China – EU Cooperation Project

International Symposium
December 8-0, 2002
Beijing, PRC

Five Sub-Projects
- New Vehicles & Fuel Quality
- I/M Lab QC
- National Database
- Economic Instruments

Where It All Began!

Integrated Air Quality Management Framework

Issues
- Technical
- Economic
- Institutional
- Legal
- Social
- Stakeholder Involvement

Options
- Fuels & Vehicle Technology
- Traffic Management
- Standards
- Economic Incentives and Disincentives
- Dose-Response
- Exposure Assessment
- Damage Assessment
- Emission Management
- Establish objectives, identify data gaps, studies and pilots
- Identify, analyze and select management options
- Develop strategies & implement action plan
- Institute monitoring and enforcement
Motor Vehicle Production in China

2002: First Three Quarters
Domestic Made Vehicles Up 34%
Passenger Cars Up 46%
Will Go Over 3 Million This Year

China Has A Growing Love Affair With The Car!

Motorcycle Annual Production and Sales

22 Million and Growing Rapidly
The Vehicle Population Is Expected To Grow Rapidly

A Median Estimate is 120 million Vehicles & 200 Million Motorcycles by 2030 – Tsinghua University

Air Pollution Problem is Already Severe

China: Urban NOx Problems

<table>
<thead>
<tr>
<th>Year</th>
<th>No. Of cities</th>
<th>Non-attainment cities number (%)</th>
<th>Non-attainment for Class II standard number (%)</th>
<th>Non-attainment for Class III standard number (%)</th>
<th>Non-attainment cities for Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>88</td>
<td>32</td>
<td>3</td>
<td>3.4</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>88</td>
<td>27</td>
<td>25</td>
<td>28.4</td>
<td>2.3</td>
</tr>
<tr>
<td>1997</td>
<td>94</td>
<td>32</td>
<td>29</td>
<td>30.9</td>
<td>3.2</td>
</tr>
<tr>
<td>1998</td>
<td>96</td>
<td>32</td>
<td>29</td>
<td>30.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Beijing, Guangzhou, Shanghai
**BEIJING: O3 Concentration in 1997-1999**

**Ozone concentration in Beijing**

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of non-attainment days</th>
<th>Number of non-attainment hours</th>
<th>Max. Hourly concentration (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>71</td>
<td>434</td>
<td>346</td>
</tr>
<tr>
<td>1998</td>
<td>101</td>
<td>504</td>
<td>384</td>
</tr>
<tr>
<td>1999</td>
<td>119</td>
<td>777</td>
<td></td>
</tr>
</tbody>
</table>

**Beijing: PM$_{2.5}$ Mass Concentration Levels 1999-2000**

**Motor Vehicle Pollution in Urban Areas**

- Motor vehicles contribute nearly 50% of NOx emissions in metropolitan cities.
- About 1/3 of Major Cities Exceed ambient NOx NAAQS;
- CO concentration generally higher than national standard in traffic areas;
- Photochemical pollution emerging in big cities;
- PM Levels Tend To Peak in Evening when truck traffic is allowed;
- Vehicles becoming a main source of air pollution in urban areas.

**Air Pollution Causes Adverse Health Effects**
Health Impacts of Air Pollution

- Premature Deaths
- Cancer
- Developmental Effects
- Hospitalization
- Asthma Attacks and Bronchitis

Global Warming

- Fastest carbon growth globally
- 2nd largest after U.S. in Energy:
  - Production
  - Consumption
  - CO₂ emissions

