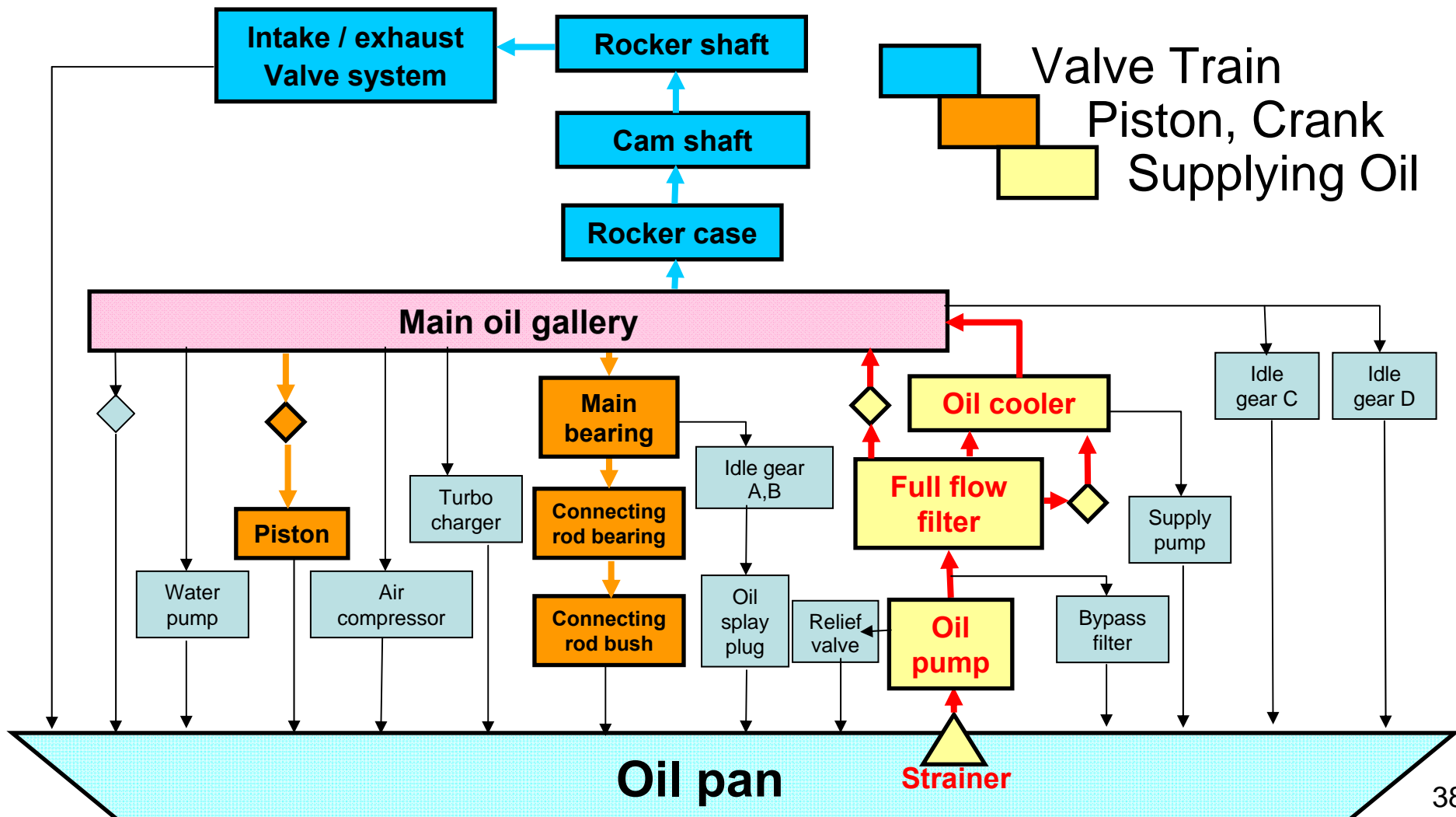
Frictional heat up

Frictional loss up

= Fuel consumption

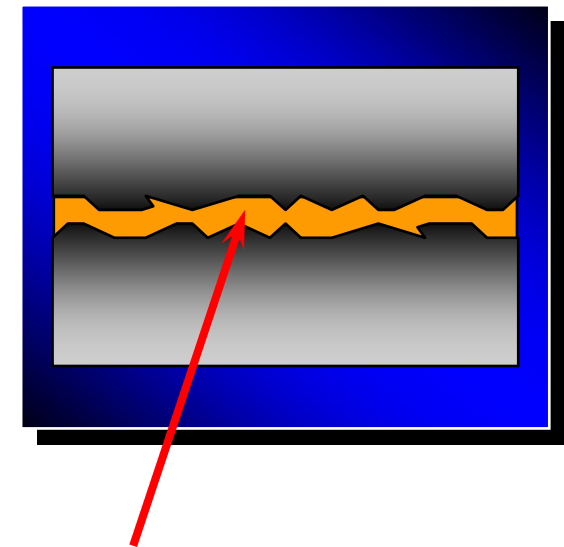
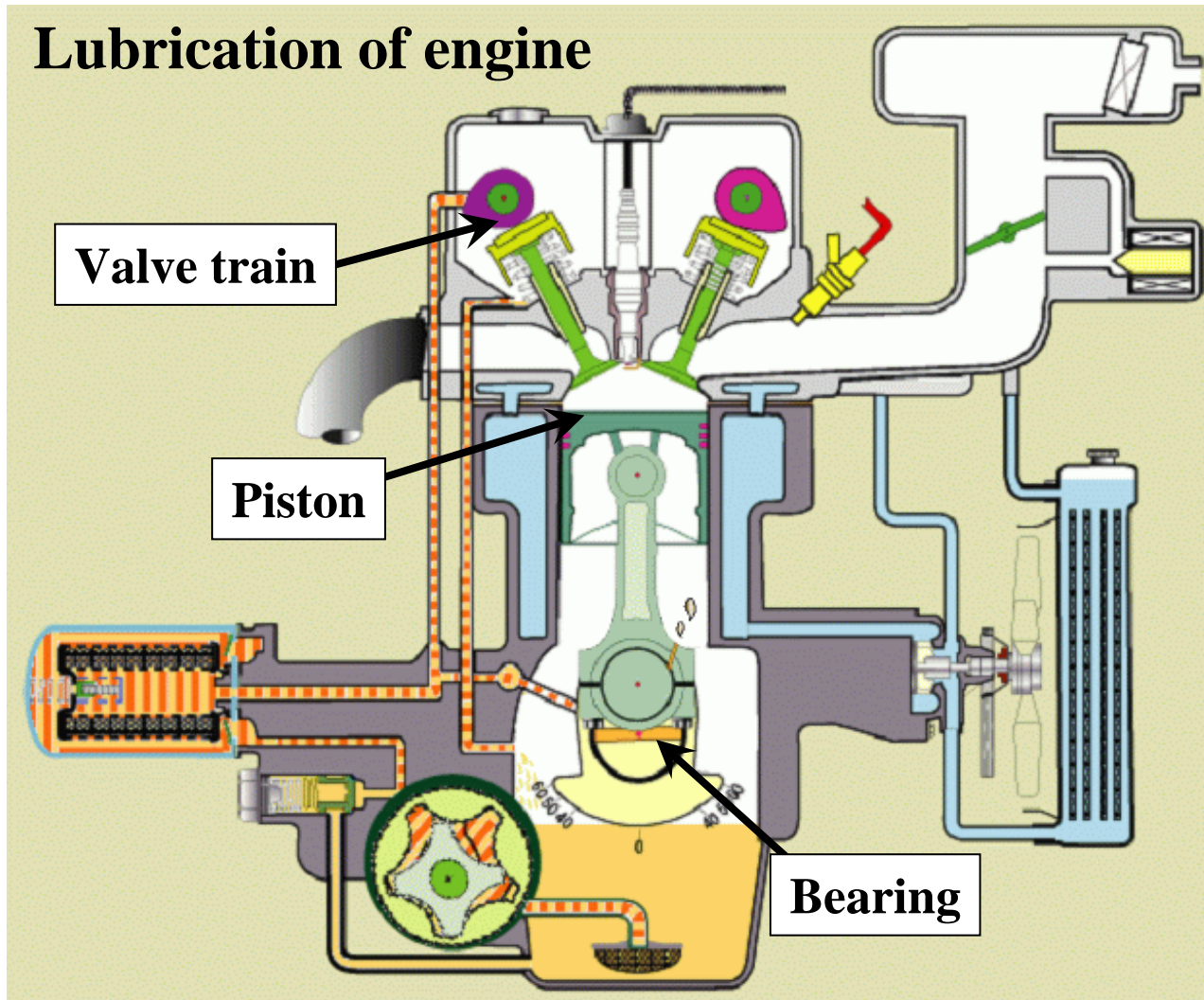
# Lubrication : 4

- To protect engine, supplying oil by pumping oil from oil pan
- Filtering and cooling oil before supplying oil to main oil gallery



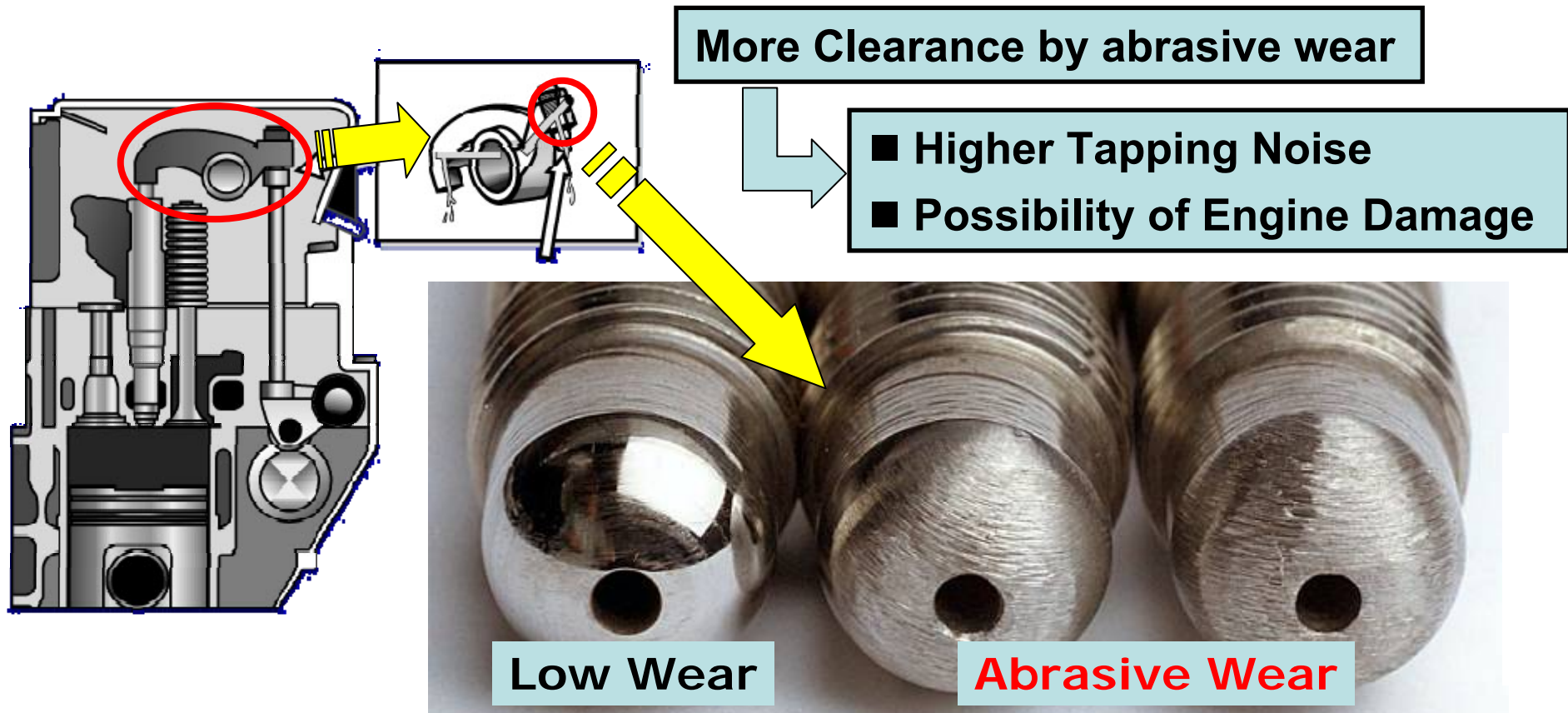
# Lubrication : 5

## Engine oil prevents wear of engine parts



Decrease friction

# Lubrication : 6



Source : SAE Paper : 2006-01-3439

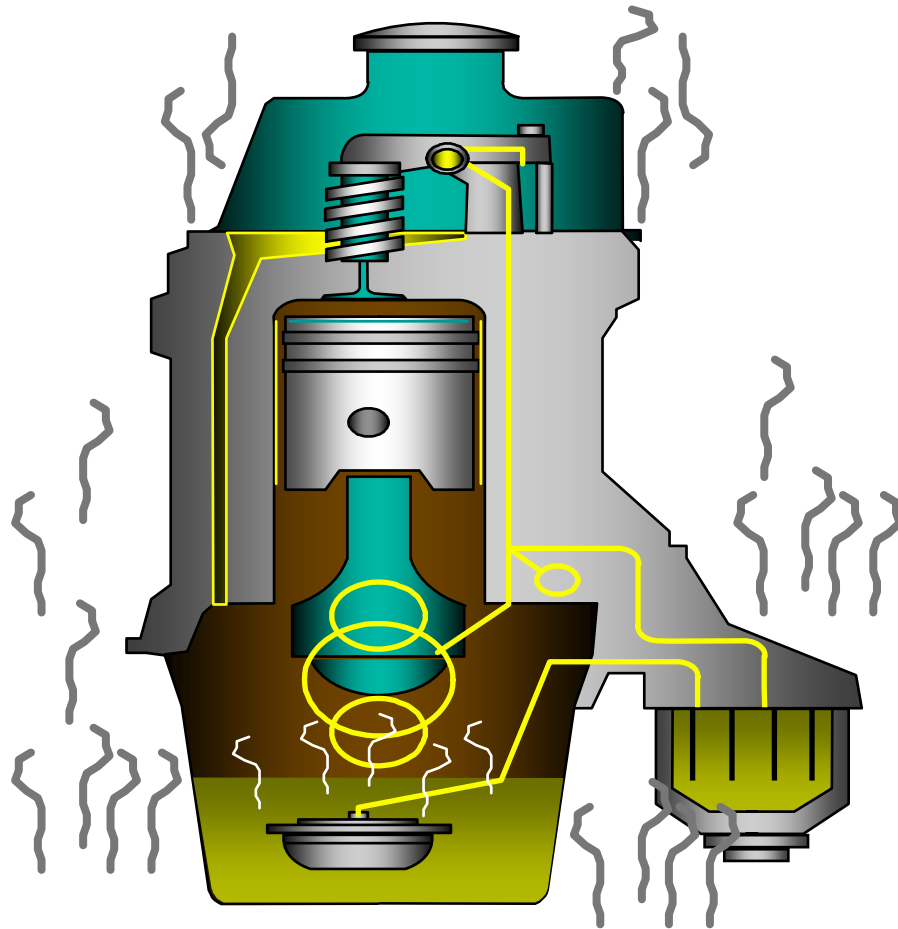
## Poor Anti-Wear Performance

**Abrasive wear due to Soot in used oil on adjusting screws**



# Cleaning : 1

## Heat degrades engine oil



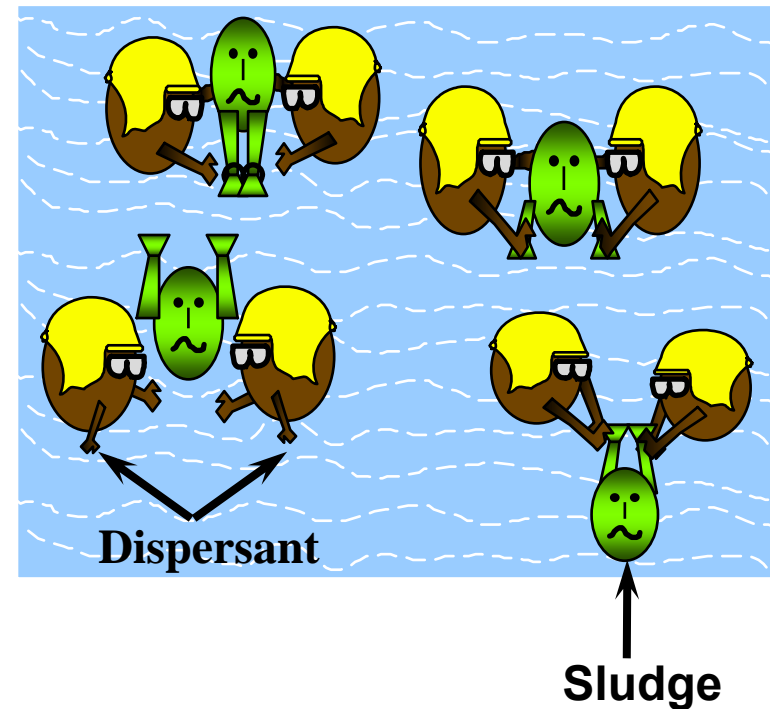
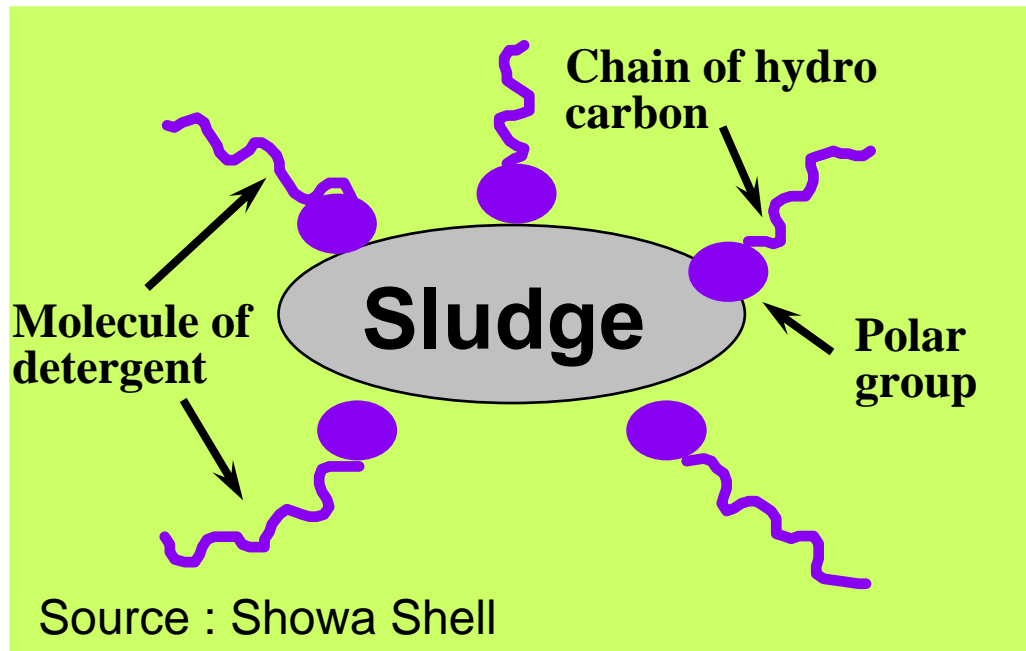
Source : Showa Shell

- **Detergency**  
to keep hot parts  
of engines clean
- **Dispersancy**  
to keep cold parts  
of engines clean

**Thermal Stability**  
**and Dispersancy**  
**are important**

## Cleaning : 2

**Engine oil keep inside of engine clean and makes engine operate stable.**



*Detergent additives accommodate sludge (soot) to oil, and remove from engine.*

*Dispersant additives prevent sludge (soot) from sticking together.*



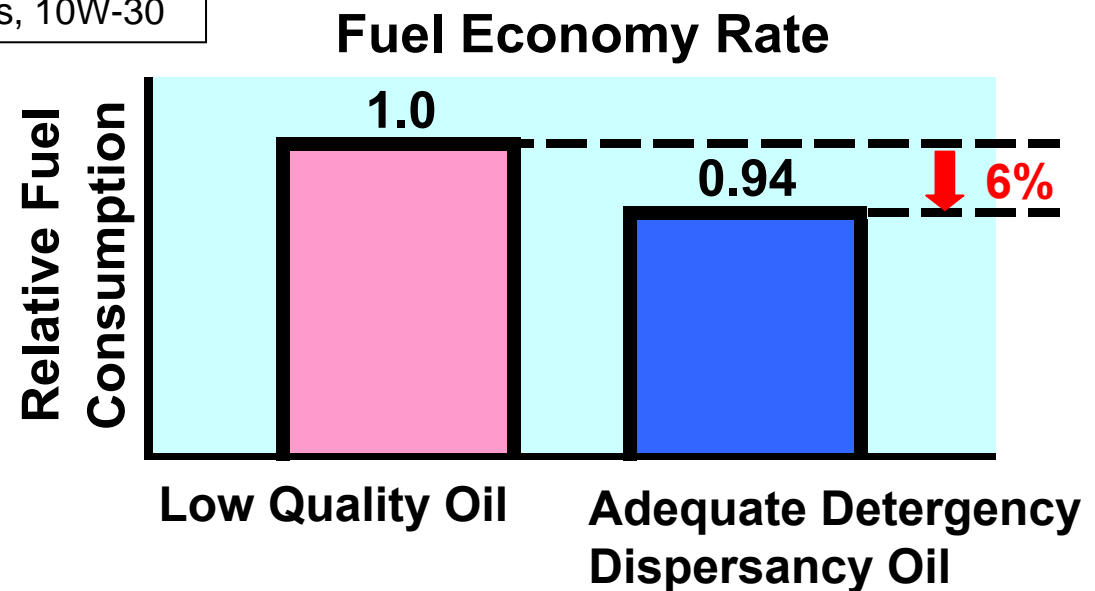
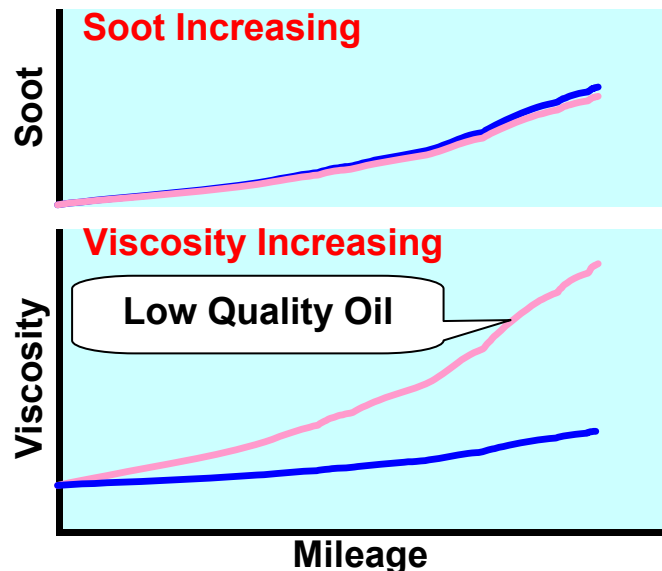
# Cleaning : 3

- ✓ Oils with adequate detergency & dispersancy provide better fuel economy than low quality oils.
- ✓ The effect on fuel economy is dependant on operating conditions such as load, speed, traffic road, engine revolution etc.

