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The Korean Approach to the Diesel Engine Emission Reduction



Korea Institute of Machinery & Materials

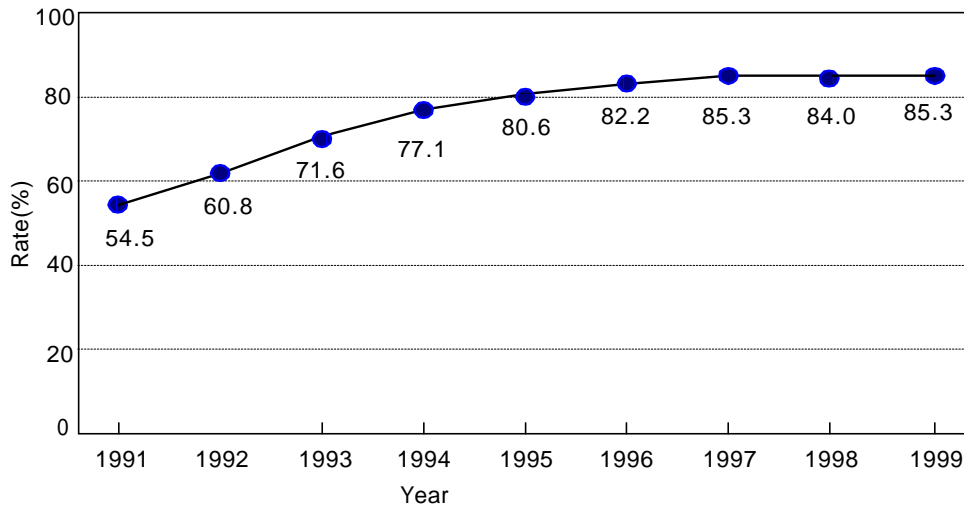
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Background

■ Automotive Exhaust Emissions in Seoul

- Vehicular pollution has been over 80% since 1995.
- Diesel vehicles have higher emissions than gasoline vehicles.
 - Smoke, PM(particulate matters), and NOx from diesel vehicles are the main source of Seoul smog and ozone alarm.
 - **Heavy duty diesel vehicles (bus, truck)** are the major target for emission reduction.



CATEGORY	NUMBER	EMISSIONS
Gasoline	70%	41.3%
Diesel (HDV)	30% (3.8%)	58.7% (42.9%)

Data in 1998

Background

Number of Diesel Vehicle (10K)

	Nation	Capital Region
HDV	25.5 (5.3%)	7 (4.5%)
MDV	49.4 (10.7%)	16 (10%)
LDV	387.1 (84%)	133 (85.5%)
Total	462 (31% of total 1,475)	156 (27% of total 582)

Amount of PM emission (ton/year)

	Nation	Capital Region
HDV	11,435 (48%)	
MDV	4,001 (17%)	
LDV	8,371 (35%)	
Total	23,807	

Exhaust Emission Standard

❖ Gasoline Passenger Car

- LEV of LEV-1 standard was applied in Jan. 2003.
- ULEV of LEV-2 standard (of CARB) will be applied from 2006.1 with a phase-in of 25/50/75/100%.

❖ Diesel HDV

- EURO-3 standard was applied in 2002.7/2003.7.
- **EURO-4** standard will be applied from 2006.10/2007.7.
- ESC/ETC test mode will be adopted.

❖ Diesel Passenger Car

- **EURO-3 will be applied from 2005.1**, but half of the cars will be induced to install DPF by an administrative guide.
- EURO-4 will start from 2006.

❖ Diesel LDT

- EURO-3 was applied in 2002.7/2003.7.
- EURO-4 will be applied from 2006.1/2007.1.

Promotion of Low Emission Vehicles

- ❖ **Diesel particulate filter traps (DPF)** were installed in 1,400 Seoul city garbage trucks in 1997. This is the first promotion program of low emission vehicles in Korea as a countermeasure for diesel powered vehicles.
- ❖ DPF program was halted by the requirement of congress to introduce a aftertreatment device that is able to reduce NOx emission simultaneously.
- ❖ **Compressed natural gas (CNG) city buses** were introduced in the year 2000 by replacing retired buses in the large cities. The target number of CNG buses is 20,000 by 2007 and 3,527 city buses are operating as of August 9.
- ❖ The Ministry of Environment (MOE) is developing **“Special Act for the Improvement of Capital Region Air Quality”**, of which the promotion of low emission vehicles is the major content. This act will be effective from 2004.
- ❖ A promotion program of low emission vehicles and devices (DPF, DOC, NGV, LPG vehicle, Bio-diesel, DME, HEV, EV, FCV) is under preparation.

