Planning and Implementation of Air Pollution Control Strategies for Major Ports in Taiwan

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Contents

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1. Introduction

- According to the "Review and Future Work Plan Meeting of the Environmental Technology Cooperation Agreements between Taiwan and the U.S. – Port Air Quality Partnership" on Nov. 21 2008, the cooperating items include:
  - Development of the air pollutant emissions inventory of ports
  - Development of domestic regulations in compliance with the amendment of Annex 6 of the MARPOL

1. Introduction

- To achieve the commitment of Taiwan-US cooperation, EPA conducted series of actions to improve air quality of port areas, and cooperated with partners to reach the sustainable development of ports in Taiwan.

2. Ports Air Pollution Evaluation

- EPA implemented “Port Evaluation Program” in 2009 to evaluate the improvement of fugitive sources and heavy-trucks exhausts, the pollution most concerned by the public. Focus as follows :
  - Stationary sources:
    - Compliance of PM on the perimeter of port area
  - Mobile sources:
    - The effectiveness of promoting self-management of diesel vehicles
    - Compliance of diesel-vehicle exhaust and fuel sulfur content
  - Effectiveness of promoting environmental protection:
    - Commitment in EIA
    - Others(Shore power, fuel sulfur content, vessels exhaust gas etc.)

2. Ports Air Pollution Evaluation

- Passed pollutant situation of port

uncovered materials storage

handling without dust control measures

vehicles traveling on unpaved roads

2. Ports Air Pollution Evaluation

- Air pollution are improved significantly at seven major ports in Taiwan as well as the enhancement of the public perceptions after implementations suggested by the specialists.
  - Good practices to improve Stationary sources