## Test Conditions

-Truck Weight : 25 tons, city driving conditions, 10W-30

Source : Hino Motors



## Effect on Fuel Economy of Higher Quality Oils

- An example of Japanese dispersancy field tests -

## Cleaning : 4



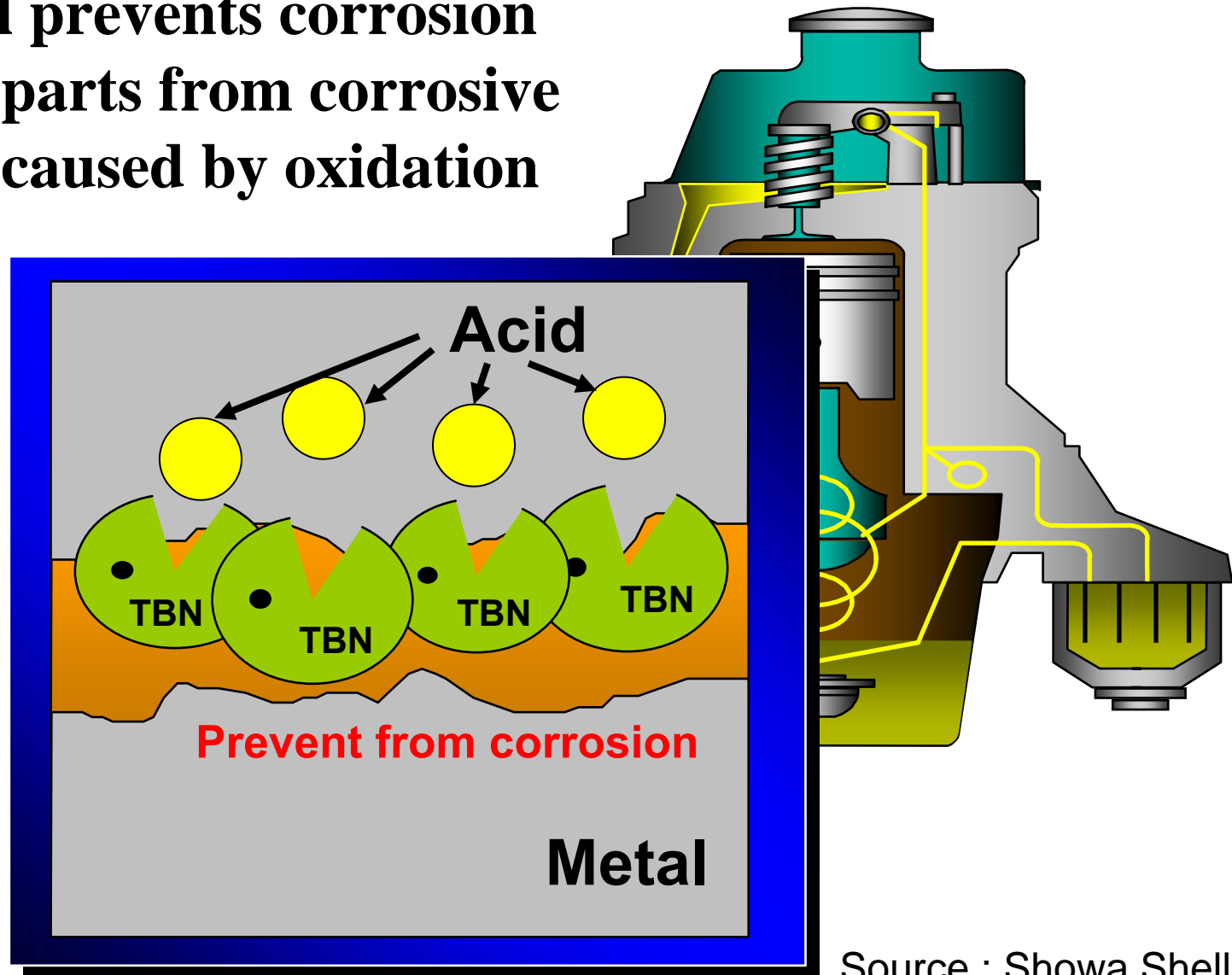
( Piston, Piston Ring )

## Poor Detergency, Dispersancy Performance

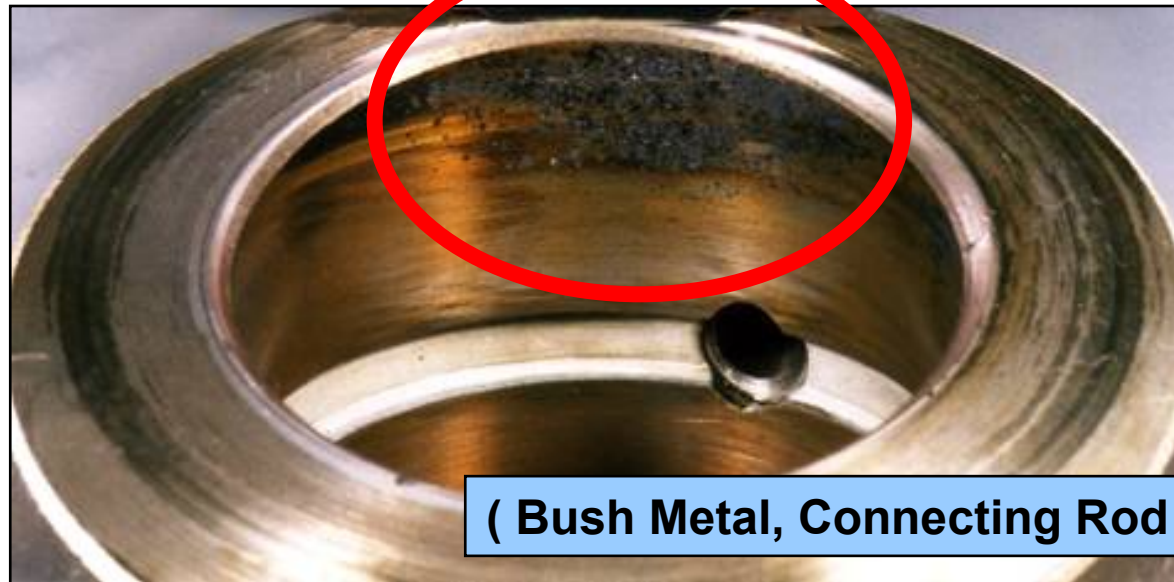
**Much Sludge & Soot Deposit on Piston Ring Grooves**

# Anti-corrosion : 1

**Engine oil prevents corrosion of engine parts from corrosive material caused by oxidation**



## Anti-corrosion : 2

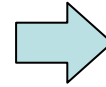


### Poor Anti-Corrosion Performance

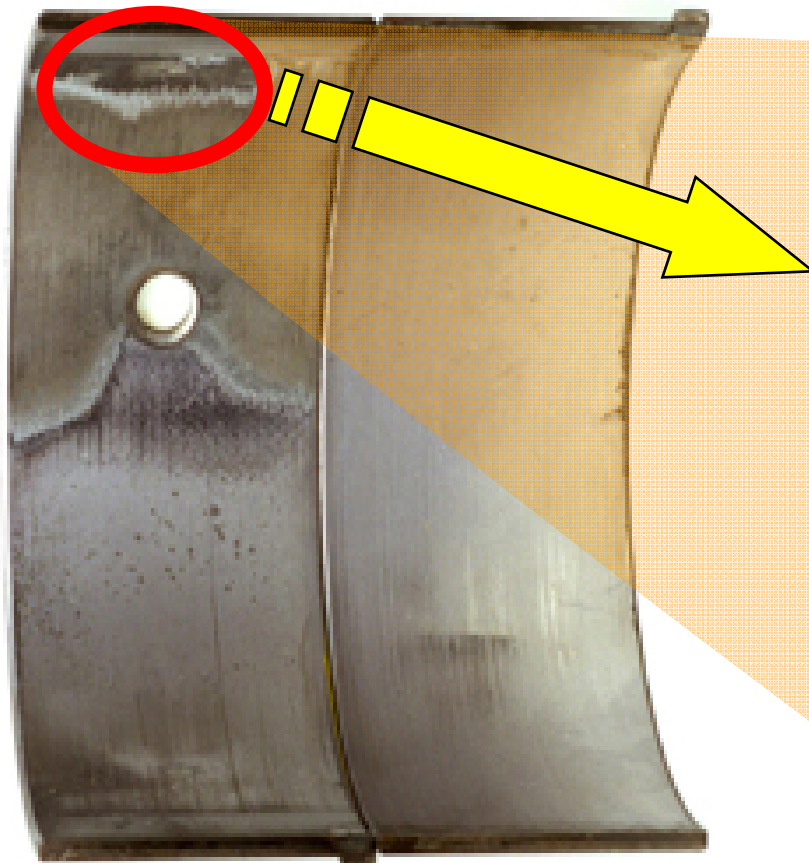
**Acids in Poor Oil are Corrosive to Metals.**

## Anti-corrosion : 3

Scuffing



Possibility of  
Engine Damage



Deeply Corroded Bearing



Source : SAE Paper : 2006-01-3439

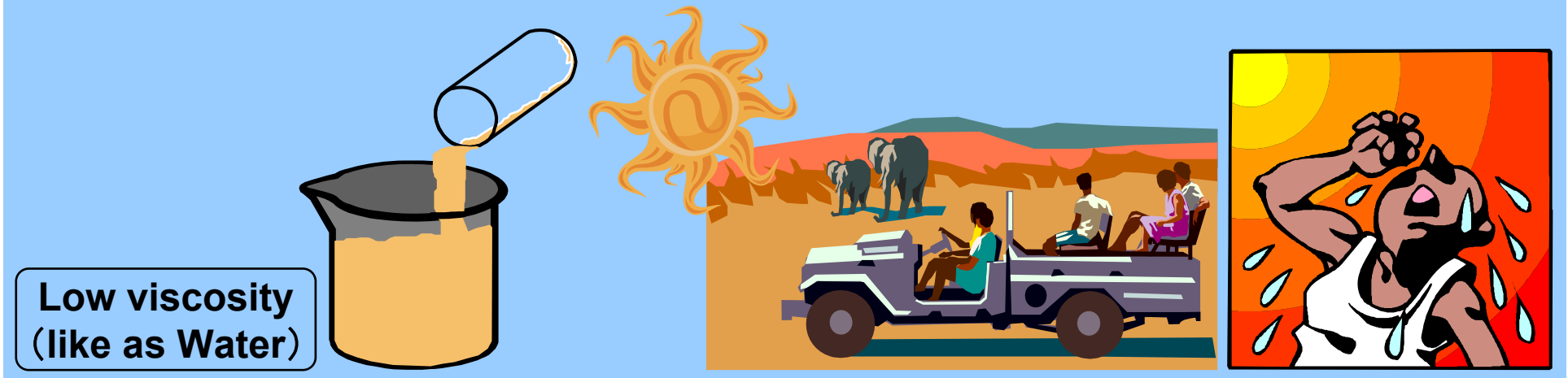
## Poor Anti-Corrosion Performance

Bearing Corrosion due to Oil Oxidation in used oil

# Operation Conditions and Durability : 1



*Engine Oil is operated under hot to cold climates for long period.*



**Engine oil must keep suitable Performance & Viscosity under wide temperature for long time.**



# Operation Conditions and Durability : 2

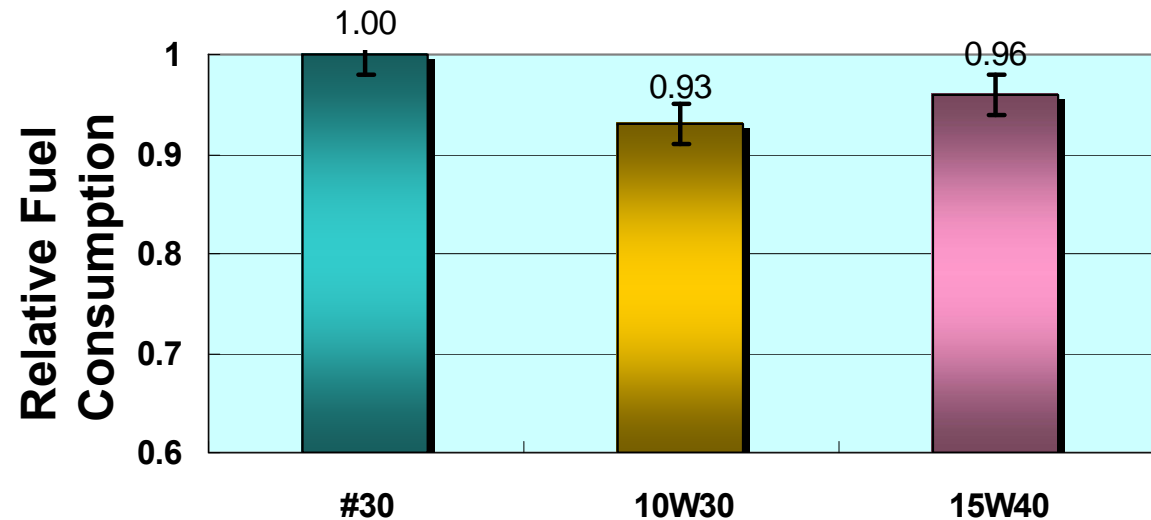
- ✓ Multi-grade oils provide better fuel economy than mono-grade oils.
- ✓ The effects vary according to operating conditions such as load, speed, traffic road, engine revolution etc.

### • Test Conditions

- Truck Weight: 20 tons
- Mileage: 150k km/year on highways
- Fuel Cost: JPY100/liter

Source:

SAE F&L Division, Steering Committee for Asia



	#30	10W30	15W40
Annual Fuel Cost (Million JPY):	4.60	4.28	4.41
Annual Effect (Million JPY):	Base	0.32	0.19
<b>Annual Effect (US\$) :</b>	<b>Base</b>	<b>3200</b>	<b>1900</b>

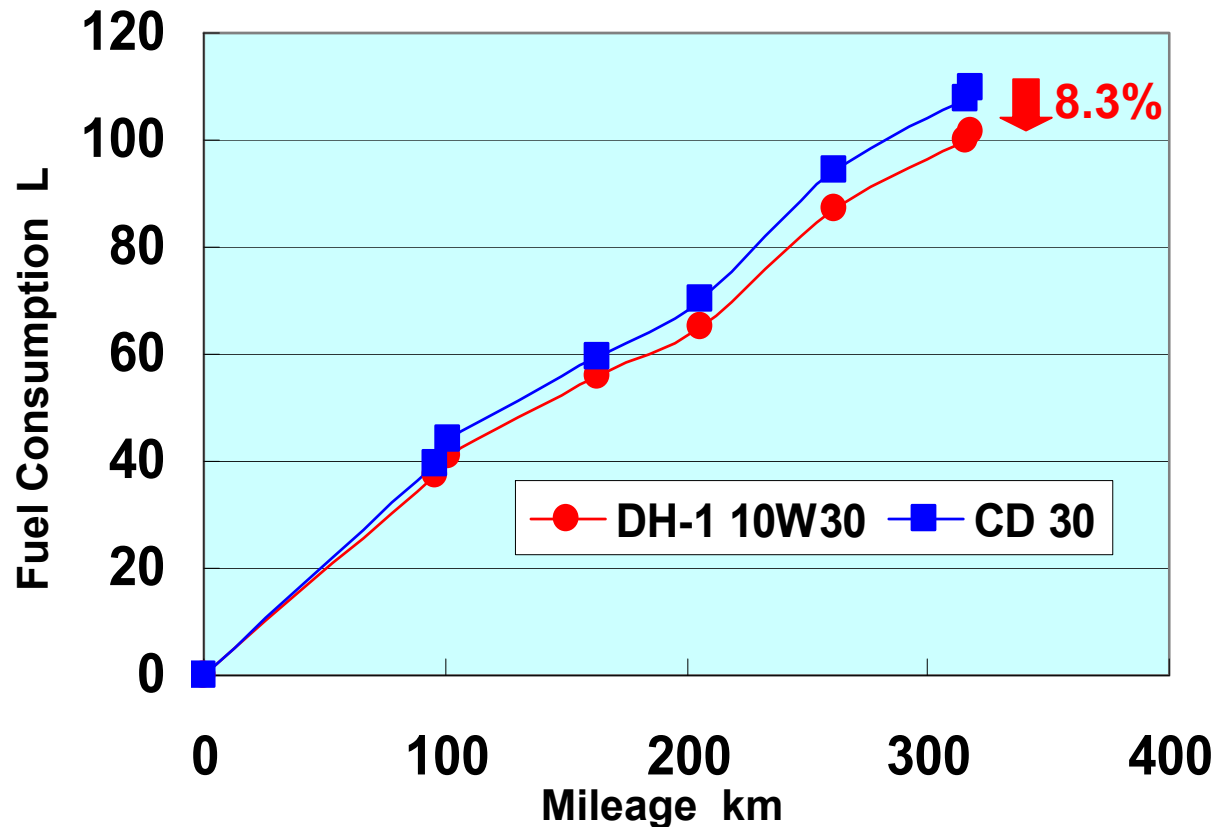
US\$1 = JPY100

## Effect of **Multi-grade Oils** on Fuel Economy in the Japanese Market



# Operation Conditions and Durability : 3

- ✓ Multi-grade oils provide better fuel economy than mono-grade oils.
- ✓ The effects vary according to operating conditions such as load, speed, traffic road, engine revolution etc.



Source : Idemitsu

**Annual Effect : US\$ 5431**  
US\$1 = JPY100

- **Test Conditions**
- - Truck Weight : 20 tons
- - 84% for highway driving
- - 16% for city driving

**Effect of Multi-grade Oils on Fuel Economy in the Japanese Market**



# Engine oil works for engine protection for long time.

*It needs many kind of performances.*

**We recommend suitable Performance &  
Viscosity for engine oil.**



# Contents :

## JASO Diesel Oil Seminar 2009

### Introduction

### Engine & Oil Technologies

- Engine Technology
- Functions of Engine Oil & Examples

### JASO Standards

- JASO DH-1 / DH-2 / DL-1
- JASO On-file System

Break 20'

### Other Topics

- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
- Japanese OEM Requirements for ATF
- Hydraulic Fluid Standards for Construction Machinery (JCMAS)

### Summary

### Discussion



# History of Diesel Engine Oil Specifications

The diesel engine oil specifications have the history of 60 years or more.

Region	Application	1940s	1950s	1960s	1970s	1980s	1990s			2000s		
USA	All Diesel Except 2 Cycle	API CA	API CB	API CC		API CE	API CF-4	API CG-4	API CH-4	API CI-4	API CJ-4	
				API CD								
Europe	Heavy-Duty					CCMC D			ACEA E			
	Light-Duty					CCMC SHPD			ACEA B	ACEA A/B and C		
Japan	Heavy-Duty									JASO DH-1		JASO DH-2
	Light-Duty											JASO DL-1



# *Automotive Diesel Engine Oil Standard* (*JASO M355:2008*)

<u>JASO</u>	<u>Application</u>	<u>Fuel Sulfur</u>	<u>Emission Regulations</u>
<b>DH-1</b>	Trucks & Buses *	~ 500ppm ~	Japan NST, Euro II&III
<b>DH-2</b>	Trucks & Buses	<50ppm	Japan NLT **, Euro IV&V **
<b>DL-1</b>	Passenger cars	<50ppm	Japan NLT **, Euro IV&V **

Recommendation should be depended on OEMs.

\* Technically applicable to passenger cars

\*\* Required after-treatment devices (DPF, de-NOx catalyst etc)



# *JASO DH-1* *Performance Requirements* *- JASO M355:2008 -*

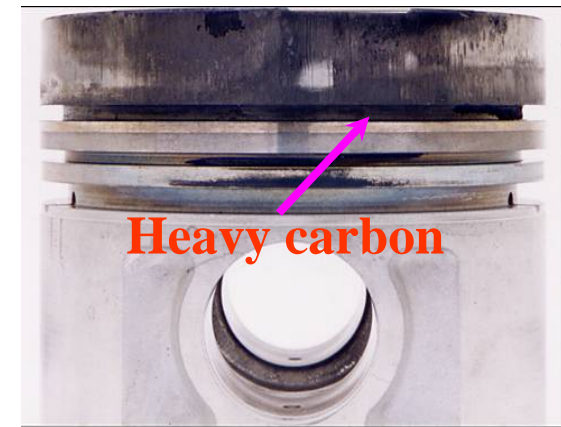
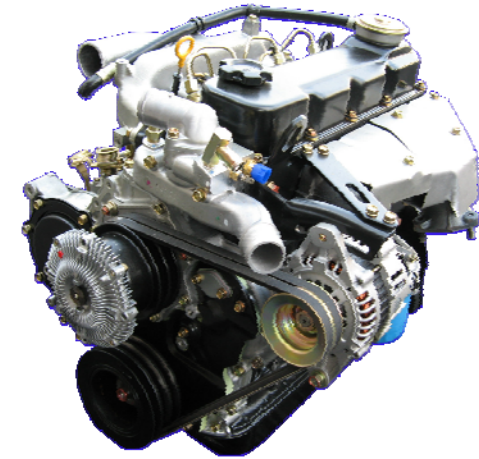
Test	Items	Test Method	Performance Criteria
Engine Test	Piston Deposit Control	Nissan Diesel TD25 JASO M 336-98	TGF ≤ 60.0 % Ring Sticking: All Free
	Valve Train Wear	Mitsubishi Fuso 4D34T4 JASO M 354-2005	Avg ≤ 95.0 μm Max ≤ 210 μm
	Soot Control	Mack T-8A ASTM D5967	≤ 0.2
	Oxidation Stability	Sequence. IIIF/IIIG ASTMD5533/D6984	= API CH-4
Laboratory Test	Hot Surface Deposit Control	Hot Tube Test JPI-5S-55-99	≥ 7.0 at 280°C
	Anti-foaming	Foaming Tendency JIS K 2518:2003	Seq. I & III: 10/0 Seq. II: 50/0
	Volatility	NOACK JPI-5S-41-2004	≤ 18.0
	Corrosiveness	Cummins HTCBT ASTM D6594 & D130-94	= API CH-4
	Shear Stability *	HTHS ASTM D6278	Stay in Grade
	Seal Compatibility	CEC-L-39-T-96	= ACEA E
Chemical Limit	Base Number	JIS K 2501 or ASTM D4739	≥ 10

\* for multi-grade oils (No requirements for mono-grades)



# Engine Test - Piston Deposit Control (JASO M336-98 )

Test Engine **Nissan Diesel TD25**  
2.5L In-line 4 IDI  
Test Condition 4,300rpm Full Load 200 hours  
Pass Criteria TGF; 60.0% max  
Piston ring sticking; Free



Source: JALOS





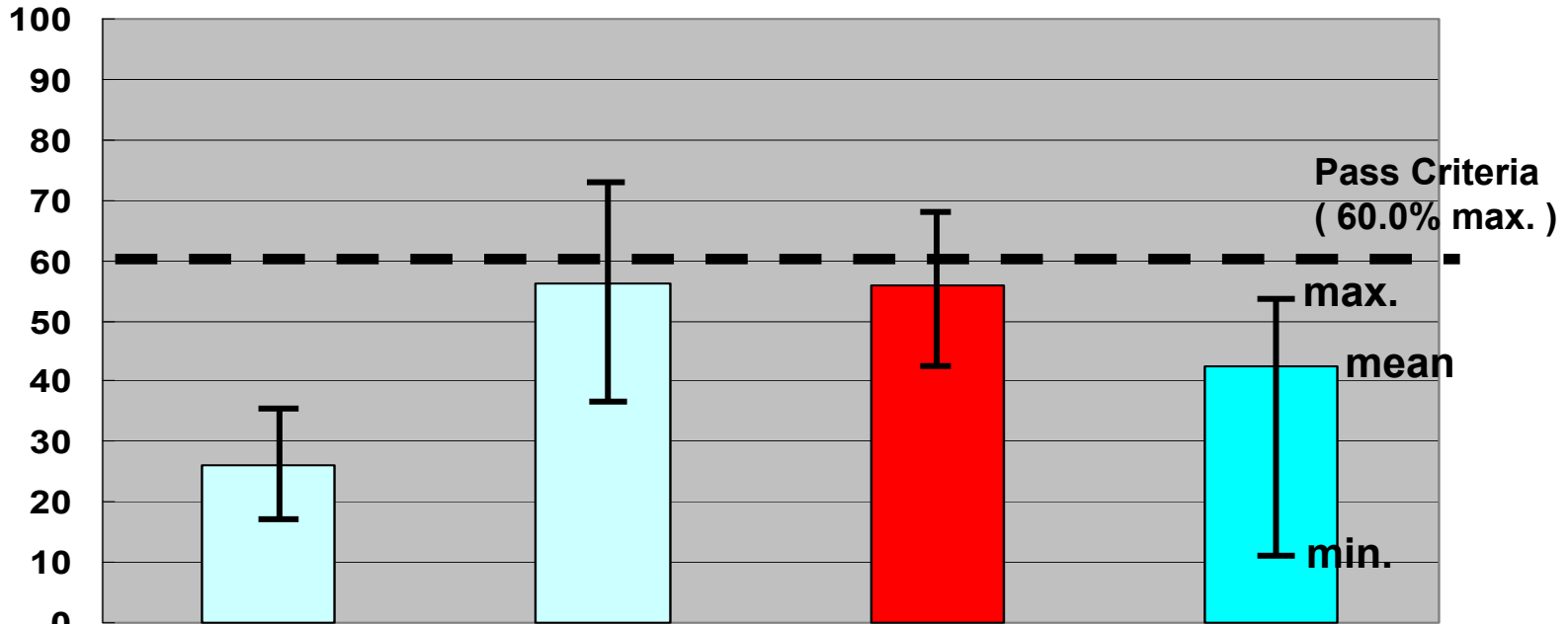
# Piston Detergency Performance

( JASO M336-98 )

- JASO Precision Test Results -

DH-1 oil has much better Detergency Performance than CG-4 for Japanese OEM Engine.