DPF Promotion Program

- ❖ 3 step program is progressing for the 2nd stage DPF retrofit promotion
- ❖ 1st step : **“DPF evaluation program”** is being performed from Dec. of 2001.
 - Examine the level of DPF technology and evaluate the applicable potential to Korean vehicles.
 - 6 systems are under evaluation, which using Catalyst, Fuel additive, Electric heater, and Plasma technology.
- ❖ 2nd step : **“Demonstration program”** will start from beginning of 2004.
 - Evaluate the real operation condition of DPF and DOC by the fleet operation of several hundred vehicles **(500 DPFs and 1000 DOCs)**.
 - The demonstration DPF systems will be selected by the results of DPF evaluation program and certification test.
- ❖ 3rd step : **“Main retrofit program”** will start from 2005.
 - Several hundred thousand DPFs and DOCs are expected to be retrofitted during 4-5 years.
 - DPF systems for LDV & MDV retrofit are necessary.
- ❖ Management system after retrofitted is important consideration.

1st Stage DPF Program



**Electric heater type DPF
installed in LDT**

**Diesel Burner type DPF
installed in HDT**

Field Test in 2nd Stage DPF Evaluation Program



**Test vehicle &
Smoke measurement**

**Catalyst type DPF
& Sealing**



Field Test in DPF Evaluation Program



Smoke Measurement



Plasma Catalyst type DPF
& Data acquisition

Performance Test in Chassis Dynamometer



Test vehicle

FBC type DPF



Performance Test in Engine Dynamometer



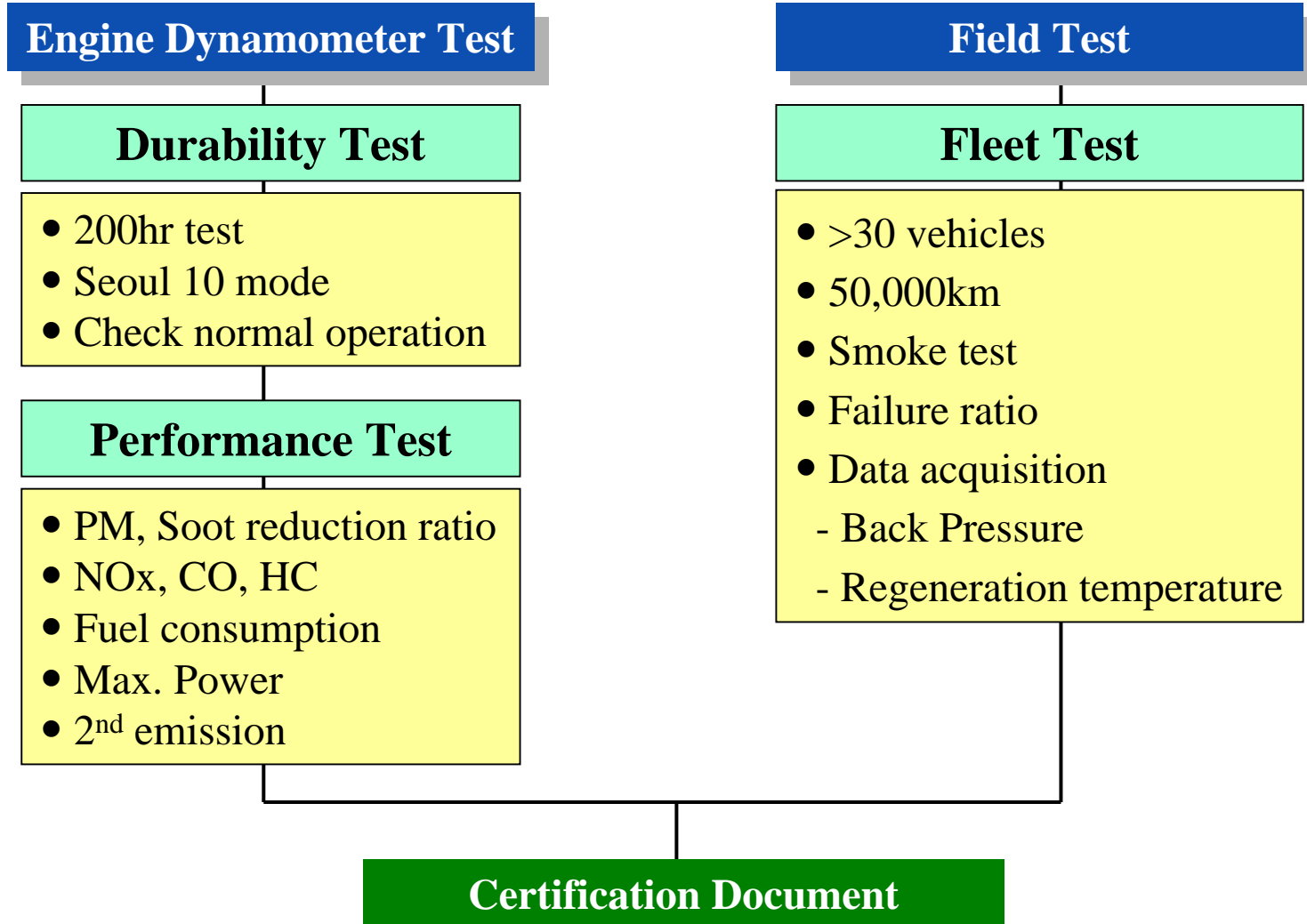
**Catalyst type DPF
installed in the test engine**