Piling Operation

Piling area are surrounded by dust gauze

Bare Area

Vegetating and Set up park or bike trail

Piling Operation

Closed storage

2. Ports Air Pollution Evaluation

- Good practices to improve mobile sources

Vehicle Washing

New automatic equipment of vehicle washing

Road

Dedicated route for heavy vehicle

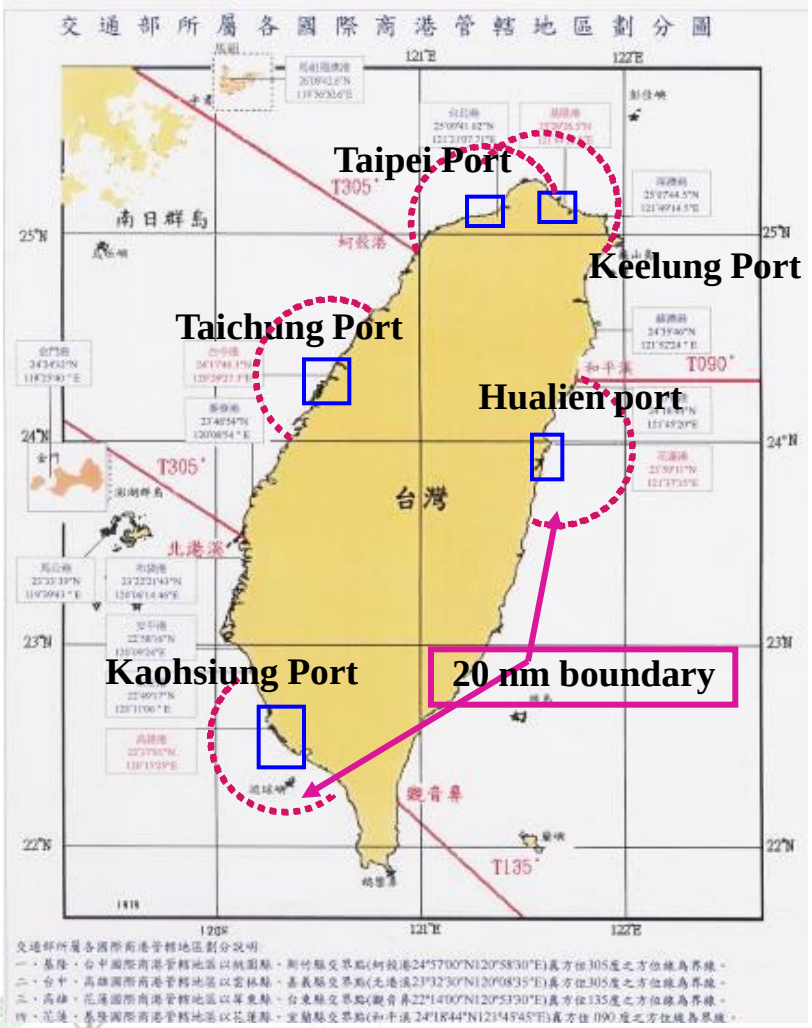
Road

Route connecting inside and outside port area

Vehicle dust-proof

15-cm pull-down of dust gauze

3. Ports Emissions Inventory



- **Baseline:**2010
- **Ports:** Keelung, Taipei , Taichung, Kaohsiung and Hualien harbors**.**
- **Pollutants:**
  NO_X,VOC,CO,SO_2,PM_{10},$PM_{2.5}$,DPM and GHG.
- **Sources :**
  - Ocean-Going Vessels(OGV)
  - Harbor Crafts(HC)
  - Rail Locomotives(RL)
  - Cargo Handling Equipment(CHE)
  - Heavy-Duty Vehicles(HDV)

3. Ports Emissions Inventory

Emission Estimate Methods

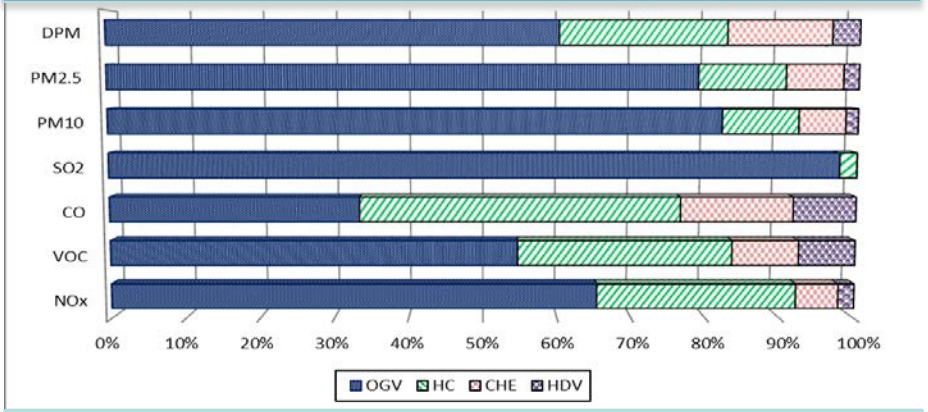
Sources	Geographical extent	Methods
Ocean-going Vessels	Port area and maritime area within 20 nm	Ship calls collected from each harbor bureau and ship data are consulted on Lloyd's ship register data. Emissions are then estimated as a function of vessel power demand multiplied by an emission factor.