Top Groove Fill (vol%)



Good REO (n=9)

Border Line REO (n=39)

USA Commercial Oil (CG-4) (n=2)

DH-1 On filed Oil (n=68)

REO : Reference Engine Oil

# Engine Test – Valve Train Wear (JASO M354-2005 )

Test Engine **Mitsubishi Fuso 4D34T4**  
3.9L In-line 4 DI

Test Condition 3,200rpm Full Load 160 Hours

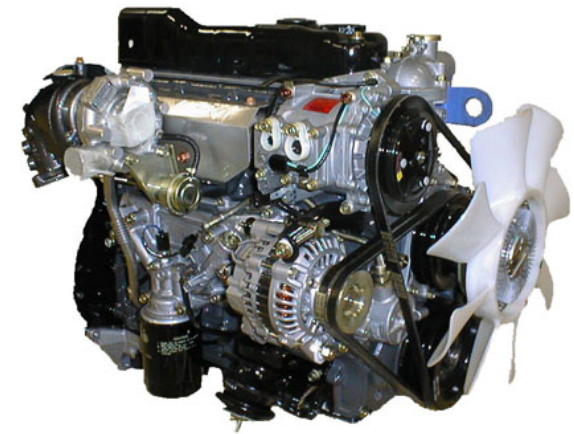
Pass Criteria Average cam nose wear; 95.0  $\mu\text{m}$  max  
Max cam nose wear; 210  $\mu\text{m}$  max  
No Pitting



No Pitting



Pitting



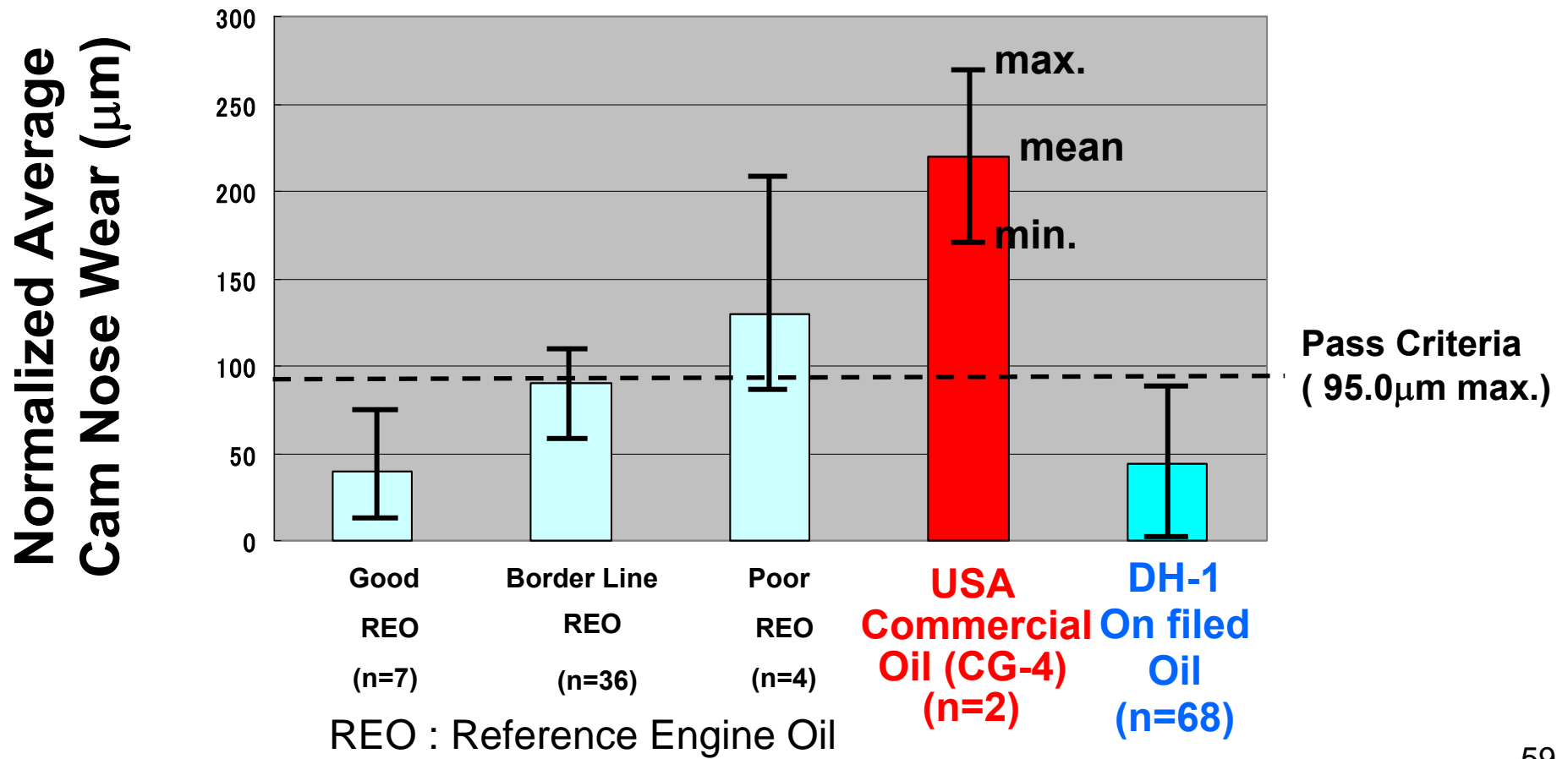


# Valve Train Wear Performance

*(JASO M 354-2005)*

*- JASO Precision Test Results -*

DH-1 oil has much better Valve Train Wear Performance than CG-4 for Japanese OEM Engine.

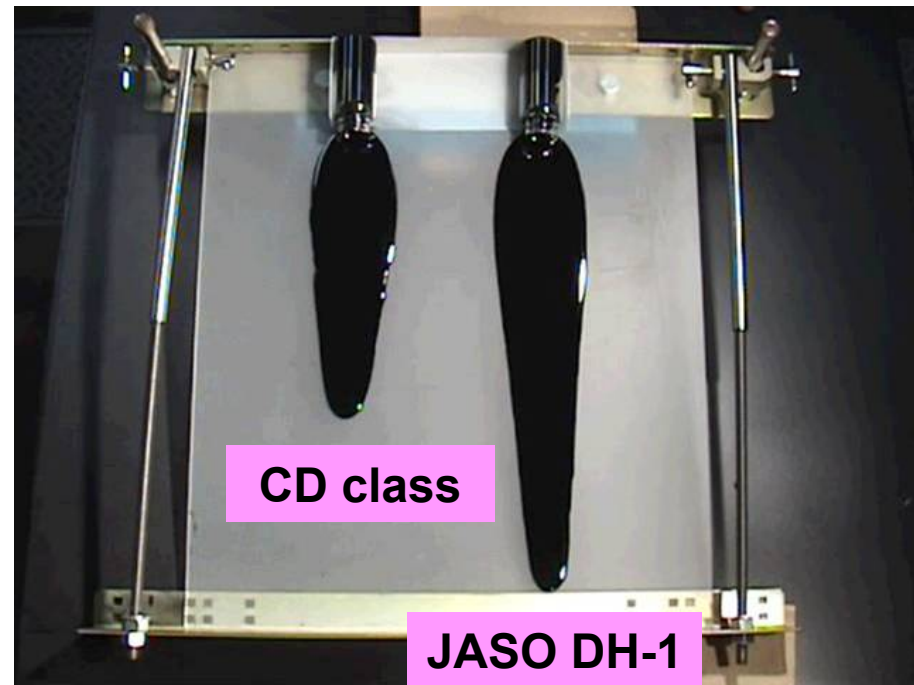




# *Engine Test – Soot Control* (*ASTM D5967*)

Test Engine      **Mack T-8A**  
                         12.0L DI  
Test Condition   1,800rpm 258kW load 150 hours  
Pass Criteria    Viscosity Increase(100-150hours); 0.2 mm<sup>2</sup>/s/h max

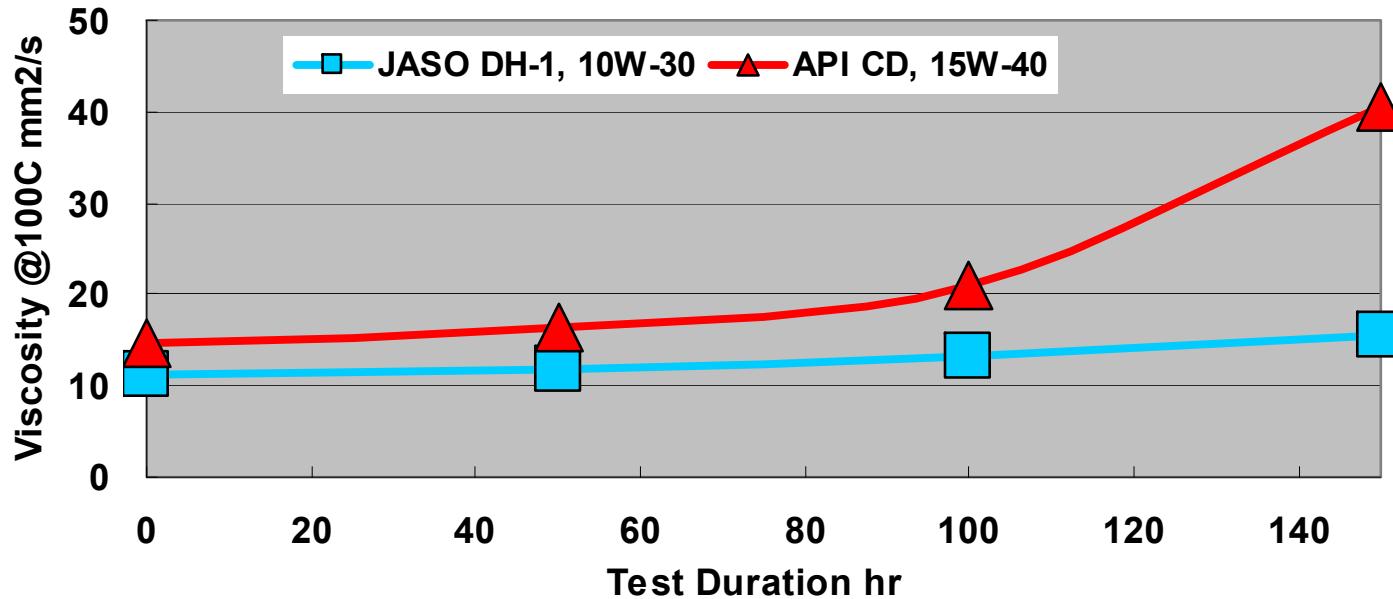
Viscosity Increase by Soot  
(Oils after Engine Test)



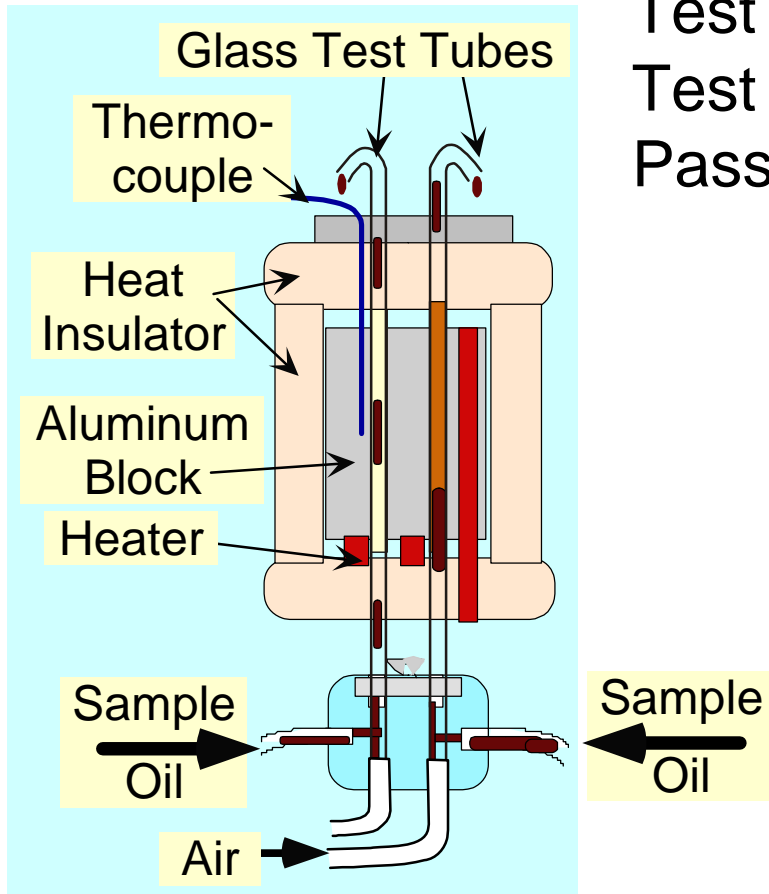


# Soot Dispersancy (Mack T-8A Data)

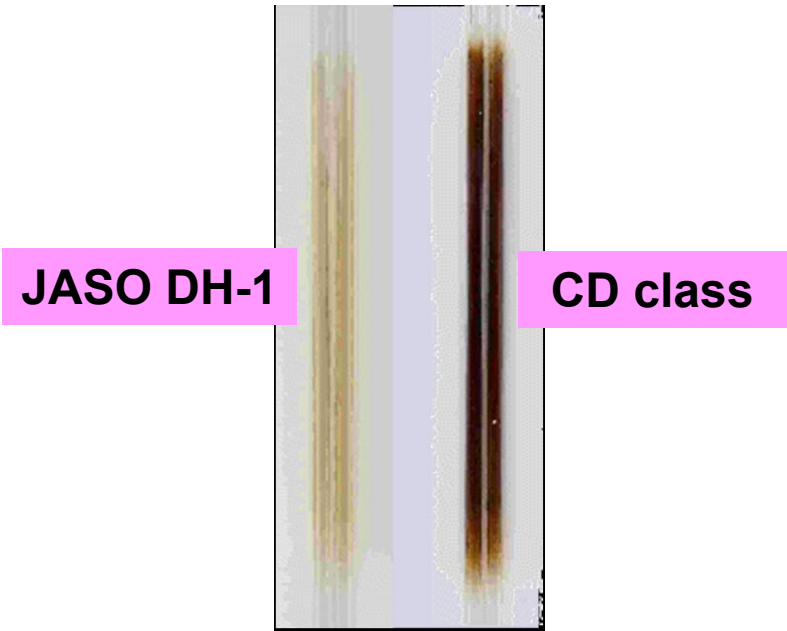
	Pass Criteria	JASO DH-1	API CD
KV100 Increase $\text{mm}^2/\text{s}/\text{hr}$	0.2 max.	0.05	0.40



# Laboratory Test – Hot Surface Deposit Control (JPI 5S-55-99 )



Test Method **Hot Tube Test**  
Test Condition 280 °C, 16hours, 0.3ml/hr  
Pass Criteria Merit rating; 7.0 min



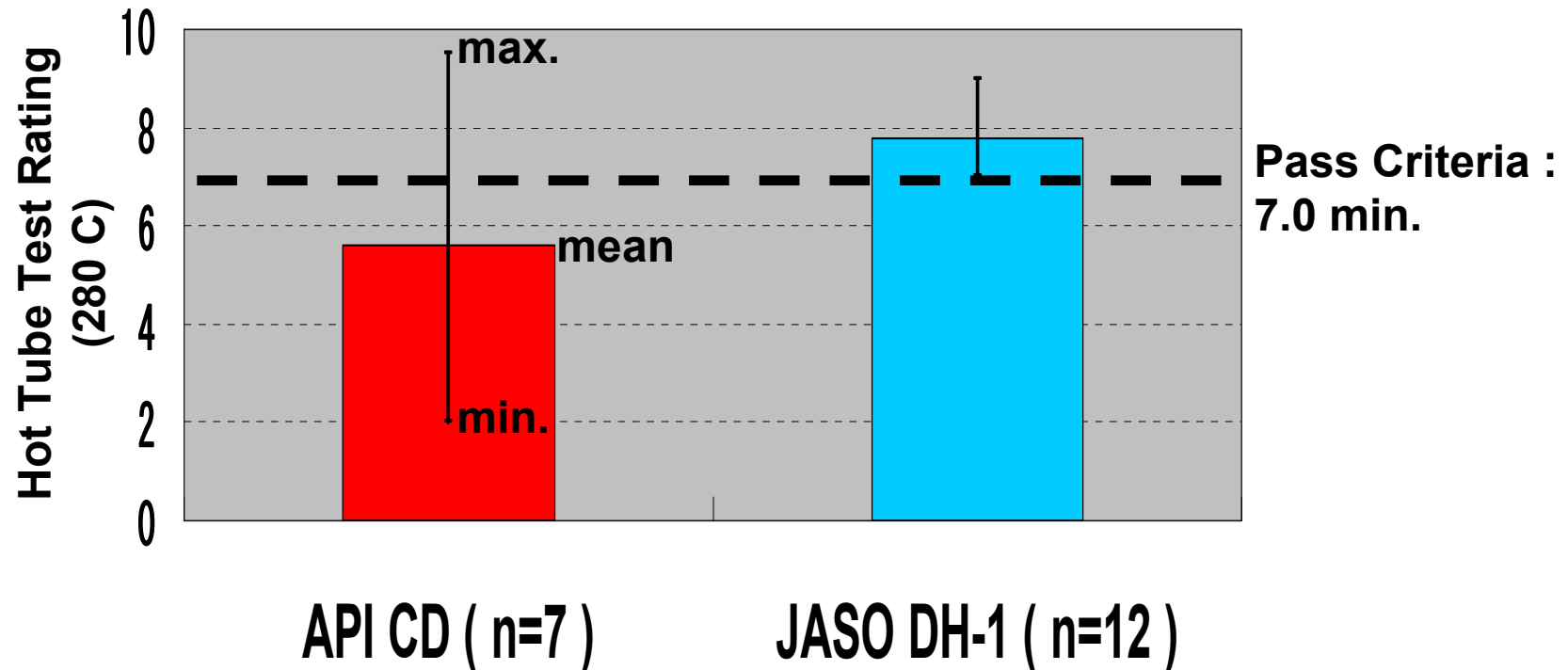


# Hot Surface Deposit Control

## *(Hot Tube Test Results)*

- This method was adopted for the hot surface deposit control such as a turbocharger.

The pass criteria based on test results of popular oils in the markets, Japan and USA etc..





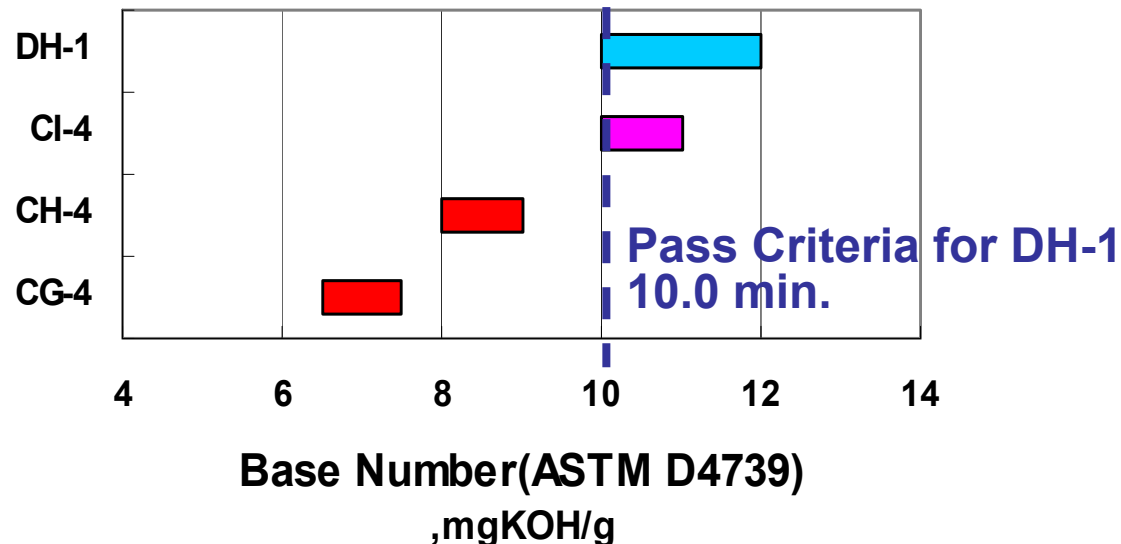
# Chemical Limit – Base Number

(JIS K2501 or ASTM D4739 )

Test Method **Base Number**

Pass Criteria JASO DH-1; 10.0 mgKOH/g min  
JASO DH-2; 5.5 mgKOH/g min

JASO DH-1 oils are advantageous to API oils in view of anti-corrosion performance. (Corrosive wear on cylinder liners, bearings, etc.)







# *Automotive Diesel Engine Oil Standard* *(JASO M355:2005)*

<u>JASO</u>	<u>Application</u>	<u>Fuel Sulfur</u>	<u>Emission Regulations</u>
DH-1	Trucks & Buses *	~ 500ppm ~	Japan NST, Euro II&III
DH-2	Trucks & Buses	<50ppm	Japan NLT **, Euro IV&V **
DL-1	Passenger cars	<50ppm	Japan NLT **, Euro IV&V **

Recommendation should be depended on OEMs.