DPF Certification Process

- ❖ The certification process of DPF for the application to the city buses and trucks was regulated in 1996.
- ❖ Three companies passed this test and supplied their systems, electric heater, burner, and catalyst type, to the DPF promotion program of 1997.
- ❖ Certification Standard

<p>■ Performance</p>	<ul style="list-style-type: none"> ● PM reduction ● Smoke reduction ● Increase of CO, HC, NO_x ● 2nd & etc. emissions ● Increase of fuel consumption ● Decrease of max. power 	<p>> 70%</p> <p>> 80%</p> <p>< 10%</p> <p>< 10%</p> <p>< 5%</p> <p>< 5%</p>
<p>■ Durability Test</p>	<ul style="list-style-type: none"> ● 200hr engine durable test ● Warranty of DPF durability ● Smoke (Bosch) ● Failure ratio 	<p>normal operation</p> <p>> 80,000 km</p> <p>< 8%</p> <p>< 10%</p>

DPF Certification Test Process



Revision of Certification Process

- ❖ Revision of certification process is under progress for the 2nd stage DPF promotion program scheduled from year 2004.
- ❖ Important subjects for revision
 - Improvement of performance
 - Reduction ratio of PM & Smoke
 - Category of PM reduction ratio
 - DOC and low efficiency DPF(>50% PM reduction) as a retrofit measure to LDV and old model vehicles
 - Durability
 - Warranty of durability
 - Durability period of engine and field test
 - Number of fleet test vehicle
 - Failure ratio
 - Nanoparticle standard

Promotion of NGV

- ❖ CNG powered engines for the city buses and garbage trucks were developed by the Hyundai motor co. and Daewoo heavy industrial Co.
- ❖ Liquefied natural gas (LNG) vehicles are being developed for application to long distance driving trucks.
- ❖ Bi-fuel and dual fuel systems are being developed for the retrofit of LDV.