Harbor Crafts	Port area and nearby maritime area	Harbor vessel data are collected from each harbor bureau. Annual hours of use in 2010 within each port area were used to calculated harbor vessel emissions.
Cargo Handling Equipment	Port area only	Cargo Handling Equipment data are collected from each harbor bureau and terminal operators. Emissions are estimated using the NONROAD model with modification for local parameters.
Rail Locomotives	Port area only	Locomotive operational data are collected from the railway administration. Emissions are estimated with power demand multiplied by an emission factor.
Heavy-Duty Vehicles	Port area only	Vehicles and journey data are collected from each harbor bureau and terminal operators. Emission factors are estimated using the Mobile-Taiwan model.

Estimate methods and emission factors are mostly adapted from report of Puget Sound maritime air emissions inventory, 2007.

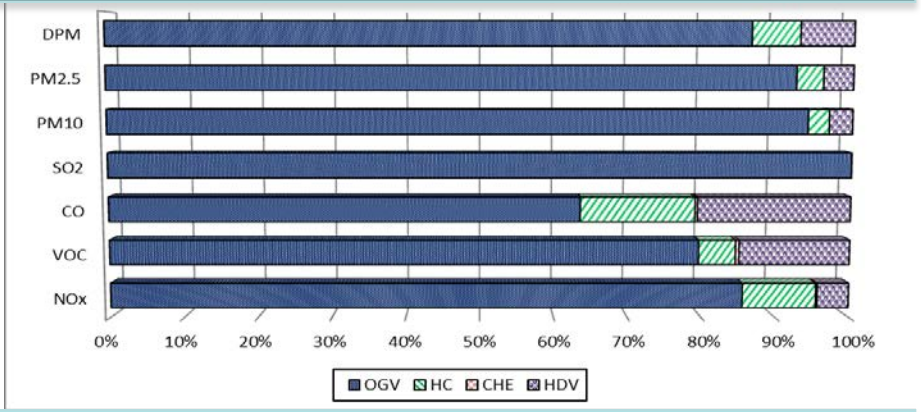
3. Ports Emissions Inventory

- **Emission estimates results in the 5 harbors of Taiwan for year 2010(not including within 20 nm area)**