\* Technically applicable to passenger cars

\*\* Required after-treatment devices (DPF, de-NOx catalyst etc)



# *Difference in Requirement* – *JASO DH-2 vs. DL-1* – After-treatment devices require low SAPS

Truck & Bus

Passenger Diesel Vehicle

Need to avoid excessively lowered Sulfated-Ash in keeping appropriate TBN level

- Oil Drain Interval
- Anti-Corrosion Performance

- Need fuel economy
- Higher oxidation stability

**DH-2**

**Sulfated-Ash:  $1.0 \pm 0.1$  %**  
**TBN: 5.5 min**

**DL-1**

**Sulfated-Ash: 0.6 % max**  
**Fuel Economy : ACEA B1**  
**Oxidation Stability : GF-3**



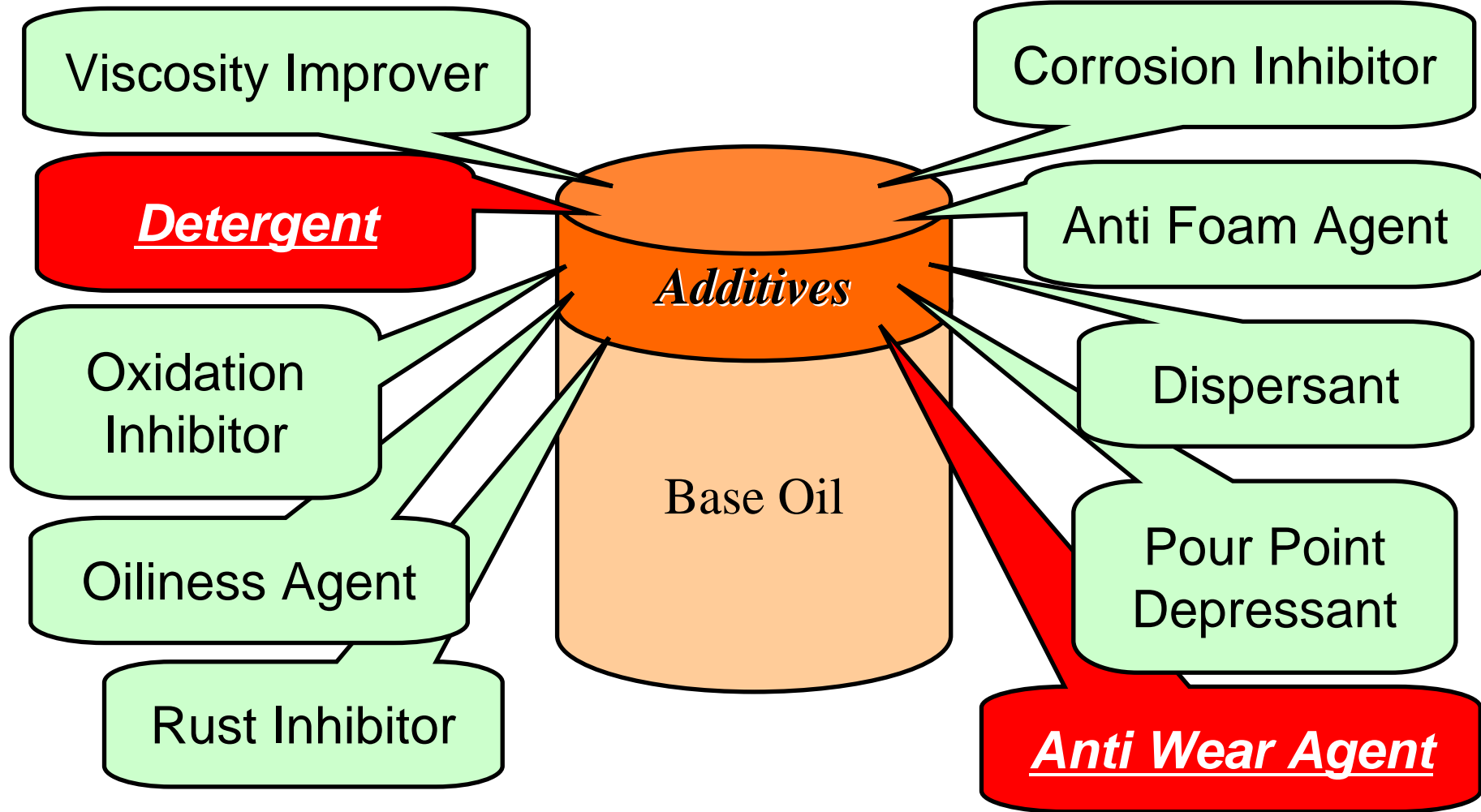
# JASO DH-2/DL-1 specification

		JASO			
		DH-1	DH-2	DL-1	
<b>Engine Tests</b>	Nissan Diesel TD25	℞	℞	℞	Detergency
	Mitsubishi Fuso 4D34T4	℞	℞	℞	Valve train wear / Soot handling
	MACK T-8 / 8E	℞	℞	℞	Soot handling / wear
	SEQ.IIIE / IIIF	℞	℞	℞ *	Oxidation / wear
	MB M111	-	-	℞	Fuel Economy
<b>Bench Tests</b>	SAE J300	-	-	XW-20,XW-30	Viscosity grade
	CEC L-36	℞	℞	℞	Viscosity(HTHS)
	ASTM D892/D6082	℞	℞	℞	Foaming
	CEC L-39	℞	℞	℞	Oil/elastomer compatibility
	CEC L-40	℞	℞	℞	Noack volatility
	JPI 5S-55	℞	℞	℞	Hot surface deposit control
	ASTM D5968 / D6594	℞	℞	℞	Corrosion(HTCBT/CBT)
<b>Chemical Limits</b>	ASTM D874	-	1.0±0.1	0.6 max	Sulfated ash, mass%
	JIS K2501		5.5 min	-	Base number, mgKOH/g
	ASTM D4739	10.0 min	-	-	
	ASTM D2622 / D5185	-	0.5 max	0.5 max	Sulfur, mass%
	ASTM D5185	-	0.12 max	0.10 max	Phosphorus, mass%
	ASTM D6443	-	150 max	150 max	Chlorine, ppm

\* Severe passing criteria

# Composition of Engine Oils

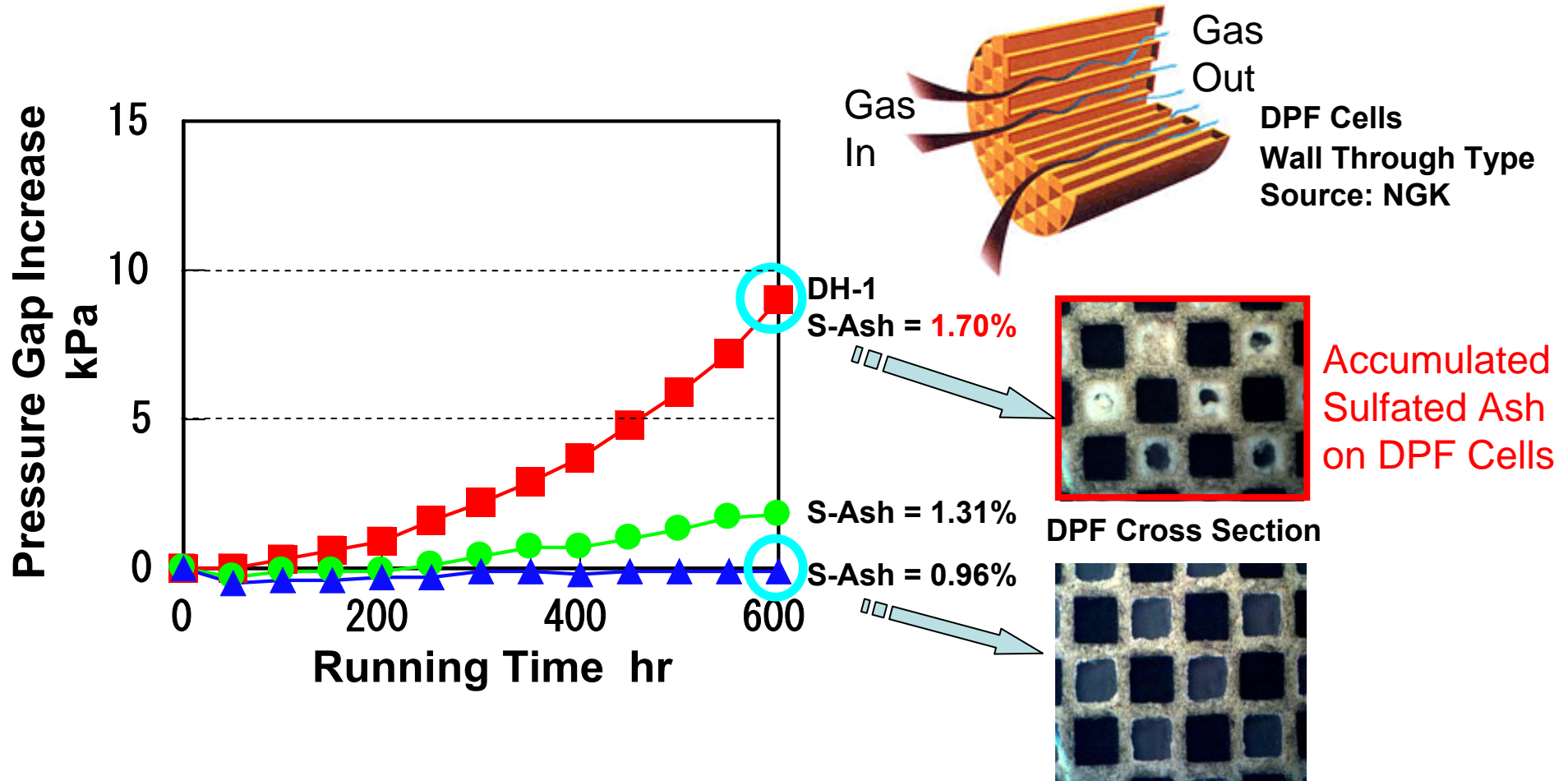
Additives are formulated to ensure engine oil performance  
Engine oil works for engine protection.



*Additives which leaves Ash after combustion*

# DPF Pressure Gap Increase

*When sulfated ash contents were higher, the DPF pressure gap increased gradually.*



DPF Pressure Gap : DPF Pressure Gap between Inlet and Outlet by Exhaust Gas  
Source : JCAP Official Report PEC-2003JC-01



# *Summary* *for JASO DH-1, DH-2 & DL-1*

JASO has 3 specifications for Diesel Engine Oils

- **DH-1**; for high sulfur fuel region
- **DH-2**; for low sulfur fuel (<50 ppm) region with DPF for trucks and buses
- **DL-1**; for low sulfur fuel (<50 ppm) region with DPF for passenger cars
- Development cost of JASO DEO are less expensive than API/ACEA.
- JASO DEO specifications are the most suitable oils for Japanese trucks, buses and light duty diesel vehicle & passenger cars
- JAMA expects the current specifications live on for many years... beyond 2010.



**JASO DH-1 is currently the most suitable engine oil for Japanese diesel vehicles in your country.**



# Contents :

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- JASO On-file System

Break 20'

### Other Topics

- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
- Japanese OEM Requirements for ATF
- Hydraulic Fluid Standards for Construction Machinery (JCMAS)

### Summary

### Discussion

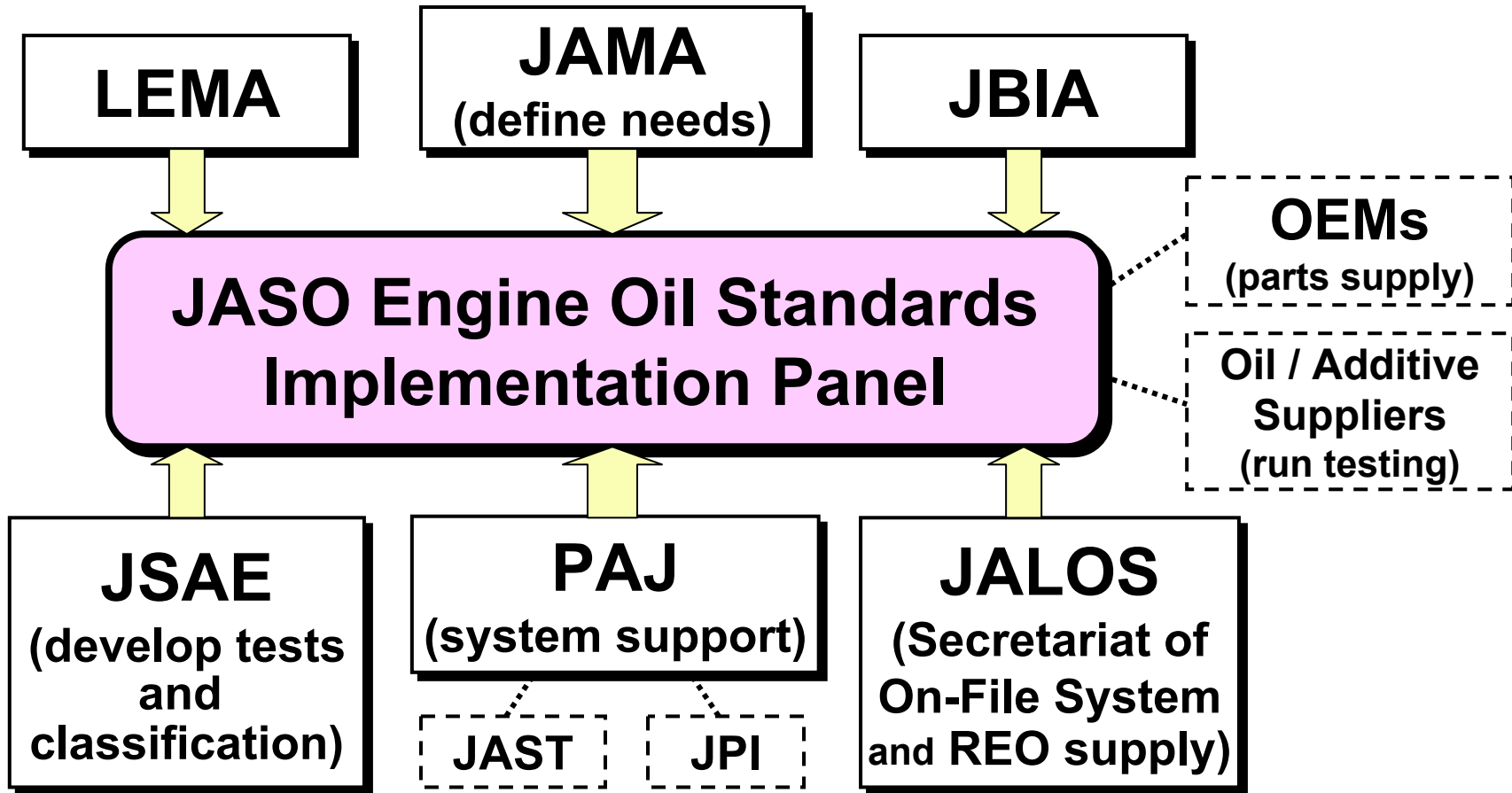


## *What is JASO On-file System?*

- A quality management system for JASO engine oil standards
- Operated by the “JASO Engine Oil Standards Implementation Panel (JEOSIP)” composed by the relevant industrial organizations with engine oils in Japan.
- Economical system compared with EOLCS (US) and EELQMS (EU) with reasonable effectiveness
- Aiming to protect end-users and lubricant suppliers from fake oils



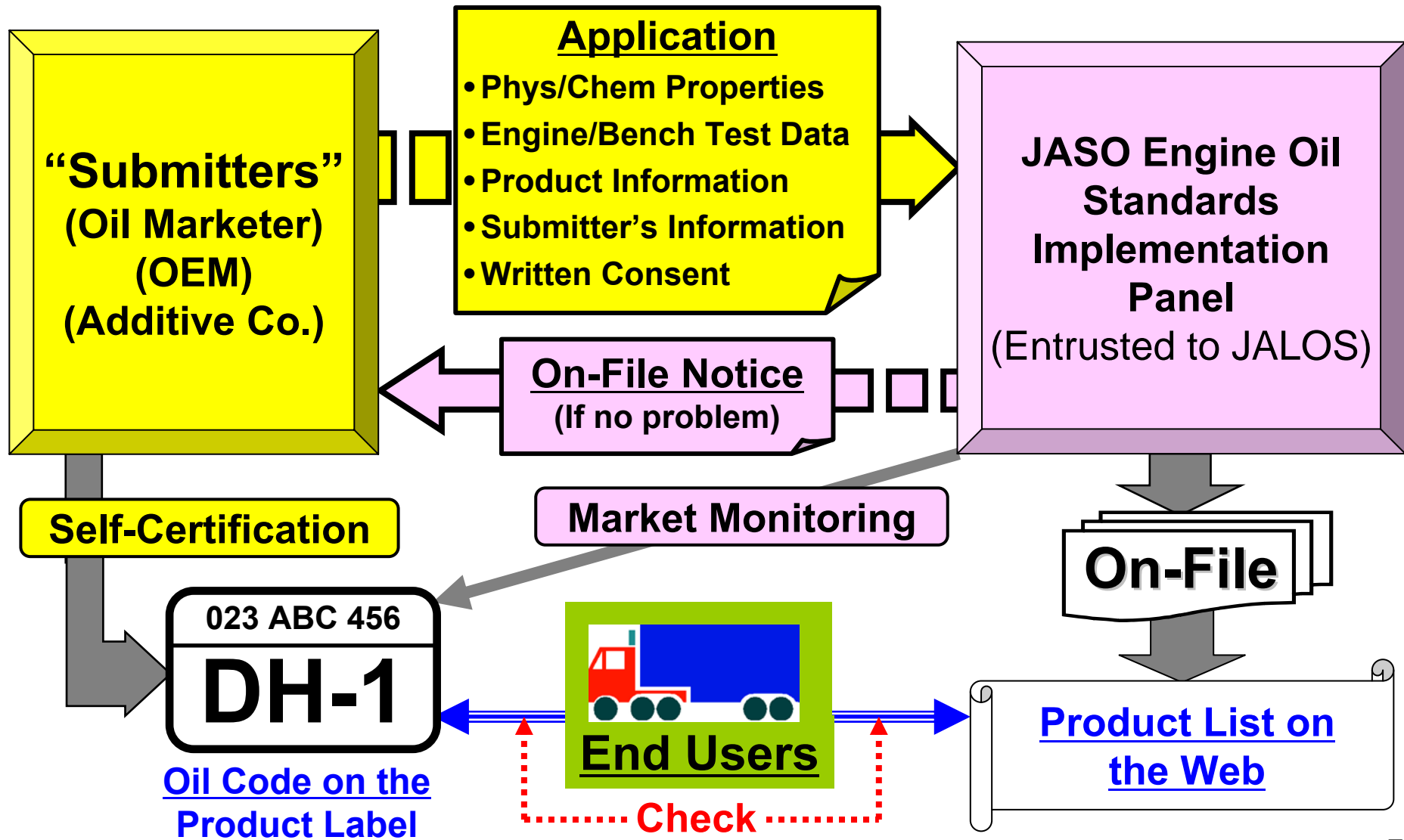
# Organizations Relative to the System



LEMA : Land Engine Manufacturers Association  
 JBIA : Japan Boating Industry Association  
 JAMA : Japanese Automobile Manufacturers Association

PAJ : Petroleum Association of Japan  
 JPI : Japanese Petroleum Institute  
 JAST : Japanese Society of Tribologists

# Outline of the On-File Process



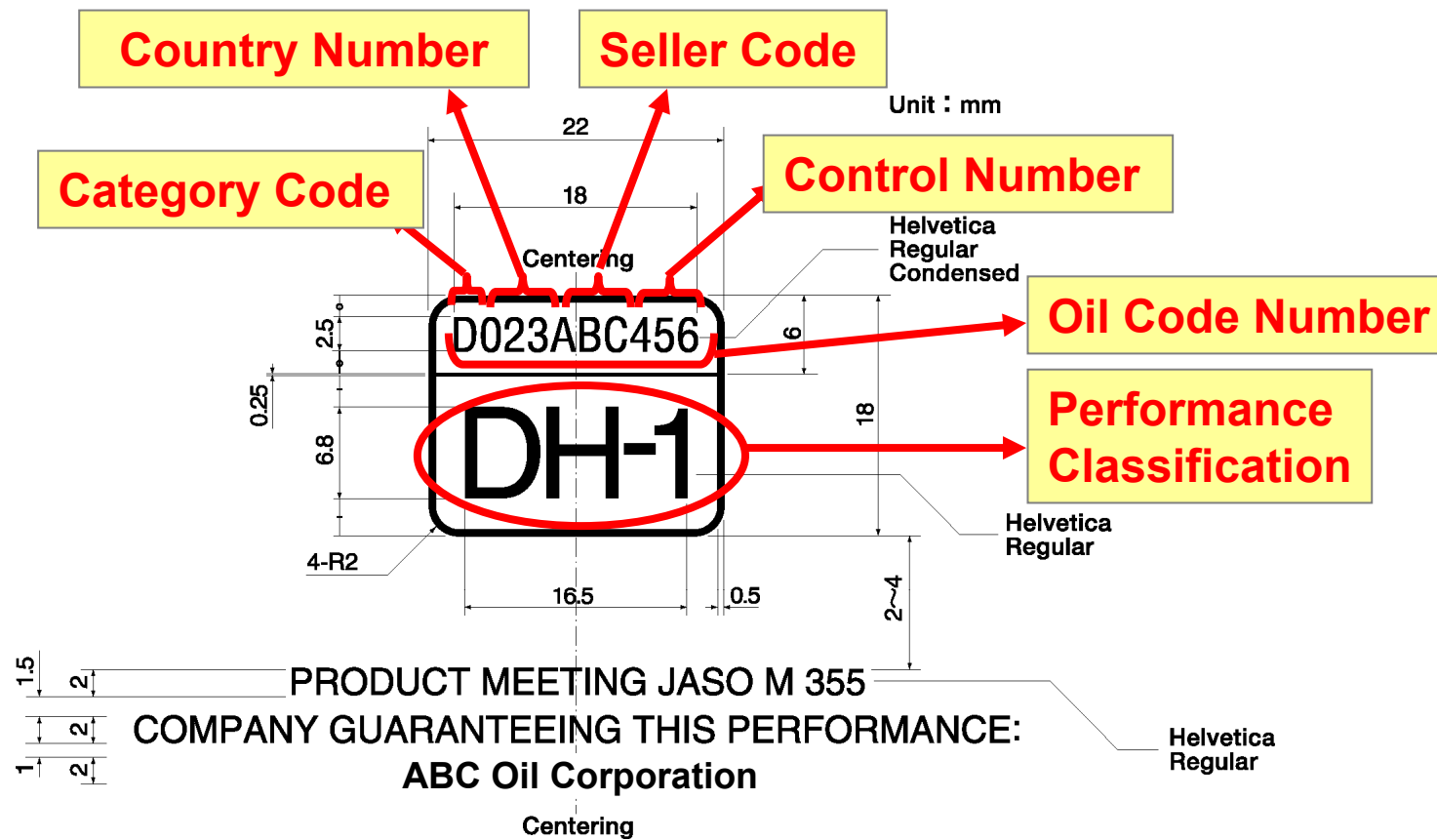


# *Items to be Submitted for the Filing System*

Items	2T	4T	Diesel
Administrative Information	- Company Name - Contact Person - Contact Address - Product Name - Viscosity Grade - Performance Grade - Oil Code - Letter of Consent		
Engine Test Results	- Lubricity - Detergency - Smoke - Blocking		- TD25 - Mack T-8A/E or 11 - 4D34T4 - Seq. IIIF or G
Rig Test Results		- Wet Clutch Friction	- Corrosion Test - Hot Tube Test
Phys./Chem. Properties	- Phys. Properties - Elemental Analysis - IR Chart	- Phys. Properties - Elemental Analysis - IR Chart	- Phys. Properties - Elemental Analysis - IR Chart
Initial Filing Fee	JPY 40,000	JPY 40,000	JPY 40,000
Maintenance Fee	NA	NA	JPY 30 x Sales Vol. (KL)
Market Monitoring	Yes	Yes	Yes



# Labeling & Oil Code (Example)





# *An Example of Logo Mark*



# *JEOSIP Web Site (<http://jalos.or.jp/>)*



Copyright(c) 1999-2008 Japan Lubricating Oil Society. All Rights Reserved.