Carbon Dioxide Emissions From the Road Transport Sector

Fuel Consumption Trends in China
Oil Imports Have Been Rising Rapidly Since 1993

Current and Projected Road Transport Oil Demand in China

Control Measures on Motor Vehicle Pollution

Emission Standards For New Vehicles

Beijing Will Introduce Euro 2 in 2003
Motor Vehicle Emissions Trends in China

With Current Program

Overview of Fuel Quality

Specifications for Gasoline

<table>
<thead>
<tr>
<th>ITEM</th>
<th>LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead (g/L, max.)</td>
<td>0.35 (0.48)</td>
</tr>
<tr>
<td>Sulphur (% Mass, max.)</td>
<td>0.18</td>
</tr>
<tr>
<td>Manganese (g/L, max.)</td>
<td>0.015</td>
</tr>
<tr>
<td>Phosphorus (g/L, max.)</td>
<td>0.0013</td>
</tr>
<tr>
<td>RON, Min.</td>
<td>90</td>
</tr>
<tr>
<td>RON+MON, Min.</td>
<td>85, 89, 85</td>
</tr>
<tr>
<td>Aromatics HC (vol. %, max.)</td>
<td>40</td>
</tr>
<tr>
<td>Octane (vol. %, max)</td>
<td>85</td>
</tr>
<tr>
<td>Aromatics (vol. %, max)</td>
<td>40</td>
</tr>
<tr>
<td>Condensation pressure</td>
<td>2.5</td>
</tr>
<tr>
<td>Vapour pressure</td>
<td>88</td>
</tr>
<tr>
<td>Oxygen (wt. %, max)</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Note 1) Implemented from Jan. 1, 2000

Overview of Fuel Quality

Specifications for Light Diesel in China

<table>
<thead>
<tr>
<th>ITEM</th>
<th>LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code of Standard</td>
<td>GB 252-94</td>
</tr>
<tr>
<td>Cetane Number, min</td>
<td>45 (40)</td>
</tr>
<tr>
<td>Flash point, °C, max</td>
<td>65 (45)</td>
</tr>
<tr>
<td>Ash, % wt, max</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td>Acidity, mg KOH/100ml, max</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Oxidation stability, mg/100ml, max</td>
<td>2</td>
</tr>
<tr>
<td>Dynamic viscosity at 20°C, kg/m.s</td>
<td>2.5</td>
</tr>
<tr>
<td>Ref.</td>
<td>1) Limits in ( ) are for basic qualified diesel; 2) GB 252-2000 went into effect on Jan. 1, 2002.</td>
</tr>
</tbody>
</table>

Fuel Quality is Critical

- Very Low Sulfur Levels
- Enhances All Catalyst Technology Performance
- Necessary To Use Advanced Technologies
- Other Benefits
- Other Fuel Properties Also Important
  - Detergents
  - MMT
  - Etc.
Diesel Fuel Specifications Around The World

Vehicle Inspection and Maintenance (I/M) Program

- **Purpose:**
  - To Assure that vehicle is properly maintained and used
  - Identify Dirtiest Vehicles With Defects & Get Them Repaired

- **General Attributes:**
  - Relatively short
  - Relatively simple
  - **Types**
    - Idle
    - 2-Stage Idle
    - Steady Speed Loaded
    - Transient Loaded

Gasoline and Diesel Reformulation Costs in China

Source: Dr. Yamaguchi

V-Mass

- **Test Procedure**
  - Uses IM240 test procedure or other transient cycle

- **Measurement**
  - Uses ASM-type equipment
  - Plus mass flow measurement device
  - Yields same measures as IM240

- **Pros/Cons**
  - Costs about the same as ASM
  - Good correlation with IM240
  - Appears to be nearly as effective as IM240
### Test Type: Mass 31 or IM240

**Analysts**
- VMAS
- NDIR - HC
- NDIR - CO
- NDIR - CO2
- Electro Chemical

**Fuel:** As received

**Vehicle:** As received

**Test Type:** European Short Cycle

**Modem Short Driving Cycle**

**TUV Short Driving Cycle**

### Test Type: European Short Cycle

**Analysts**
- VMAS
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**Modal Short Driving Cycle**

**TUV Short Driving Cycle**

### V\textsc{Mas}\textsuperscript{TM} Study Results: NOx

**Correlation:** \( R^2 = 0.992 \)

### V\textsc{Mas}\textsuperscript{TM} Study Results: CO

**Correlation:** \( R^2 = 0.995 \)
What To Do About Diesels?

Laboratory QC
- Critically Important
  - Enforcement
  - Emissions Factors
- Much More Needs To Be Done
  - Golden Standard Gases
  - Training
  - Standardized Equipment
  - Etc.

Economic Instruments
- Increasingly Important As Market Based System Introduced
- Study – Very Comprehensive
- Short Term Opportunities
  - Fuel Quality
  - Encourage Tighter Standards (if Fuel is Available)
  - Other...