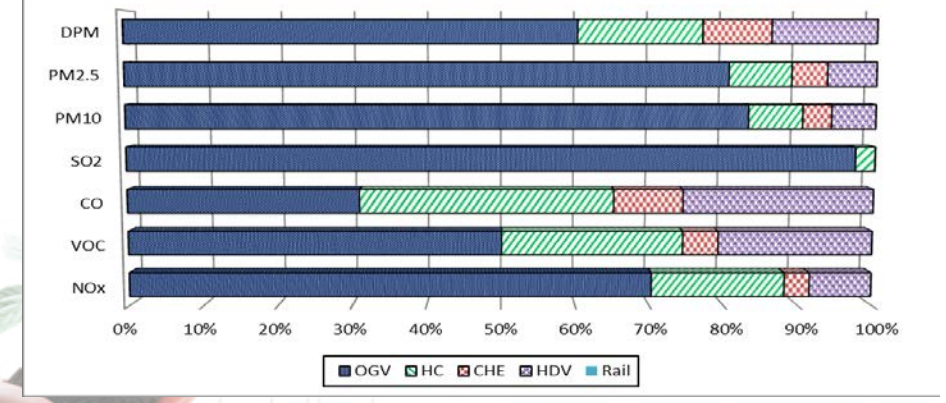
Keelung Harbor



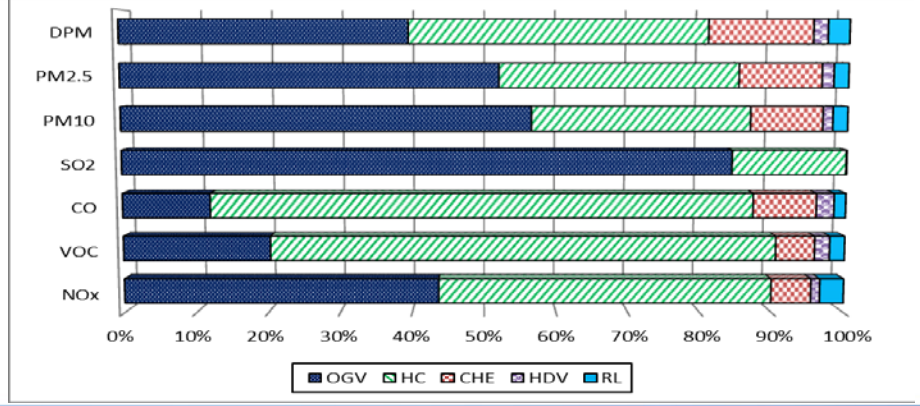
Taipei Harbor



Taichung Harbor

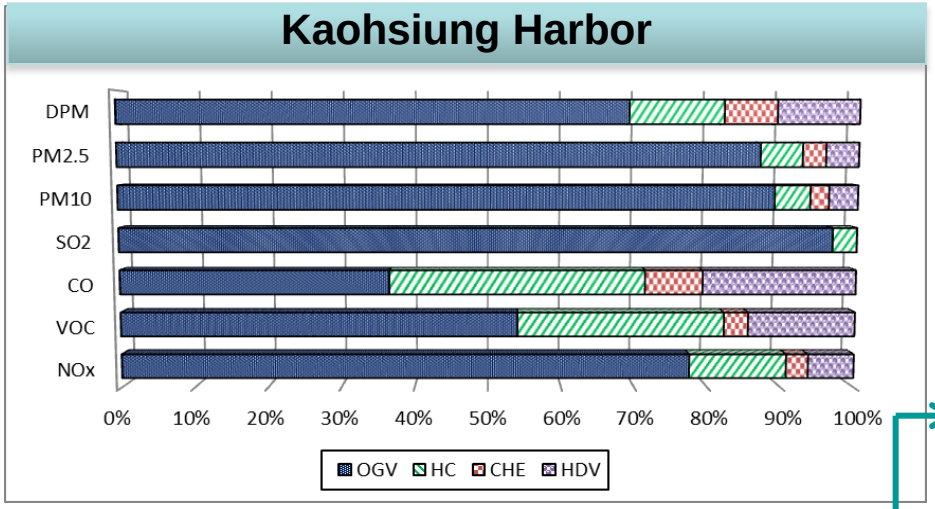


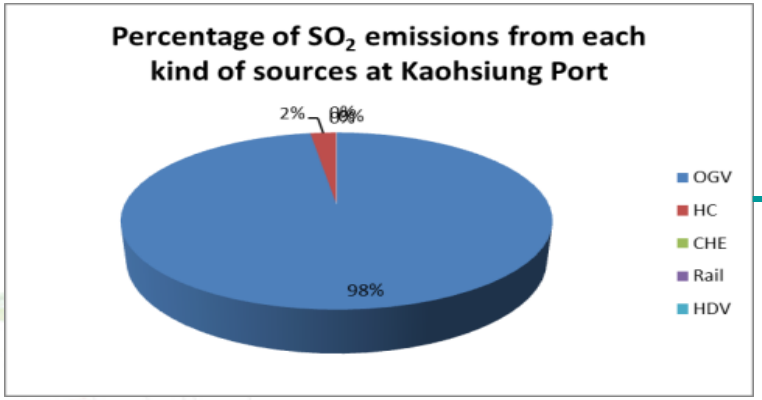
Hualien Harbor



3. Ports Emissions Inventory

- **Emission estimates results in the 5 harbors of Taiwan for year 2010**





- Figures suggest that vessels (OGV,HC)have the largest emission in every port of Taiwan, and almost occupied 90% of total emissions of all pollutants.
- Among all pollutants, as HDV and CHE are using low-sulfur diesel fuel (S< 50 ppm), vessels SO_2 occupied major emissions. For example, OGV SO_2 occupied 98% of port emissions.
- Among these ports, Kaohsiung Harbor has the largest emission. Emissions of NOx, VOCs, CO, SO_2, PM_{10}, $PM_{2.5}$ and DPM from Ocean Going Vessel in Kaohsiung Harbor port district are 9780, 429, 903, 11309, 828, 644 and 469 tons/year.