# *JEOSIP Web Site* *(Example)*

## **JASO Engine Oil Standards Implementation Panel** [ Filed Diesel Engine Oil List ]

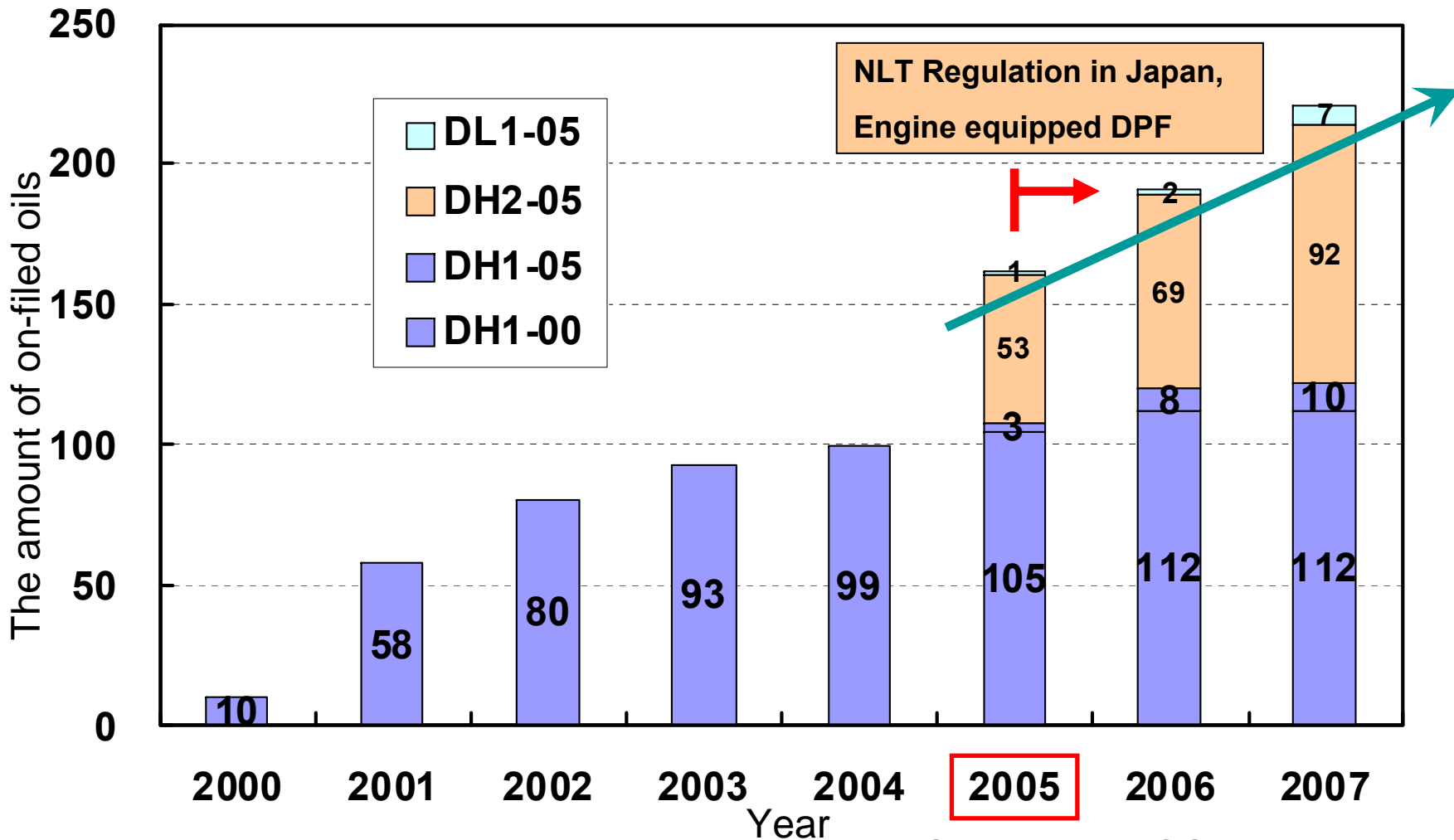
	<b>Brand Name</b>	<b>Submitter Name</b>	<b>Oil Code</b>	<b>Classification</b>	<b>Viscosity Grade</b>
1	Super Diesel HH	ABC Oil Corporation	D023ABC456	DH-1	15W40
2	Super Diesel XT	ABC Oil Corporation	D023ABC457	DH-2	10W30
3	Ultra Diesel Oil	Ultra Lube Oil Co., Ltd.	D081ULC001	DH-1	15W40

**End-users can check if the products labeled with JASO symbol mark are listed in the Engine Oil Lists published on the JEOSIP's Website**



# JASO On-filed Oils by Year (2000 to 2007)

JASO **DH-2 / DL-1** oils for DPF compatibility **going up** since 2005 in Japan



Source : JALOS Annual Report





## *Advantages of the On-File System*

- Rather simple and economical system with reasonable effectiveness
- Easy to understand for end users on the selection of suitable diesel engine oil
- Oil marketers will be protected from malignant suppliers through market monitoring by the QM system

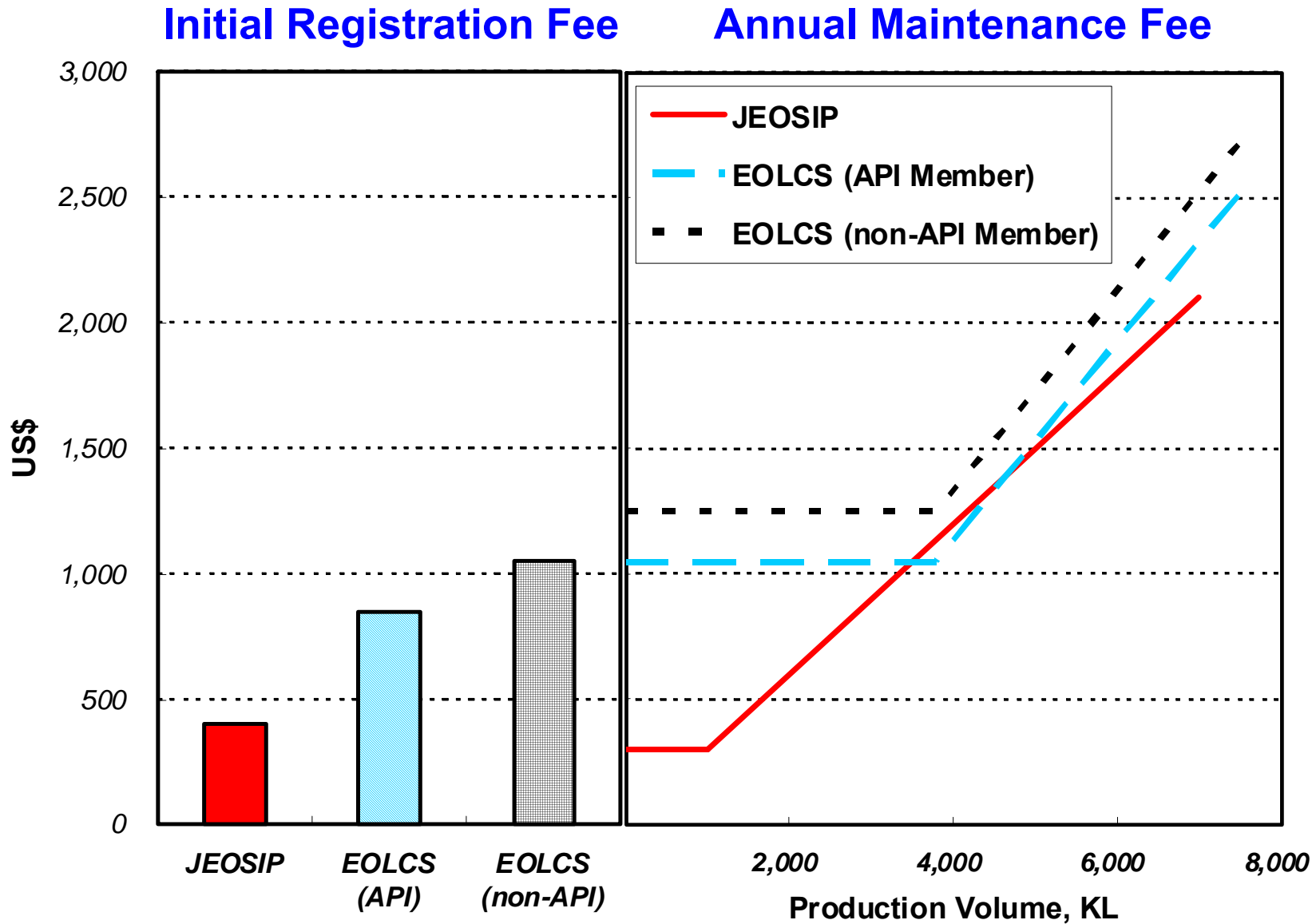


# Expense of Engine Tests for Approval

**ACEA & API are three times as expensive to run tests.**

	USD(\$)	ACEA		API		JASO
		E7	E9	CI-4 plus	CJ-4	DH-1&2
Nissan Diesel TD25	45,000					#
Mitsubishi Fuso 4D34T4	49,000					#
OM501LA	131,000	#	#			
OM602A / OM646LA	52,000	#	#			
Cummins ISM	94,000	#	#	#	#	
Cummins ISB	74,000				#	
MACK T-12	118,000	#	#	#	#	
MACK T-11	75,000		#	#	#	
MACK T-8A	39,000					#
MACK T-8E	79,000	#		#		
Cat 1N	28,000			#	#	
Cat 1R	67,000			#		
Cat C-13	163,000				#	
RFWT	13,000			#	#	
EOAT Aeration Navistar	8,000			#	#	
SEQ III E / III F / III G	35,000			#	#	#
<b>Total</b>	<b>USD(\$)</b> %	<b>474,000</b> 282	<b>470,000</b> 278	<b>517,000</b> 308	<b>608,000</b> 362	<b>168,000</b> 100

# Cost Comparison of QM Systems



## *On-File Continuation*

- **The on-file status is renewed annually.**
- **"On-file Continuation Fee":**
  - **must be paid depending on the amount of volume sold by each application submitter (not by each product).**
  - **is to be used for market monitoring, etc.**



# *Market Monitoring*

- **“Market Monitoring Panel” conducts market survey on:**
  - **Physical & chemical property measurements**
  - **Bench & engine tests**
- **Oils not meeting DH-1 requirements / registered data is to be requested for improvement.**

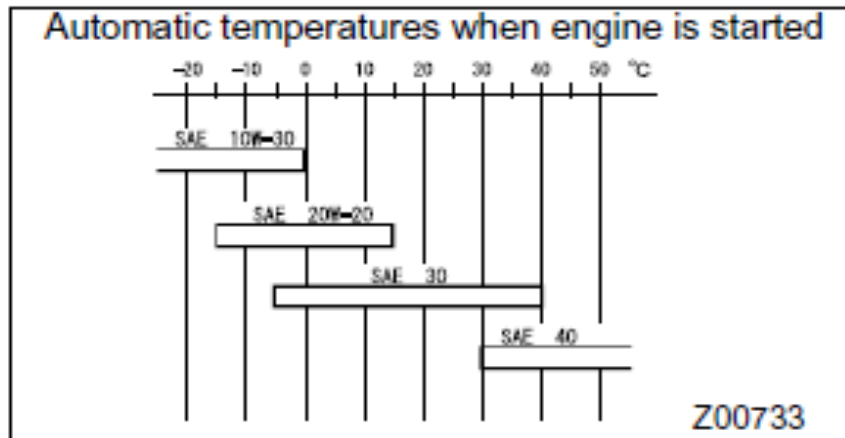


# **Japanese OEM's Recommendation (Owner's Manual Examples)**



# Japanese OEM's recommendation (Owner's Manual Example)

## Mitsubishi Fuso Heavy Duty Truck for Thailand



Recommended oil:

Engine oil

API classification CD, CD/SF, CE, CE/SF, CF-4 or

JASO classification DH-1

SAE40, 30, 20W-20, 10W-30

### Oils and fluids – check and replacement

#### 1 Engine oil

Performance, life, and startability of the engine depend to a large degree on the engine oil. Always use oil of the specified type and viscosity.

Inspection intervals	At the time of preoperational check
Replacement intervals	Every 16,000 km

- The first engine oil replacement during the run-in period should be performed at the first 5,000 km.
- When the engine is used at high speeds and high loads, replace the engine oil earlier than normal.



# Japanese OEM's recommendation (Owner's Manual Example)

SERVICE DATA

## Recommended Lubricants

Lubricant	Specifications	Remarks
Engine oil	Extra Multi, Special Multi (genuine) alternatively, <u>JASO: DH-1</u> API: CF-4, CH-4 ACEA: E3 or higher (Sulfated ash: more than 1.0%)	For further details, refer to the recommended SAE viscosity chart.

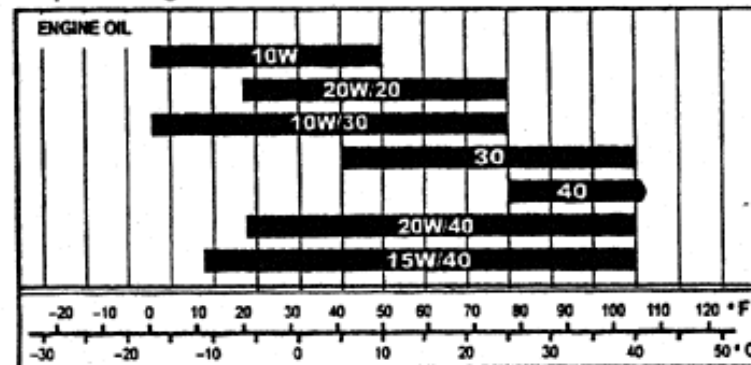
**NOTE:**

- Use NISSAN DIESEL genuine engine oil or equivalents. DH-1 is the Specification established by Japanese Automobile Standard Organization.
- API CG-4 is not recommendable due to its high dispersive quality.
- If the sulphur content in the fuel exceeds 0.05% by weight, the oil change interval must be halved.

**Nissan diesel**  
**for Heavy Duty Truck**

## Recommended SAE Viscosity Number

Use oil having the proper viscosity beforehand which meets temperatures you forecast for areas where you are planning to drive.







# Japanese OEM's recommendation (Owner's Manual Example)

## Hino Motors for Heavy Duty Truck

- ✓ JASO **DH-1** or **DH-2** depending on the Emissions Regulations & the Fuel Sulfur Content are recommended.
- ✓ API CD & CE Grades are deleted from the Owner's Manual in the future.

### PERIODIC LUBRICATION

- Perform the following inspections at the indicated mileages and time periods for both new vehicle and after overhaul.

Items	Lubricants	Capacities L {gal (US), gal (UK)}		Grades	Viscosities Temperature Range Anticipated Before Next Oil Change
Engine	Engine oil	Oil pan	Approx. 28.0 {7.40, 6.16}	<p>JASO: <u>DH-1, DH-2</u><sup>*1</sup>            API: CD<sup>*2</sup>, CE<sup>*2</sup>, CF,            CH-4, CI-4, CJ-4<sup>*1</sup>            ACEA: E-3, E-4, E-5, E-6<sup>*1</sup></p> <p><sup>*1</sup>: HINO recommends these oil to the EURO4/EPA07 regulation countries, and use ultra-low sulfur fuel only.  <sup>*2</sup>: These oil grades do not comply with the latest exhaust emission (EURO4/EPA07 etc.) regulations, and HINO cannot recommend the use of these oil grades.</p>	<p>DP120701ZG</p>
		Oil filter	6.0 {1.59, 1.32}		



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### Introduction

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### JASO Standards

- JASO DH-1 / DH-2 / DL-1
- JASO On-file System

Break 20'

### Other Topics

- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
- Japanese OEM Requirements for ATF
- Hydraulic Fluid Standards for Construction Machinery (JCMAS)

### Summary

### Discussion

# *Biodiesel is a Global Phenomena*





## *Trend of FAME-blended diesel fuel*

<i>Country</i>	<i>FAME Contents (Max)</i>	<i>FAME Major Source</i>	<i>Remarks</i>
Germany	B7	Rape seed	B6.25 mandate in 2009, Severe oxidation stability
France	B7	Rape seed	B6.25 mandate in 2009, Severe oxidation stability
Other Europe	B5	Rape seed	
U.S.A	B5	Soy	B2 mandate, Minesota plus other 3 states
<u>Indonesia</u>	Investigating	Palm	B1 to B5 are sold at the limited service station
<u>Thailand</u>	B5	Palm	B2 mandate, B5 is sold on the market
<u>Vietnam</u>	B5	Palm, Catfish	50K tons of B5 sales is planned in 2010
Japan	B5	Any, Cooking oil	No actual sales
Malaysia	B5	Palm	
India	B5	Jatropha	
Australia	B5	Tallow	
New Zealand	B5	Tallow	



# How Much Biodiesel Do the HD OEMs Allow?

## Japanese OEMs

- Japanese OEMs allow up to B5

- As far as it meets the Japanese B5 regulation
- *FAME blend stock is also required to comply with B100 guideline spec.*
  - *WWFC B100 Guidelines (to be published soon)*
- *Oxidation stability is the most important property*
  - *Induction period of minimum 10 hours is required.*

### Regulation of FAME Blended Fuel in Japan

Items	Level
Sulfur	10 ppm max
Cetane Index	45 min
T90	360 °Cmax
<b><i>FAME content</i></b>	<b><i>5 mass% max</i></b>
Methanol	0.01 mass% max
Triglyceride	0.01 mass% max
TAN	0.13 mgKOH/g max
Individual Organic Acid	30 ppm max *
Oxidation Stability (Acid)	0.12 mgKOH/g as growth

\* Total of Formic, Acetic and Propionic acid

[http://www.jama.or.jp/eco/wwfc/pdf/WWFC\\_B100\\_Guideline\\_June\\_2008.pdf](http://www.jama.or.jp/eco/wwfc/pdf/WWFC_B100_Guideline_June_2008.pdf)

# *OEM Biodiesel Concerns and Unknowns*

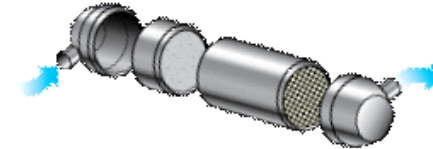
## ■ Fuel System

- Injector deposits
- Fuel filter plugging
- Injection pump durability
- Materials incompatibility
- Fuel Instability
- Low temperature handling
- May reduce detergency and anti-foam properties of fuel additive packages



## ■ Emissions Systems

- Impact on after-treatment devices and sensors
- Impact on NOx emissions
- Lower BTU content/fuel economy



## ■ Lubricant Performance

**Fuel dilution**

**Corrosion**

**Viscosity increase**

**Oxidation**

**Piston Deposits**

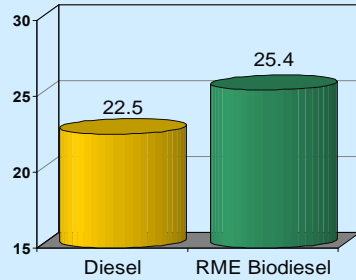
**Sludge Deposits**

**Wear**

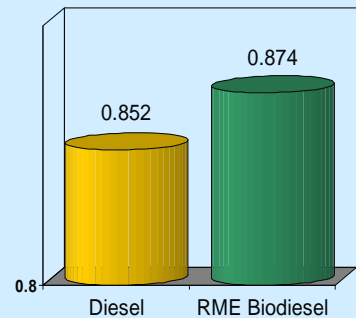


# Crankcase Fuel Dilution With Biodiesel

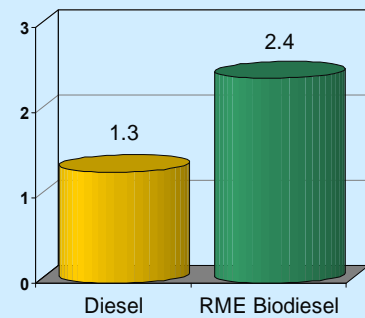
Surface Tension



Specific Gravity

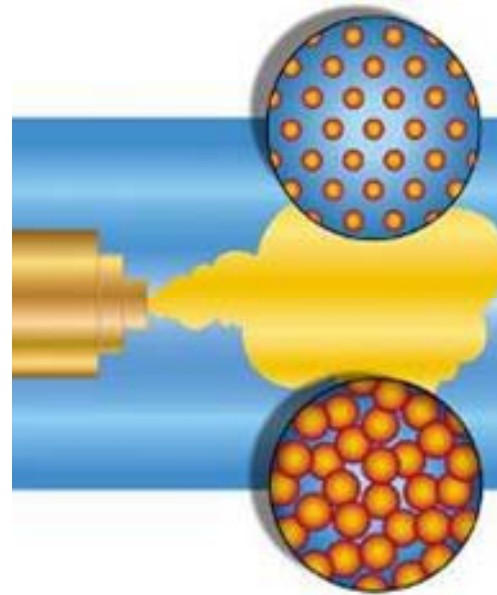


Viscosity, cSt @ 100° C



*Properties of Biodiesel lead to higher fuel dilution levels than mineral diesel*

**Diesel – Normal droplet size**



**Larger fuel spray droplet size**

**Biodiesel – Increased droplet size**

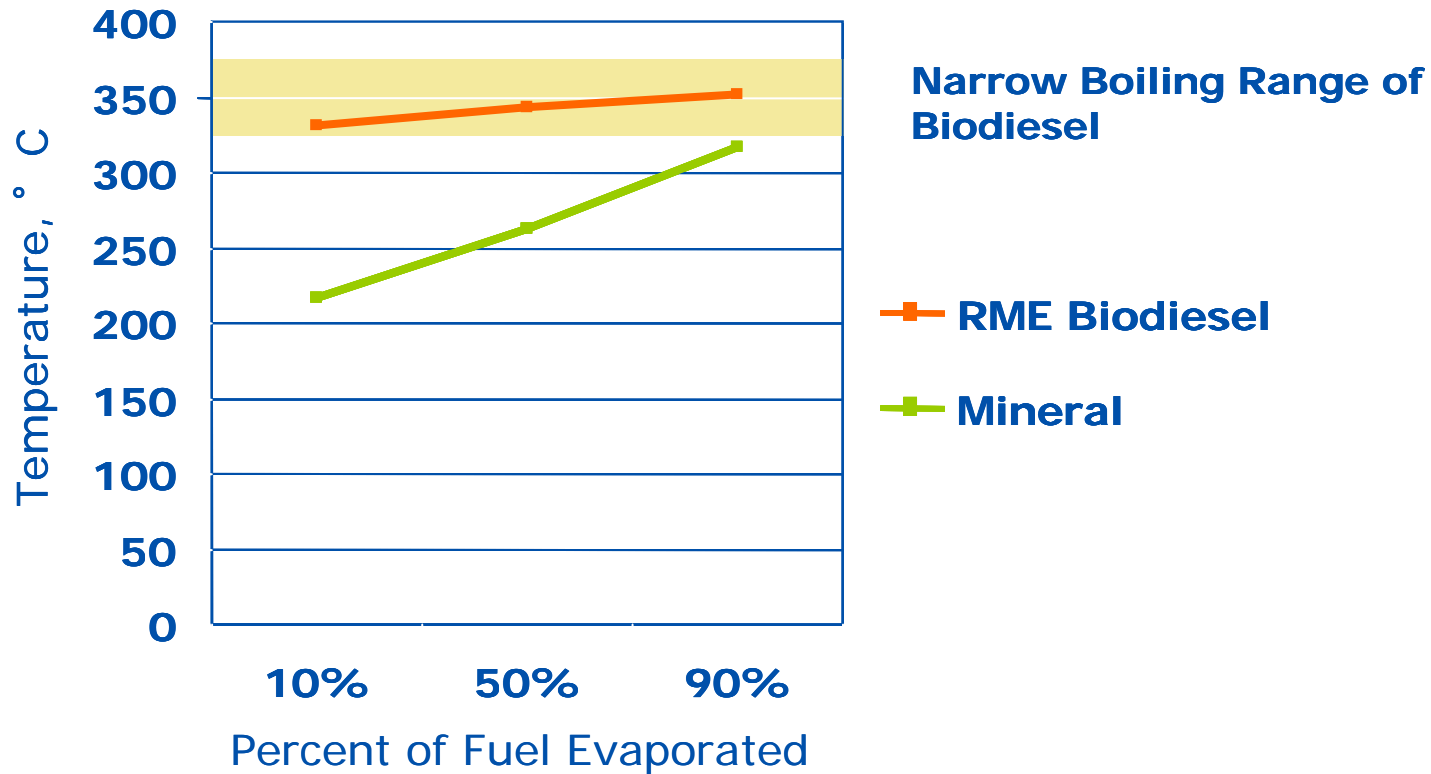


# *Crankcase Fuel Dilution With Biodiesel*

Higher and narrower boiling range of biodiesel makes it more persistent once it enters the crankcase