Special Act on Metropolitan Air Quality

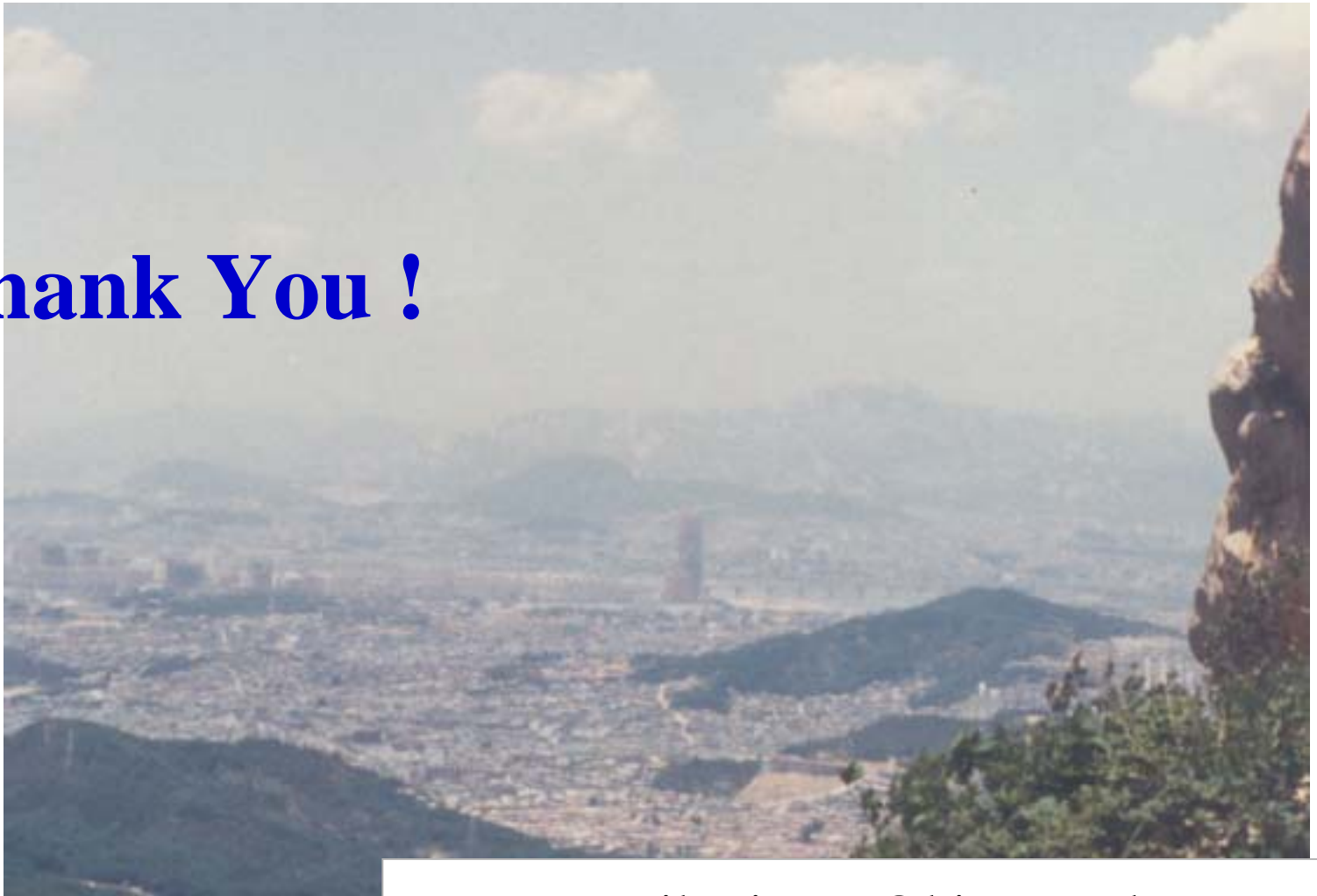
- ❖ Outline of “special act for the improvement of Capital region air quality”
 - 10 years plan from 2003 to 2012.
 - 50-70% reduction of PM and NOx aiming the average level of OECD country
 - Expected budget : US\$5-6B/10years

- ❖ Core Contents
 - Enforcement of the total maximum loading system of pollutants

 - Enforcement of Energy and Fuel Policies
 - Rearrangement of fuel price of gasoline, diesel and LPG
 - Current price ratio of gasoline:diesel:LPG is 100:61:43.

 - Promotion of Low-emission Vehicles, alternative fuels and aftertreatment.
 - DPF, DOC, NGV, LPG vehicle, Bio-diesel, DME, HEV, EV, FCV
 - **1.6M diesel vehicle** among the total 5.8M vehicles in metropolitan area is the main target of aftertreatment retrofit.

Thank You !



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