4. Clean Air Action Plan

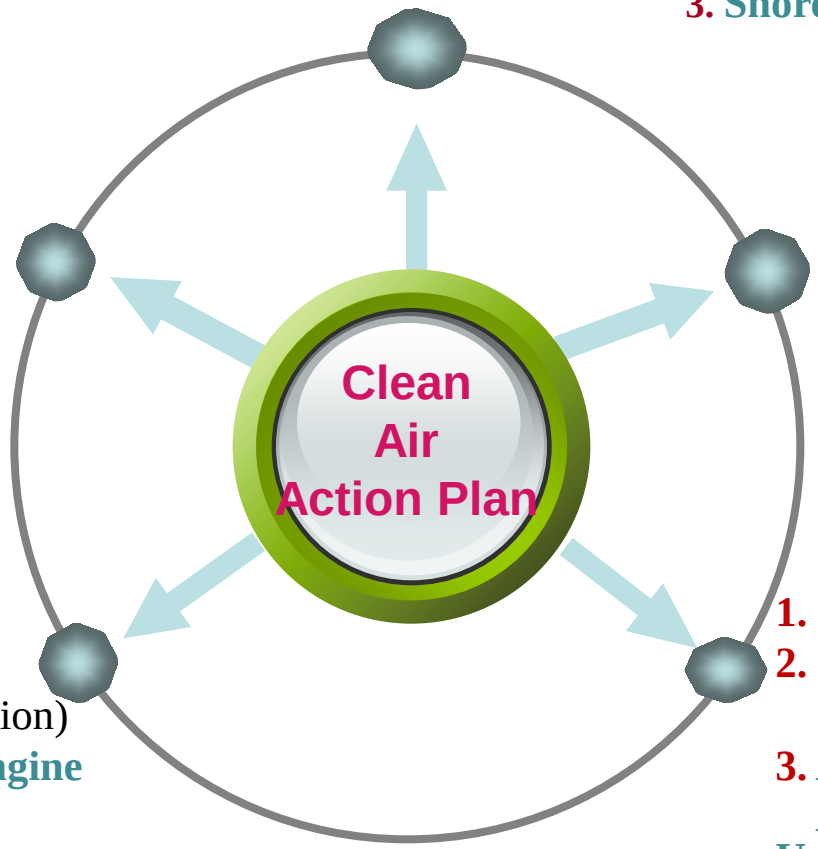
Clean Air Action Plan-Structure

Ocean Going Vessels

1. **Speed Reduction** (Incentives Mechanism)
2. **Low Sulfur Fuel** (MARPOL)
3. **Shore Power** (commitment of EIA)

Harbor Crafts

1. **Low Sulfur Fuel** (Lease Negotiation)
2. **Shore Power** (Administrative requirements)



Trucks

1. **Promotion of Anti-idling**(Regulations)
2. **Automatic Recognition for Regulations Exhaust Gas Control and Regulations** (Administrative requirements)
3. **Self-Management** (Incentives Mechanism)

Cargo Handling Equipment

1. **Low Sulfur Fuel** (Regulation)
2. **Electric Engine/Clean Engine** (Lease Negotiation)

Fugitive Sources

1. **Dust Proof Net for Vehicles** (Regulations)
2. **System for Material Loading and Unloading** (Regulations)
3. **Audit for Material Loading Unloading Area Encourage Closed Type Loading, Unloading and Warehousing System** (Lease Negotiation)

4. Clean Air Action Plan

Clean Air Action Plan –Performance

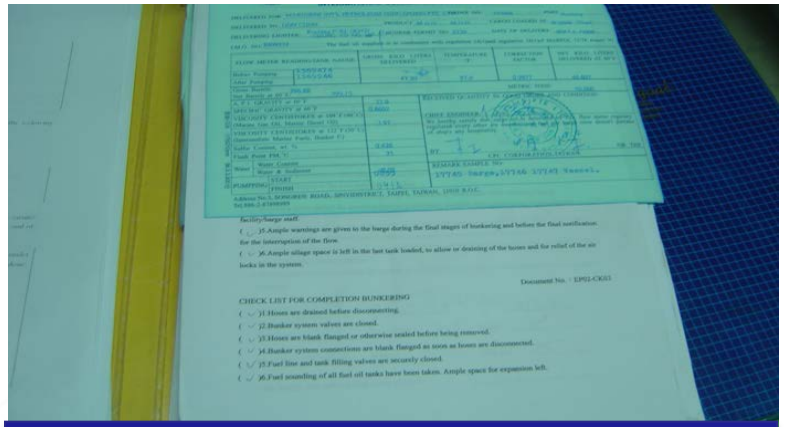
Ocean Going Vessels- Speed Reduction Program(2010)

Port	in 20 Nautical Mile			
	Fastest Type of Ship	Average Speed	under 12 knots	Status
Keelung Harbor	1. Refrigerator Ships(17.2knot) 2. Passenger Ships& Semi-Container Ships (16.5knot) 3. Hall Container Ships &Container Ships (15.7knot)	14.9 knots	17.2 %	Harbor bureau has sent an official document regarding reducing Speed to all shipping carriers. (2011.1.25)
Taipei Harbor	1. Container Ships(17.7knot) 2. Hall Container Ships (16.8knot) 3. Car container ships(16.5knot)	14.6 knots	27.8%	
Taichung Harbor	1. Container Ships(17.5knot) 2. Ro-Ro Ships(15.9knot) 3. Semi-Container Ships (15.6knot)	14.6 knots	19.6%	Harbor bureau has sent an official document regarding reducing Speed to all shipping carriers. (2011.6.3)
Kaohsiung Harbor	1. Passenger Cargo Ships(18.2knot) 2. Container Ships (17.2knot) 3. Hall Container Ships (17.2knot)	14.8 knots	20.8%	Harbor bureau has sent an official document regarding reducing Speed to all shipping carriers. (2011.4.22)
Hualien Harbor	1. Bilk Carriers(12.4knot) 2. Cement Carriers (12.2knot) 3. Chip Carriers(11.8knot)	11.7 knots	61.8%	-

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Ocean Going Vessels- Low Sulfur Fuel

1. Sulfur content of fuel is requested to below 1.5% while sailing within 5 nautical miles from shore in Taipei Harbor, Taichung Harbor, and Kaohsiung Harbor.
2. 10 cargos were spot-checked in 2008. Sulfur contents of diesel fuel were all below 0.5%, and that of heavy oil are below 2.8%.