Some OEMs have reported 15 to 20% fuel dilution at oil drain

Some OEMs reduce drain intervals when biodiesel is used







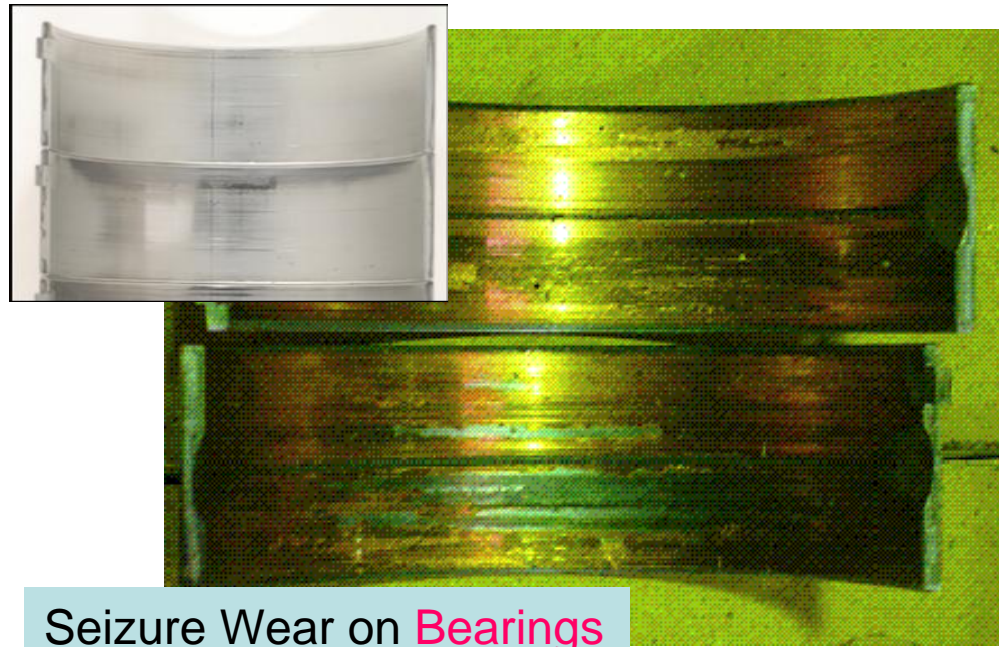
***Example of engine failure***  
***from the use of FAME***  
***(B100, Used cooking oil ME)***



Deposit & Plugging on the **Oil Strainer**



Sludge & Deposit in the **Oil Pan Sump**



Seizure Wear on **Bearings**



# Lubrication Aspects

*Nissan Diesel TD25*

*Detergency Tests*

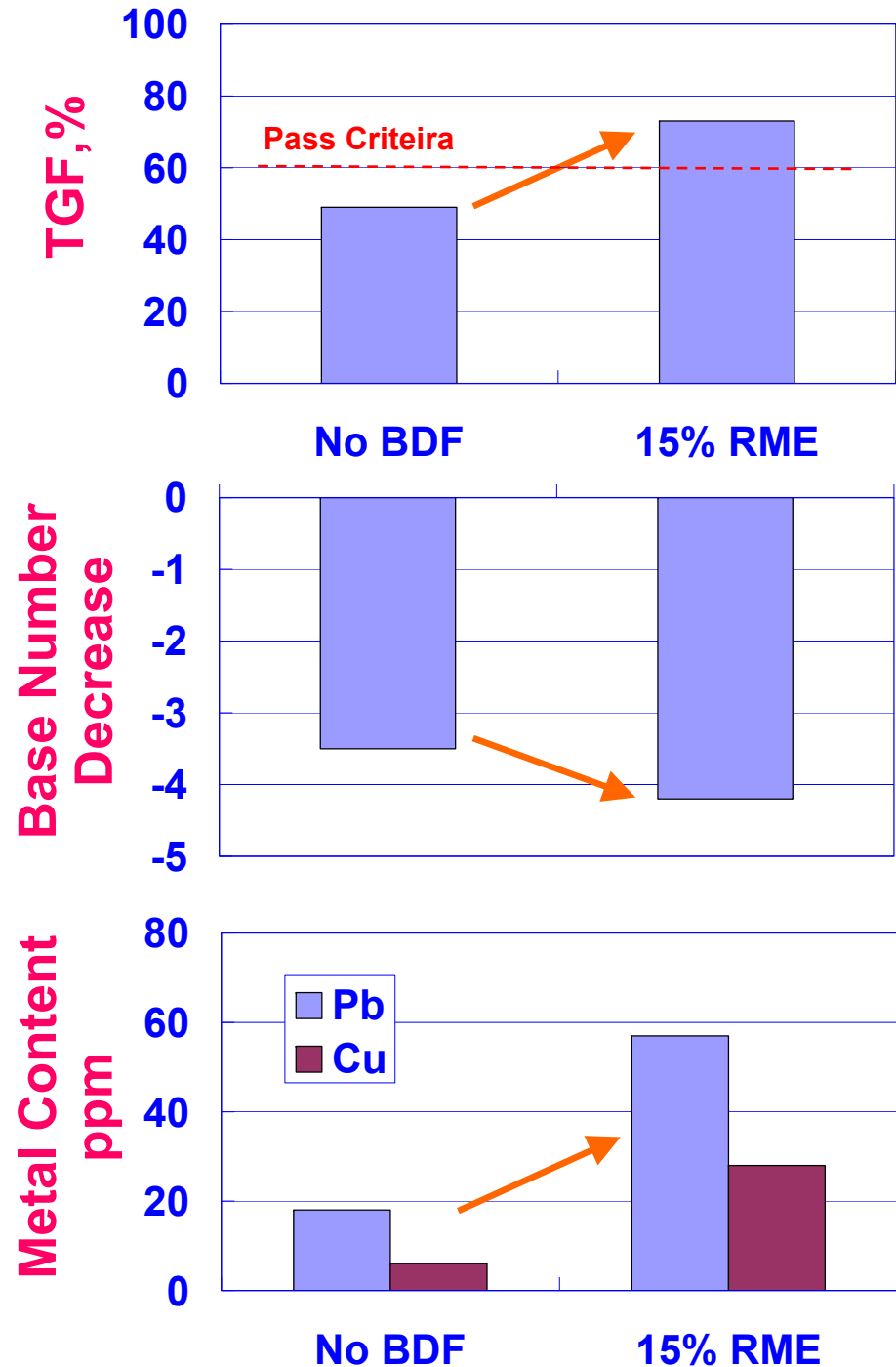
*JASO M336-98*

Test Oil; JASO DH-2, 10W30

No BDF = Test Oil

15% RME = 15% neat RME was  
blended in the Test Oil

Source : Japan Auto Oil Program

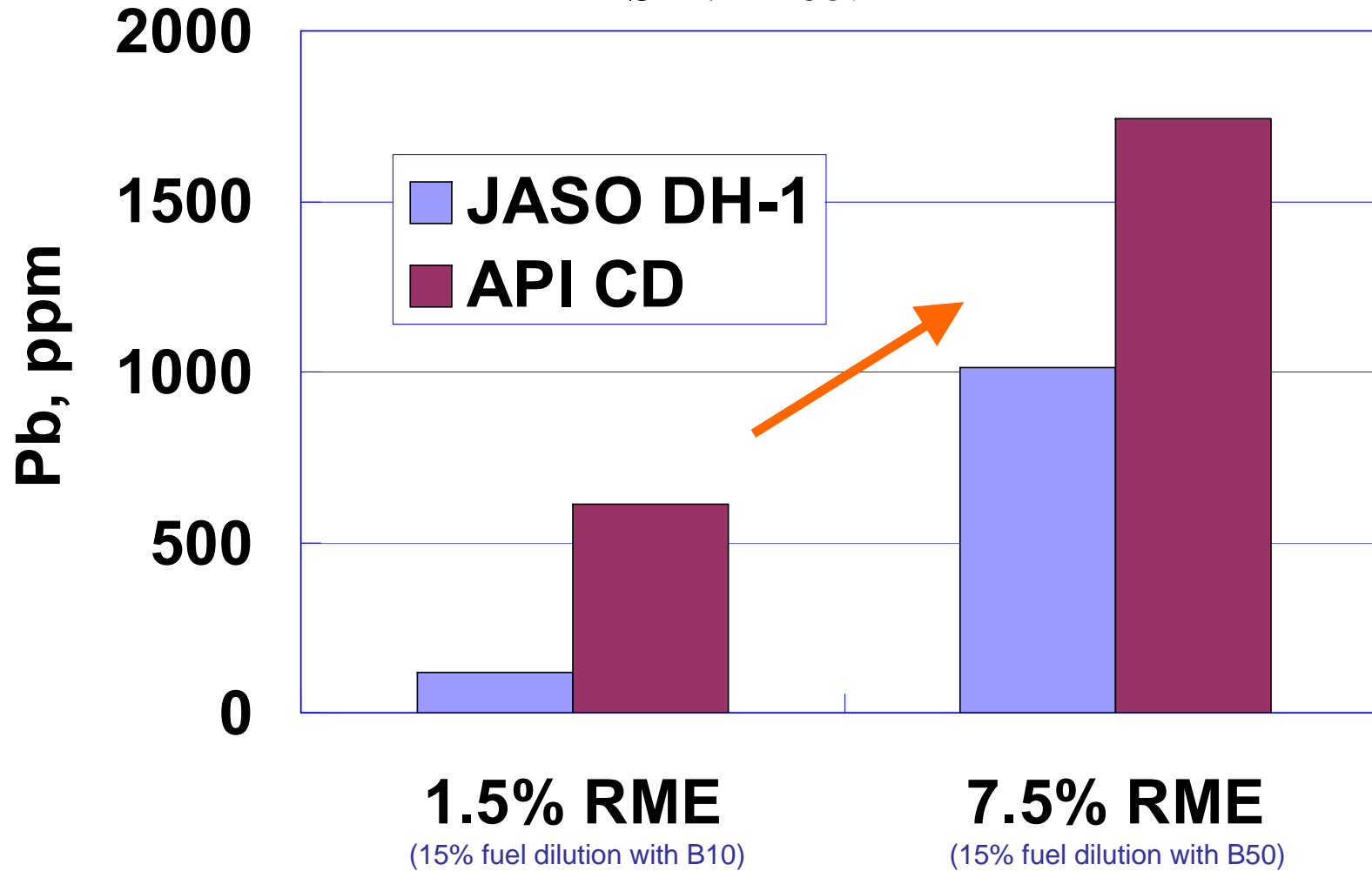




# Lubrication Aspects – Pb Corrosion

## *Cummins HTCBT Corrosion Test*

### *ASTM D6594*





# Summary

- **Engine Builders and Fuel System Suppliers currently restrict the use of biodiesel during warranty periods**
  - **Japanese OEMs allow up to B5**
- **Biodiesel properties make it more likely to enter and stay in the crankcase as fuel dilution**
- **Oxidation of biodiesel in the crankcase oil leads to higher levels of deposits and lead corrosion**
- **Use of biodiesel can lead to lubrication issues**
  - High and persistent fuel dilution
  - Oil oxidation and bearing corrosion
  - Piston deposits
- **JASO DH-1 oil gave better oxidation stability and corrosion protection than API CD oil on the study of Japan Auto Oil Program**
  - **JASO specification requires Oxidation Stability (SEQ.IIIF/IIIG)**
  - **JASO specification requires 10 minimum of Base Number**
  - **JASO specification requires Corrosion Protection (HTCBT)**
  - **It's important to keep adequate Oil Drain Interval even JASO DH-1 oil**
- **Further studies are needed to determine safe and appropriate biodiesel use levels**



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# Japanese OEM Requirements for ATF

**JAMA**

JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

**Yasushi Ando**

**ATF WG Leader in JAMA**

**TOYOTA MOTOR CORPORATION**



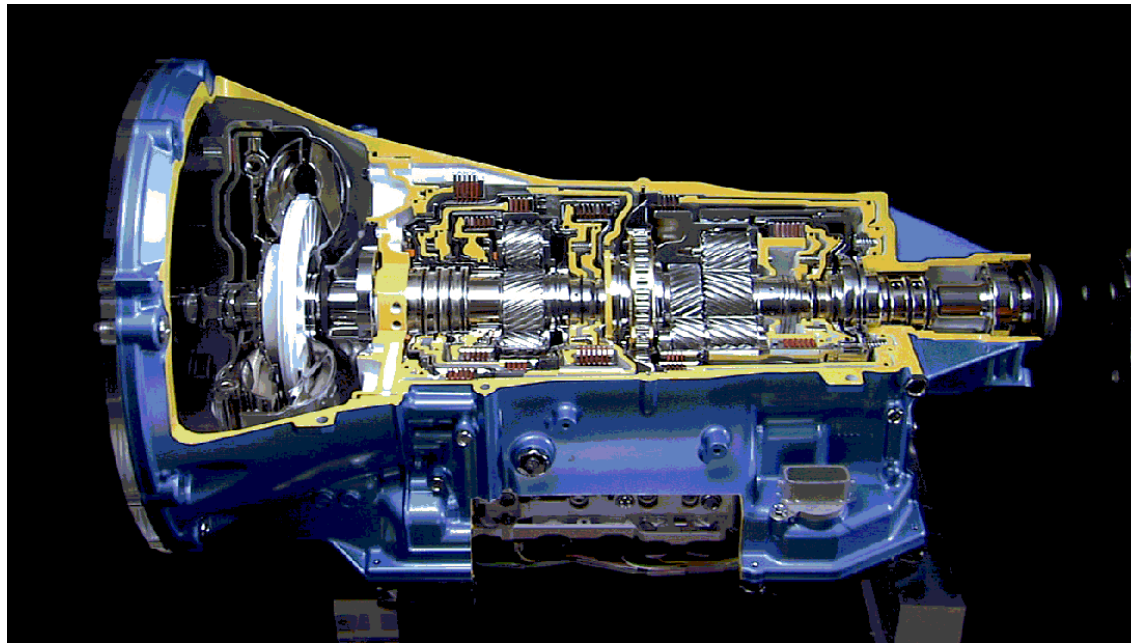
# Japanese OEM Requirements for ATF

---

- 1) Background**
- 2) ATF for Japanese Cars
- 3) JAMA' s Requirement for ATF
- 4) Summary

## Background

1. There are many brand-new Japanese cars equipped with the newest **AT** (**A**utomatic **T**ransmission) in every place of Asian market.



**Lexus 8 speed AT ,One of the newest ATs**



## Background

---

2. Those cars need higher quality ATF to make full use of its performance.  
(i.e. torque converter lock up clutch continuous slipping control)
3. Therefore, **JAMA** (**J**apan **A**utomobile **M**anufacturers **A**ssociation) requires high performance ATF standard.



# Japanese OEM Requirements for ATF

---

- 1) Background
- 2) ATF for Japanese Cars**
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## ATF for Japanese Cars

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**Many Car Manufactures in Japan**

**TOYOTA, NISSAN, HONDA,  
MAZDA, MITSUBISHI, SUZUKI,  
DAIHATSU, SUBARU, , ,  
HINO, ISUZU, MITSUBISHI FUSO,  
NISSAN DIEDEL**

**All of these are the member companies of  
JAMA.**

**( Japan Automobile Manufacturers  
Association Inc. )**

## ATF for Japanese Cars

---

Each car maker has its own genuine parts ATF and the in-house ATF specifications.

TOYOTA	=	D II, TIV, <u>WS</u>
NISSAN	=	Matic-D, <u>Matic-J, Matic-S</u>
HONDA	=	<u>ATF-Z1</u>
MAZDA	=	<u>M5</u>
MITSUBISHI	=	ATF-2, <u>ATF-SP III</u>
DAIHATSU	=	<u>D3-SP</u>
SUBARU	=	<u>F6</u>

(Blue letter shows the newest ATF)



# ATF for Japanese Cars

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**What is ATF?**

**Why so many genuine parts ATFs?**



## ATF for Japanese Cars

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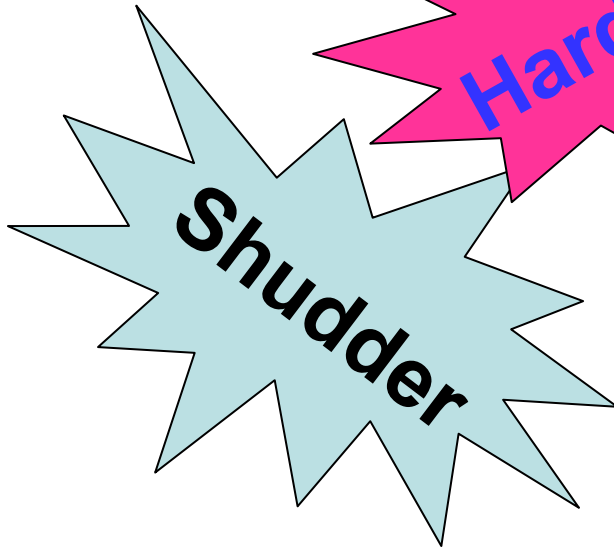
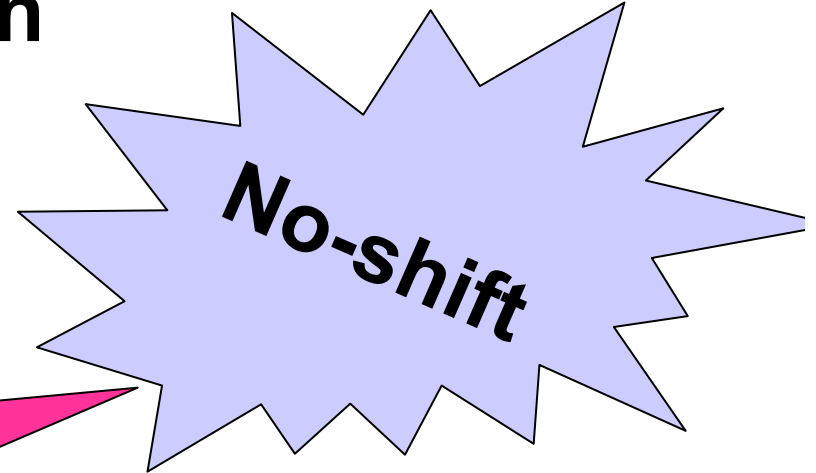
**Do you have to prepare and stock  
so many kinds of ATFs  
for Japanese cars?**

**Yes!**

**It is best for Japanese car  
to use the genuine parts ATF  
to make full use of its performance.**

## ATF for Japanese Cars

If you use wrong ATF, then





# ATF for Japanese Cars

---

**What is ATF?**

**ATF is almost something like blood!**

**If you lose your blood, you must die.  
If you are injected a different type of blood  
into your body, you maybe die.**

**AT is the same!**

**Please choose a correct type of ATF,  
or you will kill your car.**



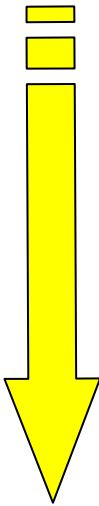


# Japanese OEM Requirements for ATF

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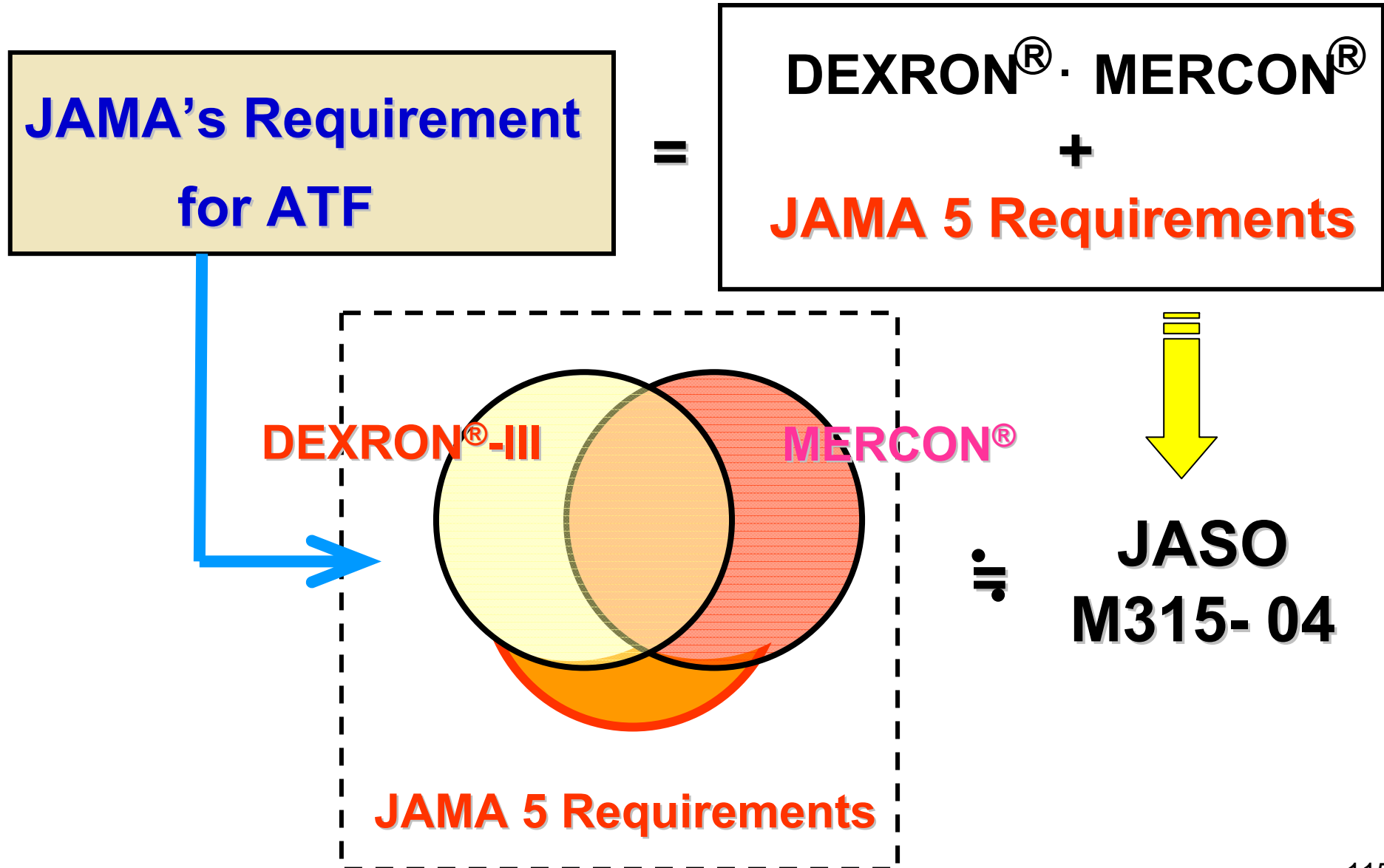
## The Technical Advantage of Japanese ATs



- **Low Fuel Consumption  
= High Efficiency**
- **Good Shift Quality**
- **High Reliability**

**These advanced performances demand  
high performance ATFs**

# JAMA's Requirement for ATF, in Other Words



# JAMA's Requirements for ATF & Test Methods

## JAMA 5 Requirements

	Item	Purpose	Test Method
1	<b>Anti-Shudder Durability</b>	<b>To prevent shudder</b> for life when TCCS is at work	<b>JASO M349-01</b>
2	<b>Plate Clutch Friction Characteristic</b>	<b>To maintain good shift feeling</b> for life	<b>JASO M348-02</b>
3	Shear Stability	To minimize leakage for life	JASO M347
4	De-Foaming Characteristics	To prevent ATF loss through AT breather	ASTM D892
5	Aniline Point	To avoid rubber swelling	JASO M315-04

# JAMA's Requirement for ATF

## JASO M315-02 Specifications

Test Item	Specification Class 1	Test Method	Report Item	Test Method	
Color	6.0 - 8.0	JIS K 2580	Element Analysis		
Density	0.82 - 0.900 g/cm <sup>3</sup>	JIS K 2249		Sulfur	JIS K 2541
Flash point °C	Above 170 °C	JIS K 2265		Nitrogen	JIS K 2609
Fire point °C	Above 185 °C	ASTM E 659		Chlorine	ASTM D 808
Kinetic viscosity	40 °C Report	JIS K 2283		Barium Boron Calcium Magnesium Phosphorus Zinc	ASTM D 4951
	100 °C Above 5.7 mm <sup>2</sup> /s				
Viscosity Index	Above 120	JIS K 2283			
Pour Point °C	Below -40 °C	JIS K 2269			
Copper Corrosion	Below 2	JIS K 2513			
Brookfield Viscosity	-20 °C Report	ASTM D 2983			
	-30 °C ≤ 5000 mPa·s				
	-40 °C ≤ 20000 mPa·s				
Oxidation stability	TAN increase 2.0 mgKOH/g Viscosity increase rate Below 20%	JIS K 2514	Neutralization number	JIS K 2501	
			Total Base No. Total Acid No.		
Compatibility of materials	Resin Rubber		Wear prevention	JPI 5S-32	
Miscibility		JIS K 2269			

## JAMA's Requirement for ATF

- a) **Good Anti-Shudder Property**
- b) **Anti-Shudder Durability for Life**
- c) **Low Viscosity**
- d) **Good  $\mu$  Characteristics for Wet Clutch**
- e) **Good  $\mu$  Stability for Wet Clutch**
- f) **Hi Shear Stability**
- h) **Anti-Oxidation Property**
- j) **Good De-foaming Characteristics**
- k) **Good Materials Compatibility**