Spot-check of cargo fuel

Spot-check of cargo fuel

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Ocean Going Vessels - Shore Power Implement Status (2012)

Kao Ming Container Terminal Shore Power

Port	Terminal	Status
Keelung Harbor	At Cruise Terminal	planning
Taipei Harbor	At Container Terminal	planning
Taichung Harbor	At Cruise Terminal(19A or18A)	planning
Kaohsiung Harbor	**At Containter Terminal**	**KM Terminal has finished (2012)**
Hualien Harbor	At Cement Terminal(10)、Mineral Stone Terminal(11)	planning

4. Clean Air Action Plan

Clean Air Action Plan –Performance

Harbor Crafts- Shore Power & Low Sulfur Fuel

1. Shore power system are equipped in Keelung Harbor, Taichung Harbor, Kaohsiung Harbor, and Hualien Harbor except Taipei Harbor and some new harbors.
2. Fuel sulfur content of harbor service vessels is reduced gradually since 2009. 50 ppmw fuel is 100% used in Taipei Harbor.

Port	Engine Average Year	2010 Sulfur(%)		
		3.5 %>S< 1.0 %	1.0 %> S > 50 ppmw	S ≦ 50 ppmw
Keelung Harbor	1996	0 %	53 %	47 %
Taipei Harbor	1994	0 %	0 %	100 %
Taichung Harbor	2001	0 %	100 %	0 %
Kaohsiung Harbor	1999	100 %	0 %	0 %
Hualien Harbor	1991	80 %	0 %	20 %

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Cargo Handling Equipment
    - Low Sulfur Fuel &Electric Engine/Clean Engine

1. 10-ppmw fuel is used in cargo handling equipment.

   (same as road vehicle)

2. Gantry cranes have been switched to shore-power system in container terminal of Taipei Harbor and Keelung Harbor. 5000-liter of diesel is reduced every month, as well as at least 13,900kg of greenhouse gases (including CO_2、CH_4 and N_2O).

Container terminal
Gantry crane switch to shore-power system

4. Clean Air Action Plan

Clean Air Action Plan –Performance

Trucks - Promotion of Anti-idling and automatic doors sentinel system

1. Regulation of idling vehicle was issued in 2012. Engine must be shutdown if idling is longer than 3 minutes.
2. Rest area for truck driver was first established in Anping Harbor. Truck driver can shutdown the engine and rest while waiting for the cargo handling.
3. RFID system has been applied to reduce the passing time from 15 minutes to 15 seconds.

Slogan of Idling stop

Automatic door sentinel system

RFID system

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Trucks - Automatic Recognition System(Regulations Exhaust Gas Control and Regulations)

Automatic Recognition System was established in the main entrances and exits of the 5 largest commercial harbors. Two cameras are equipped and operated 24 hours. One for dust-proof and one for exhaust.

Automatic Recognition System

Position of cameras

15-cm pull-down of dust gauze

4. Clean Air Action Plan

Clean Air Action Plan –Performance

Trucks - Self-Management

EPBs promote self-management of heavy vehicle, and require the owner to sign the deed. The main points are:

(1)Use required fuel

(2)Idling no more than 3 min.

(3)Regular exhaust check.

(4)Vehicle maintenance plan.

Road-side check will be waived for drivers with self-management permit.

Ultra-low pollution certificate

Low pollution certificate

General inspection certificate

4. Clean Air Action Plan

Clean Air Action Plan –Performance

Trucks – Fuel testing(S>10 ppmw)

EPBs regular fuel testing of heavy vehicle on road-side check.