**JASO M315- 04**



# Japanese OEM Requirements for ATF

---

- 1) Background
- 2) ATF for Japanese Cars
- 3) JAMA's Requirement for ATF
- 4) **Summary**

## Summary

---

- 1. The Japanese ATs need genuine parts ATF or superior ATF in both anti-shudder durability and frictional characteristics. And these important properties are specified in JASO M315.**
- 2. Please select and choose a correct ATF type to make the car better in fuel economy, to drive comfortable, not to kill the AT. And please remember ATF is always transforming with the progress of the AT technology.**





# Thanks & Any Questions?

**JAMA**

JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

**Yasushi Ando, TOYOTA**



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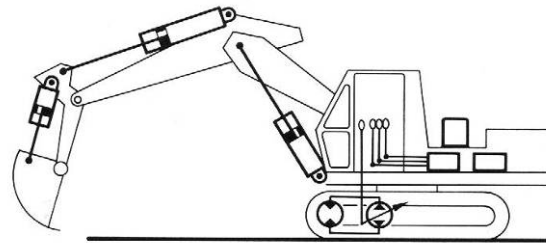
- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
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# HYDRAULIC FLUID SPECIFICATIONS FOR CONSTRUCTION MACHINERY



***Fuel and Lubricant Technical Committee  
Japan Construction Mechanization Association (JCMA)***

# Outline

- **Hydraulic Fluid Trends**
- **Needs for the New Specifications**
- **JCMAS Specifications**
  - **Categories**
  - **Physical / Chemical Requirements**
  - **Laboratory Bench Test Requirements**
  - **Rig Performance Test Requirements**
- **Quality Management System**
- **Summary**





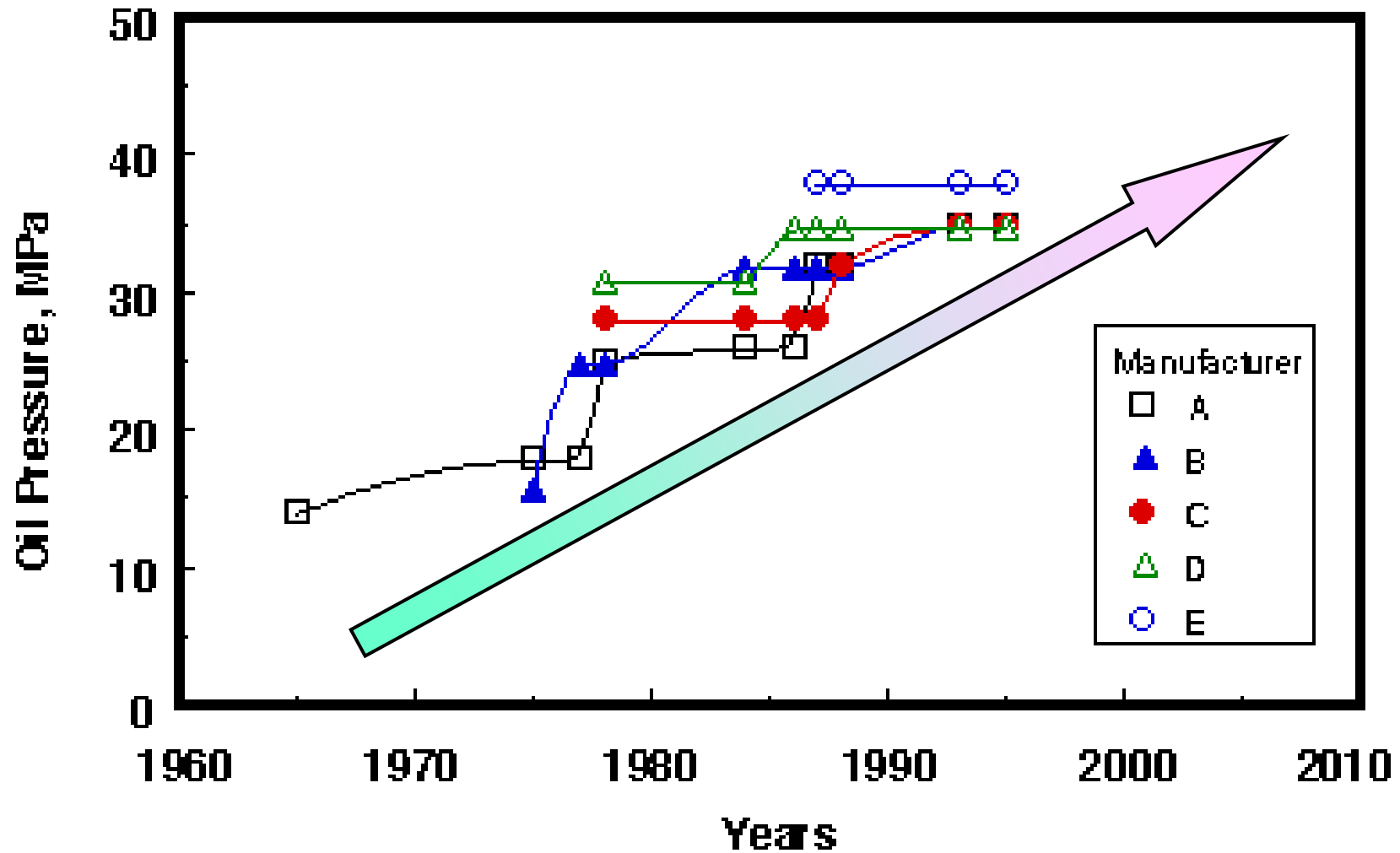
# Hydraulic Fluid Trends

- **Higher Pressures**
  - Mobile equipment now at 300 bar, moving to 450 bar
- **Smaller, Lighter Equipment**
  - Reduced fluid volumes
  - Less residence time for cooling
- **Higher Fluid Operating Temperatures**
  - 80 ° C common for mobile equipment
  - 100+ ° C peak temperatures
- **To be More Friendly with Environment**
  - Soil / Water / Air / Noise

**Improved Fluids are Required**



# Changes in Mobile Pump Pressure



# Failure Examples of Komatsu HPV35+35 Piston Pump (1)



Normal Surface of  
Cylinder Block



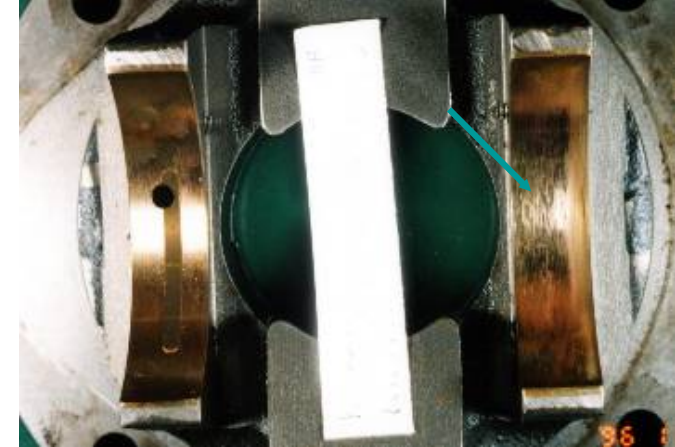
Corroded Cylinder Block



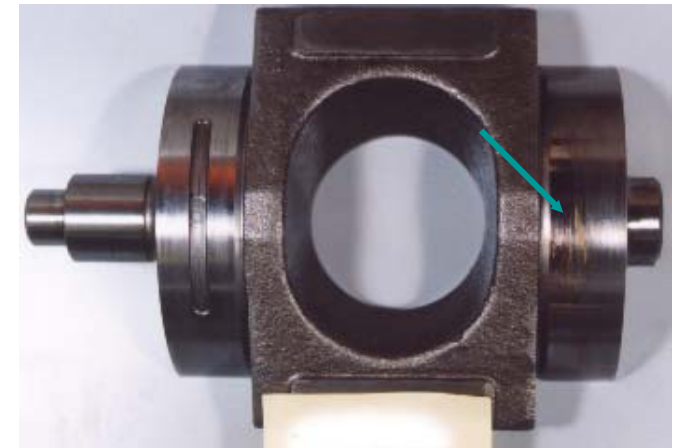
Scratched Cylinder Block



Cavitation and Wear  
of Cylinder Bore



Scuffed Cradle Bearing



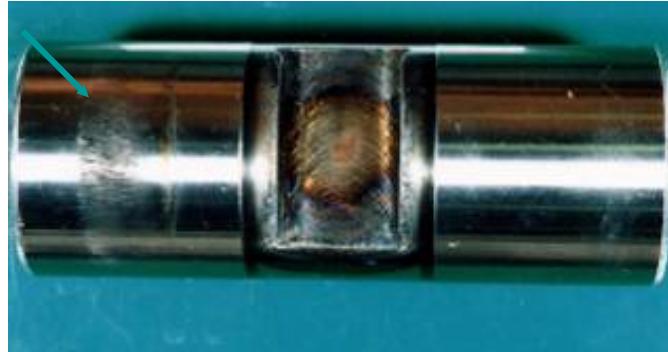
Copper Transfer on  
Mating Rocker-Cam



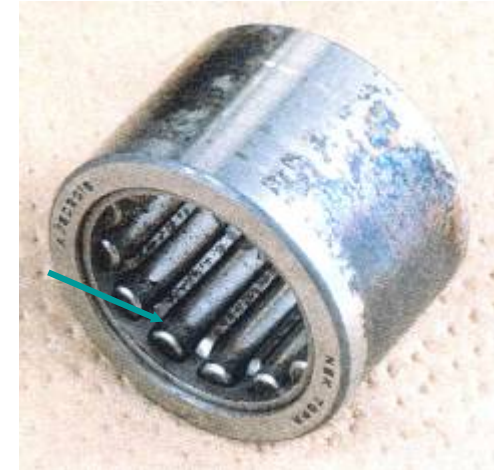
# Failure Examples of Komatsu HPV35+35 Piston Pump (2)



Worn Piston Shoes



Scuffed Big Servo Piston



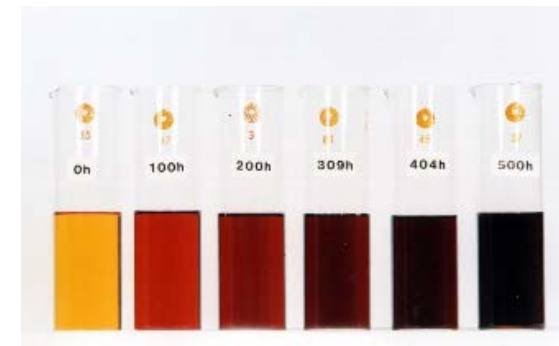
Pitting of Bearing



Scuffed Piston Shoes



Lacquer on Servo Piston Caused Flow Reduction

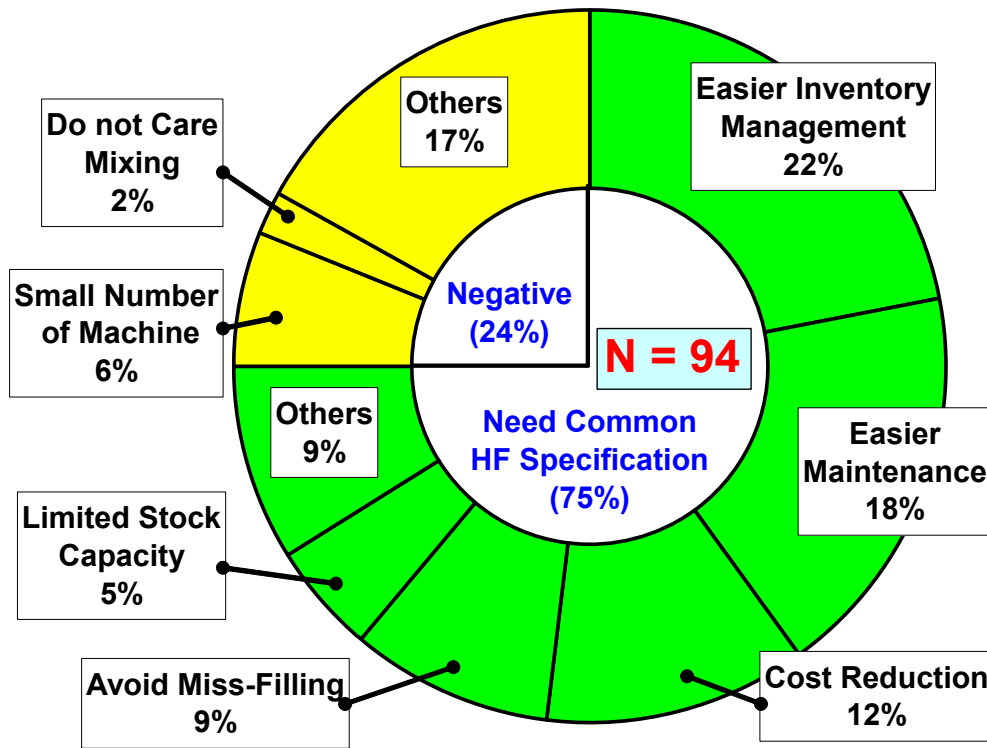


Oil Deterioration

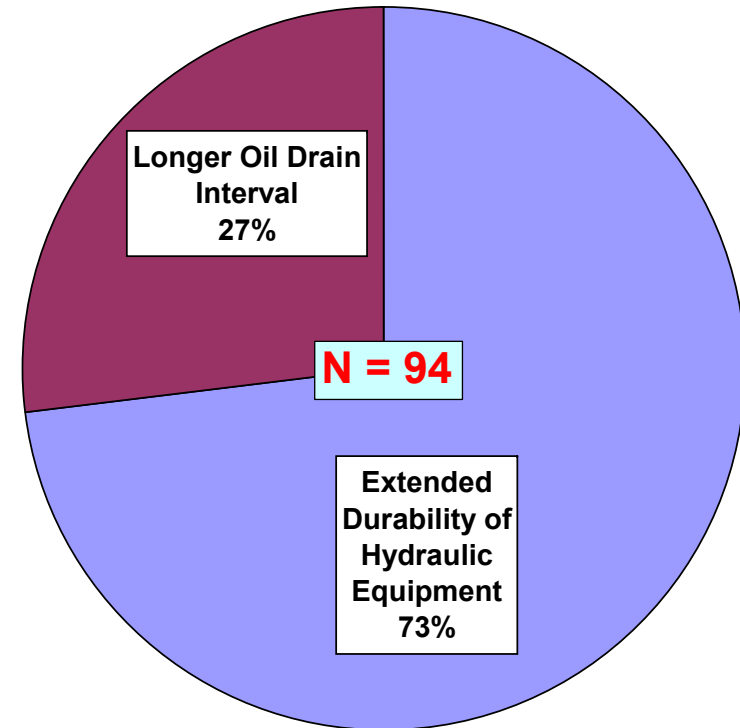


# Needs for HF Specification by End-Users

- 75% of Japanese end-users; general contractors, repair shops and rental companies, require a new hydraulic fluid specification.
- Main focus of Japanese end-users requesting HF specification is improvement in hydraulic system durability.

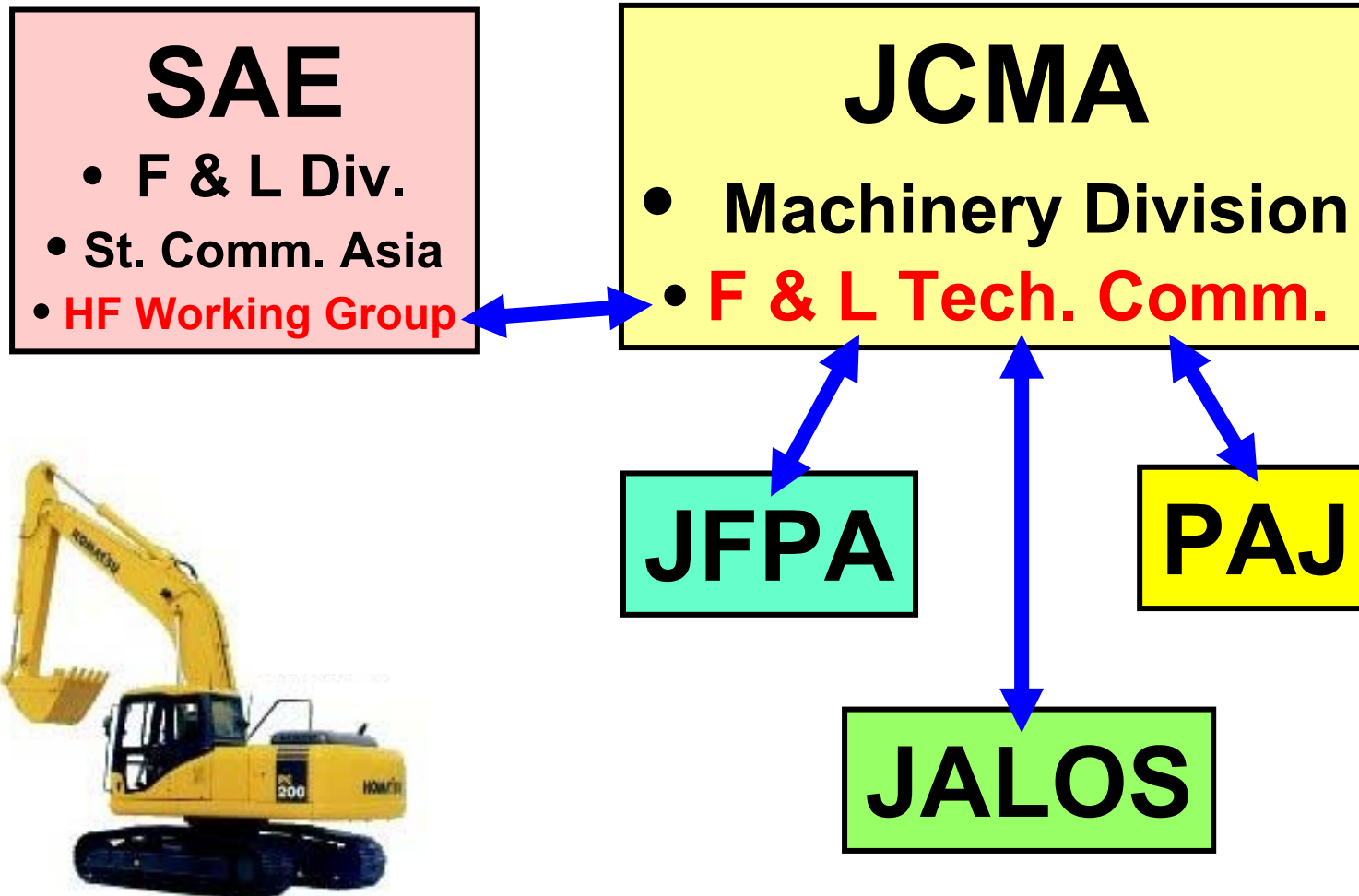


a) Need Common Specification ?



b) Specification Target ?

# Working Scheme for the Development of New Standards



## Membership of JCMA F&L Tech. Committee

*as of December 2008*

Name	Organization	Type	Category
Genroku Sugiyama (Chair)	Hitachi Construction Machinery	Construction Machinery	Users (63%)
Satoshi Ohkawa	Komatsu Ltd.		
Atsuhiko Hirosawa	Komatsu Ltd.		
Yutaka Touji	Kobelco Construction Machinery		
Keiichiro Yamamoto	Kubota Corporation		
Toshimitsu Kobayashi	Caterpillar Japan		
Hiroshi Ishiyama	Sumitomo Construction Machinery		
Hiroyasu Koderu	Kawasaki Heavy Industries		
Masato Nagao	Tadano Ltd.		
Shiro Yoshida	Mitsubishi Heavy Industry		
Takahisa Moriuchi	Hitachi Construction Machinery		
Tomoki Ando	Kayaba Industry	Component	
Shinichi Mitsumoto (Vice Chair)	Nippon Oil Corporation	Lubricants	Producers (37%)
Yoshitaka Shiraga	Idemitsu Kosan		
Hirohiko Ootsu	Showa Shell Sekiyu		
Jun Fujii	Cosmo Oil Lubricants		
Noriyuki Naganuma	Japan Energy Corporation		
Akihiro Mochizuki	Chevron Japan		
Hitoshi Hamaguchi	Evonik Degussa Japan	Additives	



## User Language for JCMAS HK

JCMAS Hydraulic Oil Category HK describes oils for use in hydraulic system of **all the construction equipment**.

HK oils are effective to use in hydraulic systems designed to pressurize up to **34.3MPa (5000psi)** and to heat oil up to **100 degrees Celsius**. HK oils are divided into four categories by viscosity and low temperature fluidity. These oils provide performances **controlling wear, oxidation, rust, and seal swelling**. In addition, lubricating performance of these oils confirmed by a high-pressure piston pump test, a high-pressure vane pump test and a friction test.

Since **drain interval** and required performance in every hydraulic system are diversified, HK oils can be used by following individual construction equipment **manufacturer's recommendation**.



# JCMAS Hydraulic Fluid Specifications

## - Category, Grade and Viscometric Properties -

JCMAS		HK				HKB			
Classification		Single Grade		Multi Grade		Normal Climate Grade		Cold Climate Grade	
Code		VG32	VG46	VG32W	VG46W	VG32	VG46	VG32L	VG46L
Operating Temperature		> - 5°C		> - 25°C	> - 20°C	> - 5°C		> - 25°C	> - 20°C
ISO Viscosity Grade		VG32	VG46	VG32	VG46	VG32	VG46	VG32	VG46
K. Viscosity at 40°C, mm <sup>2</sup> /s		32 ± 3.2	46 ± 4.6	32 ± 3.2	46 ± 4.6	32 ± 3.2	46 ± 4.6	32 ± 3.2	46 ± 4.6
K. Viscosity at 100°C, mm <sup>2</sup> /s		5.0 min.	6.1 min.	5.3 min.	6.8 min.	5.3 min.	6.8 min.	5.3 min.	6.8 min.
Viscosity Index		90 min.		120 min.		-			
Pour Point, °C		- 18 max.	- 15 max.	- 39 max.	- 30 max.	- 18 max.	- 15 max.	- 39 max.	- 30 max.
Low Temperature Viscosity, mPas (Brookfield)	at - 10°C	-				Report		-	
	at - 20°C	-		-	5000 max.	-		-	5000 max.
	at - 25°C	-		5000 max.	-	-		5000 max.	-
Shear Stability *, % Viscosity Loss at 100°C		-		10 max.		-			

\* Sonic Shear Stability Tests: Either ASTM D 5821 or API-5S-29



# JCMAS Hydraulic Fluid Specifications (Cont.)

## - Physical / Chemical Properties -

Requirements		HK	HKB
Density, g/cm <sup>3</sup>		-	Report
Color (ASTM)		-	Report
Flash Point, °C		Report	
Foaming (Tendency / Stability), ml	at 24°C	50 / 0 max.	
	at 93.5°C	50 / 0 max.	
	at 24°C after 93.5°C	50 / 0 max.	
Aniline Point, °C		90 min.	-
Acid Value, mgKOH/g		-	Report
Water Content, ppm		-	1000 max.
Environmental Acceptability	Biodegradability (28 Days), %	-	60 min.
	Acute Fish Toxicity (96h, LC50), mg/l		100 min.



# JCMAS Hydraulic Fluid Specifications (Cont.)

## - Laboratory Bench Test Requirements -

Requirements		HK	HKB
Oxidation Stability, AV Increase (TOST: 95°C, 1000h), mgKOH/g		1.0 max.	-
Copper Corrosion (100°C, 3h)		1 max.	
Rust-Preventing (Procedure B)		Pass	
Elastomer Compatibility [NBR] (100°C, 240h)	Change in Hardness, Grade	- 25 min.	- 40 / + 10
	Change in Tensile Strength, %	- 50 max.	- 5 / + 70
	Change in Elongation, %	- 50 max.	- 60 / + 20
	Change in Volume, %	+ 30 max.	- 65 / + 20
Elastomer Compatibility [HNBR] (120°C, 240h)	Change in Hardness, Grade	-	- 8 / + 8
	Change in Tensile Strength, %		- 5 / + 15
	Change in Elongation, %		- 15 / + 20
	Change in Volume, %		- 15 / + 20
Elastomer Compatibility [AU] (120°C, 240h)	Change in Hardness, Grade	- 5 / + 5	Report
	Change in Tensile Strength, %	- 30 max.	Report
	Change in Elongation, %	- 30 max.	Report
	Change in Volume, %	- 5 / + 5	Report
Hydrolytic Stability (95°C, 48h)	Copper Weight Loss, mg/cm <sup>2</sup>	-	Report
	Copper Color Change		Report
	AV Increase, mgKOH/g		Report
Filterability (JCMAS P043), min.		Pass	-



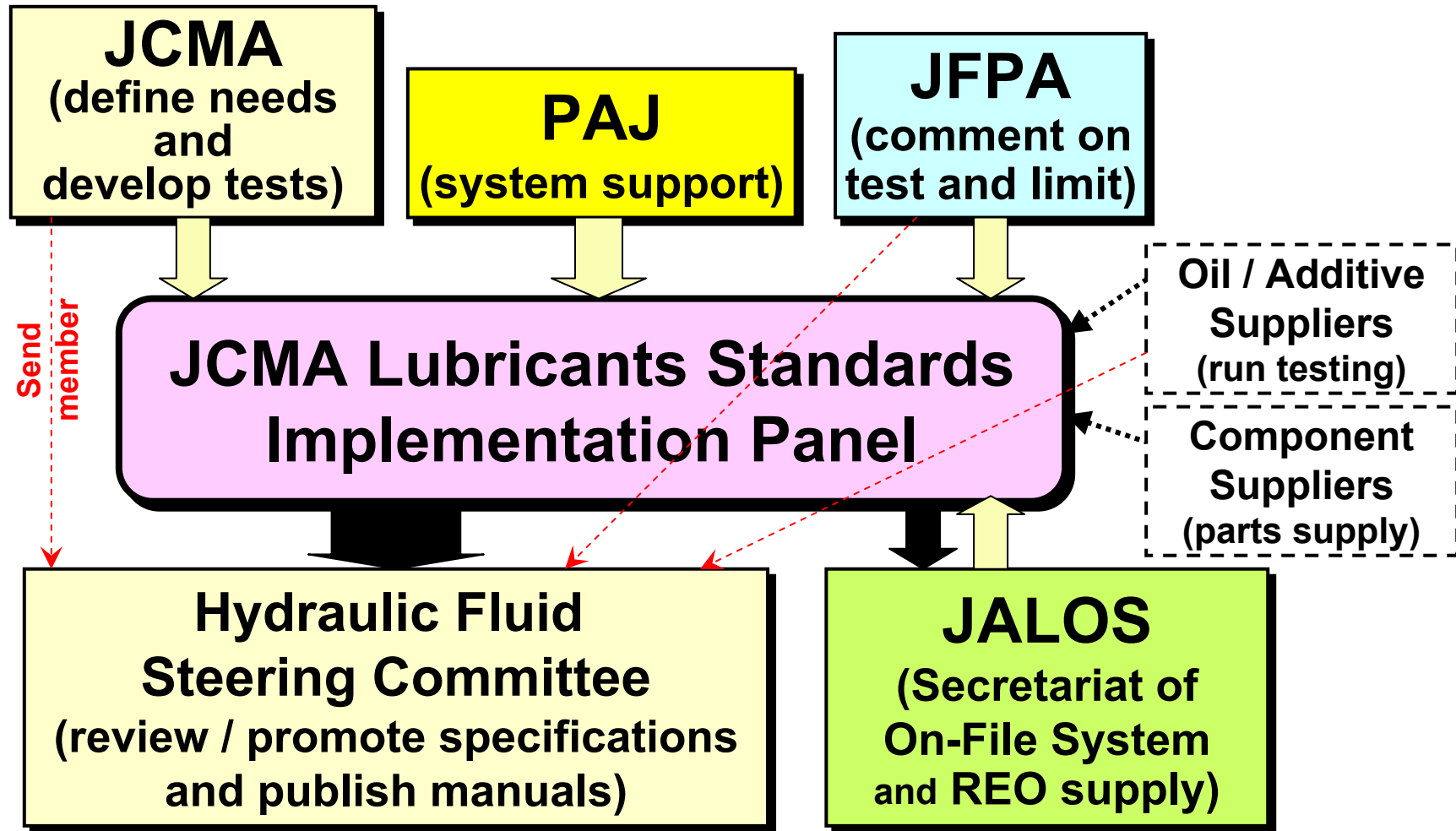
# JCMAS Hydraulic Fluid Specifications (Cont.)

## - Mechanical Rig Test Requirements -

Requirements		HK	HKB
Load Carrying Capacity, Weld Load (JPI-5S-32: 4-Ball Method), N		1235 min.	
Wear Preventive Properties, Scar Diameter (JPI-5S-40: 4-Ball Method), mm		0.6 max.	
Load Carrying Capacity (DIN 51354-3: FZG A/8, 3/90), stage		8 min.	
High Pressure Piston Pump Test (JCMAS P044: Komatsu HPV35+35)		Pass (Flow Rate, Wear, Used Oil Properties)	
High Pressure Piston Pump Test (JCMAS P045: Bosch Rexroth A2F-10)	Viscosity Increase Ratio, %	10 max.	10 max.
	AV Increase, mgKOH/g	2.0 max.	2.0 max.
	Sludge (0.8µ Fliter), mg/100ml	10 max.	10 max.
	Copper in Used Oil, mass-ppm	-	report
Vane Pump Test (ASTM D6973: Vickers 35VQ25, 150h)	Ring Wear, mg	75 max.	-
	Vane Wear, mg	15 max.	
Vane Pump Test (ASTM D2882: Vickers V104C, 100h)	Ring Wear, mg	50 max.	120 max.
	Vane Wear, mg		30 max.
Friction Characteristics (JCMAS P047: Micro Clutch Test), $\mu$		0.08 min.	
Friction Characteristics (JCMAS P047: SAE No.2 Clutch Test), $\mu_0$		0.07 min.	



# Organizations for JCMA On-File System



JCMA : Japan Construction Mechanization Association  
JFPA : Japanese Fluid Power Association

PAJ : Petroleum Association of Japan  
JALOS : Japan Lubricating Oil Society



# Summary

- Hydraulic fluid specifications for construction machineries (JCMAS HK/HKB) have been developed
- JCMAS HK is anti-wear type mineral based HF designed for high pressure / temperature applications
- JCMAS HKB is ester based biodegradable HF
- English version of the specifications and test procedures are available
- A quality management system has been implemented since 2007
- For more details, please visit <http://jalos.or.jp/>



## Abbreviations

- **JCMA** Japan **C**onstruction **M**echanization **A**ssociation
- **JCMAS** **JCMA** **S**tandards
- **HK** Hydraulic fluid specification for Kenki  
*(Construction Machinery in Japanese)* ←
- **HKB** **HK** with **B**iodegradability
- **GK** Grease specification for **K**enki
- **GKB** **GK** with **B**iodegradability
- **JFPA** Japanese **F**luid **P**ower **A**ssociation
- **PAJ** **P**etroleum **A**ssociation of **J**apan
- **JALOS** **J**apan **L**ubricating **O**il **S**ociety
- **SAE** **S**ociety of **A**utomotive **E**ngineers



# Contents :

## JASO Diesel Oil Seminar 2009

### Introduction

### Engine & Oil Technologies

- Engine Technology
- Functions of Engine Oil & Examples

### JASO Standards

- JASO DH-1 / DH-2 / DL-1
- JASO On-file System

Break 20'

### Other Topics

- Biodiesel Fuel Impact on Diesel Engine and the Lubricant
- Japanese OEM Requirements for ATF
- Hydraulic Fluid Standards for Construction Machinery (JCMAS)

### Summary

### Discussion



## *Summary*

- (1) Improving the quality of engine oils helps to achieve environmental protection and global warming reduction.**
- (2) Engine oil works for engine protection.**
- (3) JASO Standards for Japan-brand-engines.**
  - > **DH-1** ..... For High Sulfur Fuel Markets with below Euro III
  - > **DH-2 / DL-1**... For DPFs with less 50 ppm S fuel & beyond Euro IV
- (4) JASO On-file System is:**
  - > oil quality management system
  - > economical system compared with EOLCS and EELQMS
  - > to protect end-users and lubricant suppliers from fake oils
- (5) Detail information of JASO Standards available at**  
<http://www.jalos.or.jp/>  
[http://www.bookpark.ne.jp/jsae/book\\_e.asp](http://www.bookpark.ne.jp/jsae/book_e.asp)



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### Summary

### Discussion

# Abbreviations

ACEA	Association of European Constructors of Automobiles	JP05	New Long Term exhaust emission regulation in Japan
AN	(Total) Acid Number	JP09	Post New Long Term exhaust emission regulation in Japan
API	American Petroleum Institute	JPI	Japanese Petroleum Institute
ASTM	American Society for Testing Materials	JPN	Japan
ATF	Automatic Transmission Fluid	JPY	Japanese Yen
BDF	Bio Diesel Fuel	JSAE	Society of Automotive Engineers of Japan
BN, TBN	(Total) Base Number	JAST	Japanese Society of Tribologists
B5	5% FAME blended diesel fuel	KV	Kinematic Viscosity
CEC	Coordinating European Council	LEMA	Land Engine Manufacturers Association
CO	Carbon Monoxide	LD	Light Duty (Truck)
CO <sub>2</sub>	Carbon Dioxide	MCMO	Motorcycle Motor Oil
CR	Common Rail (System)	ME	Methyl Ester
CR-	Continuously Regenerating	MD	Medium Duty (Truck)
DEO	Diesel Engine Oil	NA	Natural Aspirated (Engine)
DI	Direct Injection	NEDO	New Energy and Industrial Technology Development Organization
DOC	Diesel Oxidation Catalyst	NLT	New Long Term (Regulation)
DPF	Diesel Particulate Filter	NO <sub>x</sub>	Nitrogen Oxides
ECU	Electronic Control Unit	NST	New Short Term (Regulation)
EELQMS	European Engine Lubricant Quality Management System	NSR	NO <sub>x</sub> Storage Reduction (Catalyst)
EGR	Exhaust Gas Recirculation	OEM	Original Equipment Manufacturer
EOLCS	Engine Oil Licensing and Certification System	PAJ	Petroleum Association of Japan
EPA	Environmental Protection Agency	PCMO	Passenger Car Motor Oil
EU	European Union	PEC	Petroleum Energy Center
FC	Fuel Consumption	PM	Particulate Matter
F&L	Fuels & Lubricants	QM	Quality Management
FAME	Fatty Acid Methyl Ester	REO	Reference Engine Oil
HC	Hydrocarbon	RME	Rapeseed Methyl Ester
HD	Heavy Duty (Truck)	S-Ash	Sulfated Ash
HTHS	High Temperature High Shear	SAE	Society of Automotive Engineers
IDI	Indirect Injection	SCR	Selective Catalytic Reduction
JALOS	Japan Lubricating Oil Society	SOF	Soluble Organic Fraction
JAMA	Japan Automobile Manufacturers Association	TGF	Top Groove Filling
JASO	Japanese Automobile Standard Organization	TI	Turbo Intercooled (Engine)
JATOP	Japan Auto Oil Program	U.I.	Unit Injector
JBIA	Japan Boating Industry Association	U.P.	Unit Pump
JCAP	Japanese Clean Air Program	US	United States
JCMAS	Japan Construction Mechanization Association Standards	VG	Variable Geometry Turbo
JEOSIP	JASO Engine Oil Standards Implementation Panel	WWFC	World Wide Fuel Charter
JIS	Japanese Industrial Standards		

# JASO M355:2008

Items		Unit	Performance Criteria			Test Method
			DH-1-05	DH-2-08	DL-1-08	
Viscosity Grade			—	—	XW-30, XW-20	SAE J300
Piston Detergency	TGF(Top Groove Fill)	vol%	60.0 Max.	60.0 Max	60.0 Max	JASO M 336
	Piston Ring Stickings		All free	All free	All free	
	Deposits on Ring Lands	Merit Rating	Report	Report	Report	
Valve Train Wear Protection	Average Cam Diameter Loss (Normalized at 4.5 mass % Carbon Residue Increase)	$\mu$ m	95.0 Max.	95.0 Max	95.0 Max	JASO M 354
	Maximum Cam Diameter Loss (Normalized at 4.5 mass % Carbon Residue Increase)	$\mu$ m	210 Max.	210 Max	210 Max	
	Cam Surface Wear		No pitting	No pitting	No pitting	
Soot Dispersancy	Viscosity Increase (100~150H) @100°C	mm <sup>2</sup> /s/h	0.2 Max.	0.2 Max.	0.2 Max.	ASTM D 5967
High Temperature Oxidation Stability	Viscosity Increase@40°C or	%	200 Max.	200 Max.	—	ASTM D 5533
	Viscosity Increase@40°C(60H)	%	295 Max.	295 Max.	—	ASTM D 6984
	Viscosity Increase@40°C(80H)	%	—	—	275 Max.	ASTM D 6984



# JASO M355:2008

Items		Unit	Performance Criteria			Test Method	
			DH-1-05	DH-2-08	DL-1-08		
Fuel Economy	Fuel Economy Improvement	%	—	—	2.5 Min.	CEC-L-54-T-96	
Hot Surface Deposit Control	@280°C	Merit Rating	7.0 Min.	7.0 Min.	7.0 Min.	JPI-5S-55-99	
Anti-foaming	Sequence I	Foaming/ Stability	mL/mL	10/0 Max.	10/0 Max.	10/0 Max.	JIS-K-2518:2003
	Sequence II		mL/mL	50/0 Max.	50/0 Max.	50/0 Max.	
	Sequence III		mL/mL	10/0 Max.	10/0 Max.	10/0 Max.	
High Temperature Anti-foaming	Sequence IV		mL/mL	—	—	100/0 Max.	ASTM D 6082
Volatility	Evaporation Loss@250°C	mass %	18.0 Max.	18.0 Max.	15 Max	JPI-5S-41-2004	

# JASO M355:2008

Items		Unit	Performance Criteria			Test Method
			DH-1-05	DH-2-08	DL-1-08	
Anti-corrosion	Copper	mass ppm	20 Max.	20 Max.	20 Max.	ASTM D 6594
	Lead	mass ppm	120 Max.	100 Max.	120 Max.	
	Tin	mass ppm	50 Max.	50 Max.	50 Max.	
	Discoloration of Copper Coupon after Test @135°C		3 Max	3 Max	3 Max	ASTM D 130
Shear Stability (NOTE 4)	Kinetic Viscosity of Oil after Test@100°C	mm <sup>2</sup> /s	Stay-in-grade of virgin oil viscosity classification in SAE J300		XW-30: 8.6 Min. XW-20: Stay-in-grade of virgin oil viscosity classification in J300	ASTM D 6278
Sulfated Ash		mass %	—	1.0±0.1	0.6 Max.	JIS K 2272 1998 5.
Base Number		mgKOH/g	10.0 Min.	5.5 Min.	—	JIS K 2501 2003 8.
				—	—	ASTM D 4739
Phosphorus		mass %	—	0.12 Max.	0.10 Max	JPI-5S-38-2003
Sulfur		mass %	—	0.5 Max	0.5 Max	JIS K 2541 2003 5.
Chlorine		mass ppm	—	150 Max	150 Max	JPI-5S-64-2002



JASO M355

# JASO M355:2008

## Appendix 5

Items			Unit	Performance Criteria			Test Method
				DH-1-05	DH-2-08	DL-1-08	
Seal Compatibility	RE1 (Fluoro)	Hardness Change	Point	-1~+5	-1~+5	-1~+5	CEC-L-39-T-96
		Tensile Strength Rate of Change	%	-40~+10	-50~+10	-40~+10	
		Elongation Rate of Change	%	-50~+10	-60~+10	-50~+10	
		Volume Rate of Change	%	-1~+5	-1~+5	-1~+5	
	RE2-99 (Acrylic)	Hardness Change	Point	-5~+8	-5~+8	-5~+8	
		Tensile Strength Rate of Change	%	-15~+18	-15~+18	-15~+18	
		Elongation Rate of Change	%	-35~+10	-35~+10	-35~+10	
		Volume Rate of Change	%	-7~+5	-7~+5	-7~+5	
	RE3 (Silicon)	Hardness Change	Point	-25~+1	-25~+1	-25~+1	
		Tensile Strength Rate of Change	%	-45~+10	-45~+10	-45~+10	
		Elongation Rate of Change	%	-20~+10	-20~+10	-20~+10	
		Volume Rate of Change	%	-1~+30	-1~+30	-1~+30	
	RE4 (Nitrile)	Hardness Change	Point	-5~+5	-5~+5	-5~+5	
		Tensile Strength Rate of Change	%	-20~+10	-20~+10	-20~+10	
		Elongation Rate of Change	%	-50~+10	-50~+10	-50~+10	
		Volume Rate of Change	%	-5~+5	-5~+5	-5~+5	
	AEM (Ethylene Acrylic)	Hardness Change	Point	Per agreement between concerned parties			
		Tensile Strength Rate of Change	%				
		Elongation Rate of Change	%				
		Volume Rate of Change	%				

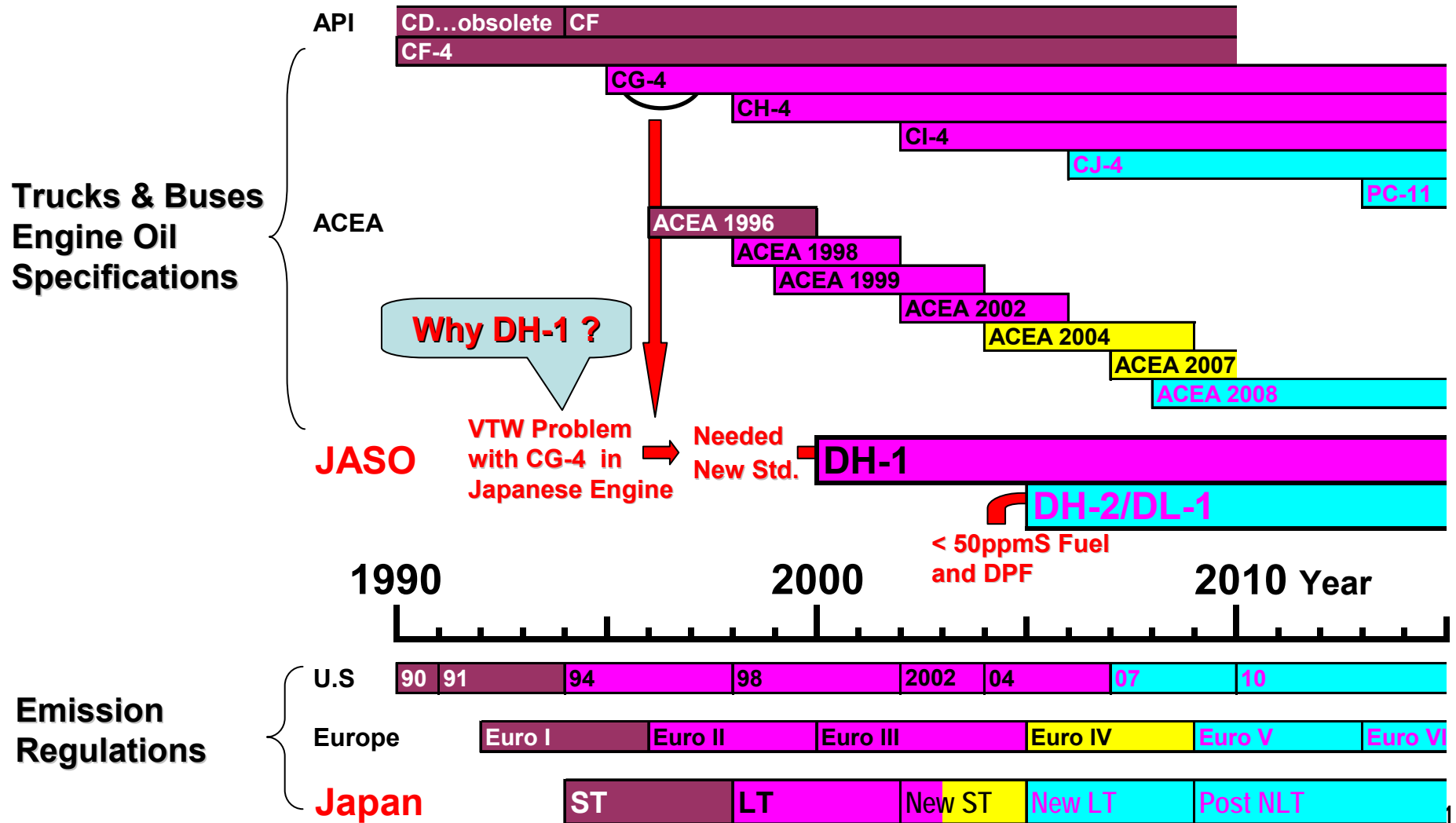


# Position of JASO Standards Global and Historical

Appendix 6

**Oil specifications are reflected in both emission regulations and fuel specifications.**

Color	Fuel Sulfur
Dark Purple	> 500 ppm
Magenta	< 500 ppm
Yellow	< 50 ppm
Cyan	< 15 ppm





# API, ACEA & JASO Diesel Oil Specifications for Trucks & Buses *- Engine Tests -*

Appendix 7

**JASO DH-1 has less numbers of Engine Tests than API / ACEA .**

	ACEA 2008				API							JASO			
	E4	E6	E7	E9	CD	CF	CF-4	CG-4	CH-4	CI-4 plus	CJ-4	DH-1	DH-2		
OM501LA	#	#	#	#										General performance	
OM602A / OM646LA	#	#	#	#											
Cat 1G2					#									Piston Cleanliness	
Cat 1K							#		#						
Cat 1M-PC						#									
Cat 1N								#		#	#				
Cat 1P									#						
Cat 1R										#					
Cat C-13											#				
Nissan Diesel TD25												#	#		
Cummins M11									#					Soot handling / wear	
Cummins ISM			#	#							#	#			VTWear, Filter P, Sludge
Cummins ISB											#			VTWear	
Mack T-12		#	#	#							#	#			Ring, Liner, Bearing Wear
MACK T-11				#							#	#			Soot handling / wear
MACK T-9							#		#						
MACK T-8A													# *	# *	
MACK T-8 / 8E	#	#	#				#	#	#	#					
Mitsubishi Fuso 4D34T4												#	#	Soot handling / wear	
Cummins NTC400							#							Oil cons / wear	
SEQ IIIE / IIIF / IIIG								#	#	#	#	#	#	Oxidation / wear	
CRC L-38 / SEQ VIII					#	#	#	#						Bearing corrosion	
RFWT								#	#	#	#			Wear	
EOAT Aeration Navistar								#	#	#	#			Dearation	

\* Either MACK T8A, T8E or T11



# API, ACEA & JASO Diesel Oil Specifications for Trucks & Buses *- Laboratory Tests -*

	ACEA 2008				API								JASO		
	E4	E6	E7	E9	CD	CE	CF	CF-4	CG-4	CH-4	CI-4 plus	CJ-4	DH-1	DH-2	
SAE J300	#	#	#	#	#	#	#	#	#	#	#	#	#	#	Viscosity grade
CEC L-36 / ASTM D4683	#	#	#	#	#	#	#	#	#	#	#	#	#	#	Viscosity(HTHS)
ASTM D892/D6082	#	#	#	#					#	#	#	#	#	#	Foaming
CEC L-39 / ASTM D471	#	#	#	#							#	#	#	#	Oil/elastomer compatibility
CEC L-14 / ASTM D6278	#	#	#	#								#			Shear stability
ASTM D3945										#	#				
CEC L-40 / ASTM D2887	#	#	#	#			#	#	#	#	#	#	#	#	(Noack) Volatility
ASTM D874	#	#	#	#										#	Sulfated ash
ASTM D5185		#												#	Phosphorus
ASTM D5185		#												#	Sulfur
ASTM D4739/D2896	#												#	#	Base number
JPI 5S-55													#	#	Hot surface deposit control
CEC L-85			#	#											Oxidation(PDSC)
ASTM D5968 / D6594			#					#	#	#	#	#	#	#	Corrosion(HTCBT/CBT)