County	Fuel test (2011)		
	Total samples	Failure samples	Failure % (S>10 ppmw)
Keelung City	147	3	0.025 %
New Taipei City	172	2	1.2 %
Taichung City	54	0	0 %
Kaohsiung City	703	12	0.003 %

Fuel testing

Fuel testing

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Fugitive Sources- **System for Material Loading and Unloading**

Closed delivery system

Closed loading and unloading system

Closed delivery system

Closed loading and unloading system

4. Clean Air Action Plan

- **Clean Air Action Plan –Performance**
  - Fugitive Sources- **Closed Warehousing System (Taipei Harbor)**

Closed storage of sand and coal

Closed storage of sand and coal

Closed storage of sand and coal

5. Self-Management of Harbor Authorities

- **Practices of port authorities to achieve green port (Taipei Harbor)**

Sewage System

Air Quality Monitoring

Multi-powered Street Light

Trash Rack

Reusing Dredging Sediment

5. Self-Management of Harbor Authorities

- **Practices of port authorities to achieve green port (Taipei Harbor)**

Slope Design

Oil spill

Rainwater Recycle

Real-time Air Quality Monitoring System

測站一號		
PM-10	54.0	μg/m^3
PM-10 [10:00]平均值：53.0 ug/m^3		
法規標準值：125 ug/m^3		
PM-2.5	9.0	μg/m^3
PM-2.5 [10:00]平均值：16.0 ug/m^3		
法規標準值：35 ug/m^3		
室內溫度： 26.4 度 C		

測站二號		
PM-10	25.0	μg/m^3
PM-10 [10:00]平均值：31.0 ug/m^3		
法規標準值：125 ug/m^3		
PM-2.5	985.0	μg/m^3
PM-2.5 [10:00]平均值：985.0 ug/m^3		
法規標準值：35 ug/m^3		
室內溫度： 23.5 度 C		

測站三號		
PM-10	36.0	μg/m^3
PM-10 [10:00]平均值：29.0 ug/m^3		
法規標準值：125 ug/m^3		
PM-2.5	9.0	μg/m^3
PM-2.5 [10:00]平均值：12.0 ug/m^3		
法規標準值：35 ug/m^3		

測站四號		
PM-10	167.0	μg/m^3
PM-10 [10:00]平均值：41.0 ug/m^3		
法規標準值：125 ug/m^3		
PM-2.5	14.0	μg/m^3
PM-2.5 [10:00]平均值：21.0 ug/m^3		
法規標準值：35 ug/m^3		

5. Self-Management of Harbor Authorities

- **The channel for the public to communicate with EPBs(harbor authorities) environmental quality**
- The public can directly appeal with the EPBs, the EPBs will send the inspector to the scene and check pollution matters, and require for an instant improvement.
- Furthermore, harbor authorities are always available to accept the publics' telephone, letters of complaints and any reports of pollution, and to instantly deal with the environmental issues.

Kaohsiung Harbor Love Pier

5. Self-Management of Harbor Authorities

- **The interactive activities between harbor and the public**
- Planning for the Harbor Line Bike Path, Open sightseeing pier and etc., provide a leisure and recreation place where people can go and enjoy the holidays.
- Open Sightseeing Pier, Naval Vessels, Kaohsiung Museum of Port History and etc.
- To hold a large-scale activities during the harbor celebration.

Keelung Harbor Anniversary

Kaohsiung Museum of Port History

Naval Vessels

6. Future Control Strategies

- **Stationary Pollution Sources:**
- Implement the “Stationary fugitive particles pollution prevention facilities management regulations”
- Execute auditing and reporting, random inspections of fuel quality, provide guidelines and promotion videos for public reference.
- Oversight of EPBs, and enhance auditing and monitoring of air quality at ports.
- Business operators should investigations locate their pollution sources and provide budgets for improvements.

6. Future Control Strategies

- **Mobile sources：**

- Continuously perform fuel quality and exhaust emissions irregularly scheduled inspections.
- Planning on requiring ocean-going vessels to reduction speed slower than 12 knots while within 20 nm.
- Planning on requiring shore power for berth vessels to utilize a certain ratio of shore electricity power.
- Planning on requiring diesel generators and diesel loading machinery for anchored vessels, to utilize a certain ratio of Ultra Low Sulfur Diesel or Bio-Diesel Fuel.

7. Conclusions

- The Taiwan EPA will continuously collaborate with EPBs and harbor authorities to implement relevant control measures.
- Besides the regulatory control measures, the EPA also encourages operators to voluntarily develop action plans to maintain port air quality.
- Keep a good communication channel with the public, making them to cooperate with the port to improve the environmental quality of it.

Thank You